Bows and Arrows

A Wikipedia Compilation
by
Michael A. Linton

Contents

Chapter 1

Bow and arrow

The **bow and arrow** is a projectile weapon system (a bow with arrows) that predates recorded history and is common to most cultures. Archery is the art, practice, or skill of applying it.

1.1 Description

A bow is a flexible arc which shoots aerodynamic projectiles called arrows. A string joins the two ends of the bow and when the string is drawn back, the ends of the bow are flexed. When the string is released, the potential energy of the flexed stick is transformed into the velocity of the arrow.*[1] Archery is the art or sport of shooting arrow from bows.*[2]

Today, bows and arrows are used primarily for hunting and for the sport of archery. Though they are still occasionally used as weapons of war, the development of gunpowder and muskets, and the growing size of armies, led to their replacement in warfare several centuries ago in much of the world.

Someone who makes bows is known as a bowyer,*[3] and one who makes arrows is a fletcher*[4] —or in the case of the manufacture of metal arrow heads, an arrow smith.*[5]

1.2 History

Main article: History of archery

The bow and arrow appears around the transition from the Upper Paleolithic to the Mesolithic. After the end of the last glacial period, use of the bow seems to have spread to every continent, including the New World, except for Australia.*[6]

The oldest extant bows in one piece are the elm Holmegaard bows from Denmark which were dated to 9,000 BCE. High performance wooden bows are currently made following the Holmegaard design. The Stellmoor bow fragments from northern Germany were dated to about 8,000 BCE, but they were destroyed in Hamburg during the Second World War, before carbon 14 dating was available; their age is attributed by archaeological association.*[7]

The bow was an important weapon for both hunting and warfare from prehistoric times until the widespread use of gunpowder in the 16th century. Organised warfare with bows ended in the mid 17th century in Europe, but it persisted into the early 19th century in Eastern cultures and in tribal warfare in the New World. It has recently been used as a weapon of tribal warfare in some parts of Sub-Saharan Africa; an example was documented in 2009 in Kenya when Kisii people and Kalenjin people clashed resulting in four deaths.*[8]*[9]

The British upper class led a revival of archery from the late 18th century.*[10] Sir Ashton Lever, an antiquarian and collector, formed the Toxophilite Society in London in 1781, with the patronage of George, the Prince of Wales.

1.3 Construction

1.3.1 Parts of the bow

The basic elements of a bow are a pair of curved elastic limbs, traditionally made from wood, joined by a riser. Both ends of the limbs are connected by a string known as the bow string.*[1] By pulling the string backwards the archer exerts compressive force on the string-facing section, or belly, of the limbs as well as placing the outer section, or back, under tension. While the string is held, this stores the energy later released in putting the arrow to flight. The force required to hold the string stationary at full draw is often used to express the power of a bow, and is known as its draw weight, or weight.*[11]*[12] Other things being equal, a higher draw weight means a more powerful bow, which is able to project heavier arrows at the same velocity or the same arrow at a greater velocity.

The various parts of the bow can be subdivided into further sections. The topmost limb is known as the upper limb, while the bottom limb is the lower limb. At the tip of each limb is a nock, which is used to attach the bowstring to the limbs. The riser is usually divided into the grip, which is held by the archer, as well as the arrow rest and the bow window. The arrow rest is a small ledge or extension above the grip which the arrow rests upon while being aimed. The bow window is that part of the riser above the grip, which contains the arrow rest.*[1]

In bows drawn and held by hand, the maximum draw weight is determined by the strength of the archer.*[12] The maximum distance the string could be displaced and thus the longest arrow that could be loosed from it, a bow's draw length, is determined by the size of the archer.*[13]

A composite bow uses a combination of materials to create the limbs, allowing the use of materials specialized for the different functions of a bow limb. The classic composite bow uses wood for lightness and dimensional stability in the core, horn to store energy in compression, and sinew for its ability to store energy in tension. Such bows, typically Asian, would often use a stiff end on the limb end, having the effect of a recurve.*[14] In this type of bow, this is known by the Arabic name 'siyah'.*[15]

Modern construction materials for bows include laminated wood, fiberglass, metals,*[16] and carbon fiber components.

1.3.2 Arrows

Main article: Arrow

An arrow usually consists of a shaft with an arrowhead attached to the front end, with fletchings and a nock at the other.*[17] Modern arrows are usually made from carbon fibre, aluminum, fiberglass, and wood shafts. Carbon shafts have the advantage that they do not bend or warp, but they can often be too light weight to shoot from some bows and are expensive. Aluminum shafts are less expensive than carbon shafts, but they can bend and warp from use. Wood shafts are the least expensive option but often will not be identical in weight and size to each other and break more often than the other types of shafts.*[18] Arrow sizes vary greatly across cultures and range from very short ones that require the use of special equipment to be shot to ones in use in the Amazon River jungles that are 8.5 feet (2.6 metres) long. Most modern arrows are 22 inches (56 cm) to 30 inches (76 cm) in length.*[17]

Arrows come in many types, among which are breasted, bob-tailed, barrelled, clout, and target.*[17] A breasted arrow is thickest at the area right behind the fletchings, and tapers towards the nock and head.*[19] A bob-tailed arrow is thickest right behind the head, and tapers to the nock.*[20] A barrelled arrow is thickest in the centre of the arrow.*[21] Target arrows are those arrows used for target shooting rather than warfare or hunting, and usually have simple arrowheads.*[22]

For safety reasons, a bow should never be fired without an arrow nocked; without an arrow, the energy that is normally transferred into the projectile is instead directed back into the bow itself, which will cause damage to the bow's limbs.

1.3.3 Arrowheads

Main article: Arrowhead

The end of the arrow that is designed to hit the target is called the arrowhead. Usually, these are separate items that are attached to the arrow shaft by either tangs or sockets. Materials used in the past for arrowheads include flint, bone, horn, or metal. Most modern arrowheads are made of steel, but wood and other traditional materials

are still used occasionally. A number of different types of arrowheads are known, with the most common being bodkins, broadheads, and piles.*[23] Bodkin heads are simple spikes made of metal of various shapes, designed to pierce armour.*[20] A broadhead arrowhead is usually triangular or leaf-shaped and has a sharpened edge or edges. Broadheads are commonly used for hunting.*[24] A pile arrowhead is a simple metal cone, either sharpened to a point or somewhat blunt, that is used mainly for target shooting. A pile head is the same diameter as the arrow shaft and is usually just fitted over the tip of the arrow.*[25] Other heads are known, including the blunt head, which is flat at the end and is used for hunting small game or birds, and is designed to not pierce the target nor embed itself in trees or other objects and make recovery difficult.*[20] Another type of arrowhead is a barbed head, usually used in warfare or hunting.*[17]

1.3.4 Bowstrings

Main article: Bowstring

Bowstrings may have a nocking point marked on them, which serves to mark where the arrow is fitted to the bowstring before firing.*[26] The area around the nocking point is usually bound with thread to protect the area around the nocking point from wear by the archer's hands. This section is called the serving.*[27] At one end of the bowstring a loop is formed, which is permanent. The other end of the bowstring also has a loop, but this is not permanently formed into the bowstring but is constructed by tying a knot into the string to form a loop. Traditionally this knot is known as the archer's knot, but is a form of the timber hitch. The knot can be adjusted to lengthen or shorten the bowstring. The adjustable loop is known as the “tail”.*[28]

Bowstrings have been constructed of many materials throughout history, including fibres such as flax, silk, and hemp. Other materials used were animal guts, animal sinews, and rawhide. Modern fibres such as Dacron or Kevlar are now used in bowstring construction, as well as steel wires in some compound bows.*[29] Compound bows have a mechanical system of pulley cams over which the bowstring is wound.*[27]

1.4 Types of bows

There is no one accepted system of classification of bows.*[30] Bows may be described by various characteristics including the materials used, the length of the draw that they permit, the shape of the bow in sideways view, and the shape of the limb in cross-section.*[31]

Common types of bow include

- Recurve bow: a bow with the tips curving away from the archer. The curves straighten out as the bow is drawn and the return of the tip to its curved state after release of the arrow adds extra velocity to the arrow.*[32]
- Reflex bow: a bow whose entire limbs curve away from the archer when unstrung. The curves are opposite to the direction in which the bow flexes while drawn.*[32]
- Self bow: a bow made from one piece of wood.*[27]
- Longbow: a self bow with limbs rounded in cross-section, about the same height as the archer so as to allow a full draw, usually over 5 feet (1.5 metres) long. The traditional European longbow was usually made of yew wood, but other woods are also used.*[33]
- Flatbow: the limbs are approximately rectangular in cross-section. This was traditional in many Native American societies and was found to be the most efficient shape for bow limbs by American engineers in the 20th century.
- Composite bow: a bow made of more than one material.*[31]
- Takedown bow: a bow that can be demounted for transportation, usually consisting of 3 parts: 2 limbs and a Riser.
- Compound: a bow with mechanical aids to help with drawing the bowstring. Usually, these aids are pulleys at the tips of the limbs.*[14]

1.5 Crossbow

Main article: Crossbow

In a crossbow, the limbs of the bow, called a **prod**, are attached at right angles to a crosspiece or stock in order to allow for mechanical pulling and holding of the string. The mechanism that holds the drawn string has a release or trigger that allows the string to be released.*[34] A crossbow shoots a "bolt" or "quarrel", rather than an arrow.*[35]

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[1] Paterson *Encyclopaedia of Archery* pp. 27-28

[2] Paterson *Encyclopaedia of Archery* p. 17

[3] Paterson *Encyclopaedia of Archery* p. 31

[4] Paterson *Encyclopaedia of Archery* p. 56

[5] Paterson *Encyclopaedia of Archery* p. 20

[6] M. H. Monroe, *Aboriginal Weapons and Tools* "The favoured weapon of the Aborigines was the spear and spear thrower. The fact that they never adopted the bow and arrow has been debated for a long time. During post-glacial times the bow and arrow were being used in every inhabited part of the world except Australia. A number of reasons for this have been put forward [...] Captain Cook saw the bow and arrow being used on an island close to the mainland at Cape York, as it was in the Torres Strait islands and New Guinea. But the Aborigines preferred the spear. "

[7] Collins *Background to Archaeology*

[8] http://www.dengedenge.com/2009/10/traditional-war-for-land-in-africa/ Bow and arrow-warfare in todays Africa

[9] http://www.time.com/time/photogallery/0,29307,1722198,00.html

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[11] Paterson *Encyclopaedia of Archery* p. 111

[12] Sorrells *Beginner's Guide* pp. 20-21

[13] Sorrells *Beginner's Guide* pp. 19-20

[14] Paterson *Encyclopaedia of Archery* p. 38

[15] Elmer *Target Archery*

[16] Heath *Archery* pp. 15-18

[17] Paterson *Encyclopaedia of Archery* pp. 18-19

[18] Sorrells *Beginner's Guide* pp. 21-22

[19] Paterson *Encyclopaedia of Archery* p. 32

[20] Paterson *Encyclopaedia of Archery* pp. 25-26

[21] Paterson *Encyclopaedia of Archery* p. 24

[22] Paterson *Encyclopaedia of Archery* p. 103

[23] Paterson *Encyclopaedia of Archery* p. 19

[24] Paterson *Encyclopaedia of Archery* p. 33

[25] Paterson *Encyclopaedia of Archery* p. 85

[26] Paterson *Encyclopaedia of Archery* p. 80

[27] Paterson *Encyclopaedia of Archery* pp. 93-94

[28] Heath *Archery* pp. 27-28

[29] Paterson *Encyclopaedia of Archery* pp. 28-29

[30] Paterson *Encyclopaedia of Archery* p. 37

[31] Heath *Archery* pp. 14-16

[32] Paterson *Encyclopaedia of Archery* pp. 90-91

[33] Paterson *Encyclopaedia of Archery* pp. 73-75

[34] Paterson *Encyclopaedia of Archery* p. 41

[35] Paterson *Encyclopaedia of Archery* p. 26

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- *The Traditional Bowyers Bible Volume 2*. 1992 The Lyons Press. ISBN 1-58574-086-1
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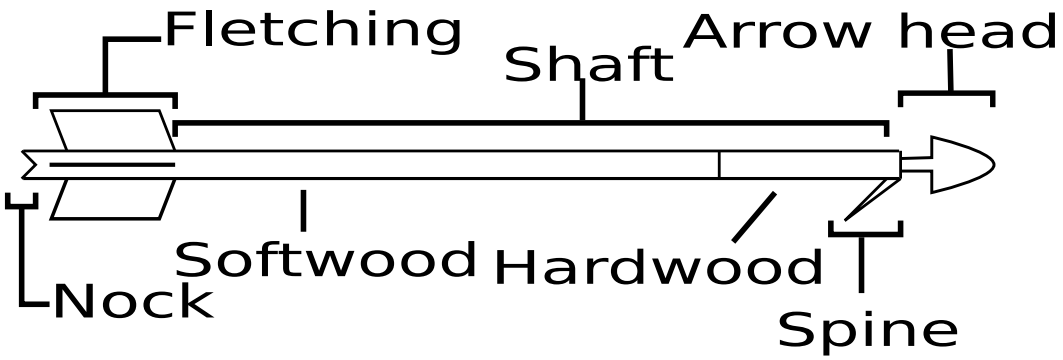
- Gray, David, "Bows of the World". The Lyons Press, 2002. ISBN 1-58574-478-6.
- Comstock, Paul. "The Bent Stick"

1.9 External links

- The Asian Traditional Archery Research Network
- Simon Archery Collection From The Manchester Museum, The University of Manchester
- An Approach to the Study of Ancient Archery using Mathematical Modeling

Scythians shooting with bows, Panticapeum (known today as Kertch, Ukraine), 4th century BCE.

Polychrome small-scale model of the archer XI of the west pediment of the Temple of Aphaea, ca. 505–500 BCE.

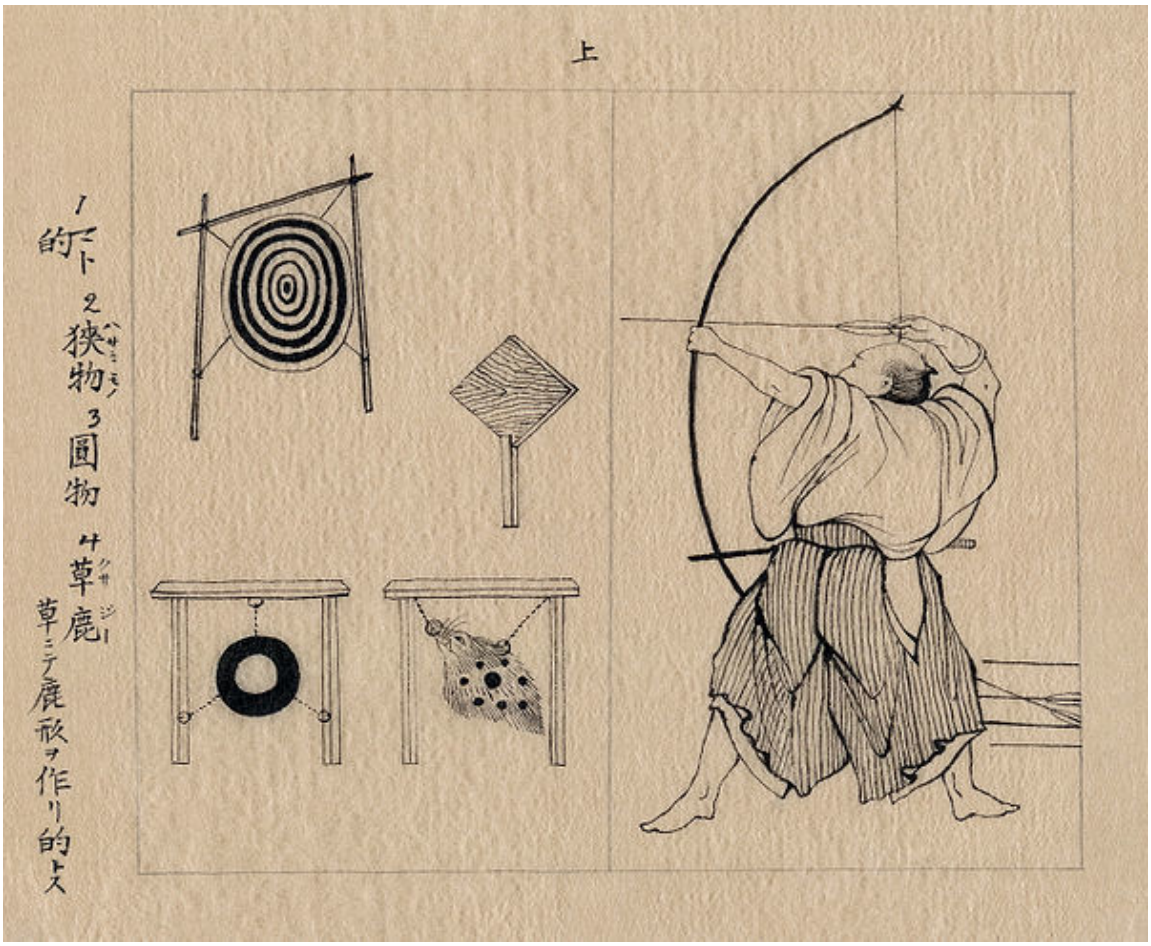


Schematic of an arrow showing its parts.

Bow and arrow in heraldry

Chapter 2

History of archery



A Japanese archer with targets. Ink on paper, 1878.

The bow and arrow are known to have been invented by the end of the Upper Paleolithic.

Projectile points (used on spears or atlatl darts) are known from earlier prehistory, dating to the Middle Paleolithic. Bows eventually replaced spear-throwers as the predominant means for launching sharp projectiles on all continents except Australia.

Archery was an important military and hunting skill before the widespread and efficient use of firearms, throughout classical antiquity and the medieval period. Arrows were especially destructive against unarmoured masses and the use of archers often proved decisive. Mounted archers combined range with speed and mobility. Archery is also featured prominently in the mythologies of many cultures.

2.1 Stone Age and Bronze Age archery

Scythian bowmen on gold plaque from Kul Oba kurgan, in Crimea, 4th century BC.

The bow seems to have been invented near the transition from the Upper Paleolithic to the Mesolithic, roughly 10,000 years ago. Spears or darts are much older; it has been suggested that some early points from Africa might have been arrowheads.*[1]

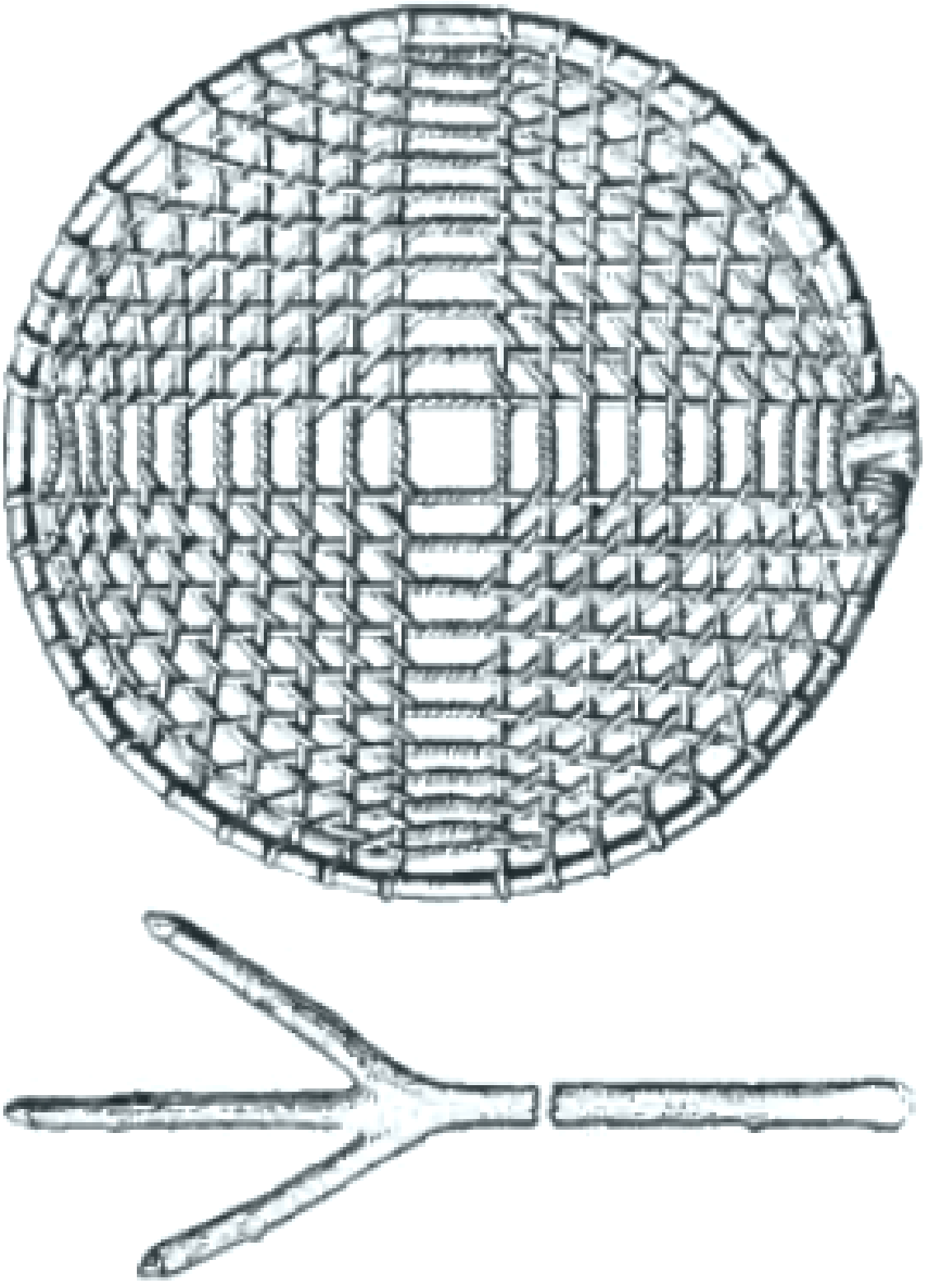
The oldest indication for archery in Europe comes from Stellmoor in the Ahrensburg valley north of Hamburg, Germany. They were associated with artifacts of the late Paleolithic (11,000-9,000 BP)(B.P-Before Present). The arrows were made of pine and consisted of a mainshaft and a 15-20 centimetre (6-8 inches) long foreshaft with a flint point. They had shallow grooves on the base, indicating that they were shot from a bow.*[2]

The oldest definite bows known so far come from the Holmegård swamp in Denmark. In the 1940s, two bows were found there, dated to about 8,000BP.*[3] The Holmegaard bows are made of elm and have flat arms and a D-shaped midsection. The center section is biconvex. The complete bow is 1.50 m (5 ft) long. Bows of Holmegaard-type were in use until the Bronze Age; the convexity of the midsection has decreased with time.

Mesolithic pointed shafts have been found in England, Germany, Denmark, and Sweden. They were often rather long, up to 120 cm (4 ft) and made of European hazel (*Corylus avellana*), wayfaring tree (*Viburnum lantana*) and other small woody shoots. Some still have flint arrow-heads preserved; others have blunt wooden ends for hunting birds and small game. The ends show traces of fletching, which was fastened on with birch-tar.

In the Levant, artifacts which may be arrow-shaft straighteners are known from the Natufian culture, (ca. 12,800-10,300 BP) onwards. The Khiamian and PPN A shouldered Khiam-points may well be arrowheads. Bows and arrows have been present in Egyptian culture since its predynastic origins. The "Nine Bows" symbolize the various peoples that had been ruled over by the pharaoh since Egypt was united.

Archery seems to have arrived in the Americas via Alaska, as early as 6000 BCE,*[4] with the Arctic small tool tradition, about 2,500 BCE, spreading south into the temperate zones as early as 2,000 BCE, and was widely known among the indigenous peoples of North America from about 500 CE.*[5] An archery game was widely practiced among the societies of the Southern US which involved shooting at a hoop rolled with a forked stick. Points were



The hoop was often netted, like this.

scored based on how the arrow landed. The competition was popularly related to notions of fertility.*[6] After the introduction of horses to the Americas, tribesmen of the Great Plains became extremely adept at archery on horseback.

The oldest Neolithic bow known from Europe was found in anaerobic layers dating between 7,400-7,200BP, the earliest layer of settlement at the lake settlement at La Draga, Banyoles, Catalonia. The intact specimen is short at

1.08m, has a D-shaped cross-section, and is made of yew wood.*[7] European Neolithic fortifications, arrow-heads, injuries, and representations indicate that, in Neolithic and Early Bronze Age Europe, archery was a major form of interpersonal violence.*[8] Stone wrist-guards, interpreted as display versions of bracers, form a defining part of the Beaker culture and arrowheads are also commonly found in Beaker graves.

Chariot-borne archers became a defining feature of Middle Bronze Age warfare, from Europe to Eastern Asia and India. However, in the Middle Bronze Age, with the development of massed infantry tactics, and with the use of chariots for shock tactics or as prestigious command vehicles, archery seems to have lessened in importance in European warfare.*[8] However, in approximately the same period, with the Seima-Turbino Phenomenon and the spread of the Andronovo culture, mounted archery became a defining feature of Eurasian nomad cultures and a foundation of their military success, until the massed use of guns. In China, crossbows were developed, and Han Dynasty writers attributed Chinese success in battles against nomad invaders to the massed use of crossbows, first definitely attested at the Battle of Ma-Ling in 341 BCE.*[9]

2.2 Ancient history

Further information: Mounted archery, Composite bow, Perso-Parthian bow, Parthian shot, Sassanid army, Rashidun army, Mongol military tactics and organization, Mongol bow, Turkish archery, Turkish bow and English longbow
Ancient civilizations, notably the Persians, Parthians, Indians, Koreans, Chinese, and Japanese fielded large numbers of archers in their armies. Arrows were destructive against massed formations, and the use of archers often proved decisive. The Sanskrit term for archery, dhanurveda, came to refer to martial arts in general.

Mounted archers were used as the main military force for many of the equestrian nomads, including the Cimmerians and the Mongols.

2.2.1 Egypt

The ancient Egyptian people took to archery as early as 5,000 years ago. Archery was widespread by the time of the earliest pharaohs and was practiced both for hunting and use in warfare. Legendary figures from the tombs of Thebes are depicted giving "lessons in archery".*[10] Some Egyptian deities are also connected to archery.*[11]

2.2.2 Middle East

The Assyrians and Babylonians extensively used the bow and arrow; the Old Testament has multiple references to archery as a skill identified with the ancient Hebrews. Xenophon describes long bows used to great effect in Corduene.

The Chariot warriors of the Kassites relied heavily on the bow. The Nuzi texts detail the bows and the number of arrows assigned to the chariot crew. Archery was essential to the role of the light horse-drawn chariot as a vehicle of warfare.*[12]

Information on regional Arabic arrowheads found from the period 100BC-150AD in the United Arab Emirates show the use of three-bladed arrowheads, or trilobate arrowhead. "A trilobate arrowhead can be defined as an arrowhead that has three wings or blades that are usually placed at equal angles (i.e. c. 120°) around the imaginary longitudinal axis extending from the centre of the socket or tang. Since this type of arrowhead is rare in southeastern Arabia, we must investigate its origin and the reasons behind its presence at ed-Dur." *[13]

A treatise on Saracen archery was written in 1368. This was a didactic poem on archery dedicated to a Mameluke sultan by ṬAIBUGHĀ, al-Ashrafī.*[14]

A 14th century treatise on Arab archery was written by Hussain bin Abd al-Rahman.*[15]

"Arab Archery" is a translation of an Oriental manuscript dated approximately 1500AD. It describes the practices and techniques of archery among the Arabs of that time.*[16] An online copy of the text is available.*[17]

Another treatise on Arab archery by Ibn Qayyim Al-Jawziyya, Muḥammad ibn Abī Bakr (1292AD-1350AD) comes from the 14th century.*[18]

Further information on Medieval Arab archery can be found in a recent article by John Jandora.*[19]

Archers with recurve bows and short spears, detail from the archers' frieze in Darius' palace in Susa. Siliceous glazed bricks, c. 510 BC.

2.2.3 Greco-Roman antiquity

The people of Crete practiced archery and Cretan mercenary archers were in great demand.*[20] Crete was known for its unbroken tradition of archery.*[21]

Apollo and Artemis. Tondo of an Attic red-figure cup, ca. 470 BC.

The Greek god Apollo is the god of archery, also of plague and the sun, metaphorically perceived as shooting invisible arrows, Artemis the goddess of hunting. Herakles and Odysseus and other mythological figures are often depicted with a bow.

During the invasion of India, Alexander the Great personally took command of the shield-bearing guards, foot-companions, archers, Agrianians and horse-javelin-men and led them against the Kamboja clans—the Aspasios of Kunar valleys, the Guraeans of the Guraeus (Panjkora) valley, and the Assakenois of the Swat and Buner valleys.*[22]

The early Romans had very few archers, if any. As their empire grew, they recruited auxiliary archers from other nations. Julius Caesar's armies in Gaul included Cretan archers, and Vercingetorix his enemy ordered "all the archers, of whom there was a very great number in Gaul, to be collected" .*[23] By the 4th century, archers with powerful composite bows were a regular part of Roman armies throughout the empire. After the fall of the western empire, the Romans came under severe pressure from the highly skilled mounted archers belonging to the Hun invaders, and later Eastern Roman armies relied heavily on mounted archery.*[24]

2.2.4 East Asia

Main articles: Chinese archery, Gungdo, Kyudo and Yabusame

For millennia, archery has played a pivotal role in Chinese history.[*][25] In particular, archery featured prominently in ancient Chinese culture and philosophy: archery was one of the Six Noble Arts of the Zhou dynasty (1146–256 BCE); archery skill was a virtue for Chinese emperors; Confucius himself was an archery teacher; and Lie Zi (a Daoist philosopher) was an avid archer.[*][26][*][27] Because the cultures associated with Chinese society spanned a wide geography and time range, the techniques and equipment associated with Chinese archery are diverse.[*][28]

In East Asia the Joseon Korea adopted a military-service examination system from China,[*][29] and South Korea remains a particularly strong performer at Olympic archery competitions even to this day.[*][30][*][31]

2.2.5 India

The bow and arrow constituted the classical Indian weapon of warfare, from the Vedic period, until the advent of Islam.[*][32][*][33] Some Rigvedic hymns lay emphasis on the use of the bow and arrow.[*][34]

Detailed accounts of training methodologies in early India concern archery, considered to be an essential martial skill in early India.[*][35] Legendary figures like Drona, are depicted as masters in the art of archery.[*][36] Arjuna, Eklavya, Karna, Rama, Lakshmana, Bharata and Shatrughan the great warrior are also associated with archery.

2.3 Middle Ages

Skilled archers were prized in Europe throughout the Middle Ages. The Assize of Arms of 1252 tells us that yeomen were required by law, in an early version of a militia, to practice archery and maintain their skills. We are told that 6,000 English archers launched 42,000 arrows per minute at the Battle of Crecy in 1346.[*][37] The Battle of Agincourt in 1415 is notable for Henry V's introduction of the English longbow into military lore. Henry VIII was so concerned about the state of his archers that he enjoined tennis and other frivolous pursuits in his Unlawful Games Act 1541.

Archery was also an important skill for the Vikings, both in hunting and battle (cf. Viking Age arms and armour).

2.4 Decline of archery

The advent of firearms eventually rendered bows obsolete in warfare. Despite the high social status, ongoing utility, and widespread pleasure of archery, almost every culture that gained access to even early firearms used them widely, to the relative neglect of archery. Although early firearms were vastly inferior in rate-of-fire, and were very susceptible to wet weather, they had a longer effective range,[*][38] greater penetration,[*][39] and were tactically superior in the common situation of soldiers shooting at each other from behind obstructions. They also required significantly less training to use properly, in particular penetrating steel armour without any need to develop special musculature. Armies equipped with guns could thus provide superior firepower, and highly trained archers became obsolete on the battlefield.

> "Have them bring as many guns as possible, for no other equipment is needed. Give strict orders that all men, even the samurai, carry guns."
> —Asano Yukinaga, 1598[*][40]

In Ireland, Geoffrey Keating (c. 1569 - c. 1644) mentions archery as having been practiced "down to a recent period within our own memory" [*][41] The last regular unit armed with bows was the Archers' Company of the Honourable Artillery Company, ironically a part of the oldest regular unit in England to be armed with gunpowder weapons. The last recorded use of bows in battle in Britain seems to have been a skirmish at Bridgnorth; in October 1642, during the English Civil War, an impromptu militia was effective against un-armoured musketmen.[*][42] (A more recent use of archery in war was in 1940, on the retreat to Dunkirk, when Jack Churchill, who had brought his bows on active service, "was delighted to see his arrow strike the centre German in the left of the chest and penetrate his body").[*][43]

Archery continued in some areas that were subject to limitations on the ownership of arms, such as the Scottish Highlands during the repression that followed the decline of the Jacobite cause, and the Cherokees after the Trail of Tears. The Tokugawa shogunate severely limited the import and manufacture of guns, and encouraged traditional martial skills among the samurai; towards the end of the Satsuma Rebellion in 1877, some rebels fell back on the use of bows and arrows. Archery remained an important part of the military examinations until 1894 in Korea and 1904 in China.

Within the steppe of Eurasia, archery continued to play an important part in warfare, although now restricted to mounted archery. The Ottoman Empire still fielded auxiliary cavalry which was noted for its use of bows from horseback. This practice was continued by the Ottoman subject nations, despite the Empire itself being a proponent of early firearms. The practice declined after the Crimean Khanate was absorbed by Russia; however mounted archers remained in the Ottoman order of battle until the post 1826 reforms to the Ottoman Army. The art of traditional archery remained in minority use for sport and for hunting in Turkey up until the 1820s, but the knowledge of constructing composite bows, fell out of use with the death of the last bowyer in the 1930s. The rest of the Middle East also lost the continuity of its archery tradition at this time.

An exception to this trend was the Comanche culture of North America, where mounted archery remained competitive with muzzle-loading guns. "After... about 1800, most Comanches began to discard muskets and pistols and to rely on their older weapons." *[44] Repeating firearms, however, were superior in turn, and the Comanches adopted them when they could. Bows remained effective hunting weapons for skilled horse archers, used to some extent by all Native Americans on the Great Plains to hunt buffalo as long as there were buffalo to hunt. The last Comanche hunt was in 1878, and it failed for lack of buffalo, not lack of appropriate weapons.*[45]

Ongoing use of bows and arrows was maintained in isolated cultures with little or no contact with the outside world. The use of traditional archery in some African conflicts has been reported in the 21st century, and the Sentinelese still use bows as part of a lifestyle scarcely touched by outside contact. A remote group in Brazil, recently photographed from the air, aimed bows at the aeroplane.*[46] Bows and arrows saw considerable use in the 2007–2008 Kenyan crisis.

2.5 Archery revival

The British initiated a major revival of archery as an upper-class pursuit from about 1780-1840.*[47] Early recreational archery societies included the Finsbury Archers and the Kilwinning Papingo, established in 1688. The latter held competitions in which the archers had to dislodge a wooden parrot from the top of an abbey tower. The Company of Scottish Archers was formed in 1676 and is one of the oldest sporting bodies in the world. It remained a small and scattered pastime, however, until the late 18th century when it experienced a fashionable revival among the aristocracy. Sir Ashton Lever, an antiquarian and collector, formed the Toxophilite Society in London in 1781, with the patronage of George, the Prince of Wales.

Archery societies were set up across the country, each with its own strict entry criteria and outlandish costumes. Recreational archery soon became extravagant social and ceremonial events for the nobility, complete with flags, music and 21 gun salutes for the competitors. The clubs were "the drawing rooms of the great country houses placed outside" and thus came to play an important role in the social networks of local elites. As well as its emphasis on display and status, the sport was notable for its popularity with females. Young women could not only compete in the contests but retain and show off their sexuality while doing so. Thus, archery came to act as a forum for introductions, flirtation and romance.*[47] It was often consciously styled in the manner of a Medieval tournament with titles and laurel wreaths being presented as a reward to the victor. General meetings were held from 1789, in which local lodges convened together to standardise the rules and ceremonies. Archery was also co-opted as a distinctively British tradition, dating back to the lore of Robin Hood and it served as a patriotic form of entertainment at a time of political tension in Europe. The societies were also elitist, and the new middle class bourgeoisie were excluded from the clubs due to their lack of social status.

After the Napoleonic Wars, the sport became increasingly popular among all classes, and it was framed as a nostalgic reimagining of the preindustrial rural Britain. Particularly influential was Sir Walter Scott's 1819 novel, *Ivanhoe* that depicted the heroic character Lockseley winning an archery tournament.*[48]

2.6 A modern sport

The 1840s saw the first attempts at turning the recreation into a modern sport. The first Grand National Archery Society meeting was held in York in 1844 and over the next decade the extravagant and festive practices of the past were gradually whittled away and the rules were standardised as the 'York Round' - a series of shoots at 60, 80, and 100 yards. Horace A. Ford helped to improve archery standards and pioneered new archery techniques. He won the Grand National 11 times in a row and published a highly influential guide to the sport in 1856.

Towards the end of the 19th century, the sport experienced declining participation as alternative sports such as croquet and tennis became more popular among the middle class. By 1889, just 50 archery clubs were left in Britain, but it was still included as a sport at the 1900 Paris Olympics.

In the United States, primitive archery was revived in the early 20th century. The last of the Yahi Indian tribe, a native known as Ishi, came out of hiding in California in 1911.*[49]*[50] His doctor, Saxton Pope, learned many of Ishi's traditional archery skills, and popularized them.*[51]*[52] The Pope and Young Club, founded in 1961 and named in honor of Pope and his friend, Arthur Young, became one of North America's leading bowhunting and conservation organizations. Founded as a nonprofit scientific organization, the Club was patterned after the prestigious Boone and Crockett Club and advocated responsible bowhunting by promoting quality, fair chase hunting, and sound conservation practices.

In Korea, the transformation of archery to a healthy pastime was led by Emperor Gojong, and is the basis of a popular modern sport. The Japanese continue to make and use their unique traditional equipment. Among the Cherokees, popular use of their traditional longbows never died out.*[53]

In China, at the beginning of the 21st century, there has been revival in interest among craftsmen looking to construct bows and arrows, as well as in practicing technique in the traditional Chinese style.*[54]*[55]

In modern times, mounted archery continues to be practiced as a popular competitive sport in modern Hungary and in some Asian countries but it is not recognized as an international competition.*[56] Archery is the national sport of the Kingdom of Bhutan.*[57]

From the 1920s, professional engineers took an interest in archery, previously the exclusive field of traditional craft experts.*[58] They led the commercial development of new forms of bow including the modern recurve and compound bow. These modern forms are now dominant in modern Western archery; traditional bows are in a minority. In the 1980s, the skills of traditional archery were revived by American enthusiasts, and combined with the new scientific understanding. Much of this expertise is available in the *Traditional Bowyer's Bibles* (see Additional reading). Modern game archery owes much of its success to Fred Bear, an American bow hunter and bow manufacturer.*[59]

2.7 See also

- Archery
- Kyūdō, Japanese archery
- Yabusame, Japanese horseback archery
- Gungdo, Korean archery
- Turkish archery
- Chinese archery
- Archery in India

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heads. If the bone point from the HP layers at Sibudu Cave is substantiated by future discoveries, this will push back the origin of bow and bone arrow technology by at least 20,000 years" Middle Stone Age bone tools from the Howiesons Poort layers, Sibudu Cave, South Africa. Lucinda Backwell, Francesco d'Errico, and Lyn Wadley. Journal of Archaeological Science. Volume 35, Issue 6, June 2008, Pages 1566-1580. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WH8-4S044NX-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=f05bdc6b1b9f132ea45c27fb73e85a38 "Explicit tests for distinctions between thrown spears and projected arrows have not yet been conducted, and many of the segments could have been employed equally successfully as insets for spears or arrows (Lombard & Pargeter 2008)." Indications of bow and stone-tipped arrow use 64 000 years ago in KwaZulu-Natal, South Africa. Marlize Lombard & Laurel Phillipson. ANTIQUITY 84 (2010): 635–648 http://antiquity.ac.uk/ant/084/ant0840635.htm

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2.9 Further reading

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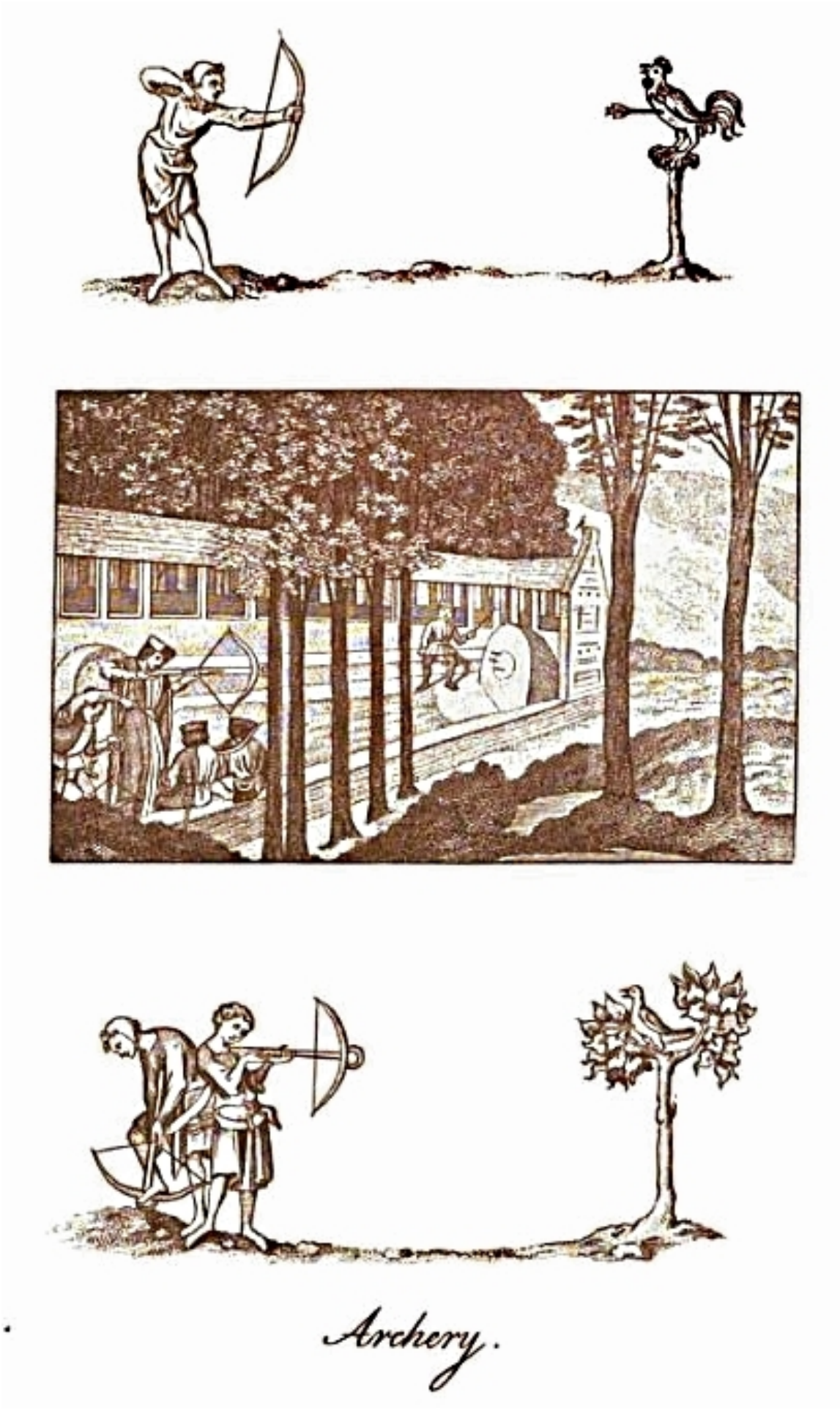
2.10 External links

- Archery Library Online Archery Books with historical content



Panels depicting Archery in England from Joseph Strutt's 1801 book, The sports and pastimes of the people of England from the earliest period. *The date of the top image is unknown; the middle image is from 1496 and the bottom panel is circa fourteenth century.*

A print of the 1822 meeting of the "Royal British Bowmen" archery club.

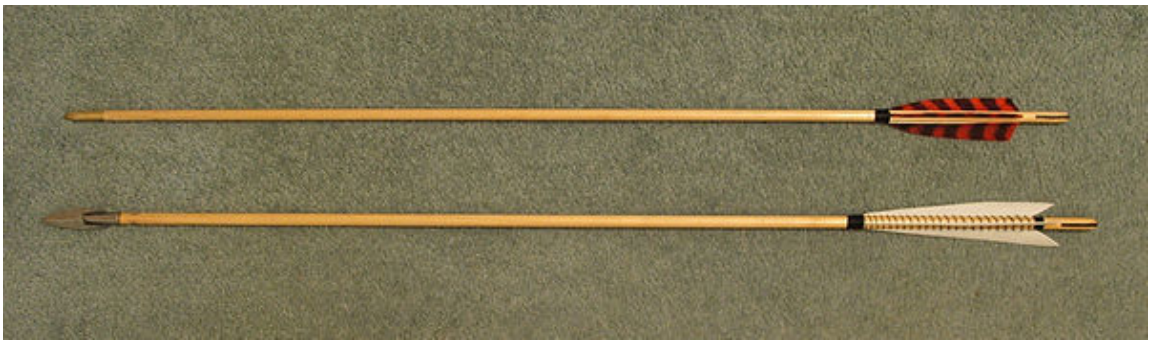
Picture of Pope taken while grizzly hunting at Yellowstone

Chapter 3

Arrow

This article is about the weapon. For the symbol （↑↓←→） , see Arrow (symbol). For other uses, see Arrow (disambiguation).

An **arrow** is a shafted projectile that is shot with a bow. It predates recorded history and is common to most cultures.



Traditional target arrow and replica medieval arrow.

Modern arrow with plastic fletchings and nock.

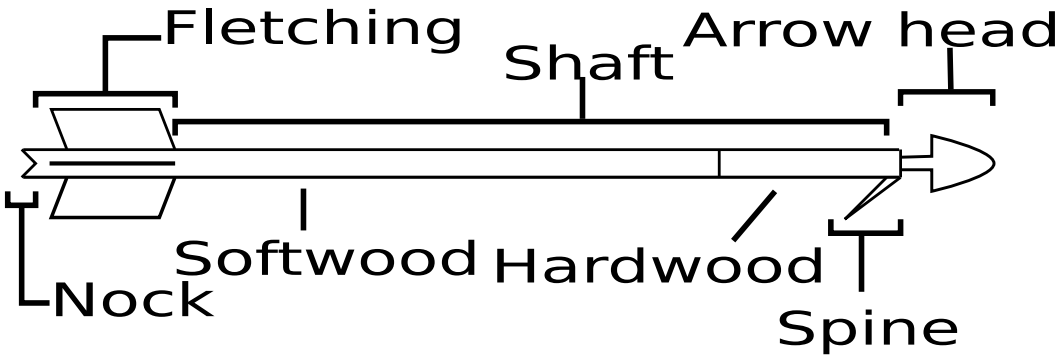
An arrow usually consists of a shaft with an arrowhead attached to the front end, with fletchings and a nock at the other.

3.1 History

Main article: History of archery

The oldest evidence of stone-tipped projectiles, which may or may not have been propelled by a bow (c.f. atlatl), dating to c. 64,000 years ago, were found in Sibudu Cave, South Africa.*[1] The oldest evidence of the use of bows to shoot arrows dates to about 10,000 years ago; it is based on pinewood arrows found in the Ahrensburg valley north of Hamburg. They had shallow grooves on the base, indicating that they were shot from a bow.*[2] The oldest bow so far recovered is about 8,000 years old, found in the Holmegård swamp in Denmark. Archery seems to have arrived in the Americas with the Arctic small tool tradition, about 4,500 years ago.

3.2 Size



Schematic of an arrow with many parts.

Arrow sizes vary greatly across cultures, ranging from eighteen inches to five feet (45 cm to 150 cm).*[3] However, most modern arrows are 75 centimetres (30 in) to 96 centimetres (38 in); most war arrows from an English ship sunk in 1545 were 76 centimetres (30 in).*[4] Very short arrows have been used, shot through a guide attached either to the bow (an "overdraw") or to the archer's wrist (the Turkish "siper").*[5] These may fly farther than heavier arrows, and an enemy without suitable equipment may find himself unable to return them.

3.2.1 Shaft

The shaft is the primary structural element of the arrow, to which the other components are attached. Traditional arrow shafts are made from lightweight wood, bamboo or reeds, while modern shafts may be made from aluminium, carbon fibre reinforced plastic, or a combination of materials. Such shafts are typically made from an aluminium core wrapped with a carbon fibre outer.

The stiffness of the shaft is known as its spine, referring to how little the shaft bends when compressed. Hence, an arrow which bends less is said to have more spine. In order to strike consistently, a group of arrows must be similarly spined. "Center-shot" bows, in which the arrow passes through the central vertical axis of the bow riser, may obtain consistent results from arrows with a wide range of spines. However, most traditional bows are not center-shot and the arrow has to deflect around the handle in the archer's paradox; such bows tend to give most consistent results with a narrower range of arrow spine that allows the arrow to deflect correctly around the bow. Higher draw-weight bows will generally require stiffer arrows, with more spine (less flexibility) to give the correct amount of flex when shot.

GPI rating

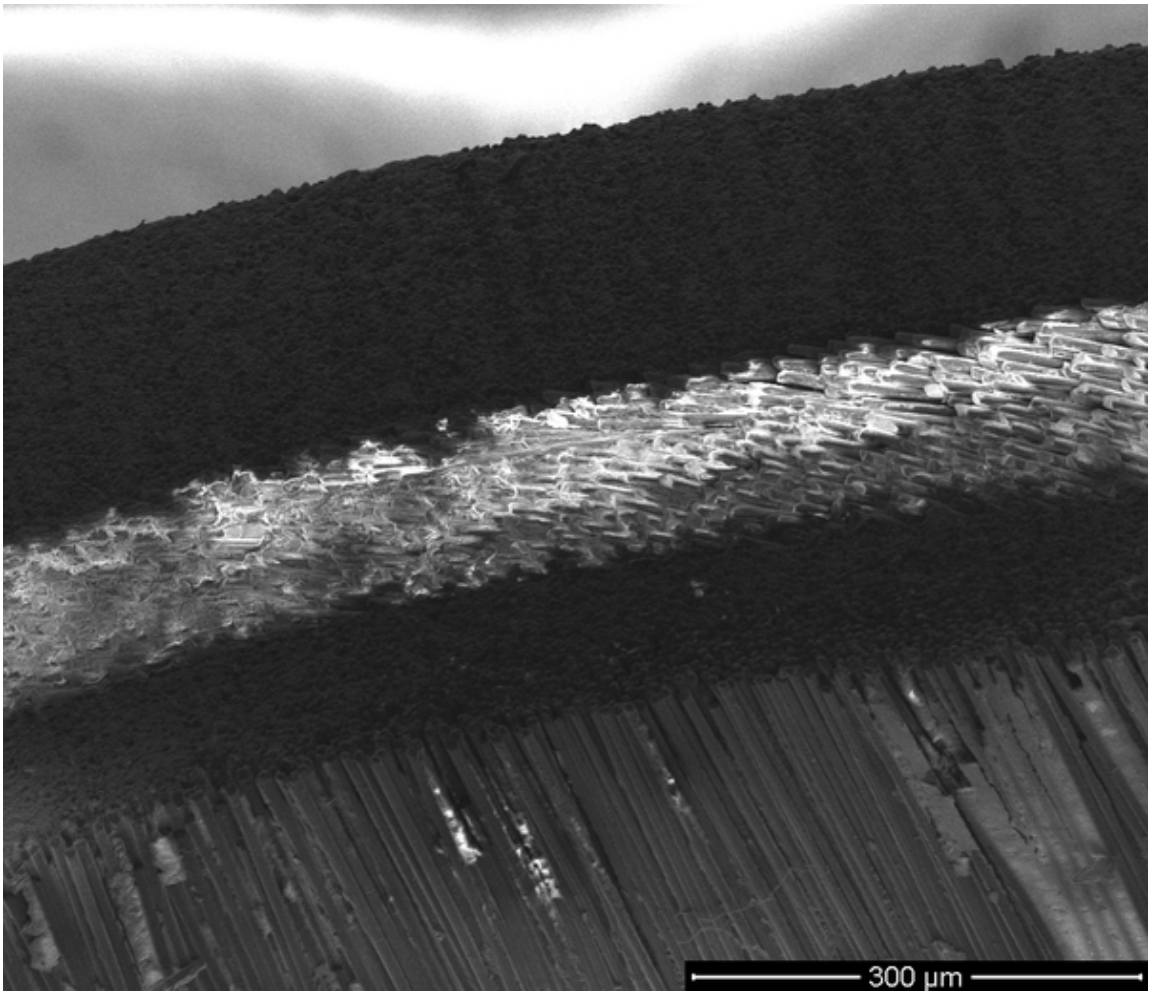
The weight of an arrow shaft can be expressed in GPI (Grains Per Inch).*[6] The length of a shaft in inches multiplied by its GPI rating gives the weight of the shaft in grains. For example, a shaft that is 30 inches long and has a GPI of

A Shoshone man using a shaft straightener in traditional arrow construction.

9.5 weighs 285 grains, or about 18 grams. This does not include the other elements of a finished arrow, so a complete arrow will be heavier than the shaft alone.

Footed arrows

Sometimes a shaft will be made of two different types of wood fastened together, resulting in what is known as a footed arrow. Known by some as the finest of wood arrows,[*][7] footed arrows were used both by early Europeans and Native Americans. Footed arrows will typically consist of a short length of hardwood near the head of the arrow, with the remainder of the shaft consisting of softwood. By reinforcing the area most likely to break, the arrow is more likely to survive impact, while maintaining overall flexibility and lighter weight.



A sideprofile of an Easton Carbon One arrow with a spine of 900, taken with a scanning electron microscope (SEM). The arrow is a bond of two carbon tubes, an inner and an outer tube (black wires). In between both carbon layers, an other fiber is used (white fiber). This second fiber is an Mg-Al-Si-fiber. The "white" fiber is twisted around the inner carbon tube. The fibers of the carbon tubes are not twisted, to ensure a maximum of possible mechanical tension of the arrow. The Mg-Al-Si-fiber enhances the flexibility of the arrow. The diameter of a single carbon fiber is approx. 7 µm.

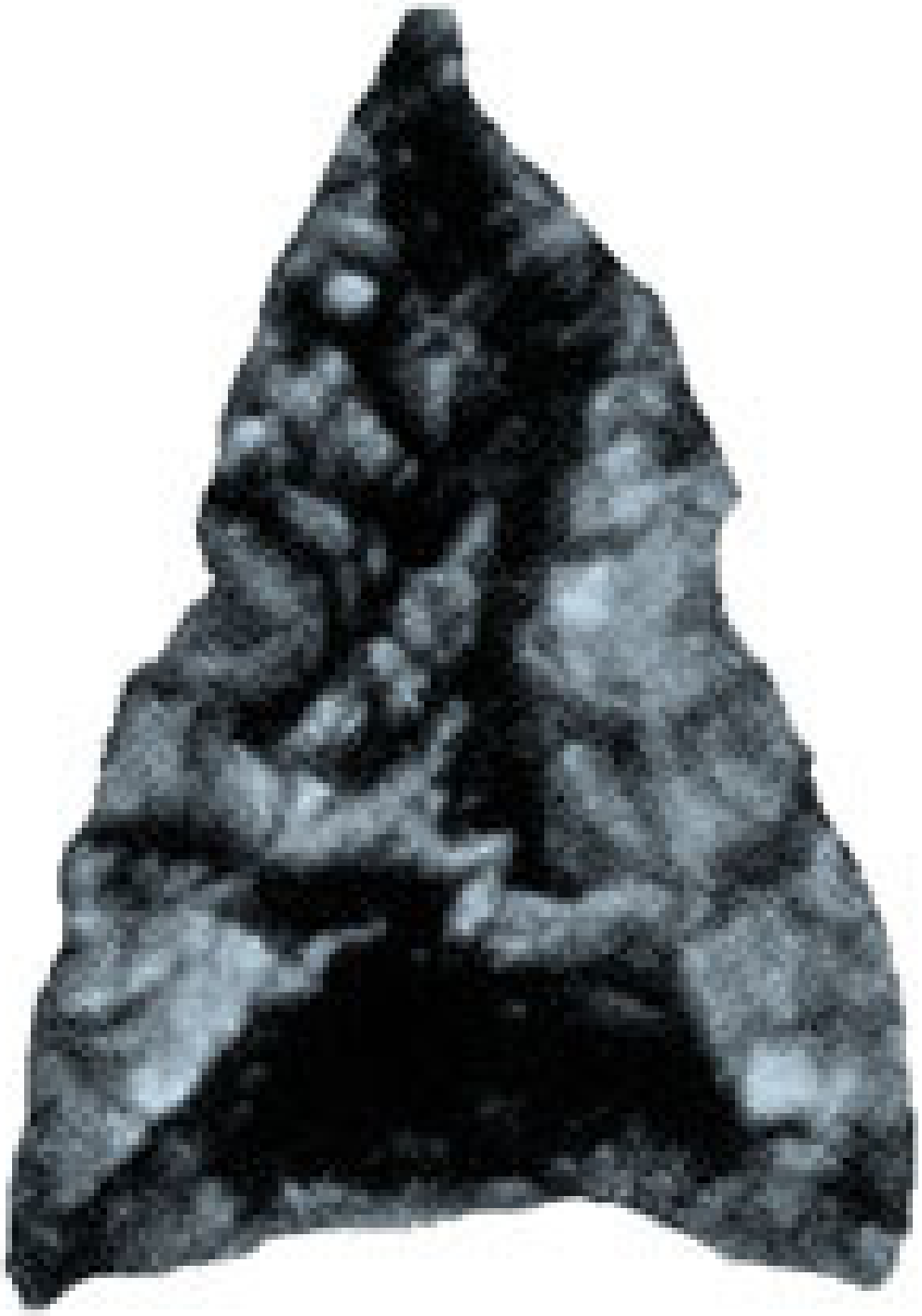
3.2.2 Arrowhead

Main article: Arrowhead

The arrowhead or projectile point is the primary functional part of the arrow, and plays the largest role in determining its purpose. Some arrows may simply use a sharpened tip of the solid shaft, but it is far more common for separate arrowheads to be made, usually from metal, horn, or some other hard material. Arrowheads are usually separated by function:

- **Bodkin points** are short, rigid points with a small cross-section. They were made of unhardened iron and may have been used for better or longer flight, or for cheaper production. It has been mistakenly suggested that the bodkin came into its own as a means of penetrating armour, but research*[8] has found no hardened bodkin points, so it is likely that it was first designed either to extend range or as a cheaper and simpler alternative to the broadhead. In a modern test, a direct hit from a hard steel bodkin point penetrated Damascus chain armour.*[9] However, archery was not effective against plate armour, which became available to knights of fairly modest means by the late 14th century.*[10]

- **Blunts** are unsharpened arrowheads occasionally used for types of target shooting, for shooting at stumps or other targets of opportunity, or hunting small game when the goal is to stun the target without penetration. Blunts are commonly made of metal or hard rubber. They may stun, and occasionally, the arrow shaft may penetrate the head and the target; safety is still important with blunt arrows.



Obsidian broadhead

- **Judo points** have spring wires extending sideways from the tip. These catch on grass and debris to prevent the arrow from being lost in the vegetation. Used for practice and for small game.

- **Broadheads** were used for war and are still used for hunting. Medieval broadheads could be made from steel,* [8] sometimes with hardened edges. They usually have two to four sharp blades that cause massive bleeding in the victim. Their function is to deliver a wide cutting edge so as to kill as quickly as possible by

Ancient Greek bronze arrowhead, 4th century BC, from Olynthus, Chalcidice

Various Japanese arrowheads

cleanly cutting major blood vessels, and cause further trauma on removal. They are expensive, damage most targets, and are usually not used for practice.

There are two main types of broadheads used by hunters: The **fixed-blade** and the **mechanical** types. While the fixed-blade broadhead keeps its blades rigid and unmovable on the broadhead at all times, the mechanical broadhead deploys its blades upon contact with the target, its blades swinging out to wound the target. The mechanical head flies better because it is more streamlined, but has less penetration as it uses some of the kinetic energy in the arrow to deploy its blades.*[11]

- **Field tips** are similar to target points and have a distinct shoulder, so that missed outdoor shots do not become as stuck in obstacles such as tree stumps. They are also used for shooting practice by hunters, by offering

Native American arrowheads

20th century field points

similar flight characteristics and weights as broadheads, without getting lodged in target materials and causing excessive damage upon removal.

- **Target points** are bullet-shaped with a conical point, designed to penetrate target butts easily without causing excessive damage to them.

- **Safety arrows** are designed to be used in various forms of reenactment combat, to reduce the risk when shot at people. These arrows may have heads that are very wide or padded. In combination with bows of restricted draw weight and draw length, these heads may reduce to acceptable levels the risks of shooting arrows at suitably armoured people. The parameters will vary depending on the specific rules being used and on the levels of risk felt acceptable to the participants. For instance, SCA combat rules require a padded head at least $1\frac{1}{4}$" in diameter, with bows not exceeding 28 inches (710 mm) and 50 lb (23 kg) of draw for use against well-armoured individuals.[*] [12]

Arrowheads may be attached to the shaft with a cap, a socketed tang, or inserted into a split in the shaft and held by a process called hafting.[*] [3] Points attached with caps are simply slid snugly over the end of the shaft, or may be held

Modern replicas of various medieval European arrowheads

on with hot glue. Split-shaft construction involves splitting the arrow shaft lengthwise, inserting the arrowhead, and securing it using a ferrule, sinew, or wire.*[13]

3.2.3 Fletchings

Main article: Fletching

Fletchings are found at the back of the arrow and act as airfoils to provide a small amount of force used to stabilize

Straight parabolic fletchings on an arrow.

the flight of the arrow. They are designed to keep the arrow pointed in the direction of travel by strongly damping down any tendency to pitch or yaw. Some cultures, for example most in New Guinea, did not use fletching on their arrows.*[14]

Fletchings are traditionally made from feathers (often from a goose or turkey) bound to the arrow's shaft, but are now often made of plastic (known as "vanes"). Historically, some arrows used for the proofing of armour used copper vanes.*[15] Flight archers may use razor blades for fletching, in order to reduce air resistance. With conventional three-feather fletching, one feather, called the "cock" feather, is at a right angle to the nock, and is normally nocked so that it will not contact the bow when the arrow is shot. Four-feather fletching is usually symmetrical and there is no preferred orientation for the nock; this makes nocking the arrow slightly easier.

Artisans who make arrows by hand are known as "fletchers," a word related to the French word for arrow, *flèche*. This is the same derivation as the verb "fletch", meaning to provide an arrow with its feathers. Glue and/or thread are the main traditional methods of attaching fletchings. A "fletching jig" is often used in modern times, to hold the fletchings in exactly the right orientation on the shaft while the glue hardens.

Whenever natural fletching is used, the feathers on any one arrow must come from the same side of the bird. The slight twist in natural feathers then makes the arrow rotate in flight, which increases accuracy. Artificial *helical* fletchings have the same effect. Most arrows will have three fletches, but some have four or even more. Fletchings generally range from two to six inches (152 mm) in length; flight arrows intended to travel the maximum possible distance typically have very low fletching, while hunting arrows with broadheads require long and high fletching to stabilize

them against the aerodynamic effect of the head. Fletchings may also be cut in different ways, the two most common being *parabolic* (i.e. a smooth curved shape) and *shield* (i.e. shaped as one-half of a very narrow shield) cut.

A flu-flu is a form of fletching, normally made by using long sections of full length feathers taken from a turkey, in most cases six or more sections are used rather than the traditional three. Alternatively two long feathers can be spiraled around the end of the arrow shaft. The extra fletching generates more drag and slows the arrow down rapidly after a short distance, about 30 m or so .

Flu-Flu arrows are often used for hunting birds, or for children's archery, and can also be used to play Flu-Flu Golf.

3.2.4 Nocks

The nock is a notch in the rearmost end of the arrow. It serves to keep the arrow in place on the string as the bow is being drawn. Nocks may be simple slots cut in the back of the arrow, or separate pieces made from wood, plastic, or horn that are then attached to the end of the arrow.*[16] Modern nocks, and traditional Turkish nocks, are often constructed so as to curve around the string or even pinch it slightly, so that the arrow is unlikely to slip off.*[17] In English it is common to say "nock an arrow" when one readies a shot.

In Arab archery, there was the description of the use of "nockless arrows". In shooting at the enemies, either the Turks or the Persians, it was seen that the enemies would pick up the expended arrows and shoot them back at the Arabs. So they developed "nockless arrows", which would be useless to their foes. The bowstring would have a small ring that is tied onto the string at the proper point where the nock would normally be placed. The end of the arrow, rather than being slit for a nock, would be sharpened like an arrowhead, then the rear end of the arrow would be slipped into this ring and drawn and released as usual. Then the enemy could collect all the arrows they wanted, but they would be useless to them in shooting back. A piece of advice was in battle, to have several rings tied onto the bowstring in case one broke.*[18]

3.3 See also

- Archery
- Arrow poison
- Bowfishing
- Early thermal weapons
- Fire arrows
- Flechette
- Flu-Flu Arrow
- Quarrel
- Signal arrow
- Swiss arrow

3.4 Notes

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3.5 External links

- What's the Point?: Identifying Flint Artifacts (OPLIN)
- Dr. Ashby's reports on broadhead penetration
- Types of Bows and Arrows

Chapter 4

Arrowhead

For other uses, see Arrowhead (disambiguation).
"Broadhead" redirects here. For other uses, see Broadhead (disambiguation).

An **arrowhead** is a tip, usually sharpened, added to an arrow to make it more deadly or to fulfill some special

Chert arrowhead, Late Neolithic (Rhodézien) (3300-2400 BCE), France

purpose. The earliest arrowheads were made of stone and of organic materials; as human civilization progressed other materials were used. Arrowheads are important archaeological artifacts; they are a subclass of projectile points. Modern enthusiasts still "produce over one million brand-new spear and arrow points per year".*[1]

4.1 History

Main article: Projectile point

In the Stone Age, people used sharpened bone, flintknapped stones, flakes, and chips of rock as weapons and tools.

Arrowheads made of bone and antler found in Nydam Mose (3rd - 5th century)

Such items remained in use throughout human civilization, with new materials used as time passed. As archaeological artifacts such objects are classed as projectile points, without specifying whether they were projected by a bow or by some other means such as throwing since the specific means of projection (the bow, the arrow shaft, the spear shaft, etc.) is found too seldom in direct association with any given point and the word "arrow" would imply a certainty about these points which simply does not exist.*[2]

Such artifacts can be found all over the world in various locations. Those that have survived are usually made of stone, primarily being flint, obsidian, or cherts, but in many excavations bone, wooden and metal arrowheads have been found.

Stone projectile points dating back 64,000 years were excavated from layers of ancient sediment in Sibudu Cave, South Africa. Examinations found traces of blood and bone residues, and glue made from a plant-based resin that was used to fasten them on to a wooden shaft. This indicated "cognitively demanding behavior" required to manufacture glue.*[3]

These hafted points might have been launched from bows. While "most attributes such as micro-residue distribution patterns and micro-wear will develop similarly on points used to tip spears, darts or arrows" and "explicit tests for distinctions between thrown spears and projected arrows have not yet been conducted" the researchers find "contextual support" for the use of these points on arrows: a broad range of animals were hunted, with an emphasis on taxa that prefer closed forested niches, including fast moving, terrestrial and arboreal animals. This is an argument for the use of traps, perhaps including snares. If snares were used, the use of cords and knots which would also have been adequate for the production of bows is implied. The employment of snares also demonstrates a practical understanding of the latent energy stored in bent branches, the main principle of bow construction. Cords and knots are implied by use-wear facets on perforated shell beads around 72,000 years old from Blombos. Archeologists in Louisiana have discovered that early Native of Americans used Alligator gar scales to use as arrow heads.

Ancient Greek bronze leaf-shaped, trefoil and triangular arrowheads.

Some arrowheads made of Quartz

"Hunting with a bow and arrow requires intricate multi-staged planning, material collection and tool preparation and implies a range of innovative social and communication skills." *[4]

4.2 Design

Arrowheads are attached to arrow shafts to be shot from a bow; similar types of projectile points may be attached to a spear and "thrown" by means of an Atlatl (spear thrower).

The arrowhead or projectile point is the primary functional part of the arrow, and plays the largest role in determining its purpose. Some arrows may simply use a sharpened tip of the solid shaft, but it is far more common for separate arrowheads to be made, usually from metal, horn, rock, or some other hard material.

Arrowheads may be attached to the shaft with a cap, a socket tang, or inserted into a split in the shaft and held by a process called hafting.*[5] Points attached with caps are simply slid snugly over the end of the shaft, or may be held on with hot glue. In medieval Europe, arrowheads were often anchored with nothing but candlewax minutes before firing, if not merely saliva - this ensured that the head would remain in enemy's body if the shaft was pulled out. Split-shaft construction involves splitting the arrow shaft lengthwise, inserting the arrowhead, and securing it using ferrule, sinew, rope, or wire.*[6]

4.3 Variants

Japanese arrowheads of several shapes and functions

Arrowheads are usually separated by function:

Modern replicas of various medieval European arrowheads

- *Bodkin points* are short, rigid points with a small cross-section. They were made of unhardened iron and may have been used for better or longer flight, or for cheaper production. It has been mistakenly suggested that the bodkin came into its own as a means of penetrating armour, but research*[7] has found no hardened bodkin points, so it is likely that it was first designed either to extend range or as a cheaper and simpler alternative to the broadhead. In a modern test, a direct hit from a hard steel bodkin point penetrated Damascus chain armour.*[8] However, archery was minimally effective against plate armour, which became available to knights of fairly modest means by the late 14th century.*[9]

- *Blunts* are unsharpened arrowheads occasionally used for types of target shooting, for shooting at stumps or other targets of opportunity, or hunting small game when the goal is to stun the target without penetration. Blunts are commonly made of metal or hard rubber. They may stun, and occasionally, the arrow shaft may penetrate the head and the target; safety is still important with blunt arrows.

- *Judo points* have spring wires extending sideways from the tip. These catch on grass and debris to prevent the arrow from being lost in the vegetation. Used for practice and for small game.

A modern broadhead tip

- *Broadheads* were used for war and are still used for hunting. Information on regional Arabic arrowheads found from the period 100BC-150AD in the United Arab Emirates show the use of three-bladed broadheads, or trilobate arrowhead. "A trilobate arrowhead can be defined as an arrowhead that has three wings or blades that are usually placed at equal angles (i.e. c. 120°) around the imaginary longitudinal axis extending from the centre of the socket or tang. Since this type of arrowhead is rare in southeastern Arabia, we must investigate its origin and the reasons behind its presence at ed-Dur." *[10]

Medieval broadheads could be made from steel,*[7] sometimes with hardened edges. They usually have two to four sharp blades that cause massive bleeding in the victim. Their function is to deliver a wide cutting edge so as to kill as quickly as possible. They are expensive, damage most targets, and are usually not used for practice. There are two main types of broadheads used by hunters: The *fixed-blade broadhead* and the *mechanical broadhead* types.

A mechanical broadhead deploys its blades in-flight to increase lethality in hunting game.

While the fixed-blade broadhead keeps its blades rigid and unmovable on the broadhead at all times, the mechanical broadhead deploys its blades upon contact with the target, its blades swinging out to wound the target.

The mechanical head flies better because it is more streamlined, but has less penetration as it uses some of the kinetic energy in the arrow to deploy its blades.*[11]

- *Target points* are bullet-shaped with a sharp point, designed to penetrate target butts easily without causing excessive damage to them.
- *Field points* are similar to target points and have a distinct shoulder, so that missed outdoor shots do not become as stuck in obstacles such as tree stumps. They are also used for shooting practice by hunters, by offering similar flight characteristics and weights as broadheads, without getting lodged in target materials and causing excessive damage upon removal.
- *Safety arrows* are designed to be used in various forms of reenactment combat, to reduce the risk when shot at people. These arrows may have heads that are very wide or padded. In combination with bows of restricted draw weight and draw length, these heads may reduce to acceptable levels the risks of shooting arrows at suitably armoured people. The parameters will vary depending on the specific rules being used and on the levels of risk felt acceptable to the participants. For instance, SCA combat rules require a padded head at least $1\frac{1}{4}$" in diameter, with bows not exceeding 28 inches (710 mm) and 50 lb (23 kg) of draw for use against well-armoured individuals.*[5]

4.4 See also

- Elf-Arrows
- Stone tool

4.5 References

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4.6 External links

Media related to Arrowheads at Wikimedia Commons

Chapter 5

Bowstring

For the bowstring bridge, see tied arch bridge. For the community in Minnesota, see Bowstring, Minnesota.

A **bow string** joins the two ends of the bow stave and launches the arrow. Desirable properties include light weight,

Japanese bowstring (tsuru) and woven bowstring holder (tsurumaki).

strength, resistance to abrasion, and resistance to water. Mass has most effect at the center of the string; 1 gram (0.035 oz) of extra mass in the middle of the string slows the arrow about as much as 3.5 grams (0.12 oz) at the ends.*[1]

5.1 String forms

Most bow strings may be described as either simple, reverse-twisted, or looped.*[2]

Simple strings may be made of any fiber, twisted into a single cord. Such strings have been used in many parts of the world and are still effective and fairly quick to make. However, they tend to be weaker for their weight, and they

may also come apart if not kept constantly under tension. They are normally secured to the bow by a knot/round turn and two half-hitches at each end.

Reverse-twisted strings are traditional in Europe and North America for most natural materials. Linen and hemp fiber have been widely used. The form is also used for modern materials. A reverse-twisted string is made of separate bundles, each bundle individually twisted in one direction; the entire group of bundles is then twisted in the other direction. The result tends to be stronger for its weight than a simple or looped string, and holds together better than a simple string. Unlike some looped strings, the full thickness of the string passes around the nocks on the ends of the bow, where wear is usually greatest. Additional threads may also be laid in at the nocking points for the bow stave and for the arrow, which are sites of likely wear. The string may be secured to the bow by a knot at each end, usually a timber hitch, also known as the bowyer's knot.

The traditional "Flemish" string has a laid-in loop at one end, which is easier than most knots to fit over the nock of the bow when stringing and unstringing. It is more trouble to make; the short length, towards one end, that will form the loop is reverse-twisted first. The ends of each bundle are then laid into the main length of the bundles, which are reverse-twisted in turn. The Japanese bow string is made by reverse-twisting in different directions in the core and outer layers of the string. See Kyūdō.

Looped strings are made of one or more continuous loops of material. Modern strings are often made as a single continuous loop: this is then served to give the final form. Disadvantages include the lesser amount of fiber at the ends, where wear is most likely; this may be overcome by serving the string.

In many parts of Asia, traditional strings have a single loop in the center, with the ends made of separate lengths tied on using a special knot.*[3] This design allows extra fiber to be used at the ends, where weight is less important and wear more likely.

5.2 String materials

Traditional materials include linen, hemp, other vegetable fibers, sinew, silk, and rawhide. Almost any fiber may be used in emergency. Natural fibers would be very unusual on a modern recurve bow or compound bow, but are still effective and still used on traditional wooden or composite bows. Sinew and hide strings may be seriously affected by water.*[4]

Widely used modern materials are stronger for their weight than any natural material, and most are unaffected by water. They include:

Dacron - (strength per strand = 22.5 kg (50 lb), stretch = 2.6%), a polyester material. Because of its durability and stretch, Dacron is commonly used on beginners' equipment, wooden bows, and older bows. The relatively high stretch causes less shock to the bow, which is an important consideration for wooden-handled recurves. Dacron strings are easy to maintain and can last several years.

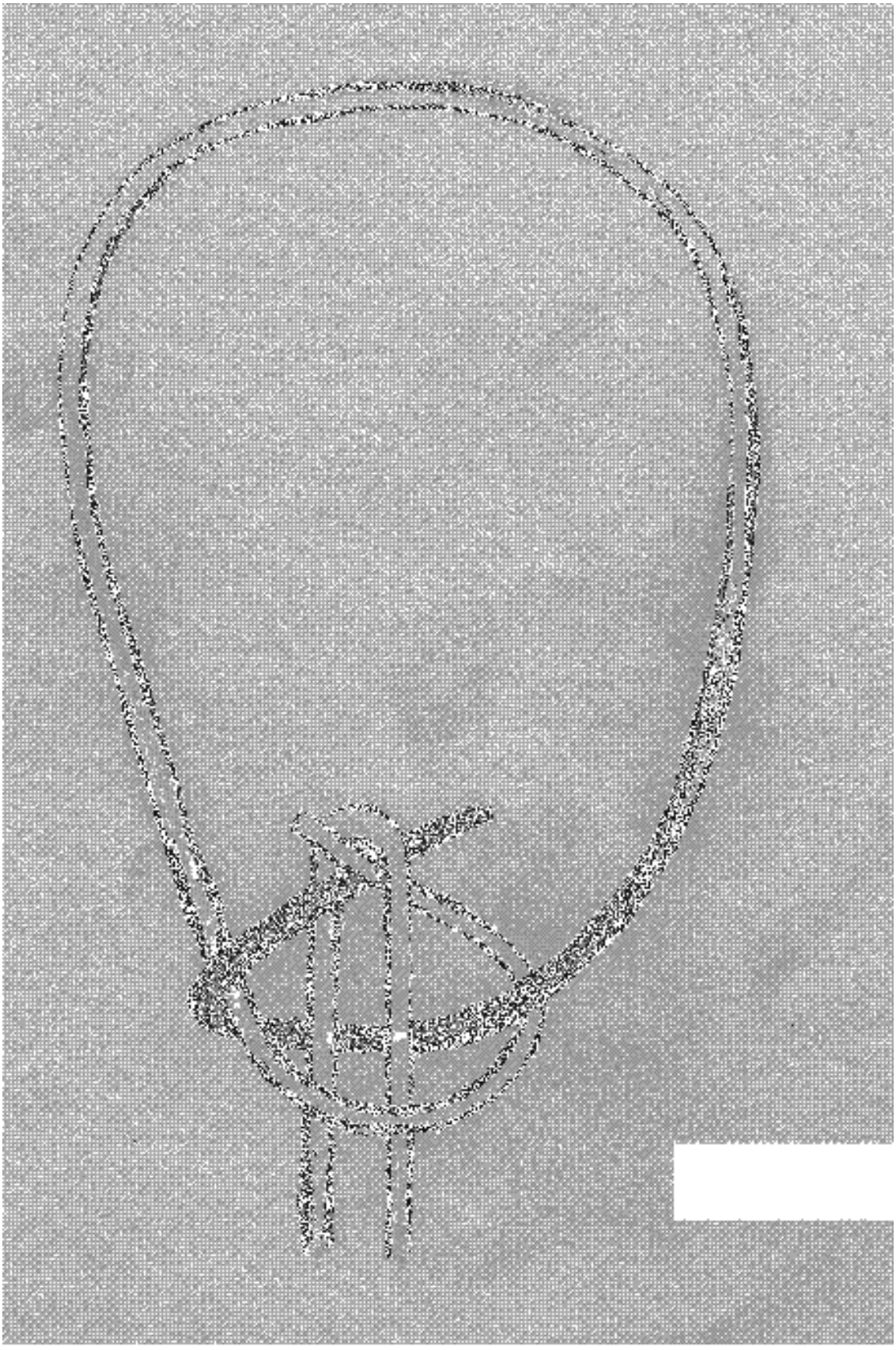
Liquid crystal polymers such as Kevlar and Vectran - (strength per strand = 31.8 kg (70 lb), stretch = 0.8%), are polymer materials with a higher density and smaller diameter than Dacron, which results in a faster arrow speed (approximately 2 metres per second (6.6 ft/s) faster). There are two problems with this material. First, its limited stretch causes increased stress in the bow limbs. Secondly, a Kevlar bowstring may only last 1000 shots before breaking as it tends to fatigue due to bending at the nocking point. Failure tends to be sudden rather than gradual.

Ultra-high-molecular-weight polyethylenes, such as Spectra and Dyneema, - (strength per strand = 45.5 kg (100 lb), stretch = 1.0%), have been used since the 1990s. They are lighter, therefore faster, than Kevlar - and have a much longer life.

Modern strings are often made from composite fibres - such as a mixture of Vectran and Dyneema - to gain the advantages of both.

5.3 Serving

Serving a bow string refers to the use of an additional thread, commonly wrapped round the main string at the nocking points where abrasion is most likely, and also used on looped strings to keep the two sides of the loop together.



A Turkish bow string knot

5.4 See also

- Archery
- Bow (weapon)
- Fistmele

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Chapter 6

Recurve bow

A **recurve bow** is a bow with tips that curve away from the archer when the bow is strung. By definition, the difference between recurve and other bows is that the string touches a section of the limb when the bow is strung. A recurve bow stores more energy and delivers energy more efficiently than an equivalent straight-limbed bow, giving a greater amount of energy and speed to the arrow. A recurve will permit a shorter bow than the simple straight limb bow for a given arrow energy and this form was often preferred by archers in environments where long weapons could be cumbersome, such as in brush and forest terrain, or while on horseback.

Recurved limbs also put greater strain on the materials used to make the bow, and they may make more noise with the shot. Extreme recurves make the bow unstable when being strung. An unstrung recurve bow can have a confusing shape and many Native American weapons, when separated from their original owners and cultures, were incorrectly strung backwards and destroyed when attempts were made to shoot them.*[1]

6.1 Historical and current use

Further information: Composite bow

Perhaps the most ancient written record of the use of recurved bows is found Psalm 78:57 ("They were turned aside like a deceitful bow" KJV), which is dated by most scholars to the eighth century BCE.*[2] Adam Clarke points out that "If a person, who is unskillful or weak, attempt to recurve and string one of these bows, if he take not great heed, it will spring back, and regain its quiescent position; and, perhaps, break his arm. And sometimes I have known it, when bent, to start aside, - regain its quiescent position, to my no small danger...this is precisely the kind of bow mentioned by Homer, Odyss. xxi, which none of Penelope's suitors could bend, called καμπυλα τοξα [*kampula toxa*] in the state of rest; but τοξον παλιντονον [*toxon palintonon*], the recurved bow when prepared for use." *[3]

Recurve bows made out of composite materials were used by, among other groups, the Persians, Scythians, Cumans, Hyksos, Magyars, Huns, Greeks, Turks, Mongols, and Chinese. The recurve bow spread to Egypt and much of Asia in the second millennium BC. The standard weapon of Roman imperial archers was a composite recurve, and the stiffening laths (also called siyah in Arabic/Asian bows*[4] and *szarv* (horns) in Hungarian bows) used to form the actual recurved ends have been found on Roman sites throughout the Empire, as far north as Bar Hill on the Antonine Wall in Scotland.*[5] During the Middle Ages composite recurve bows were used in the drier European countries; the all-wooden straight longbow was the normal form in wetter areas. Recurve bows depicted in the British Isles (see illustrations in "The Great War Bow")*[6] may have been composite weapons, or wooden bows with ends recurved by heat and force, or simply artistic licence. Many North American bows were recurved, especially West Coast bows. Recurve bows went out of widespread use, for war, with the availability of effective firearms. Self bows, composite bows, and laminated bows using the recurve form are still made and used by bowyers and amateur and professional archers.

6.2 Modern use

The unqualified phrase "recurve bow" or just "a recurve" in modern archery circles usually refers to a typical modern recurve bow, as used by archers in the Olympics and many other competitive events. It employs advanced technologies and materials. The limbs are usually made from multiple layers of fiberglass, carbon and/or wood on a core of carbon foam or wood. The riser (the centre section of the bow) is generally separate and is constructed from wood, carbon, aluminium alloy or magnesium alloy. The term 'riser' is used because, in a one-piece bow, the centre section rises from the limbs in a taper to spread the stress. Several manufacturers produce risers made of carbon fibre (with metal fittings) or aluminium with carbon fibre. Risers for beginners are usually made of wood or plastic. The synthetic materials allow economic, predictable manufacture for consistent performance. The greater mass of a modern bow is in itself an aid to stability, and therefore to accuracy. It should be remembered, however, that accuracy is also related to a bow's draw weight, as well as how well an archer handles it. It's therefore imperative, particularly for beginner archers, to never overestimate their capabilities, and to choose a draw weight that is appropriate for their body build and level of experience.*[7]

The modern recurve is the only form of bow permitted in the Olympics (though the Compound bow is permitted in some categories at the Paralympic Games) and is the most widely used by European and Asian sporting archers.

The modern Olympic-style recurve is a development of the American Flatbow, with rectangular-section limbs that taper towards the limb tips. Most recurves today are "take-down" bows: that is, the limbs can be detached from the riser for ease of transportation and storage, and for interchangeability. Older recurves and some modern hunting recurves are one-piece bows. Hunters often prefer one-piece bows over take-down bows because the limb pockets on take-down bows can be a source of noise while drawing.

6.3 Terminology

Arrow rest Where the arrow rests during draw. These may be simple fixed rests or may be spring-loaded or magnetic flip rests.

Back The face of the bow on the opposite side to the string

Belly The face of the bow on the same side as the string

Bow sight An aiming aid attached to the riser

Brace height The distance between the deepest part of the grip and the string; *fistmele* is the traditional term, referring to the equivalent length of a closed fist with the thumb extended, indicating the proper traditional distance used between the deepest part of the grip and the string.

Grip The part of the bow held by the bow hand

Limbs The upper and lower *working parts* of the bow, which come in a variety of different poundages

Nocking point The place on the bowstring where the nock (end) of an arrow is fitted

Riser The rigid centre section of a bow to which the limbs are attached

String The cord that attaches to both limb tips and transforms stored energy from the limbs into kinetic energy in the arrow

Sling A strap or cord attached to the bow handle, wrist or fingers to prevent the bow from falling from the hand

Tab or Thumb ring A protection for the digits that draw the string. Also provides better release performance. Usually made of leather.

Tiller The difference between the limb-string distances measured where the limbs are attached to the riser. Usually the upper distance is slightly more than the bottom one, resulting in a *positive* tiller. Reflects the power-balance between both limbs.

6.4 Other equipment

Archers often have many other pieces of equipment attached to their recurve bows, such as:

Clicker a blade or wire device fitted to the riser, positioned to drop off the arrow when the archer has reached optimum draw length. Used correctly, this ensures the same cast-force each time. Many archers train themselves to shoot automatically when the clicker 'clicks' off the arrow.

Kisser a button or nodule attached to the bowstring. The archer touches the kisser to the same spot on the face each time (usually the lips, hence the name) to give a consistent vertical reference.

Plunger Button a fine-tuning device consisting of a spring-cushioned tip inside a housing. The plunger button screws through the riser so that the tip emerges above the rest. The side of the arrow is in contact with the tip when the arrow is on the rest. The spring is tuned so that it allows a certain amount of movement of the arrow towards the riser on release, bringing the arrow to the ideal "centre shot" location. The plunger button is used to compensate for the arrow's flex, since the arrow flexes as the string pushes onto it with a very high acceleration, creating what is commonly known as the archer's paradox. The device is also known as a cushion plunger, pressure button, or Berger button.

Stabilizers weight-bearing rods attached to a recurve bow to balance the bow to the archer's liking, dampen the effect of torque and dissipate vibration.

- Crossbow
- Mongol bow
- Turkish bow
- Flatbow
- Bow draw
- Gakkung

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[7] Recurve bow draw weight chart

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Scythians shooting with bows, Kerch (antique Panticapeum), Ukraine, 4th century BC

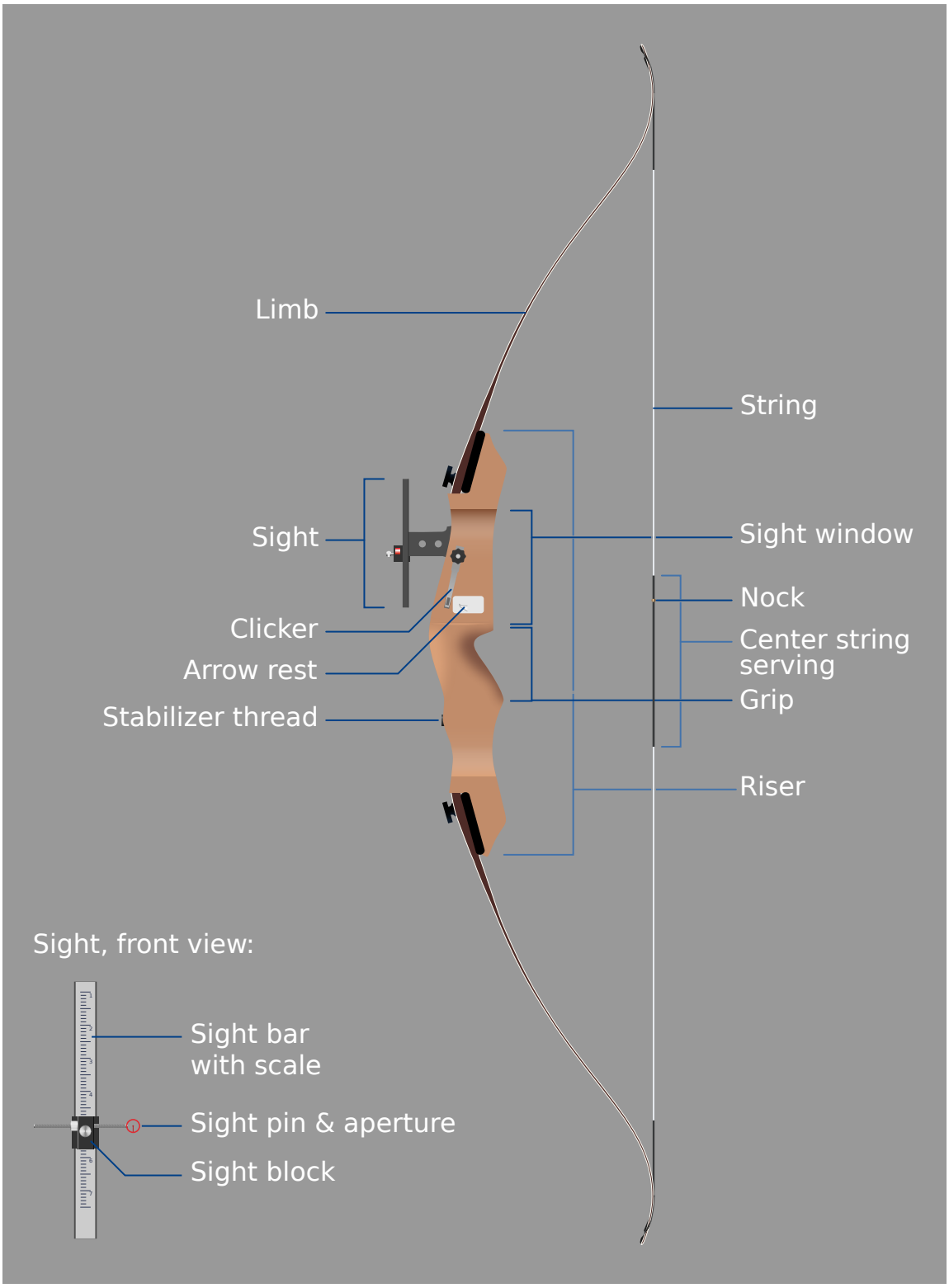

Diagram showing the parts of a modern recurve bow

Chapter 7

Bow shape

A simple left-handed recurve bow, to be held in the right hand. Unlike a composite bow, it is in one piece, with flat limbs made of laminated fiberglass, and a sculpted handle

In archery, the shape of the bow is usually taken to be the view from the side. It is the product of the complex relationship of material stresses, designed by a bowyer. This shape, viewing the limbs, is designed to take into account the construction materials, the performance required, and the intended use of the bow.

There are many different kinds of bow shapes. However, most fall into three main categories: straight, recurve and compound. Straight and recurve are considered traditional bows. If a limb is 'straight' its effective length remains the same as the bow is drawn. That is, the string goes directly to the nock in the strung (braced) position. The materials must withstand these stresses, store the energy, and rapidly give back that energy efficiently. Many bows, especially traditional self bows, are made approximately straight in side-view profile. Longbows as used by English Archers in the Middle Ages at such battles as Crecy and Agincourt were straight limb bows. A recurve bow has tips that curve away from the archer when the bow is strung. By definition, the difference between recurve and other bows is that the string touches a section of the limb when the bow is strung. Recurve bows made out of composite materials were used by, among other groups, the Scythians, Hyksos, Magyars, Huns, Turks, Mongols, and Chinese.

7.1 Design factors

If a limb is 'straight' its effective length remains the same as the bow is drawn. That is, the string goes directly to the nock in the strung (braced) position. When the limb is recurved (tip of limb away from the archer), the string touches the limb before it gets to the nock. The effective length of the limb, as the draw commences, is therefore shorter. However, as the bow is drawn, the recurve 'unwinds', the limb becomes effectively longer, and the mechanical advantage of the archer increases. Counter to this, stresses are building up in the materials of the limbs. The belly of the bow (nearest the archer) is in compression, the back (furthest away from the archer) is in tension, and the line

between is in shear.

The materials must withstand these stresses, store the energy, and rapidly give back that energy efficiently. The amount of energy stored is determined by the stresses withstood and the shape of the limb, from the unstrung position to strung (consider as pre-stressed), then de-formed further to full draw as the recurve unwinds. These basic principles of changing mechanical advantage, to efficiently store more energy, and deliver it to accelerate the arrow, were clearly understood in antiquity, as shown by the examples that follow.

7.2 Straight bows

Many bows, especially traditional self bows, are made approximately straight in side-view profile. They are generally referred to as straight, despite the minor curves of natural wood and the "set" or curvature that a wooden bow takes after use. When the archer commences the draw, mechanical advantage is at its greatest and the bow limbs are only pre-stressed to the strung position; therefore drawing weight is at a minimum. However, the drawing weight rapidly increases because mechanical advantage reduces (consider the string is pulling more and more directly on the limbs) and stresses are building up in the limbs. Consequently, drawing weight 'stacks' (very rapidly increases). On release, the reverse happens, the arrow is accelerated by maximum force, and this force rapidly decreases. Hence, the arrow must be sturdy enough to withstand such acceleration and, as the string may decelerate, it is possible for the arrow to leave the string prematurely, which is inefficient.

Longbows as used by English Archers in the Middle Ages at such battles as Crecy and Agincourt were straight limb bows. Usually made of yew, these bows were used to great effect by many archers shooting together in massed volleys. The arrows were long and heavy ('clothyard shafts') with armour piercing 'bodkin' heads. Practice for such long range warfare survives today in a Clout shoot, named after a type of shirt.

7.3 Recurve bows

Main article: recurve bow

A recurve bow has tips that curve away from the archer when the bow is strung. By definition, the difference between recurve and other bows is that the string touches a section of the limb when the bow is strung. A recurve bow stores more energy and delivers energy more efficiently than an equivalent straight-limbed bow, giving a greater amount of energy and speed to the arrow. A recurve will permit a shorter bow than the simple straight limb bow for a given arrow energy and this form was often preferred by archers in environments where long weapons could be cumbersome, such as in brush and forest terrain, or while on horseback.

Recurved limbs also put greater strain on the materials used to make the bow, and they may make more noise with the shot. Extreme recurves make the bow unstable when being strung. An unstrung recurve bow can have a confusing shape and many Native American weapons, when separated from their original owners and cultures, were incorrectly strung backwards and destroyed when attempts were made to shoot them.*[1]

The unqualified phrase "recurve bow" or just "a recurve" in modern archery circles usually refers to a typical modern recurve bow, as used by archers in the Olympics and many other competitive events. A reflex bow is a bow that has curved or curled arms which turn away from the archer throughout their length.

7.4 Reflex bows

A *reflex bow* is a bow that has curved or curled arms which turn away from the archer throughout their length. When unstrung, the entire length of the bow curves forward from the belly (away from the archer), resembling a "C"; this differentiates a reflex bow from a recurve bow in which only the outer parts of the limbs turn away from the archer. The curves put the materials of the bow under greater stress, allowing a fairly short bow to have a high draw weight and a long draw length. This allows a bow that is 1:2 the length of a recurve or 1:3 the length of a longbow to fire at the same or greater velocity and stopping power. The materials and workmanship must be of high quality. Highly reflexed bows are more difficult to string and may reverse themselves suddenly; they have seldom been used for hunting. However, they were the main armament of the Mongol armies that conquered much of Asia and Europe; their short profile compared to longer bows made them ideal for horseback use.

Scythians shooting with bows, Kerch (antique Panticapeum), Ukraine, 4th century BCE

Bows of traditional materials with significant reflex are almost all composite bows, made of the classic three layers of horn, wood, and sinew; they are a variant of the recurve form normally used for such bows. Highly reflexed composite bows are still used in Korea and were common in Turkish and Indian traditional archery.

There is a section in Homer's Odyssey when the suitors attempt to string Odysseus' bow and are unable to do so, whereas Odysseus is able to string it *without standing up*. A reflex bow is almost impossible to string unless one knows the technique and is easiest to string from a sitting position. This passage has been suggested as evidence that reflex bows were just beginning to spread into the Aegean area at the time of writing.

7.5 Decurve bows

A *decurve bow* is a bow that has arms curved or curled at the ends to turn towards the archer. This bow form reduces the strain on the bow when it is used, and the bow may be under no tension at all when strung, so that it can be kept ready for immediate use at all times. It also reduces the energy stored in the bow, and the speed of the arrow. The form is seldom used in modern or historical bows, but was occasionally used by groups such as the Mohave who did not have easy access to good quality bow wood. It allowed them to make effective hunting weapons from the poor-quality material available.

7.6 Deflex bows

A *deflex bow* is a bow that has arms curved or curled at the base, to turn towards the archer when unstrung. This bow form reduces the strain on the limbs and also the energy stored by the weapon. Most modern recurve bows are built with some degree of deflex. It has been used occasionally in traditional bows, for example to make a bow that looks like a traditional hornbow without using any actual horn.

7.7 Compound bows

Main article: Compound bow

The *compound bow*, not to be confused with a composite bow, is a modern bow that uses a levering system, usually of cables and pulleys, to bend the limbs.The limbs of a compound bow are much stiffer than those of a recurve bow or longbow. This limb stiffness makes the compound bow more energy-efficient than other bows, in conjunction with the pulley/cams. The typical compound bow has its string applied to pulleys (cams), and one or both of the pulleys have one or more cables attached to the opposite limb. When the string is drawn back, the string causes the pulleys to turn. When the draw commences, the archer has reduced mechanical advantage, but during the draw, as the pulley cams rotate, and the archer gains mechanical advantage over the bending limbs, more energy is stored, in comparison to other bows.

7.8 Shaping and tapering

Bows usually taper from the handle to the tips. Tapering reduces mass in the outer limb and dissipates the limb stresses; this increases the speed at which the tips move which propels arrows faster. Shapes may be optimized for various purposes, especially maximum speed of the arrow; the details are the subject of active research.

Narrow bows normally taper uniformly. However, the taper of flatbows varies. The working limbs of "paddle" bows maintain width for almost the entire limb length, "pyramid" bows taper uniformly from the handle to a narrow tip, and "Holmegaard-style" bows remain full width to about two-thirds of the way along the limb, then narrow sharply. "Eiffel Tower" bows taper sharply, but smoothly, to a very narrow outer tip.

The optimal cross-section of the bending section of a bow limb is rectangular, and almost all modern bows have such limbs. However, many, perhaps most, traditional bows have had a cross-section closer to circular, with every possible variation being used at some point. Current definitions of the traditional longbow require approximations of a D-shaped cross section.

7.9 See also

- Crossbow
- English longbow
- Cable-backed bow
- Compound bow
- Laminated bow
- Composite bow
- Mongol bow
- Turkish bow
- Flatbow
- Self bow
- Recurve bow
- Bow draw

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Korean traditional reflex recurve bow, "C" Type - a sitting position (loosened) for portability and storage, used by Old Korean soldiers and officers.

A "pyramid" bow from the front

Chapter 8

Self bow

A **self bow** is a bow made from a single piece of wood. Extra material such as horn nocks on the ends, or built-up handles, would normally be accepted as part of a self bow. Some modern authorities would also accept a bow spliced together in the handle from two pieces of wood.*[1]

8.1 Advantages and disadvantages compared to composite bows

An effective self bow can be made from widely available local material in most inhabited parts of the world, with limited tools whose functions include chopping, shaving, and scraping. A day of work may be needed, starting with a seasoned stave; a composite bow requires a week's work, starting with a much greater range of materials and skills.*[2] However self bows must be long, approximately the height of the archer if they are to allow a long draw, and they are less efficient in the specialized art of flight archery. Well-designed composite bows of high draw-weight give higher arrow velocity, and the bow itself is shorter.

At the weights more usual for modern amateurs, the greater density of horn and sinew compared to wood usually cancels any advantage of composite construction. For most practical non-mounted archery purposes, self bows can perform as well as composite; "the initial velocity is about the same for all types of bow... within certain limits"*[3]

8.2 History

In many parts of the world including much of Africa, the Americas, northern Europe, and Southern Asia, the great majority of traditional bows are self bows. The first bow artifacts, the Stellmoor and Holmegaard artifacts of Northern Europe, are self bows. The Stellmoor bow was made from the heartwood of a Scots pine while the oldest Holmegaard bows were carved from small-diameter elms. In primitive flight archery competitions, bows inspired by the design of the Holmegaard bows perform very well because of their light, non-bending tips.

8.3 Selecting wood

In most inhabited areas, common timbers can be made into high-quality self bows. The pieces must be long enough (approximately the height of the archer), and the grain must be sufficiently straight. Denser timbers normally store energy better and can be made into narrower bows with less effort – high-quality yew allows for particularly narrow self bows, such as the traditional European version of the longbow. The Eastern Woodlands tribes of North America used hickory, tribes in parts of the Midwestern United States osage orange, Native Americans of the west coast used short, wide, recurved bows made of American Pacific yew, Brazilian rainforest tribes used palm wood, and many others. In Europe and North America, common woods such as maple, ash, elm, and oak make excellent flat bows, and are far easier to obtain than good-quality yew.

The fibres on the back of a self bow must be, so far as possible, continuous. This may be achieved by using the outer, under-bark surface of the tree as the back of the bow (convenient with most white woods), by the painstaking

process of removing outer growth rings (often used with yew and osage orange), or by making or following a cut or split surface which happens to have continuous grain (a usual approach if starting with commercially sawn wood).

The density of timber correlates well with its ability to store energy as it is bent. Denser timbers can make narrower bows. The same design for less dense timbers results in the bow taking excessive set-string follow, or even breaking. However, equally effective bows may be made from less dense timber by making them wider near the centre. The mass of equivalent bows is closely similar whatever the density of wood; approximately the same mass of wood is required whatever the density of the timber.

The overall length of bending wood must be about 2.3 times the draw length. Narrow bows (known as "longbows") can bend in the handle. Wider bows (known as "flatbows") must be narrow in the handle if they are to be practical, but the handle must be made thicker so as not to bend, and the complete bow will therefore tend to be longer.

Self bows may be of any side-view profile; moderate recurving can often be achieved with heat and force.

8.4 See also

- Crossbow
- English longbow
- Cable-backed bow
- Compound bow
- Laminated bow
- Composite bow

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Chapter 9

Longbow

This article is about the medieval weapon. For the military helicopter, see Boeing AH-64 Apache#AH-64D. For the video game, see Apache Longbow (video game).

A **longbow** is a type of bow that is tall—roughly equal to the height of the user; allowing the archer a fairly long draw, at least to the jaw. A longbow is not significantly recurved. Its limbs are relatively narrow so that they are circular or D-shaped in cross section. Flatbows can be just as long; the difference is that, in cross-section, a flatbow has limbs that are approximately rectangular.

Longbows have been made from many different woods by many cultures; in Europe they date from the Paleolithic, and since the Bronze Age were made mainly from yew, or from wych elm if yew was unavailable. The historical longbow was a self bow made of wood, but modern longbows may also be made from modern materials or by gluing different timbers together.

Organizations which run archery competitions have set out formal definitions for the various classes; many definitions of the longbow would exclude some medieval examples, materials, and techniques of use.*[1]*[2] According to the British Longbow Society, the English longbow is made so that its thickness is at least ⅝ (62.5%) of its width, as in Victorian longbows, and is widest at the handle. This differs from the Medieval longbow, which had a thickness between 33% and 75% of the width. Also, the Victorian longbow does not bend throughout the entire length, as does the medieval longbow. Longbows have been used for hunting and warfare, by many cultures around the world, a famous example being the English longbow, during the Middle Ages.

9.1 History

In the Middle Ages the English and Welsh were famous for their very powerful longbows, used to great effect in the civil wars of the period and against the French in the Hundred Years' War (with notable success at the battles of Crécy (1346), Poitiers (1356), and Agincourt (1415).*[3]

The first book in English about longbow archery was *Toxophilus* by Roger Ascham, first published in London in 1545 and dedicated to King Henry VIII.

The average length of arrow shafts recovered from the 1545 sinking of the Mary Rose is 75 cm/30 in.

Although firearms supplanted bows in warfare, wooden or fibreglass laminated longbows continue to be used by traditional archers and some tribal societies for recreation and hunting. A longbow has practical advantages compared to a modern recurve or compound bow; it is usually lighter, quicker to prepare for shooting, and shoots more quietly. However, other things being equal, the modern bow will shoot a faster arrow more accurately than the longbow.

The last recorded use of the longbow in war was by British Lt. Col. Jack Churchill, who used it to kill a German soldier in World War II.*[4]

9.2 Design and construction

Because the longbow can be made from a single piece of wood, it can be crafted relatively easily and quickly. Amateur bowyers today can make a longbow in about ten to twenty hours, while highly skilled bowyers, such as those who

produced medieval English longbows, can make wooden longbows in just a few hours.

One of the simpler longbow designs is known as the self bow, by definition made from a single piece of wood. Traditional English longbows are self bows made from yew wood. The bowstave is cut from the radius of the tree so that sapwood (on the outside of the tree) becomes the back and forms about one third of the total thickness; the remaining two thirds or so is heartwood (50/50 is about the maximum sapwood/heartwood ratio generally used). Yew sapwood is good only in tension, while the heartwood is good in compression. However, compromises must be made when making a yew longbow, as it is difficult to find perfect unblemished yew. The demand for yew bowstaves was such that by the late 16th century mature yew trees were almost extinct in northern Europe.*[5] In other desirable woods such as Osage orange and mulberry the sapwood is almost useless and is normally removed entirely.

Longbows, because of their narrow limbs and rounded cross-section (which does not spread out stress within the wood as evenly as a flatbow's rectangular cross section), need to be less powerful, longer or of more elastic wood than an equivalent flatbow. In Europe the last approach was used, with yew being the wood of choice, because of its high compressive strength, light weight and elasticity. Yew is the best widespread European timber that will make good self longbows, (other woods such as Elm can make longbows but require heat treating of the belly and a wider belly/narrower back, whilst still falling into the definition of a longbow) and has been the main wood used in European bows since Neolithic times. More common and cheaper hard woods, including elm, oak, hickory, ash, hazel and maple, are good for flatbows. A narrow longbow with high draw-weight can be made from these woods, but it is likely to take a permanent bend (known as "set" or "following the string") and would probably be outshot by an equivalent made of yew.

Wooden laminated longbows can be made by gluing together two or more different pieces of wood. Usually this is done to take advantage of the inherent properties of different woods: some woods can better withstand compression while others are better at withstanding tension. Examples include hickory and lemonwood, or bamboo and yew longbows: hickory or bamboo is used on the back of the bow (the part facing away from the archer when shooting) and so is in tension, while the belly (the part facing the archer when shooting) is made of lemonwood or yew and undergoes compression (see bending for a further explanation of stresses in a bending beam). Traditionally made Japanese yumi are also laminated longbows, made from strips of wood: the core of the bow is bamboo, the back and belly are bamboo or hardwood, and hardwood strips are laminated to the bow's sides to prevent twisting. Ready-made laminated longbows are available for purchase.

Any wooden bow must have gentle treatment and be protected from excessive damp or dryness. Wooden bows may shoot as well as fiberglass, but they are more easily dented or broken by abuse. Bows made of modern materials can be left strung for longer than wood bows, which may take a large amount of set if not unstrung immediately after use.

9.3 Legacy

The longbow and its historical significance, arising from its effective use by the English and Welsh during the Hundred Years' War, have created a lasting legacy for the longbow, which has given its name to modern military equipment, including:

- The AH-64D Apache Longbow, an attack helicopter;
- The AGM-114L Longbow Hellfire, an air-to-ground missile; and
- The Dakota Longbow T-76, a sniper rifle.

9.4 See also

9.5 References

Notes

[1] The (UK) National Field Archery Association's definition of a longbow

[2] The International Field Archery's definition

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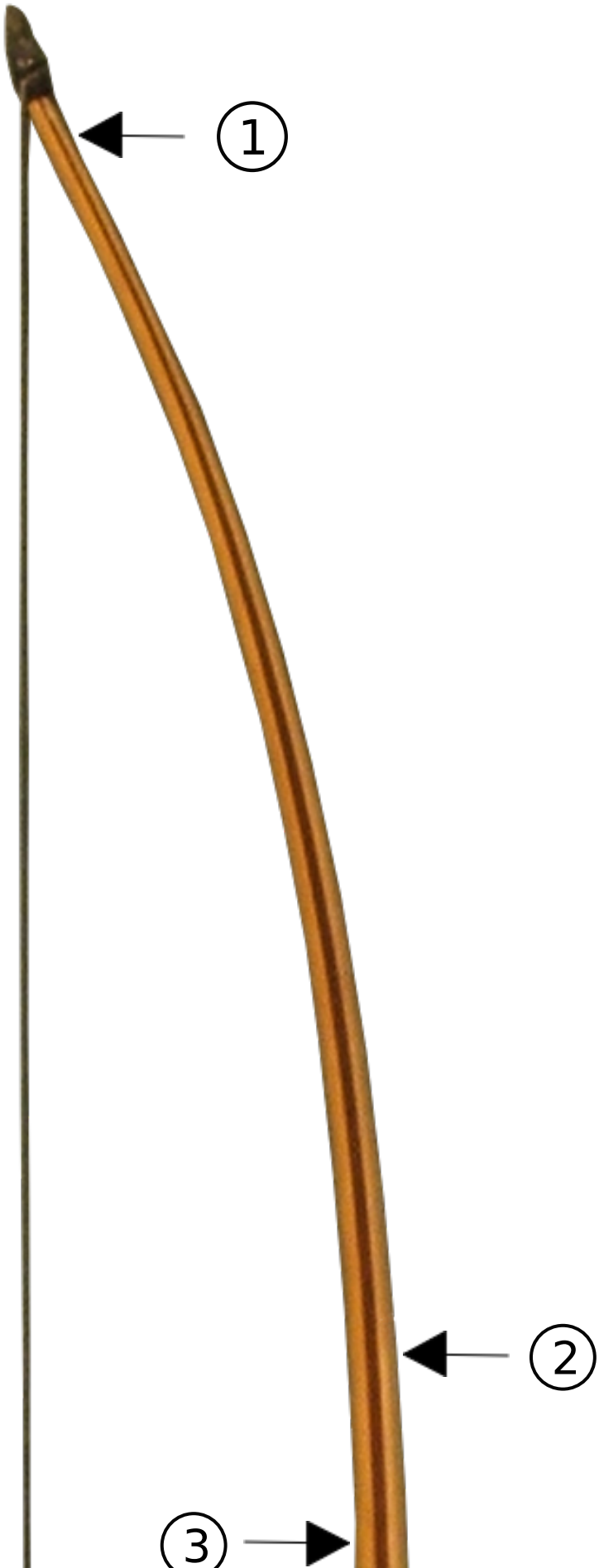
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English longbow of elm

Top: Lemonwood, purpleheart and hickory laminated bow.
Bottom: Yew selfbow.

Chapter 10

Flatbow

A replica of the Holmegaard bow; a flatbow from the Mesolithic period

A **flatbow** is a bow with non-recurved, flat, relatively wide limbs that are approximately rectangular in cross-section. Because the limbs are relatively wide, flatbows will usually narrow and become deeper at the handle, with a rounded, non-bending handle for easier grip. This design differs from that of a longbow, which has rounded limbs that are circular or D shaped in cross-section, and is usually widest at the handle. A flatbow can be just as long as a longbow, but can be very short. (typical lengths would be say, 68-70" flatbow. 70-72" English longbow. 72-76" warbow weight English longbow, but these styles may easily overlap each other). Traditional flatbows are usually wooden selfbows (bows made of one solid piece of wood), though laminated and composite flatbows have been made in ancient and modern times. Modern flatbows commonly use fiberglass.

10.1 Advantages of a rectangular cross-section

The flatbow is a superior bow design for almost all materials because the stress is more evenly spread out than with rounded limb sections. A bow limb is essentially a flexed beam undergoing bending, and in any flexed beam the farther from the neutral axis (line in the middle of the flexing beam which is not under tension or compression: see diagram in Bending article) the more stress there is within the material. When a limb is rounded, as in a longbow, some material sticks out farther from the neutral axis, and thus is put under greater stress. In a flatbow, the flat belly and back ensure that all of the most strained material is a uniform distance from the neutral axis, spreading the load over a wider limb, minimizing stress and making weaker woods far less likely to fail (break or become permanently bent and lose the resilience needed in a bow). Only particularly resilient timbers can make an effective and powerful wooden longbow.

10.2 Suitable timbers

In most parts of the world, common hardwoods may be used to create excellent bows. Suitable and easily available timbers include elm (used in ancient Europe, as evidenced by bows pulled from European bogs), maple, sycamore,

hazel, and ash. The flatbow design also lends itself to very dense, high strength woods such as hickory and especially osage orange (a wood favored by many Native American tribes for bow making). Good quality yew wood is still much more expensive and difficult to find than woods suitable for flatbows, and beginning bowyers are strongly recommended to start with a flatbow made from easily available wood. Because yew, the wood of choice for European longbows, is light, resilient, and has exceptional compressive strength, the rounded design can be used to produce a smooth shooting, efficient, powerful bow. This is economical of wood and of the bowyer's time.

10.3 Disadvantages of a rectangular cross-section

Compared to a narrow, rounded longbow design, the bowyer needs to start with a wider stave, take more time to achieve an approximately rectangular cross-section, and may need to cut through growth rings on the back of the bow.

10.4 Historic use

Flatbows were used by Native American tribes such as the Hupa, Karok, and Wampanoag, prehistoric ancient Europeans, some Inuit tribes, Finno-Ugric nations and a number of other pre-gunpowder societies for hunting and warfare because, unlike longbows, good flatbows can be made from a wide variety of timbers. Flatbows fell from favour in Europe after the Mesolithic, replaced with yew longbows. The trade of yew wood for English longbows was such that it depleted the stocks of yew over a huge area.*[1] Flatbows are currently used by the paleolithic Sentinelese tribes of the Andaman Islands. Flatbows survived in cold areas, such as Finland, where yew does not grow naturally because of the unsuitable climate. The traditional Finnish flatbow is made either from ash, or as birch/pine laminate glued together with fish or hide glue. Yew was available as an imported material for bows in Finland, but it was considered not suitable for serious use, because it is fragile at cold temperatures and the season for hunting for furs is in January and February, when the furs are at their best.

10.5 American flatbow

An American flatbow made out of ash

The American flatbow, also known as the *American longbow*, was developed in the 1930s. It resulted from scientific investigation into the best cross-sectional shape for a bow limb. This research was expected to explain why the English longbow's *D*-section was superior to all other extant designs. Instead, it showed that the best cross-section was a simple rectangle.*[2] The American Flatbow was developed by applying these research findings to the English longbow. The result was a more efficient and stable bow which can be made from more common woods. Because of its coincidental resemblance to some Native American bows, the American flatbow is also known as the *semi-Indian* bow.

The American flatbow was popularised by Howard Hill and quickly displaced the English longbow as the preferred bow for target shooting. The modern Olympic-style recurve bow is a development of the American flatbow, usually using fiberglass rather than wood for the backing and belly of the recurved limbs, artificial materials such as carbon for the core, and with a built-up riser (handle) section (often made of metal, but other materials such as wood or phenolic have been used).*[3] While the tips are superficially like those of the traditional Asiatic composite bow, they are flexible rather than static as described in Fred Bear's patent (#2,665,678)*[4] for bows with working limb tips (recurve).

10.6 See also

- Cable-backed bow
- Horse archer

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10.8 External links

- A step by step reconstruction of the Meare Heath Bow - a Neolithic flatbow. From Digital Digging
- A picture of the Meare Heath bow, a Neolithic European flat bow made of yew heartwood

Chapter 11

Composite bow

Reconstruction of a Ming dynasty Kaiyuan bow by Chinese bowyer Gao Xiang. This is a horn, bamboo, sinew composite.

A **composite bow** is a traditional bow made from horn, wood, and sinew laminated together, cf., laminated bow. The horn is on the belly, facing the archer, and sinew on the outer side of a wooden core. When the bow is drawn, the sinew (stretched on the outside) and horn (compressed on the inside) store more energy than wood for the same length of bow. The strength can be made similar to that of all-wood "self" bows, with similar draw-length and therefore a similar amount of energy delivered to the arrow from a much shorter bow. However, a composite bow requires more different materials than a self bow, its construction takes much more time, and the finished bow is more

Master Heon Kim using a modern Korean composite bow.

sensitive to moisture.

Composite bows have been known from archaeology and art since the second millennium BCE, but their history is not well recorded as they were developed by cultures without a written tradition. They originated among Asiatic pastoralists who used them as daily necessities, classically for mounted archery although they can also be used on foot. Such bows spread among the military (and hunters) of civilizations that came into contact with nomad tribes; composite bows have been used across Asia from Korea to the Atlantic coasts of Europe and North Africa, and southwards in the Arabian peninsula and in India.

The details of manufacture varied between the various cultures that used them. Initially the tips of the limbs were made to bend when the bow was drawn. Later, the tips were stiffened with bone or antler laths; post-classical bows usually have stiff tips, *siyahs*, made as an integral part of the wooden core of the bow.

Like other bows, they lost importance with the introduction and increasing accuracy of guns. In some areas composite bows were still used and were further developed for leisure purposes. Later Turkish bows are specialized for flight archery (shooting for distance). Composite bows are still made and used in Korea and in China, and the tradition has been revived elsewhere. Modern replicas are available, often made with fiberglass bellies and backs with a natural or man-made core.

11.1 Construction and materials

The wooden core gives the bow its shape and dimensional stability. It is often made of multiple pieces, joined with animal glue in V-splices, so the wood must accept glue well. Pieced construction allows the sharp bends that many designs require, and the use of woods with different mechanical properties for the bending and nonbending sections. The wood of the bending part of the limb ("*dustar*") must endure intense shearing stress, and denser woods such as hard maples are normally used in Turkish bows.*[1] Bamboo, and wood of the mulberry family, are traditional in China. Some composite bows have nonbending tips ("*siyahs*"), which need to be stiff and light; they may be made of woods such as Sitka spruce.*[2]

A thin layer of horn is glued onto what will be the belly of the bow, the side facing the archer. Water buffalo horn is very suitable, as is horn of several antelopes such as gemsbok, oryx, ibex, and that of Hungarian grey cattle.*[3] Goat and sheep horn can also be used. Most forms of cow horn are not suitable, as they soon delaminate with use. The horn can store more energy than wood in compression.*[2]

The sinew, soaked in animal glue, is then laid in layers on the back of the bow; the strands of sinew are oriented along the length of the bow. The sinew is normally obtained from the lower legs and back of wild deer or domestic ungulates. Traditionally, ox tendons are considered inferior to wild-game sinews since they have a higher fat content, leading to spoilage.*[1] Sinew will extend farther than wood, again allowing more energy storage.

Hide glue or gelatin made from fish gas bladders is used to attach layers of sinew to the back of the bow, and to attach the horn belly to the wooden core.*[2]

Stiffening laths, if used, are attached. Both horn and laths may be bound and glued with further lengths of sinew. After months of drying the bow is ready for use. Further finishing may include thin leather or waterproof bark, to protect the bow from moisture, and recent Turkish bows were often highly decorated with colourful paints and gold leaf.

Strings and arrows are essential parts of the weapon system, but no type of either is specifically associated with composite bows throughout their history.

11.2 Advantages and disadvantages of composite construction

11.2.1 Advantages

The main advantage of composite bows over self bows (made from a single piece of wood) is their combination of smaller size with high power. They are therefore more convenient than self bows when the archer is mobile, as from horseback, or from a chariot. Almost all composite bows are also recurve bows as the shape curves away from the archer; this design gives higher draw-weight in the early stages of the archer's draw, storing somewhat more total energy for a given final draw-weight. It would be possible to make a wooden bow that has the same shape, length and draw-weight as a traditional composite bow, but it could not store the energy, and would break before full draw.*[2]

For most practical non-mounted archery purposes, composite construction offers no advantage; "the initial velocity is about the same for all types of bow... within certain limits, the design parameters... appear to be less important than is often claimed." However, they are superior for horsemen and in the specialized art of flight archery: "A combination of many technical factors made the composite flight bow better for flight shooting." *[4] The higher arrow velocity is only for well-designed composite bows of high draw-weight. At the weights more usual for modern amateurs, the greater density of horn and sinew compared to wood usually cancels any advantage.*[1]

11.2.2 Disadvantages

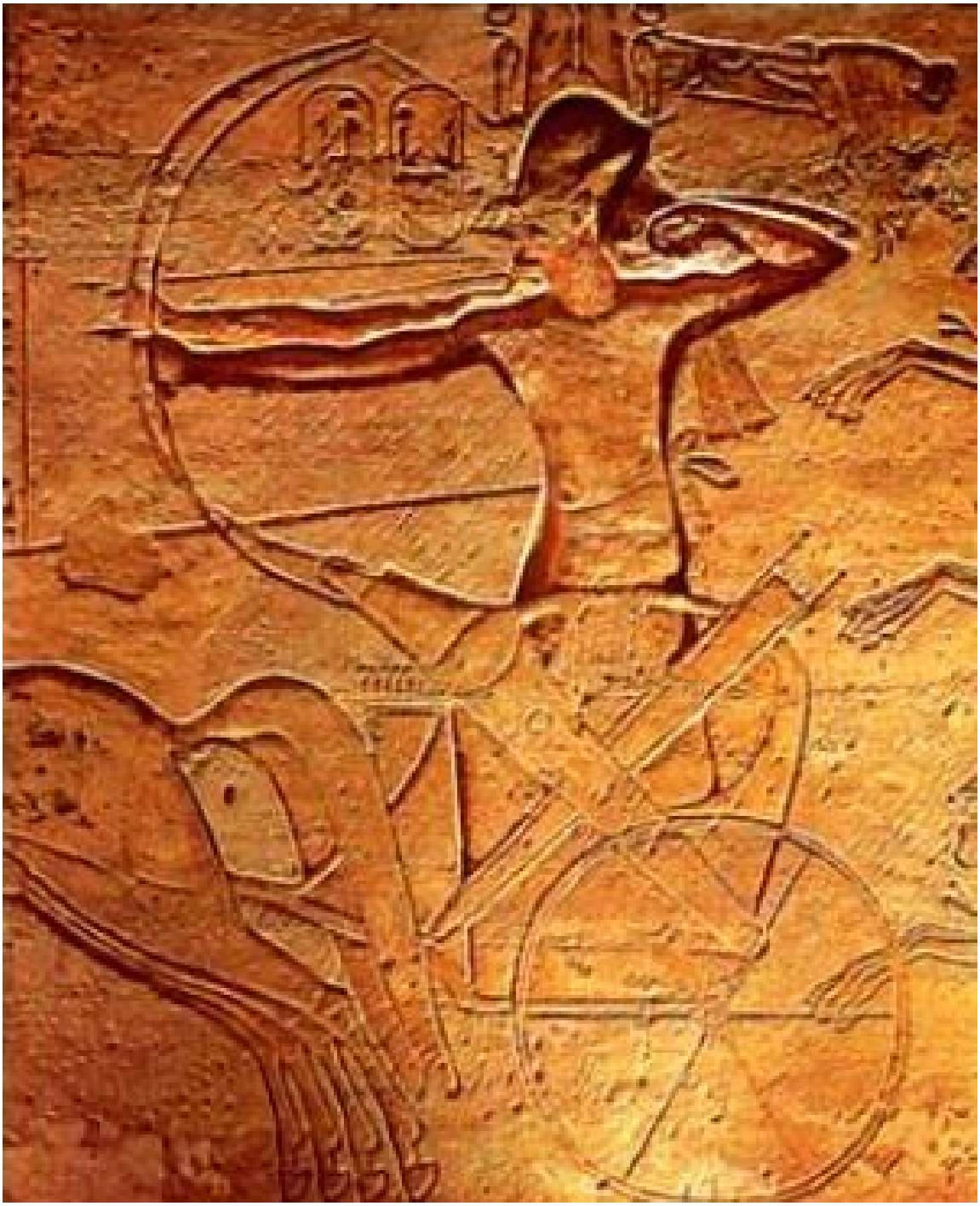
Constructing composite bows requires much more time and a greater variety of materials than self bows, and the animal glue used can lose strength in humid conditions and be quickly ruined by submersion. Karpowicz suggests that crafting a composite bow may take a week's work, excluding drying time (months) and gathering materials, while a self bow can be made in a day and dried in a week.*[1] Peoples living in humid or rainy regions historically have favoured self-bows, while those living in dry or arid regions have favoured composite bows.

Medieval Europeans favoured self bows as hand bows, but they made composite prods for crossbows. The prods were usually well protected from rain and humidity which are prevalent in much of Europe.

11.3 Origins and use

11.3.1 By charioteers

Bows of any kind seldom survive in the archaeological record. Composite bows may have been invented first by the nomads of the Asiatic steppe, who may have based it on earlier Northern Asian laminated bows.*[5] However, archaeological investigation of the Asiatic steppe is still limited and patchy; literary records of any kind are late and scanty and seldom mention details of bows.*[1] There are arrowheads from the earliest chariot burials at Krivoye

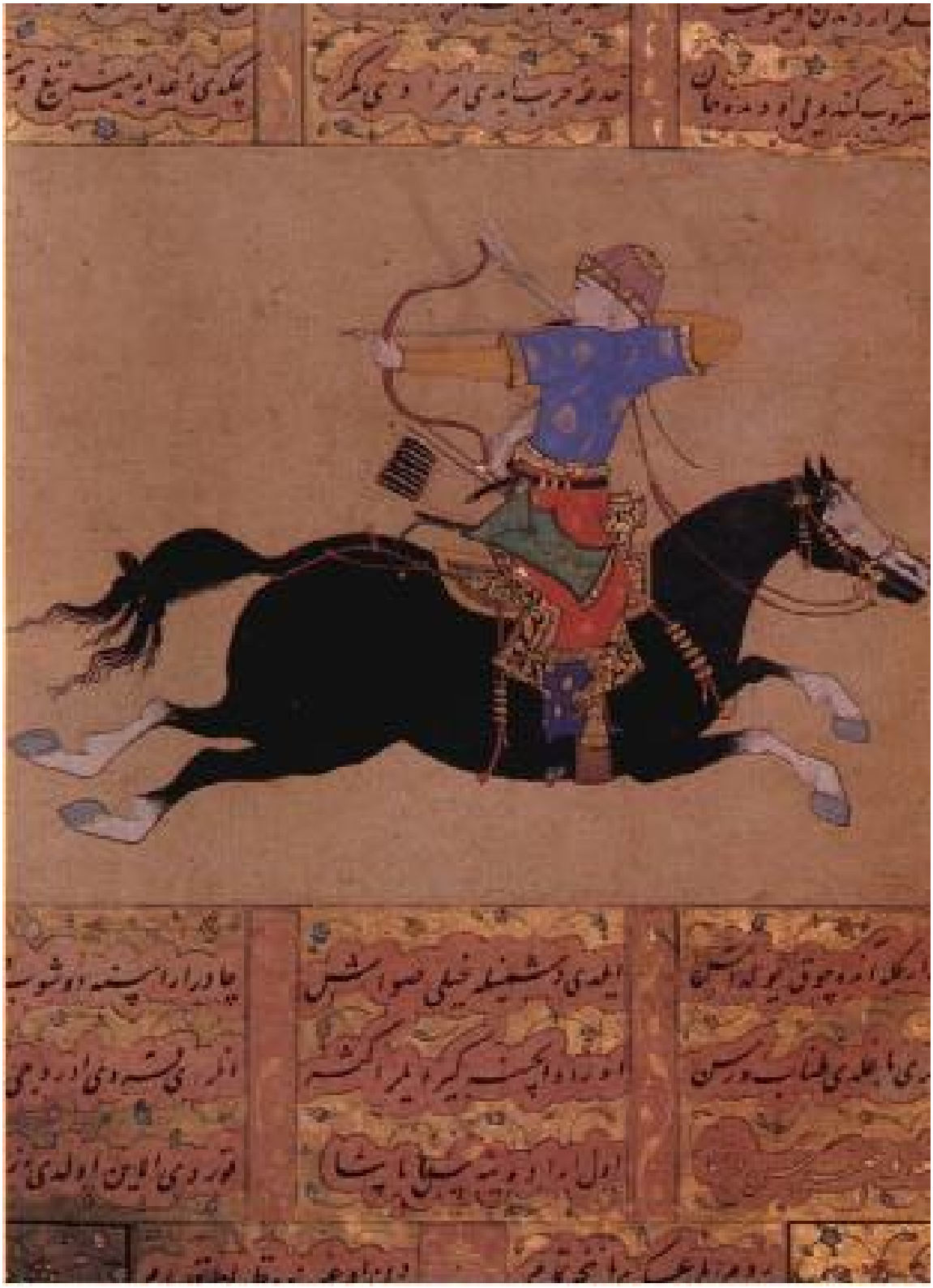


Ramses II at the Battle of Kadesh

Lake, part of the Sintashta-Petrovka culture about 2100–1700 BCE, but the bow that shot them has not survived. The Andronovo Culture, descendant of the Sintashta-Petrovka culture, was the first to extend from the Ural Mountains to Tian Shan,[*] [6] and its successor cultures gave rise to the Indo-Aryan migration.

Composite bows were soon adopted and adapted by civilizations who came into contact with nomads, such as the Chinese, Assyrian, and Egyptian. Several composite bows were found in the tomb of Tutankhamun, who died in 1324 BCE.[*] [7] Composite bows (and chariots) are known in China from at least the Shang Dynasty (1700–1100 BCE).[*] [8] By the 4th century BCE, chariotry had ceased to have military importance, replaced by cavalry everywhere (except in Britannia where charioteers are not recorded as using bows).

11.3.2 By mounted archers



Ottoman horse archer

The mounted archer became the archetypal warrior of the steppes and the composite bow was his archetypal weapon, used to protect the herds, in steppe warfare, and in incursions (notably those of the Huns, Magyars, Mongols, and Turkic peoples such as Cumans, Oghuz and Pechenegs) into settled lands. Classic tactics for horse-mounted archers

included skirmishing; they would approach, shoot, and retreat before any effective response could be made.*[9] The term Parthian shot refers to the widespread horse-archer tactic of shooting backwards over the rear of their horses as they retreated. Parthians inflicted heavy defeats on Romans, the first being the Battle of Carrhae. However, horse archers did not make an army invincible; Han General Ban Chao led successful military expeditions in the late 1st century CE that conquered as far as central Asia, and both Philip of Macedon and his son Alexander the Great defeated horse archer armies. Well-led Roman armies defeated Parthian armies on several occasions and twice took the Parthian capital.

11.3.3 By infantry

The infantry archers of classical Greece and the Roman Empire used composite bows. The military of the Han Dynasty (220 BCE–206 CE) utilized composite crossbows, often in infantry square formations, in their many engagements against the Xiongnu. Until 1571 composite archers were a main component of the forces of the Ottoman Empire, but in the Battle of Lepanto in that year they lost most of these troops and never replaced them.*[10]

11.4 Technical changes to classical times

The details of bow construction changed somewhat with time. It is not clear that the various developments of the composite bow led to measurable improvements: "the development of archery equipment may not be a process involving progressive improvements in performance. Rather, each design type represents one solution to the problem of creating a mobile weapon system capable of hurling lightweight projectiles." *[4]

11.4.1 Scythian bows, bending tips

Scythians shooting with bows, Panticapaeum (known today as Kertch, Ukraine), 4th century BCE.

Variants of the Scythian bow were the dominant form in Asia until approximately the first century BCE. These were short weapons - one was 119 cm long when strung, with arrows perhaps 50–60 cm long - with flexible, "working" tips; the wooden core was continuous from the centre to the tip.*[11]

11.4.2 Siyahs/kasans, stiff tips

From about the 4th century BCE, the use of stiffened ends on composite bows became widespread. The stiffened end of the bow is a "siyah" (Arabic, Persian),*[12] "szarv" (Hungarian), "sarvi" (Finnish; both 'sarvi' and 'szarv' mean 'horn') or "kasan" (Turkish); the bending section is a "dustar" (Arabic), "lapa" (Finnish) or "sal" (Turkish). For centuries, the stiffening was accomplished by attaching laths of bone or antler to the sides of the bow at its ends. The bone or antler strips are more likely to survive burial than the rest of the bow. The first bone strips suitable for this purpose come from "graves of the fourth or third centuries" BCE.*[13] These stiffeners are found associated with nomads of the time. Maenchen-Helfen states that they are not found in Achaemenid Persia, nor in early Imperial Rome, nor in Han China. However Coulston attributes Roman stiffeners to about or before 9 CE.*[14] He identifies a Steppe Tradition of Scythian bows with working tips, which lasted, in Europe, until the arrival of the Huns, and a Near East or Levantine tradition with siyahs, possibly introduced by the Parni as siyahs are found in Sassanid but not Achaemenid contexts. Siyahs have also been described from the Arabian peninsula.*[15] Composite bows were adopted by the Roman Empire and were made even in the cold and damp of Britannia.*[16] They were the normal weapon of later Roman archers, both infantry and cavalry units (although Vegetius recommends training recruits "*arcubus ligneis*" , with wooden bows).*[17]

11.4.3 Laths stiffening the grip

A new bow type, in which bone reinforcements cover the handle of the bow as well as the tips, may have developed in Central Asia during the 3rd to 2nd century BCE,*[18]*[19]*[20] with earliest finds from the area of Lake Baikal. Fittings from this type of bow appear right across Asia*[21] from Korea to the Crimea. Such bows with reinforcement of both grip and siyahs have been called "Hun," "Hunnic" or "Hsiung-nu" composite bows.*[15]*[22]*[23] Huns did use such bows, but so did many other peoples; Rausing termed this type the 'Qum-Darya Bow' from the Han Chinese type-site at the frontier post of Loulan, at the mouth of the Qum Darya river, dated by analogy between c. 1st century BCE and the 3rd century CE.*[21]

With the arrival of the Huns, this tradition of bows with stiffened grips arrived in Europe. "Alanic graves in the Volga region dating to the 3rd to 4th century CE signal the adoption of the Qum-Darya type by Sarmatian peoples from Hunnic groups advancing from the East. In general, Hunnic/Qum-Darya bows had two pairs of ear laths identical in every respect to those found on Roman limes sites. The ear laths show only a greater proportion of longer laths (like those of Roman examples from Bar Hill and London). More distinctively, 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. 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." *[21]

Such bows were often asymmetric, with lower limbs shorter than the upper.*[13]*[24]*[25]

The Huns and their successors greatly impressed their neighbours with their archery. Germanic tribes transmitted their respect orally for a millennium; in the Scandinavian Hervarar saga, the Geatish king Gizur taunts the Huns and says, "Eigi gera Húnar oss felmtraða né hornbogar yðrir." (We fear neither the Huns nor their hornbows.) The Romans, as described in the Strategikon, Procopius's histories, and other works, changed the entire emphasis of their army, from heavy infantry to cavalry, many of them armed with bows. Maurikios's Strategikon describes the Byzantine cavalry as bow-armed *cursores* and lance-armed *defensores*.*[26]

11.4.4 Additional stiffening laths

The Qum-Darya bow was superseded in the modern area of Hungary by an 'Avar' type, with more and differently-shaped 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. The siyah 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 of the siyah than on Qum-Darya type examples. Additional laths were usually added to the belly and back of the siyah 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. Examples measured in situ suggest bow lengths of 120–140 cm. When unstrung the siyahs reversed sharply forward at an angle of 50-60 degrees.*[21]

11.5 Post-classical development

After the fall of the Western Roman Empire, armies of the Byzantine Empire maintained their tradition of horse archery for centuries. Byzantium finally fell to the Turks before the decline of military archery in favour of guns. Turkish armies included archers until about 1591 (they played a major role in the Battle of Lepanto (1571),*[10] and flight archery remained a popular sport in Istanbul until the early 19th century.*[27] Most surviving documentation of the use and construction of composite bows comes from China and the Middle East; until reforms early in the 20th century, skill with the composite bow was an essential part of the qualification for officers in the Chinese Imperial army.

The composite bow was adopted throughout the Arab world, even though some Bedu tribesmen in the Hijaz retained the use of simple self bows.*[25] Persian designs were used after the conquest of the Sassanid Empire, and Turkish-type bows were widely used after the Turkic expansions. Roughly speaking, Arabs favoured slightly shorter siyahs and broader limbs than the Indo-Persian designs. Sometimes the protective cover on the back was painted with Arab calligraphy or geometric patterns.*[25] No design was standardized over the vast area of the Arab conquests. It was said that the best Arab composite bows were manufactured in Damascus, Syria. The first surviving treatise on composite bow construction and archery was written in Arabic under Mamluk rule about 1368.*[25]*[28]

11.5.1 Integral wooden siyahs

Later developments in the composite bow included siyahs made of separate pieces of wood, attached with a V-splice*[29] to the wooden core of the bow, rather than strengthened by external reinforcement.*[1] Mediaeval and modern bows generally have integral wooden siyahs and lack stiffening laths.

11.5.2 String bridges

A string "bridge" or "run" is an attachment of horn or wood, used to hold the string a little further apart from the bow's limbs at the base of the siyahs, as well as allowing the siyah to rest at an angle forward of the string. This attachment may add weight, but might give a small increase in the speed of the arrow by increasing the initial string angle and therefore the force of the draw in its early stages. Large string bridges are characteristic of Manchu (Qing dynasty, 1644–1911) bows and late Mongolian bows, while small string bridges are characteristic of Korean, Crimean Tatar, and some Ming dynasty (1368–1644) bows.*[30]*[31]*[32] String bridges are not present in artwork in the time of Genghis Khan or before.

11.6 Modern living traditions of composite bows

All Eurasian composite bows derive from the same nomad origins, but every culture that used them has made its own adaptations to the basic design. The Turkish, Mongolian, and Korean bows were standardized when archery lost its military function and became a popular sport.*[33] Recent Turkish bows are optimized for flight shooting.

11.6.1 Arab bow

Fragments of composite bows bone laths were found among grave goods in the United Arab Emirates dating from the period between 100BC-150AD.*[34]

11.6.2 Turkish bow

Main article: Turkish bow

A Saracen pirate holding a bow of the then-popular short Kipchak (Mameluk) design.

This is the Ottoman development of the composite bow, presumably brought from the steppes. Turkish bows evolved, after the decline of military archery, into probably the best traditional flight bows. Their decoration often included delicate and beautiful multicoloured designs with gold.[*][1][*][27]

11.6.3 Chinese bow

Main article: Chinese archery

For millennia, archery has played a pivotal role in Chinese history.*[35] Because the cultures associated with Chinese society spanned a wide geography and time range, the techniques and equipment associated with Chinese archery are diverse. Historical sources and archaeological evidence suggest that a variety of bow designs existed throughout Chinese history.*[36] For much of the 20th century, only one Chinese traditional bow and arrow making workshop was active.*[37] However, in the beginning of the 21st century, there has been revival in interest among craftsmen looking to construct bows and arrows in the traditional Chinese style.*[38]

11.6.4 Mongol bow

Main article: Mongol bow

The Mongolian tradition of archery is attested by an inscription on a stone stele that was found near Nerchinsk in Siberia: "While Genghis Khan was holding an assembly of Mongolian dignitaries, after his conquest of Sartaul (Khwarezm), Yesüngge (the son of Genghis Khan's brother) shot a target at 335 alds (536 m)." The Mongol bowmaking tradition was lost under the Manchus, who forbade archery; the present bowmaking tradition emerged after independence in 1921 and is based on Manchu types of bow.*[39] Mounted archery had fallen into disuse and has been revived only in the 21st century.

Archery with composite bows is part of the annual festival of the three virile sports (Wrestling, Horseriding, Archery), called "Naadam".

11.6.5 Hungarian bow

The Hungarian bow is a fairly long, approximately symmetrical, composite reflex bow with bone stiffeners. Its shape is known from two graves in which the position of the bone plates could be reconstructed.*[40] Modern Hungarians have attempted to reconstruct the composite bows of their ancestors and have revived mounted archery as a competitive sport.

11.6.6 Korean bow

Main article: Korean bow

A traditional Korean bow, or gakgung, is a small but very efficient horn-bamboo-sinew composite bow. Korean archers normally practice at a range of approximately 145 metres.*[33]

11.6.7 Perso-Parthian bow

The Perso-Parthian bow is a symmetric recurve under high tension when strung. The "arms" of the bow are supposed to reflex far enough to cross each other when the bow is unstrung. The finished bow is covered by bark, fine leather, or in some cases shark skin to keep out moisture.*[2]

Perso-Parthian bows were in use as late as the 1820s in Persia (ancient Iran). They were then replaced by muskets.

11.7 Analogous New World bows, modern replicas, alternative materials

11.7.1 American sinew-backed bows

When Europeans first contacted Native Americans, some bows, especially in the area that became California, already had sinew backing. After the reintroduction of horses, newly mounted groups rapidly developed shorter bows, which

were often given sinew backing. The full three-layer composite bow with horn, wood, and sinew does not seem to be recorded in the Americas, and horn bows with sinew backing are not recorded before European contact.*[41]

11.7.2 Replicas made with modern materials

Modern replicas of traditional composite bows are commercially available; they are usually made with fibreglass or carbon on both belly and back, easier to mass-produce and easier to take care of than traditional composite bows.

Other less satisfactory materials than horn have been used for the belly of the bow (the part facing the archer when shooting), including bone, antler, or compression-resistant woods such as osage orange, hornbeam, or yew. Materials that are strong under tension, such as silk, or tough wood, like hickory, have been used on the back of the bow (the part facing away from the archer when shooting).*[2]

11.8 See also

- Crossbow
- English longbow
- Longbow
- Flatbow
- Archery
- Mounted archery
- Bow shape

11.8.1 Bow construction techniques

- Self bow
- Compound bow
- Laminated bow
- Cable-backed bow

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11.10 External links

- The Asian Traditional Archery Research network
- The building process of a Manchu composite bow
- Ancient Composite Bows
- Making an Asiatic Composite Bow
- Five composite bows from the tomb of Tutankhamun

Chapter 12

Takedown bow

A **Takedown bow** is a bow assembled out of a riser and two limbs to make a working bow when strung.*[1]

The primary advantage of the takedown design is that it can be transported in a much shorter case when disassembled. The secondary advantage is that an archer can change bow configuration by changing limbs.

The riser is the center where the archer holds the bow. The limbs attach to the riser.

The limbs are the parts of a bow that bend when the string is drawn. The string attaches at each end of the limbs and gives propelling force to the arrow.

An archer can update their takedown bow with new limbs to take advantage of advancements in materials or design.*[2]

Stronger limbs give a greater draw weight, which will impart more force to the arrow. But stronger limbs require the archer to do more work to pull the string back, and more effort to hold steady while aiming.

Longer or shorter limbs can be used to change the length of the bow for convenience or to match the preference of the archer for smoothness in the draw cycle, and stability.

Almost all bows used for Olympic Archery are takedown recurve bows.*[3]

12.1 References

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[2] *Fundamentals of the Design of Olympic Recurve Bows*

[3] *Archery Equipment and History*

12.2 External links

- World Archery, Archery Equipment

Chapter 13

Compound bow

A **compound bow** is a modern bow that uses a levering system, usually of cables and pulleys, to bend the limbs.*[1]

The pulley/cam system grants the wielder a mechanical advantage, and so the limbs of a compound bow are much stiffer than those of a recurve bow or longbow. This rigidity makes the compound bow more energy-efficient than other bows, as less energy is dissipated in limb movement. The higher-rigidity, higher-technology construction also improves accuracy by reducing the bow's sensitivity to changes in temperature and humidity.

The pulley/cam system also confers a benefit called "let-off". As the string is drawn back, the pulleys rotate. The pulleys are eccentric rather than round, and so their effective radius changes as they rotate. By the time the bow is at full draw, the change in pulley radius has approximately doubled the wielder's mechanical advantage, and so less force is needed to hold at full draw. This "let-off" gives compound bows their characteristic draw-force curve: a quick rise to peak force and then diminishing to a much lower holding force. The exact shape of the curve is a function of the pulley geometry, which is a matter of buyer preference.

The compound bow was first developed in 1966 by Holless Wilbur Allen in Missouri, and a US patent was granted in 1969. The compound bow has become increasingly popular. In the United States, the compound is the dominant form of bow.

In literature of the early 20th century, before the invention of compound bows, composite bows were described as "compound".*[2] This usage is now outdated.

13.1 Construction of compound bow

A bow's central mount for other components such as the limbs, sights, stabilizers and quivers is called the riser. Risers are designed to be as rigid as possible. The central riser of a compound bow is usually made of aluminium, magnesium alloy, or carbon fiber and many are made of the aircraft-grade 7075 aluminium alloy.

Limbs are made of composite materials and are capable of taking high tensile and compressive forces. The limbs store all the energy of the bow – no energy is stored in the pulleys and cables. A draw weight generally falls between 10 and 100 pounds enabling arrow speeds of 150 to 370 feet per second (46 to 113 m/s)

In the most common configuration, there is a cam or wheel at the end of each limb. The shape of the cam may vary somewhat between different bow designs. There are several different concepts of using the cams to store energy in the limbs, and these all fall under a category called **bow eccentrics**. The four most common types of bow eccentrics are Single Cam, Hybrid Cam, Dual Cam and Binary Cam. However, there are also other less common designs, like the Quad Cam and Hinged. The "let off" is a term that describes what happens as the cam rolls all the way over. This can be seen in the close-up picture. As the bow is drawn, the draw weight increases to a peak and then "lets off" a certain percentage of the peak draw weight before a stop (known as "the wall") prevents the bow from being drawn further. The let-off is commonly between 65% and 80% of the peak weight for recently designed compound bows, although some older compound bows provided a let-off of only 50% and some of the most recent designs achieve let offs in excess of 90%.

The photo on the right shows the axle attaching the limb to cam is mounted at the edge of the cam as opposed to the center. As the string is drawn the cam turns and imparts force to compress the limb. Initially, the archer has the

'short' side of the cam, with the leverage being a mechanical disadvantage. High energy input is therefore required. When near full draw is reached, the cam has turned to its full extent, the archer has gained mechanical advantage, and the least amount of force needs to be applied to the string to keep the limbs bent. This is known as "let off". The lower holding weight enables the archer to maintain the bow fully drawn and take more time to aim. This let-off enables the archer to accurately shoot a compound bow with a much higher peak draw weight than other bows (see below).

However, there are quite a few youth-oriented compound bows with low draw weights that feature no let-off and have a maximum draw length deliberately set farther than the majority of young shooters would reach. This effectively makes the bow function very similar to a recurve, with the draw length determined by the shooter's preferred anchor point. This feature removes the necessity to adjust the bow draw length or use a different bow for different shooters (or to change bows as the shooter gets older). This type of bow is required for use in the U.S. National Archery in the Schools Program.

At the other extreme, one manufacturer, Concept Archery, is known for producing a compound bow with 99% let-off. Although it is quite unsafe to do so, such a bow can be drawn and pointed at the ground, and the mere weight of the bow will keep it drawn even if the grip is released and the bow is hung by the string (although extreme caution must be exercised when the bow is drawn to avoid accidentally disturbing the bow out of the let-off zone without first establishing a firm grip on the string and the foregrip).

Compound bow strings and cables are normally made of high-modulus polyethylene and are designed to have great tensile strength and minimal stretchability, so that the bow transfers its energy to the arrow as efficiently and durably as possible. In earlier models of compound bows, the cables were often made of plastic-coated steel.

13.2 Comparison to other bow types

13.2.1 Technical advantages

- The function of the cam systems (known as the 'eccentrics') is to maximize the energy storage throughout the draw cycle and provide let-off at the end of the cycle (less holding weight at full draw). A traditional recurve bow has a very linear draw weight curve - meaning that as the bow is drawn back, the draw force becomes heavier with each inch of draw (and most difficult at full draw). Therefore, little energy is stored in the first half of the draw, and much more energy at the end where the draw weight is heaviest. The compound bow operates with a different weight profile, reaching its peak weight within the first few inches of the draw, and remaining more flat and constant until the end of the cycle where the cams "let-off" and allow a reduced holding weight. This manipulation of the peak weight throughout the draw (accomplished by the elliptical shape of the cams that change leverage and mechanical advantage) is why compound bows store more energy and shoot faster than an equivalent peak weight recurve bow or longbow.
- The design of the cams directly controls the acceleration of the arrow. What is termed a "soft cam" will accelerate the arrow more gently than a "harder" cam. Novice archers will typically shoot a soft cam whereas a more advanced archer may choose to use a harder cam to gain speed. Bows can be had with a variety of cams, in a full spectrum from soft to hard.
- Some pulley systems use a single cam at the bottom of the bow and a balanced wheel at the top of the bow instead of two identical cams. This design eliminates the need for buss cables and instead uses a single string that begins at the cam on the bottom of the bow, travels over the wheel on top, around the bottom cam again, and ends attaching to the top limb.
- When a compound bow is drawn, the limbs are pulled in toward each other, by the buss cables, unlike a longbow or recurve where the limbs flex in the direction of the bow string. This difference allows modern compounds to have limbs that are horizontal instead of angled. The horizontal limb configuration minimizes the recoil and vibration felt by the shooter when the arrow is released.
- The compound bow is resistant to temperature and humidity changes, giving the bow superior accuracy, velocity, and distance in comparison to bows made of natural materials.
- The pulley system will usually include some rubber-covered blocks that act as draw-stops. These provide a solid "wall" that the archer can draw against. These draw stops can be adjusted to suit the archer's optimum draw-length, which helps the archer achieve a consistent anchor point and a consistent amount of force imparted to the arrow on every shot, further increasing accuracy.

13.2.2 Technical disadvantages

- The relatively large number of moving parts requires additional maintenance and creates more points of failure.
- Warranties for compound bows do not cover "dry loosing" (dry fire), and it's not unusual for numerous parts, especially the limbs, to be damaged or destroyed after even a single dry loosing. If a string or cable breaks when the bow has been drawn this will have a similar damaging effect on the limbs.
- Unlike traditional bows, replacing the string or making adjustments to let-off or draw length often requires a bow press or a trip to an archery pro shop that has one.
- In some compound bow models, adjusting draw length or let-off weight percentage requires replacing cams or other parts along with a bow press to do so. This makes selling and buying certain used compound bows more difficult due to considerable extra expense needed to adjust a bow that doesn't already match the new shooter's exact preference.

13.2.3 Circumstantial advantages

- Compound archers often use a mechanical release aid to hold and release the string. This attaches to the bowstring near the point where the arrow attaches, the nocking point, and permits the archer to release the string with a squeeze of a trigger or a slight increase of tension. The use of a release aid gives a more consistent release than the use of fingers on the string as it avoids archer's paradox which is inevitable when the bowstring is released directly from the fingers.
- In tournaments, compound archers usually equip their bows with a sighting system, consisting of a "peep sight" held within the bowstring that acts as a back sight, and a front sight attached to the bow handle. Some front sights are magnifying and/or adjustable for targets at different distances. Some sights have multiple "pins" set up for targets at different distances.
- Stabilisers and dampers are particularly well-developed for the compound bow. They allow the archer to hold steadier at full draw, reduce movement of the bow as the arrow is released, and absorb some of the recoil shock that would otherwise be transmitted to the archer's body, especially shoulder and elbow.

13.2.4 Circumstantial disadvantages

- The relatively low holding weight of a compound bow compared to a recurve bow makes the compound more sensitive to certain shooting form faults when the archer is at full draw. In particular, it's easier for the archer to torque (twist) the bow around the vertical axis, leading to left-right errors, and also a plucked or snatched release can have more effect.

13.3 Quantities describing compound bows

AMO standard draw length is the distance from the string at full draw to the lowest point on the grip plus 1.75 inches / 4.45 cm.[*] [3] Because the draw force may increase more or less rapidly, and again drop off more or less rapidly when approaching peak draw, bows of the same peak draw force can store different amounts of energy. Norbert Mullaney has defined the ratio of stored energy to peak draw force (S.E./P.D.F.). This is usually around one foot-pound per pound / .3048 joules per meter (but can reach 1.4 ft·lbf/lbf / .42672 J/m).

The efficiency of bows also varies. Normally between 70-85% of the stored energy is transferred to the arrow. This stored energy is referred to as potential energy. When transferred to the arrow it is referred to as kinetic energy. The product of S.E./P.D.F. and efficiency can be called the power factor. There are two measurement standards of this quantity - AMO and IBO speed. AMO is defined as the initial velocity of a 35 g / 540 grain arrow when shot from a bow with a peak draw weight of 270 N / 60 lbf and draw length 76 cm / 30 inches. IBO speed is defined as the initial velocity of a 22.7 g / 350 grain arrow shot from a bow with a peak draw weight of 300 N / 70 lbf and a draw length of 76 cm / 30 inches.

Brace height is the distance from the pivot point of the grip to the string at rest. Typically a shorter brace height will result in an increased power stroke, but comes at the price of a bow that's less forgiving to shooter error and having harsher string slap.

13.4 Arrows used

See also: Arrow

Arrows used with compound bows do not differ significantly from arrows used with recurve bows, being typically either aluminium alloy, carbon fiber, or often a composite of the two materials. The only notable difference is that the spine of the arrow, which is a measure of its stiffness, is not as great for a compound bow as it would be for a recurve bow of the same draw weight (power). This is due to the fact that a compound bow will accelerate an arrow more gently and linearly as the cam unwinds so flexing the arrow less, as compared to the explosive acceleration of an arrow from a recurve bow where the full power of the limbs is applied to the arrow as soon as the string is released.

Wooden arrows are not recommended for use with compound bows due to the higher overall forces that are applied to the arrow being more likely to break the arrow, possibly driving parts of the broken arrow shaft into an archer's arm.

Manufacturers produce arrow shafts with different weights (mass), different spines (stiffness), and different lengths in the same model of shaft to accommodate different draw weights and lengths, matched to archers' different styles, preferences and physical attributes.

Arrow stiffness (spine) is an important parameter in finding arrows that will shoot accurately from any particular bow (see Archer's paradox), the spine varying with both the construction and length of the arrow.

Another important consideration is that the IBO (International Bowhunter Organization) recommends at least 5 grains of total arrow weight per pound of draw weight; this means a bow that draws 60 lb would need at least a 300 grain finished-with-tip arrow.

13.5 See also

- Archery
- Bow shape
- Bow (weapon)
- Binary cam
- Crossbow
- English longbow
- Flatbow
- Longbow
- Horse archer

13.5.1 Bow construction techniques

- Self bow
- Cable-backed bow
- Compound bow
- Laminated bow
- Composite bow

13.6 References

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[3] "AMO Standards".

General references

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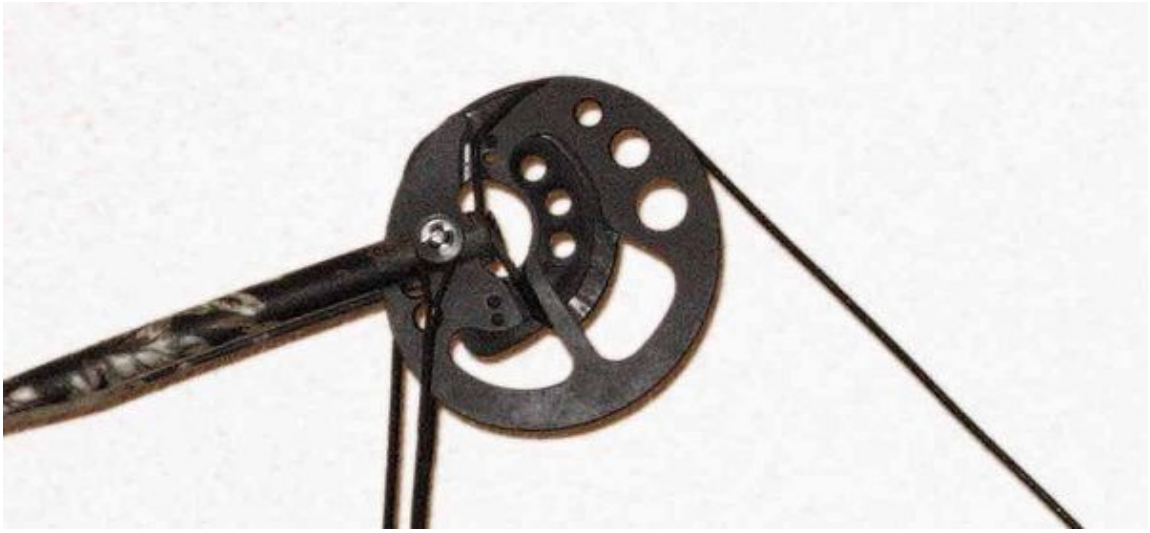
13.7 External links

- Extensive article on the compound bow *Twenty-five years after Allen's patent of December 1969.*
- Photos of compound bows from the 1970s
- Compound Bow Diagram


BROWNING



Browning Compound Bow Pulley System Closeup

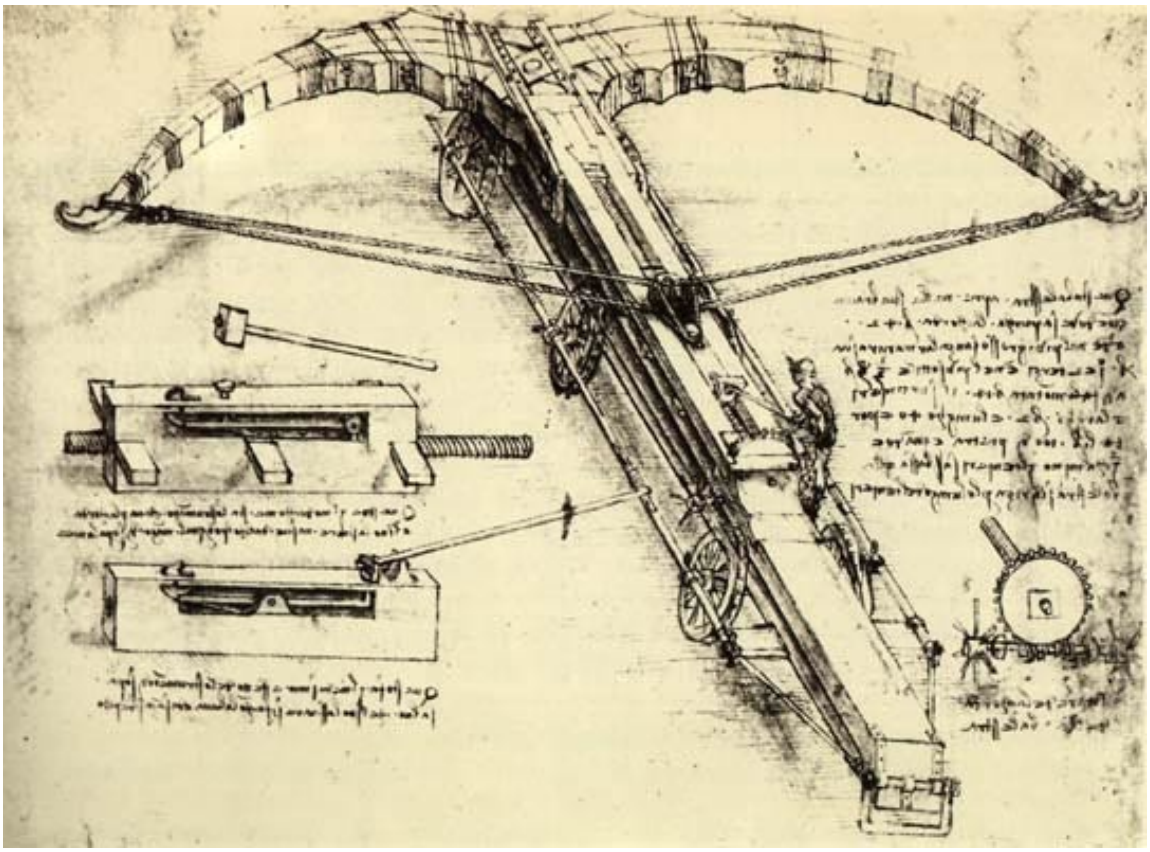
Albina Loginova at women's individual compound 3rd place, 2013 FITA Archery World Cup, Paris, France.

Chapter 14

Crossbow

This article is about the weapon. For other uses, see Crossbow (disambiguation).

A **crossbow** is a type of weapon, based on the bow, consisting of a horizontal bow-like assembly mounted on a



Sketch by Leonardo da Vinci, c. 1500

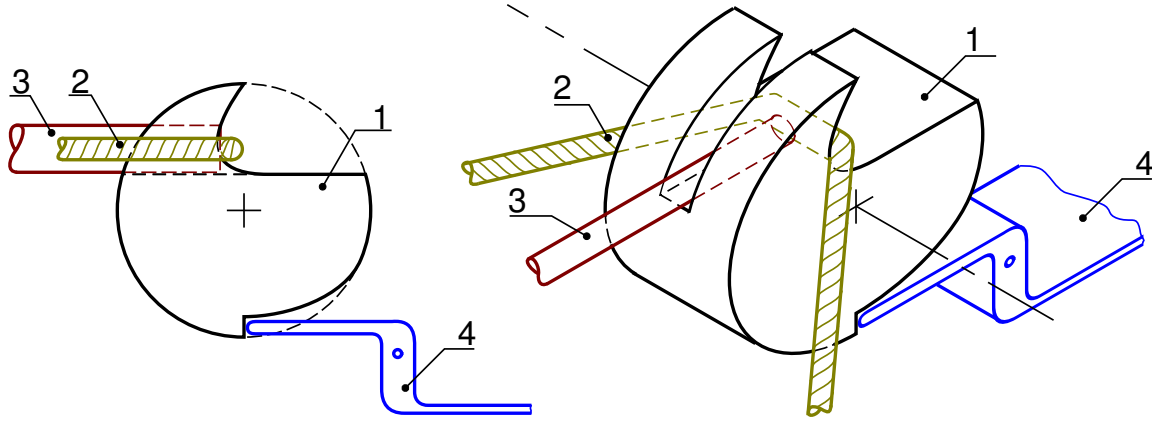
stock, that shoots projectiles called bolts or quarrels. The medieval crossbow was called by many names, most of which derived from the word ballista, a torsion siege engine resembling a crossbow.[*][1]

Historically, crossbows played a significant role in the warfare of East Asia, Europe and the Mediterranean.[*][2] The invention of the crossbow in ancient China caused a major shift in the role of projectile weaponry. The traditional bow and arrow had long been a specialized weapons system which required a considerable degree of lifetime training, physical strength and expertise to operate with any degree of efficiency; in many cultures, despite being usually drawn from the common class, bowmen were considered a separate and superior caste, as their archery skill-set (similar to many horseman cultures) was essentially developed from birth and impossible to reproduce outside a pre-established cultural tradition, which many nations lacked. In contrast, the crossbow was the first projectile weapon to be simple, cheap and physically-undemanding enough to be operated by large numbers of conscript soldiers, thus

enabling virtually any nation to field a potent force of ranged crossbowmen with little expense beyond the cost of the weapons themselves.*[3] In Europe, where crossbows became widely used in the early mediaeval period, this led to the ascendancy of large mercenary armies of crossbowmen (best exemplified by the Genoese crossbowmen), and the eventual death of the heavily armored aristocratic knight as armies became progressively dominated by conscripts equipped with increasingly-powerful ranged projectile weapons.

In modern times, although largely supplanted by firearms in most roles, crossbows are still widely used for shooting sports, hunting,*[4] and when shooting in relative silence is an important consideration.

14.1 Construction



Crossbow nut:

1. *Nut.*
2. *String.*
3. *Quarrel.*
4. *Trigger.*

A crossbow is a bow mounted on a stick (called a tiller or stock) with a mechanism in it which holds the drawn bow string. The earliest designs featured a slot in the stock, down into which the string was placed. To shoot this design, a vertical rod is thrust up through a hole in the bottom of the notch, forcing the string out. This rod is usually attached perpendicular to a rear-facing lever called a trigger or "tickler". A later design implemented a rolling cylindrical pawl called a "nut" to retain the string. This nut has a perpendicular center slot for the bolt, and an intersecting axial slot for the string, along with a lower face or slot against which the internal trigger sits. They often also have some form of strengthening internal "sear" or trigger face, usually of metal. These "roller nuts" were either free-floating in their close-fitting hole across the stock, tied in with a binding of sinew or other strong cording, or mounted on a metal axle or pins. Removable or integral plates of wood, ivory or metal on the sides of the stock kept the nut in place laterally. Nuts were made of antler, bone, or metal. Bows could be kept and ready to shoot for some time with little effort, allowing crossbowmen to aim better.*[5]

The bow (called the "prod" or "lath" on a crossbow) of early crossbows was made of a single piece of wood, usually ash or yew. Composite bows are made from layers of different material—often wood, horn and sinew—glued together and bound with animal tendon. These composite bows, made of several layers, are much stronger and more efficient in releasing energy than simple wooden bows. As steel became more widely available in Europe around the 14th century, steel prods came into use.

The crossbow prod is very short compared to ordinary bows, resulting in a short draw length. This leads to a higher draw weight in order to store the same amount of energy. Furthermore the thick prods are a bit less efficient at releasing energy, but more energy can be stored by a crossbow. Traditionally the prod was often lashed to the stock with rope, whipcord, or other strong cording. This cording is called the *bridle*.

The strings for a crossbow are typically made of strong fibers that would not tend to fray. Whipcord was very common; however linen, hemp, and sinew were used as well. In wet conditions, twisted mulberry root was occasionally used.

Very light crossbows can be drawn by hand, but heavier types need the help of mechanical devices. The simplest version of mechanical cocking device is a hook attached to a belt, drawing the bow by straightening the legs. Other devices are hinged levers which either pulled or pushed the string into place, cranked rack-and-pinion devices called "cranequins" *[6] and multiple cord-and-pulley cranked devices called windlasses.

- Stirrup
- Pull lever
- Push lever
- Cranequin (Rack & Pinion)
- Cranequin (Rack & Pinion)
- Windlass
- Iron cranequin, South German, late 15th century
- A lion holding a crossbow on the coat of arms of Småland, Sweden. The province's original coat of arms (1560) was of a crossbow alone, the lion being added later.

14.1.1 Variants

Modern recurve crossbow

Crossbows exist in different variants. One way to classify them is the acceleration system, while another is the size and energy, degree of automation or projectiles.

A recurve crossbow is a bow that has tips curving away from the archer.*[7] The recurve bow's bent limbs have a longer draw length than an equivalent straight-limbed bow, giving more acceleration to the projectile and less hand

Modern compound crossbow

shock. Recurved limbs also put greater strain on the materials used to make the bow, and they may make more noise with the shot.

Multiple bow systems have a special system of pulling the sinew via several bows (which can be recurve bows). The workings can be compared to a modern compound bow system. The weapon uses several different bows instead of one bow with a tackle system to achieve a higher acceleration of the sinew via the multiplication with each bow's pulling effect.

A compound crossbow is a modern crossbow and is similar to a compound bow. The limbs are usually much stiffer than those of a recurve crossbow. This limb stiffness makes the compound bow more energy efficient than other bows, but the limbs are too stiff to be drawn comfortably with a string attached directly to them. The compound bow has the string attached to the pulleys, one or both of which has one or more cables attached to the opposite limb. When the string is drawn back, the string causes the pulleys to turn. This causes the pulleys to pull the cables, which in turn causes the limbs to bend and thus store energy. Other types of compound bows use either (one or both) cam shaped or eccentrically mounted pulleys in order to provide a "let off", such that the archer is not holding against the maximum draw weight of the bow while trying to aim. But in a crossbow the string is held back mechanically, so there is no advantage in providing a let off. Therefore, compound crossbows generally use only pulleys that are both round and concentrically mounted, in order to capture the maximum available energy from the relatively short draw length.

The smallest crossbows are pistol crossbows. Others are simple long stocks with the crossbow mounted on them. These could be shot from under the arm. The next step in development was stocks of the shape that would later be used for firearms, which allowed better aiming. The arbalest was a heavy crossbow which required special systems for pulling the sinew via windlasses. For siege warfare the size of crossbows was further increased to hurl large projectiles such as rocks at fortifications. The required crossbows needed a massive base frame and powerful windlass devices. Such devices include the oxybeles. The ballista has torsion springs replacing the elastic prod of the oxybeles, but later also developed into smaller versions.*[8] "Ballista" is still the root word for crossbow in Romance languages such as Italian (*balestra*) and Spanish (*ballesta*).

The repeating crossbow automated the separate actions of stringing the bow, placing the projectile and shooting. This way the task can be accomplished with a simple one-handed movement, while keeping the weapon stationary. As a result, it is possible to shoot at a faster rate compared to unmodified version. The Greek Polybolos was an ancient repeating ballista reputedly invented by Dionysius of Alexandria in the 3rd century BC. The Chinese repeating crossbow, Chu Ko Nu, is a handheld crossbow that accomplishes the task with a magazine containing a number of bolts on top. The mechanism is worked by moving a rectangular lever forward and backward. The weapon was mainly used as a weapon against lightly armored soldiers, since it shot small bolts that were often dipped in poison.

A bullet crossbow is a type of handheld crossbow which rather than arrows or bolts shoots spherical projectiles made of stone, clay or lead. There are two variants; one has a double string with a pocket for the projectile, and the other has a barrel with a slot for the string.

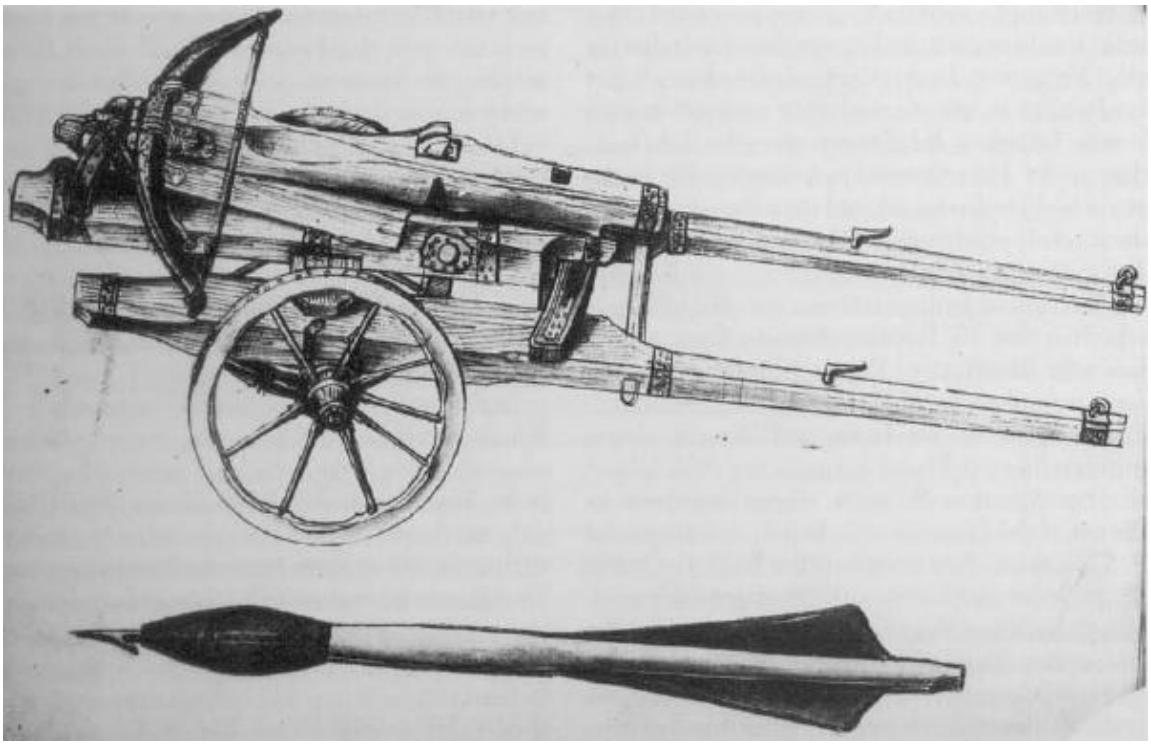
- Cocking of a Greek *gastraphetes*

15th-century Wallarmbrust*, a heavy crossbow used for siege defense.*

- Arsenal of ancient mechanical artillery in the Saalburg, Germany; left: polybolos reconstruction by the German engineer Erwin Schramm (1856-1935)
- Chinese *Chuangzi Nu* stationary windlass device with triple-bow arcuballista
- Chinese repeating crossbow with pull lever and automatic reload magazine
- Chinese Lian Nu (連弩), multiple shot crossbow without a visible nut or cocking aid
- 15th-century French soldier carrying an arbalest and a pavise
- Early modern four-wheeled ballista drawn by armored horses (1552)
- 16th-century French mounted crossbowman ("cranequinier"). His crossbow is drawn with a rack-and-pinion "cranequin" , so it can be used while riding.
- Pistol crossbow for home recreational shooting. Made by Frédéric Siber in Morges, early 19th century. On display at Morges military museum.
- French cross-bow grenade thrower Arbalète sauterelle type A d'Imphy circa 1915

14.1.2 Projectiles

The arrow-like projectiles of a crossbow are called bolts. These are much shorter than arrows, but can be several times heavier. There is an optimum weight for bolts to achieve maximum kinetic energy, which varies depending on the strength and characteristics of the crossbow, but most could pass through common mail. In ancient times the bolts of a strong crossbow were usually several times heavier than arrows. Modern bolts are stamped with a proof mark to ensure their consistent weight and do not have fletching, i.e. feathered ends like those commonly seen on arrows.* [9]



Arcuballista on wheels with a steel bow and incendiary bolt (15th century)

Modern crossbow bolt compared to a 1 eurocent coin

Crossbow bolts can be fitted with a variety of heads, some with sickle-shaped heads to cut rope or rigging; but the most common today is a four-sided point called a quarrel. A highly specialized type of bolt is employed to collect blubber biopsy samples used in biology research.

Most modern crossbows are designed to shoot arrows instead of bolts.*[9] Crossbow arrows are of similar construction to ordinary bow arrows, just shorter in length because of reduced power stroke.

Crossbows can also be adapted to shoot lead bullets or rocks, in which case they are called **stone-bows**. Primarily used for hunting wildfowl, these usually have a double string with a pouch between the strings to hold the projectile.

14.1.3 Accessories

The ancient Chinese crossbow often included a metal (i.e. bronze or steel) grid serving as iron sights. Modern crossbow sights often use similar technology to modern firearm sights, such as red dot sights and telescopic sights. Many crossbow scopes feature multiple crosshairs to compensate for the significant effects of gravity over different ranges. In most cases, a newly-bought crossbow will need to be "sighted" for accurate shooting.*[10]

Quivers can be mounted to hold ammunition. These are often made from plastic and usually hold the bolts in fixed positions along the structure. A popular detachable design consists of a main arm that is attached to the weapon, a plate on one end that secures four or more individual bolts at a point on their shafts and at the other end a cover that secures their heads. This kind of quiver is attached under the front of the crossbow, parallel to the string and

The reticle of a modern crossbow telescopic sight allows the shooter to adjust for different ranges

is designed to be quickly detached and reattached. Other designs hold bolts underneath the crossbow parallel to the stock, sometimes on either side of the crossbow.

A major cause of the sound of shooting a crossbow is vibration of various components. Crossbow silencers are multiple components placed on high vibration parts, such as the string and limbs, to dampen vibration and suppress the sound of loosing the bolt.*[11]

14.2 History

Main article: History of crossbows

14.2.1 East Asia

According to Sir Joseph Needham in his Science and Civilisation in China, the crossbow was invented in ancient China long before the 5th Century BC. However, there is undoubted evidence that it was used for military purposes during the Warring States period from the second half of the 4th century BC onwards.*[12]

Bronze crossbow bolts dating as early as the mid-5th century BC were found at a Kingdom of Chu burial site in Yutaishan, Hubei.*[13] The earliest handheld crossbow stocks with bronze trigger, dating from the 6th century BC, comes from Tomb 3 and 12 found at Qufu, Shandong, capital of the State of Lu.*[14]*[15] Other early finds of crossbows were discovered in Tomb 138 at Saobatang, Hunan dated to the mid-4th century BC.*[16]*[17] Repeating crossbows, first mentioned in the *Records of the Three Kingdoms*, were discovered in 1986 in Tomb 47 at Qinjiazui, Hubei dated to around the 4th century BC.*[18] The earliest Chinese document mentioning a crossbow is in scripts from the 4th to 3rd centuries BC attributed to the followers of Mozi. This source refers to the use of a giant crossbow in the 6th to 5th BC, corresponding to the late Spring and Autumn Period. Sun Tzu's influential book *The Art of War* (first appearance dated in between 500 BC to 300 BC*[19]) refers in chapter V to the traits and in XII to the use of crossbows.*[20] One of the earliest reliable records of this weapon in warfare is from an ambush, the Battle of Ma-Ling in 341 BC. By the 200s BC, the crossbow (Chinese: 弩; pinyin: *nǔ*) was well developed and quite widely used in China.

A bronze crossbow trigger mechanism and butt plate that were mass-produced in the Warring States period (475-221 BC)

The earliest textual evidence of the *handheld* crossbow used in battle dates to the 4th century BC.*[21] Handheld crossbows with complex bronze trigger mechanisms have also been found with the Terracotta Army in the tomb of Qin Shihuang (r. 221–210 BC) that are similar to specimens from the subsequent Han Dynasty (202 BC–220 AD), while crossbowmen described in the Qin and Han Dynasty learned drill formations, some were even mounted as cavalry units, and Han Dynasty writers attributed the success of numerous battles against the Xiongnu to massed crossbow volleys.*[22]*[23] The bronze triggers were designed in such a way that they were able to store a large amount of energy within the bow when drawn, but was easily shot with little recoil when the trigger were pulled (this allowed it for precision shooting). The metal portions of the crossbow were also mass-produced with precision, with the bronze mechanisms being interchangeable. Finally, the Qin and Han Dynasties also developed crossbow shooting lines, with alternating rows of crossbowmen shooting and reloading in a manner similar to a musket firing line.

In Vietnamese historical legend, the ruler and general Thục Phán who ruled over the ancient kingdom of Âu Lạc from 257 to 207 BC is said to have owed his power to a magic crossbow, capable of shooting thousands of bolts at once.

Crossbow technology was transferred from the Chinese to Champa, which Champa used in its invasion of the Khmer Empire's Angkor in 1177.

Different varieties of crossbows were also developed, such as the repeating crossbow, multi-shot crossbow, and repeating multi-shot crossbow.

14.2.2 Ancient Greece

The earliest reasonably reliable date for the development of the crossbow in Europe is in ancient Greece from the 5th century BC.*[24] The historian Diodorus Siculus (fl. 1st century BC), described the invention of a mechanical arrow shooting catapult (*katapeltikon*) by a Greek task force in 399 BC.*[25]*[26] According to the inventor Hero of Alexandria (fl. 1st century AD), who referred to the now lost works of the 3rd-century BC engineer Ctesibius, this weapon was inspired by an earlier hand crossbow, called the *gastraphetes* (*belly shooter*), which could store more energy than the Greek bows. A detailed description of the *gastraphetes*, along with a drawing, is found in Heron's

A miniature guard wielding a handheld crossbow from the top balcony of a model watchtower, made of glazed earthenware during the Eastern Han era (25–220 AD) of China, from the Metropolitan Museum of Art.

technical treatise *Belopoeica*.[*][27][*][28] The *gastraphetes* was powered by a composite bow. It was cocked by resting the stomach in a concavity at the rear of the stock and pressing down with all strength. In this way considerably more energy can be summoned up than by using only one arm of the archer as in the hand-bow. The heavy weight and bulk of the *gastraphetes* may have necessitated a prop to keep it standing, i.e. by mounting it on a defensive wall or using a portable prop.[*][29]

A third Greek author, Biton (fl. 2nd century BC), whose reliability has been positively reevaluated by recent scholarship,[*][26][*][30] described two advanced forms of the *gastraphetes*, which he credits to Zopyros, an engineer from southern Italy. Zopyrus has been plausibly equated with a Pythagorean of that name who seems to have flourished in the late 5th century BC.[*][31][*][32] He probably designed his bow-machines on the occasion of the sieges of Cumae and Milet between 421 BC and 401 BC.[*][33][*][34] The bows of these machines already featured a winched pull back system and could apparently throw two missiles at once.[*][35]

From the mid-4th century BC onwards, evidence of the Greek use of crossbows becomes more dense and varied: Arrow-shooting machines (*katapeltai*) are briefly mentioned by Aeneas Tacticus in his treatise on siegecraft written around 350 BC.[*][35] An Athenian inventory from 330–329 BC includes catapults bolts with heads and flights.[*][36] Arrow-shooting machines in action are reported from Philip II's siege of Perinthos in Thrace in 340 BC.[*][37] At the same time, Greek fortifications began to feature high towers with shuttered windows in the top, presumably to house anti-personnel arrow shooters, as in Aigosthena.[*][38]

The transition to the torsion catapults, which are not considered crossbows and came to dominate Greek and Roman artillery design, is first evident in inventories of the Athenian arsenal from between 338 and 326 BC.[*][35][*][36]

14.2.3 Roman Empire

The ancient world knew a variety of mechanical hand-held weapons similar to the later medieval crossbow. The exact terminology is a subject of continuing scholarly debate. Roman authors like Vegetius (fl. 4th century) note repeatedly the use of arrow shooting weapons such as *arcuballista* and *manuballista* respectively *cheiroballista*. While

Greek gastraphetes

most scholars agree that one or more of these terms refer to handheld mechanical weapons, there exist disagreement

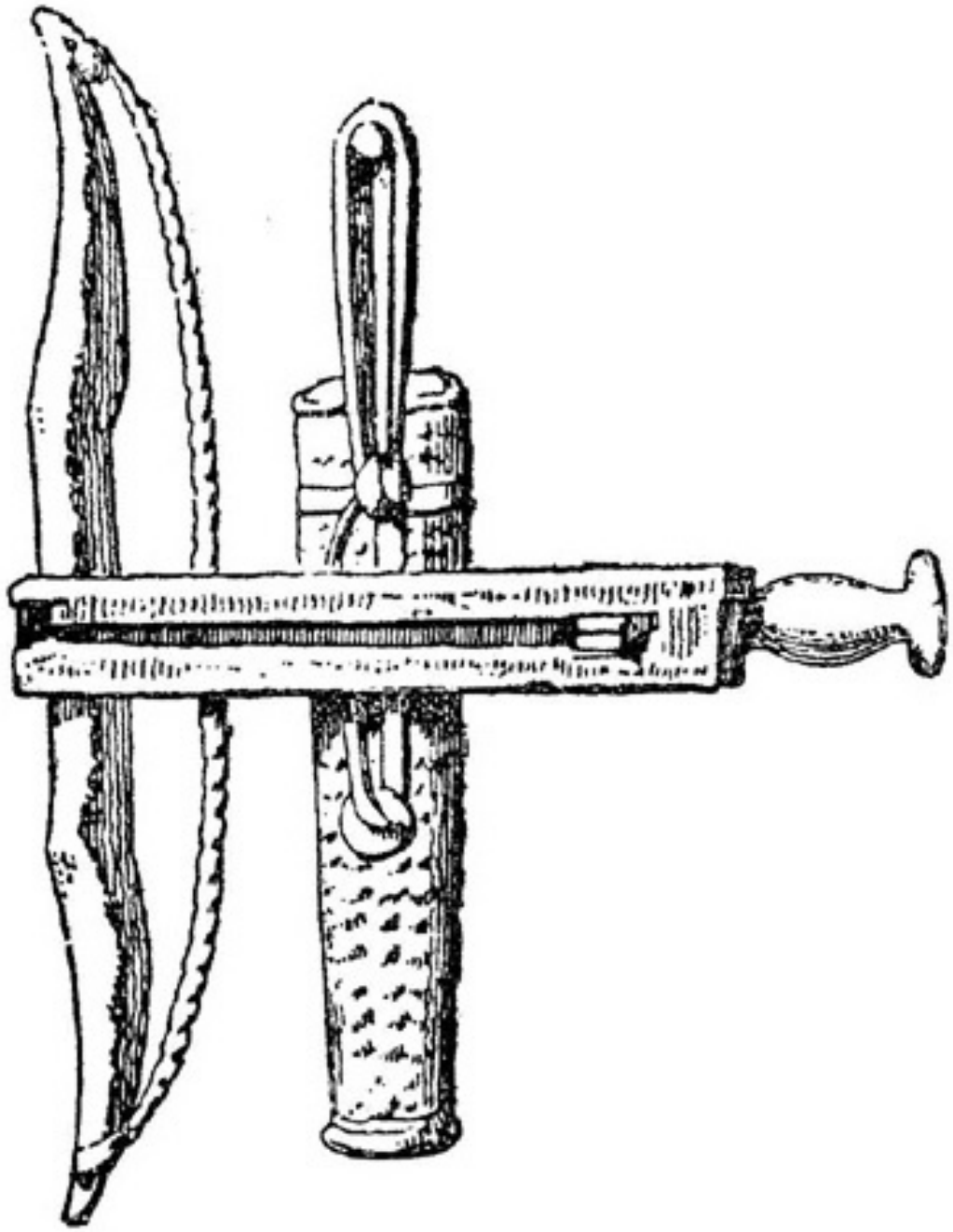


Fig. 467. Arbalète et carquois.

Roman crossbow

whether these were flexion bows or torsion powered like the recent Xanten find.*[39] According to R. Ernest Dupuy and Trevor N. Dupuy, in 36 BC a Han empire expedition into central Asia encountered and defeated a contingent of Roman legionaries. The Romans was suggested as a part of Antony's army invading Parthia.Chinese victory was based on their crossbows, whose bolts and darts seem to "have penetrated Roman shields and armor." *[40] The Chinese crossbow was transmitted to the Roman world in this event.*[40] The Roman commander Arrian (c. 86 – after 146) records in his *Tactica* Roman cavalry training for shooting some mechanical handheld weapon from horseback.*[41] Sculptural reliefs from Roman Gaul depict the use of crossbows in hunting scenes. The specimen

are remarkably similar to the later medieval crossbow, including the typical nut lock (see image).*[42]

14.2.4 Medieval Europe

A Medieval crossbowman drawing his bow behind his pavise. A hook on the end of a strap on his belt engages the bowstring. Holding the crossbow down by putting his foot through the stirrup, he draws the bow by straightening his legs

The crossbow is portrayed as a hunting weapon on four Pictish stones from early medieval Scotland (6th to 9th centuries): St. Vigeans no. 1, Glenferness, Shandwick, and Meigle.*[43] The use of crossbows in European warfare is again evident from the Battle of Hastings until about the year 1500. They almost completely superseded hand bows in many European armies in the 12th century for a number of reasons. Although a longbow achieves comparable accuracy and faster shooting rate than an average crossbow, crossbows release more kinetic energy and can be used effectively after a week of training, while a comparable single-shot skill with a longbow takes years of strength training to overcome the draw strength of the longbow, as well as years of practice needed to use it with skill.

In the armies of Europe,*[44] mounted and unmounted crossbowmen, often mixed with slingers, javeliners and archers, occupied a central position in battle formations. Usually they engaged the enemy in offensive skirmishes before an assault of mounted knights. Crossbowmen were also valuable in counterattacks to protect their infantry. The rank of commanding officer of the crossbowmen corps was one of the highest positions in any army of this time. Along with polearm weapons made from farming equipment, the crossbow was also a weapon of choice for insurgent peasants such as the Taborites.

Mounted knights armed with lances proved ineffective against formations of pikemen combined with crossbowmen whose weapons could penetrate most knights' armor. The invention of pushlever and ratchet drawing mechanisms enabled the use of crossbows on horseback, leading to the development of new cavalry tactics. Knights and mercenaries deployed in triangular formations, with the most heavily armored knights at the front. Some of these riders would carry small, powerful all-metal crossbows of their own. Crossbows were eventually replaced in warfare by more powerful gunpowder weapons, although early guns had slower rates of fire and much worse accuracy than contemporary crossbows. Later, similar competing tactics would feature harquebusiers or musketeers in formation with pikemen (pike and shot), pitted against cavalry firing pistols or carbines.

14.2.5 Elsewhere

Wheelmounted and elephantmounted double-bow-arcuballistae of the Champa kingdom.

The Saracens called the crossbow *qaws Ferengi*, or "Frankish bow," as the Crusaders used the crossbow against the Arab and Turkic horsemen with remarkable success. The adapted crossbow was used by the Islamic armies in defence of their castles. Later footstrapped version become very popular among the Muslim armies in Iberia. During the Crusades, Europeans were exposed to Saracen composite bows, made from layers of different material—often wood, horn and sinew—glued together and bound with animal tendon. These composite bows could be much more

powerful than wooden bows, and were adopted for crossbow prods across Europe. Crossbow prods could be more easily waterproofed than hand bows, which was essential in the European humid climate.

In Western Africa and Central Africa,[*][45] crossbows served as a scouting weapon and for hunting, with the Spanish and the Portuguese bringing the technology to America.[*][46] In the American South, the crossbow was used for hunting and warfare when firearms or gunpowder were unavailable because of economic hardships or isolation.[*][46]

In Northern America, light hunting crossbows were traditionally used by the Inuit.[*][47] The native Montagnards of Vietnam's Central Highlands were also known to have used crossbows, as both a tool for hunting, and later, an effective weapon against the Viet Cong during the Vietnam War. Montagnard fighters armed with crossbows proved a highly valuable asset to the US Special Forces operating in Vietnam, and it was not uncommon for the Green Berets to integrate Montagnard crossbowmen into their strike teams.[*][48]

14.3 Modern use

14.3.1 Hunting, leisure and science

Crossbows are used for shooting sports and bowhunting in modern archery and for blubber biopsy samples in scientific research. In some countries such as Canada or the United Kingdom, they may be less heavily regulated than firearms, and thus more popular for hunting; some jurisdictions have bow and/or crossbow only seasons.[*][49]

14.3.2 Modern military and paramilitary use

In modern times crossbows are no longer used for assassinations, but there are still some applications. For example, in the Americas, the Peruvian army (Ejército) equips some soldiers with crossbows and rope, to establish a zip-line in difficult terrain.[*][50] In Brazil the CIGS (Jungle Warfare Training Center) also trains soldiers in the use of crossbows.[*][51][*][52] In the United States, SAA International Ltd manufacture a 150 ft·lb crossbow-launched version of the U.S. Army type classified Launched Grapnel Hook (LGH), among other mine countermeasure solutions designed for the middle-eastern theatre. It has been successfully evaluated in Cambodia and Bosnia.[*][53] It is used to probe for and detonate tripwire initiated mines and booby traps at up to 50 meters. The concept is similar to the LGH device originally only fired from a rifle, as a plastic retrieval line is attached.[*][54] Reusable up to 20 times, the line can be reeled back in without exposing oneself. The device is of particular use in tactical situations where noise discipline is important.[*][55]

In Europe, British-based Barnett International supplied crossbows to Serbian forces which according to *The Guardian* were later used "in ambushes and as a counter-sniper weapon", against the Kosovo Liberation Army during the Kosovo War in the areas of Pec and Djakovica, south west of Kosovo.[*][56] Whitehall launched an investigation, though the department of trade and industry established that not being "on the military list" crossbows were not covered by such export regulations. Paul Beaver of Jane's defence publications commented that, "They are not only a silent killer, they also have a psychological effect". On 15 February 2008 Serbian Minister of Defence Dragan Sutanovac was pictured testing a Barnett crossbow during a public exercise of the Serbian army's Special Forces in Nis, 200 km south of capital Belgrade.[*][57] Special forces in both Greece and Turkey also continue to employ the crossbow.[*][58][*][59] Spain's Green Berets still use the crossbow as well.[*][60]

In Asia, some Chinese armed forces use crossbows, including the special force Snow Leopard Commando Unit of the People's Armed Police and the People's Liberation Army. One justification for this comes in the crossbow's ability to stop persons carrying explosives without risk of causing detonation.[*][61] During the Xinjiang riots of July 2009, crossbows were used alongside modern military hardware to quell protests.[*][62] The Indian Navy's Marine Commando Force were equipped until the late 1980s with crossbows supplied with cyanide-tipped bolts, as an alternative to suppressed handguns.[*][63]

14.4 Comparison to conventional bows

With a crossbow, archers could release a draw force far in excess of what they could have handled with a bow. Furthermore the crossbow could hold the tension for a long time, whereas even the strongest longbowman could only hold a drawn bow for so long. The disadvantage is the greater weight and clumsiness compared to a bow, as well

Fisheries scientist obtaining tissue samples from dolphins swimming in the bow wave of a NOAA ship (2010).

A whale shot by a modified crossbow bolt for a blubber biopsy sample.

A pistol crossbow

as the slower rate of shooting and the lower efficiency of the acceleration system, but there would be reduced elastic hysteresis, making the crossbow a more accurate weapon.

Crossbows have a much smaller draw length than bows. This means that for the same energy to be imparted to the arrow (or bolt), the crossbow has to have a much higher draw weight.

A direct comparison between a fast hand-drawn replica crossbow and a longbow show a 6:10 rate of shooting*[64] or a 4:9 rate within 30 seconds and comparable weapons.*[65]

14.5 Legal issues

Modern competition crossbow

Main article: Laws on crossbows

Can. 29 of the Second Lateran Council under Pope Innocent II in 1139 banned the use of crossbows, as well as slings and bows, against Christians.*[66] Although the authenticity, interpretation and translation of this source is contested.*[67]

Today, the crossbow often has a complicated legal status due to the possibility of lethal use and its similarities to both firearms and archery weapons. While some jurisdictions regard crossbows the same as firearms, many others do not require any sort of license to own a crossbow. The legality of using a crossbow for hunting varies widely around the world, and even within different jurisdictions of some federal countries.

14.6 See also

- Arbalist (crossbowman)
- Bow (weapon)

- History of crossbows
- Master of Crossbowmen
- Modern competitive archery and target archery for bows
- Shooting sport

14.7 Notes

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14.9 External links

- International Crossbow Shooting Union (IAU)
- World Crossbow Shooting Association (WCSA)
- The Crossbow by Sir Ralph Payne-Gallwey, BT
- Designing crossbows

Chapter 15

History of crossbows

This **history of crossbows** documents the historical development and use of the crossbow.

It is not clear exactly where and when the crossbow originated, it is believed to have been invented in Europe and China during the 5th Century BC. But there is undoubted evidence that it was used for military purposes during the Warring States period from the second half of the 4th century BC onwards.

15.1 China and South East Asia

In China the crossbow (Chinese: 弩; pinyin: *nǔ*) was an important weapon from the time of the Spring and Autumn Period (771-476 BC). Bronze crossbow bolts dating from as early as the mid-5th century BC have been found at a State of Chu burial site in Yutaishan, Jiangling County, Hubei Province.*[1] The earliest handheld crossbow stocks with a bronze trigger and dating from the 6th century BC come from Tombs 3 and 12 at Qufu, Shandong, capital of the State of Lu.*[2]*[3] Other early finds of crossbows were discovered in Tomb 138 at Saobatang, Hunan Province and dated to the mid-4th century BC.*[4]*[5] Repeating crossbows, first mentioned in the *Records of the Three Kingdoms*, were discovered in 1986 in Tomb 47 at Qinjiazui, Hubei Province, dating to around the 4th century BC.*[6] The earliest documention of a Chinese crossbow is in scripts from the 4th–3rd century BC and attributed to the followers of Mozi. This source refers to the use of a giant crossbow catapult between the 6th and 5th centuries BC, corresponding to the late Spring and Autumn Period. Sun Tzu's influential book *The Art of War* (first appearance dated between 500 BC to 300 BC*[7]) refers to the characteristics and use of crossbows in chapters V and XII respectively.*[8] One of the earliest reliable records of this weapon in warfare is from an ambush which took place at the Battle of Maling in 341 BC. By the 200s BC, the crossbow was well developed and widely used in China, with all crossbow parts standardised by the government and mass-produced with elaborate triggers. During Han, crossbow was spread to Roman world through silk road.*[9]

Crossbow remains have also been found amongst the soldiers of the Terracotta Army near the mausoleum of China's first emperor Qin Shi Huang (260-210 BC).*[10] The repeating crossbow and multiple bow arcuballista were both developed in China.*[11] When discussing the advantages and disadvantages of the nomadic Xiongnu and Han armies in a memorandum to the throne in 169 BC, official Chao Cuo deemed the crossbow and repeating crossbow of the Han armies superior to the Xiongnu bow, even though the latter were trained to shoot behind themselves while riding.*[12]

In Vietnamse historical legend, the ruler and general Thục Phán who ruled over the ancient kingdom of Âu Lạc from 257 to 207 BC is said to have owed his power to a magic crossbow, capable of shooting thousands of arrows at once.

Crossbow technology was transferred from the Chinese to Champa, which Champa used in its invasion of the Khmer Empire's Angkor in 1177.

According to the Chinese *Wujing Zongyao* military manuscript of 1044, the crossbow used *en masse* was the most effective weapon against northern nomadic cavalry charges.*[14] Elite crossbowmen were also valued as long-range snipers as was the case when the Liao Dynasty general Xiao Talin was picked off by a Song crossbowman at the Battle of Shanzhou in 1004.*[14] Crossbows were mass-produced in state armories with designs improving as time went on, such as the use of a mulberry wood stocks and brass; a crossbow in 1068 could pierce a tree at 140 paces.*[15]

- Chinese *Chuangzi Nu* stationary windlass device with triple-bow arcuballista

Late medieval crossbowman from ca. 1480

- Chinese repeating crossbow with pull lever and automatic reload magazine

- Chinese Lian Nu (連弩), multiple shot crossbow without a visible nut or cocking aid

15.2 Europe

Greek gastraphetes

The earliest evidence for the crossbow in Europe dates back to the 5th century BC when the *gastraphetes*, an ancient Greek crossbow type, appeared. The device was described by the Greek author Heron of Alexandria in his work *Belopoeica* ("On Catapult-making"), which draws on an earlier account of his famous compatriot engineer Ctesibius (fl. 285–222 BC). Heron identifies the gastraphetes as the forerunner of the later catapult, which places its invention some unknown time prior to 420 BC.*[16]

The gastraphetes was a large artillery crossbow mounted on a heavy stock with a lower and upper section, the lower being the case fixed to the bow and the upper being the slider which had the same dimensions as the case.*[17] Meaning "belly-bow" ,*[17] it was called as such because the concave withdrawal rest at one end of the stock was placed against the stomach of the operator, which he could press to withdraw the slider before attaching a string to the trigger and loading the bolt; this could thus store more energy than regular Greek bows.*[18] It was used in the Siege of Motya in 397 BC. This was a key Carthaginian stronghold in Sicily, as described in the 1st century AD by Heron of Alexandria in his book *Belopoeica*.*[19] Alexander's siege of Tyre in 332 BC provides reliable sources for the use of these weapons by the Greek besiegers.*[20]

Arsenal of ancient mechanical artillery: Catapults (standing), chain drive of Polybolos (bottom center), Gastraphetes (on wall)

The efficiency of the gastraphetes was improved by introducing the ballista. Its application in sieges and against rigid infantry formations featured more and more powerful projectiles, leading to technical improvements and larger ballistae. The smaller sniper version was often called *Scorpio*.*[21] An example for the importance of ballistae in Hellenistic warfare is the *Helepolis*, a siege tower employed by Demetrius during the Siege of Rhodes in 305 BC. At each level of the moveable tower were several ballistae. The large ballistae at the bottom level were designed to destroy the parapet and clear it of any hostile troop concentrations while the small armorbreaking scorpios at the top level sniped at the besieged. This suppressive shooting would allow them to mount the wall with ladders more safely.*[22]

According to R. Ernest Dupuy and Trevor N. Dupuy, in 36 BC a Han empire expedition into central Asia encountered and defeated a contingent of Roman legionaries. The Romans was suggested as a part of Antony's army invading Parthia.Chinese victory was based on their crossbows, whose bolts and darts seem to "have penetrated Roman shields and armor."The Chinese crossbow was transmitted to the Roman world in this event.*[9] The use of crossbows in Medieval warfare dates back to Roman times and is again evident from the battle of Hastings (1066) until about 1525 AD.*[23] They almost completely superseded hand bows in many European armies (England being a rare exception) in the twelfth century for a number of reasons. Although a longbow had greater range and penetration, and could achieve comparable accuracy and faster shooting rate than wooden or composite crossbow, the crossbow and be used effectively after a week of training, while a comparable single-shot skill with a longbow could take years of

A Medieval crossbowman drawing his bow behind his pavise

practice. Later crossbows (sometimes referred to as arbalests), utilizing all-steel prods were able later made with power close (and sometime superior) to longbows, but were more expensive to produce and slower to reload because they required the aid of mechanical devices such as the cranequin or windlass to draw back their extremely heavy bows. Usually these could only shoot 2 bolts per minute vs 12 or more with a skilled archer, - often necessitating the use of a pavise to protect the operator from enemy fire.*[24] In the armies of Europe,*[25] mounted and unmounted crossbowmen, often mixed with slingers, javeliners and archers, occupied a central position in battle formations.

Usually they engaged the enemy in offensive skirmishes before an assault of mounted knights. Crossbowmen were also valuable in counterattacks to protect their infantry. Crossbowmen were held in high esteem as professional soldiers, often commanding higher rates of pay than other footsoldiers.*[26] The rank of commanding officer of the crossbowmen corps was one of the highest positions in many medieval armies, including those of Spain, France and Italy. Crossbowmen were held in such high regard in Spain that they were granted status on par with the knightly class.*[23] Along with polearm weapons made from farming equipment, the crossbow was also a weapon of choice for insurgent peasants such as the Taborites. Genoese crossbowmen were famous mercenaries hired throughout medieval Europe, while the crossbow also played an important role in anti-personnel defence of ships.*[27]

16th century French mounted crossbowman ("cranequinier")

Crossbowmen among the Flemish citizens,*[25] in the army of Richard Lionheart, and others, could have up to two

servants, two crossbows and a pavise to protect the men. Then one of the servants had the task of reloading the weapons, while the second subordinate would carry and hold the pavise (the archer himself also wore protective armor). Such a three-man team could shoot 8 shots per minute, compared to a single crossbowman's 3 shots per minute. The archer was the leader of the team, the one who owned the equipment, and the one who received payment for their services. The payment for a crossbow mercenary was higher than for a longbow mercenary, but the longbowman did not have to pay a team of assistants and his equipment was cheaper. Thus the crossbow team was twelve percent less efficient than the longbowman since three of the latter could be part of the army in place of one team. Furthermore, the prod and bow string of a composite crossbow were subject to damage in rain whereas the longbowman could simply unstring his bow to protect the string. The composite crossbow was shown to be an inferior weapon at Crécy in 1346, at Poitiers in 1356 and at Agincourt in 1415 where the French armies paid dearly for their reliance upon it. As a result, use of the crossbow declined sharply in France,*[24] and the French authorities made attempts to train longbowmen of their own. After the conclusion of the Hundred Years' War, however, the French largely abandoned the use of the longbow, and consequently the military crossbow saw a resurgence in popularity. The crossbow continue to see use in French armies by both infantry and mounted troops until as late as 1520 when, as with elsewhere in continental Europe, the crossbow would be largely eclipsed by the handgun. Spanish forces in the New World would make extensive use of the crossbow, even after it had largely fallen out of use in Europe, with crossbowmen participating in Hernán Cortés' conquest of Mexico and accompanying Francisco Pizarro on his initial expedition to Peru - though by the time of the conquest of Peru in 1532-1523 he would have only a dozen such men remaining in his service.*[23]

Mounted knights armed with lances proved ineffective against formations of pikemen combined with crossbowmen whose weapons could penetrate most knights' armor. The invention of pushlever and ratchet drawing mechanisms enabled the use of crossbows on horseback, leading to the development of new cavalry tactics. Knights and mercenaries deployed in triangular formations, with the most heavily armored knights at the front. Some of these riders would carry small, powerful all-metal crossbows of their own. Crossbows were eventually replaced in warfare by gunpowder weapons, although early guns had slower rates of fire and much worse accuracy than contemporary crossbows. Later, similar competing tactics would feature harquebusiers or musketeers in formation with pikemen, pitted against cavalry firing pistols or carbines.

Up until the seventeenth century most beekeepers in Europe kept their hives spread across the woods and had to defend them against bears. Therefore their guild was granted the right to bear arms and is commonly depicted carrying heavy crossbows.

While the military crossbow had largely been supplanted by firearms on the battlefield by 1525, the sporting crossbow in various forms remained a popular hunting weapon in Europe until the eighteenth century.*[28]

A bomb-throwing crossbow called the *Sauterelle* was used by the French and British armies on the Western Front during World War I. It could throw an F1 grenade or Mills bomb 110–140 m (120–150 yd).*[29]

15.3 Islamic World

The Saracens called the crossbow *qaws Ferengi*, or "Frankish bow", as the Crusaders used the crossbow against the Arab and Turkoman horsemen with remarkable success. The adapted crossbow was used by the Islamic armies in defence of their castles. Later footstrapped version become very popular among the Muslim armies in Iberia. During the Crusades, Europeans were exposed to Saracen composite bows, made from layers of different material—often wood, horn and sinew—glued together and bound with animal tendon. These composite bows could be made smaller and handier than wooden self-bows while retaining the pull, and were adopted for crossbow prods across Europe. Crossbow prods could be more easily waterproofed than hand bows, which was essential in the European humid climate.

15.4 Africa and in the Americas

In Central Africa simple crossbows were used for hunting and as a scout weapon, previously thought to have been first introduced by the Portuguese. Until recently they were especially in use by different tribes of the pygmy-people, usually with poisoned and relatively small arrows. This silent technique of hunting in the tropical forest is quite similar to that of the South American indigenous hunting method with blow pipe and poisoned arrows. It makes sure not to startle up the prey, for example if a first shot goes astray. Since the small arrow is rarely deadly itself, the animal will drop from the trees after some time because of the poisoning. In the American South, the crossbow was used by the

French soldiers with a Sauterelle *bomb-throwing crossbow in 1915.*

conquistadors for hunting and warfare when firearms or gunpowder were unavailable because of economic hardships or isolation.*[27] Light hunting crossbows were traditionally used by the Inuit in Northern America.

15.5 Use of crossbows today

Crossbows are mostly used for target shooting in modern archery. In some countries they are still used for hunting, such as in most of states within the USA, parts of Asia, Europe, Australia and Africa. In modern Wild Care uses with special projectiles are in whale research to take blubber biopsy samples without harming the whales or other marine big "game".*[30]

A whale shot by a modified crossbow bolt

15.5.1 Modern military and paramilitary usage

The crossbow is still used in modern times by various militaries,[*][31][*][32][*][33][*][34] tribal forces[*][35] and in China even by the police forces.[*][36] As their worldwide distribution is not restricted by regulations on arms, they are used as silent weapons and for their psychological effect,[*][37] even reportedly using poisoned projectiles.[*][38] Crossbows are used for ambush and anti-sniper[*][39] operations or in conjunction with ropes to establish zip-lines in difficult terrain.[*][40]

15.6 See also

- Medieval warfare

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15.9 External links

Chapter 16

English longbow

Self-yew English longbow, 6 ft 6 in (2 m) long, 470 N (105 lbf) draw force.

The **English longbow**, also called the **Welsh longbow**, is a powerful type of medieval longbow (a tall bow for archery) about 6 ft (1.8 m) long used by the English and Welsh for hunting and as a weapon in medieval warfare. English use of longbows was effective against the French during the Hundred Years' War, particularly at the start of the war in the battles of Sluys (1340), Crécy (1346), and Poitiers (1356), and perhaps most famously at the Battle of Agincourt (1415). They were less successful after this, with longbowmen having their lines broken at the Battle of Verneuil (1424), and being completely routed at the Battle of Patay (1429) when they were charged before they had set up their defensive position. The term "English" or "Welsh" longbow is a modern usage to distinguish these bows from other longbows, though in fact identical bows were used across northern and western Europe.

The earliest longbow known from England, found at Ashcott Heath, Somerset, is dated to 2665 BC,*[1] but no longbows survive from the period when the longbow was dominant (c. 1250–1450 AD),*[2] probably because bows became weaker, broke and were replaced, rather than being handed down through generations.*[3] More than 130 bows survive from the Renaissance period, however. More than 3,500 arrows and 137 whole longbows were recovered from the *Mary Rose*, a ship of Henry VIII's navy that sank at Portsmouth in 1545.

16.1 Description

16.1.1 Length

A longbow must be long enough to allow its user to draw the string to a point on the face or body, and the length therefore varies with the user. In continental Europe it was generally seen as any bow longer than 1.2 m (3.9 ft). The Society of Antiquaries says it is of 5 or 6 feet (1.5 or 1.8 metres) in length.*[4] Richard Bartelot, of the Royal Artillery Institution, said that the bow was of yew, 6 feet (1.8 m) long, with a 3-foot (910 mm) arrow.*[5] Gaston Phoebus, in 1388, wrote that a longbow should be "of yew or boxwood, seventy inches [1.8 m] between the points of attachment for the cord".*[6] Historian Jim Bradbury said they were an average of about 5 feet and 8 inches.*[7] All but the last estimate were made before the excavation of the *Mary Rose*, where bows were found ranging in length from 1.87 to 2.11 m (6 ft 2 in to 6 ft 11 in) with an average length of 1.98 m (6 ft 6 in).*[8]

A period illustration of the Battle of Crécy. Anglo-Welsh longbowmen figure prominently in the foreground on the right, where they are driving away Italian mercenary crossbowmen.

16.1.2 Draw weights

Estimates for the draw of these bows varies considerably. Before the recovery of the *Mary Rose*, Count M. Mildmay Stayner, Recorder of the British Long Bow Society, estimated the bows of the Medieval period drew 90–110 pounds-force (400–490 newtons), maximum, and Mr. W.F. Paterson, Chairman of the Society of Archer-Antiquaries, believed the weapon had a supreme draw weight of only 80–90 lb_f (360–400 N).*[2] Other sources suggest significantly higher draw weights. The original draw forces of examples from the *Mary Rose* are estimated by Robert Hardy at 150–160 lb_f (670–710 N) at a 30-inch (76.2 cm) draw length; the full range of draw weights was between 100–185 lb_f (440–820 N).*[9] The 30-inch (76.2 cm) draw length was used because that is the length allowed by the arrows commonly found on the *Mary Rose*.

A modern longbow's draw is typically 60 lb_f (270 N) or less, and by modern convention measured at 28 inches (71.1 cm). Historically, hunting bows usually had draw weights of 50–60 lb_f (220–270 N), which is enough for all but the very largest game and which most reasonably fit adults can manage with practice. Today, there are few modern longbowmen capable of using 180–185 lb_f (800–820 N) bows accurately.*[10]*[11]

A record of how boys and men trained to use the bows with high draw weights survives from the reign of Henry VII.

> [My yeoman father] taught me how to draw, how to lay my body in my bow ... not to draw with strength of arms as divers other nations do ... I had my bows bought me according to my age and strength, as I increased in them, so my bows were made bigger and bigger. For men shall never shoot well unless they be brought up to it.
> —Hugh Latimer.*[12]

What Latimer meant when he describes laying his body into the bow was described thus:

> the Englishman did not keep his left hand steady, and draw his bow with his right; but keeping his right at rest upon the nerve, he pressed the whole weight of his body into the horns of his bow. Hence probably arose the phrase "bending the bow," and the French of "drawing" one.
> —W. Gilpin.*[13]

16.1.3 Construction and materials

The bowstave

The preferred material to make the longbow was yew, although ash, elm and other woods were also used. Giraldus Cambrensis, Gerald of Wales, speaking of the bows used by the Welsh men of Gwent, says: "They are made neither of horn, ash nor yew, but of elm; ugly unfinished-looking weapons, but astonishingly stiff, large and strong, and equally capable of use for long or short shooting".*[14] The traditional construction of a longbow consists of drying the yew wood for 1 to 2 years, then slowly working the wood into shape, with the entire process taking up to four years. (This can be done far more quickly by working the wood down when wet, as a thinner piece of wood will dry much faster.) The bow stave is shaped into a D-section. The outer "back" of sapwood, approximately flat, follows the natural growth rings; modern bowyers often thin the sapwood, while in the *Mary Rose* bows the back of the bow was the natural surface of the wood, only the bark being removed. The inner side ("belly") of the bow stave consists of rounded heartwood. The heartwood resists compression and the outer sapwood performs better in tension. This combination in a single piece of wood (a self bow) forms a natural "laminate", somewhat similar in effect to the construction of a composite bow. Longbows will last a long time if protected with a water-resistant coating, traditionally of "wax, resin and fine tallow".

The trade of yew wood to England for longbows was such that it depleted the stocks of yew over a huge area. The first documented import of yew bowstaves to England was in 1294. In 1350 there was a serious shortage, and Henry IV of England ordered his royal bowyer to enter private land and cut yew and other woods. In 1470 compulsory practice was renewed, and hazel, ash, and laburnum were specifically allowed for practice bows. Supplies still proved insufficient, until by the Statute of Westminster in 1472, every ship coming to an English port had to bring four bowstaves for every tun.*[15] Richard III of England increased this to ten for every tun. This stimulated a vast network of extraction and supply, which formed part of royal monopolies in southern Germany and Austria. In 1483, the price of bowstaves rose from two to eight pounds per hundred, and in 1510 the Venetians obtained sixteen pounds per hundred. In 1507 the Holy Roman Emperor asked the Duke of Bavaria to stop cutting yew, but the trade was profitable, and in 1532 the royal monopoly was granted for the usual quantity "if there are that many". In 1562, the Bavarian government sent a long plea to the Holy Roman Emperor asking him to stop the cutting of yew, and outlining the damage done to the forests by its selective extraction, which broke the canopy and allowed wind to destroy neighbouring trees. In 1568, despite a request from Saxony, no royal monopoly was granted because there was no yew to cut, and the next year Bavaria and Austria similarly failed to produce enough yew to justify a royal monopoly. Forestry records in this area in the 17th century do not mention yew, and it seems that no mature trees were to be had. The English tried to obtain supplies from the Baltic, but at this period bows were being replaced by guns in any case.*[16]

The string

Bow strings were, and still are, made of hemp, flax or silk, and attached to the wood via horn "nocks" that fit onto the end of the bow. Modern synthetic materials (often Dacron) are now commonly used for strings.

The arrow

A wide variety of arrows were shot from the English longbow. Variations in length, fletchings and heads are all recorded. Perhaps the greatest diversity lies in hunting arrows, with varieties like broad-arrow, wolf-arrow, dog-arrow, Welsh arrow and Scottish arrow being recorded.*[17] War arrows were ordered in the thousands for medieval armies and navies, supplied in sheaves normally of 24 arrows. For example, between 1341 and 1359 the English crown is known to have obtained 51,350 sheaves (1,232,400 arrows).*[18]

Only one significant group of arrows, from the Mary Rose, has survived. Over 3500 arrows were found, mainly made of poplar but also of ash, beech and hazel. Analysis of the intact specimens shows their length to vary from

61 to 83 centimetres (24–33 in), with an average length of 76 centimetres (30 in).*[19] Because of the preservation conditions of the Mary Rose no arrowheads survived. However, many heads have survived in other places, which has allowed typologies of arrow heads to be produced, the most modern being the Jessop typology.*[20] The most common arrowheads in military use were the short bodkin (Jessop M10) and a small barbed arrow (Jessop M4).*[21]

16.2 Use and performance

16.2.1 Training

Longbows were very difficult to master because the force required to deliver an arrow through the improving armour of medieval Europe was very high by modern standards. Although the draw weight of a typical English longbow is disputed, it was at least 360 newtons (81 pounds-force) and possibly more than 600 N (130 lb_f), with some estimates as high as 900 N (200 lb_f). Considerable practice was required to produce the swift and effective combat shooting required. Skeletons of longbow archers are recognisably adapted, with enlarged left arms and often bone spurs on left wrists, left shoulders and right fingers.*[22]

It was the difficulty in using the longbow which led various monarchs of England to issue instructions encouraging their ownership and practice, including the Assize of Arms of 1252 and King Edward III's declaration of 1363: "Whereas the people of our realm, rich and poor alike, were accustomed formerly in their games to practise archery – whence by God's help, it is well known that high honour and profit came to our realm, and no small advantage to ourselves in our warlike enterprises... that every man in the same country, if he be able-bodied, shall, upon holidays, make use, in his games, of bows and arrows... and so learn and practise archery." If the people practised archery, it would be that much easier for the King to recruit the proficient longbowmen he needed for his wars. Along with the improving ability of gunfire to penetrate plate armour, it was the long training needed by longbowmen which eventually led to their being replaced by musketmen.

16.2.2 Range

The range of the medieval weapon is not accurately known, with much depending on both the power of the bow and the type of arrow. It has been suggested that a flight arrow of a professional archer of Edward III's time would reach 400 yd (370 m)*[23] but the longest mark shot at on the London practice ground of Finsbury Fields in the 16th century was 345 yd (315 m).*[24] In 1542, Henry VIII set a minimum practice range for adults using flight arrows of 220 yd (200 m); ranges below this had to be shot with heavy arrows.*[25] Modern experiments broadly concur with these historical ranges. A 667 N (150 lbf) *Mary Rose* replica longbow was able to shoot a 53.6 g (1.89 oz) arrow 328 m (359 yd) and a 95.9 g (3.38 oz) a distance of 249.9 m (273.3 yd).*[26] In 2012, Joe Gibbs shot a 2.25 oz (64 g) livery arrow 292 yd (267 m) with a 170 lbf yew bow.*[27]

16.2.3 Armour penetration

Modern testing

In an early modern test by Saxton Pope, a direct hit from a steel bodkin point penetrated Damascus mail armour.*[28]*[29]

A 2006 test was made by Matheus Bane using a 75 lbf (330 N) draw (at 28") bow, shooting at 10 yards; according to Bane's calculations, this would be approximately equivalent to a 110 lbf (490 N) bow at 250 yards.*[30] Measured against a replica of the thinnest contemporary "Jack coat" armour, a 905 grain needle bodkin and a 935 grain curved broadhead penetrated over 3.5 inches (89 mm). ("Jack coat" armour could be up to twice as thick as the coat tested; in Bane's opinion such a thick coat would have stopped bodkin arrows but not the cutting force of broadhead arrows.) Against "high quality riveted maille", the needle bodkin and curved broadhead penetrated 2.8". Against a coat of plates, the needle bodkin achieved 0.3" penetration. The curved broadhead did not penetrate but caused 0.3" of deformation of the metal. Results against plate armour of "minimum thickness" (1.2mm) were similar to the coat of plates, in that the needle bodkin penetrated to a shallow depth, the other arrows not at all. In Bane's view, the plate armour would have kept out all the arrows if thicker or worn with more padding.

Other modern tests described by Bane include those by Williams (which concluded that longbows could *not* penetrate mail, but in Bane's view did not use a realistic arrow tip), Robert Hardy's tests (which achieved broadly similar results

to Bane), and a *Primitive Archer* test which demonstrated that a longbow **could** penetrate a plate armour breastplate. However, the *Primitive Archer* test used a 160 lbf (710 N) longbow at very short range, generating 160 joules (vs. 73 for Bane and 80 for Williams), so probably not representative of battles of the time.

In 2011, Mike Loades conducted an experiment in which short bodkin arrows were shot at a range of 10 yd (9.1 m) by bows of 140 pounds-force (620 N). The target was covered in a riveted mail over a fabric armour of deerskin over 24 linen layers. While most arrows went through the mail layer, none fully penetrated the textile armour. The experimenters, however, concluded that a long bodkin arrow would have penetrated through this armour combination. Even so, Loades cautions that this experiment did not reflect normal combat ranges and used powerful bows, so may not be typical of battlefield performance.*[31]

Other research has also concluded that later medieval armour, such as that of the Italian city state mercenary companies, was effective at stopping contemporary arrows.*[32]

Contemporary accounts

Gerald of Wales commented on the power of the Welsh longbow in the 12th century:

> ... [I]n the war against the Welsh, one of the men of arms was struck by an arrow shot at him by a Welshman. It went right through his thigh, high up, where it was protected inside and outside the leg by his iron cuirasses, and then through the skirt of his leather tunic; next it penetrated that part of the saddle which is called the alva or seat; and finally it lodged in his horse, driving so deep that it killed the animal.*[33]

Archery was described by contemporaries as ineffective against plate armour in the Battle of Neville's Cross (1346), the siege of Bergerac (1345), and the Battle of Poitiers (1356); such armour became available to European knights of fairly modest means by the late 14th century, though never to all soldiers in any army. Strickland and Hardy suggest that "even at a range of 240 yards heavy war arrows shot from bows of poundages in the mid- to upper range possessed by the Mary Rose bows would have been capable of killing or severely wounding men equipped with armour of wrought iron. Higher-quality armour of steel would have given considerably greater protection, which accords well with the experience of Oxford's men against the elite French vanguard at Poitiers in 1356, and des Ursin's statement that the French knights of the first ranks at Agincourt, which included some of the most important (and thus best-equipped) nobles, remained comparatively unhurt by the English arrows".*[34]

Summary

Modern tests and contemporary accounts agree therefore that well-made plate armour could protect against longbows. However this did not necessarily make the longbow ineffective; thousands of longbowmen were deployed in the English victory at Agincourt against plate armoured French knights in 1415. Clifford Rogers has argued that while longbows might not have been able to penetrate steel breastplates at Agincourt they could still penetrate the thinner armour on the limbs. Most of the French knights advanced on foot but, exhausted by walking across wet muddy terrain in heavy armour enduring a "terrifying hail of arrow shot", they were overwhelmed in the melee.

Less heavily armoured soldiers were more vulnerable than knights. For example, enemy crossbowmen were forced to retreat at Crecy when deployed without their protecting pavises. Horses were generally less well protected than the knights themselves; shooting the French knights' horses from the side (where they were less well armoured) is described by contemporary accounts of the Battle of Poitiers, and at Agincourt John Keegan has argued that the main effect of the longbow would have been in injuring the horses of the mounted French knights.

16.2.4 Shooting rate

A typical military longbow archer would be provided with between 60 and 72 arrows at the time of battle. Most archers would not shoot arrows at maximum rate, as it would exhaust even the most experienced man. "With the heaviest bows [a modern warbow archer] does not like to try for more than six a minute."*[35] Not only do the arms and shoulder muscles tire from the exertion, but the fingers holding the bowstring become strained; therefore, actual rates of shooting in combat would vary considerably. Ranged volleys at the beginning of the battle would differ markedly from the closer, aimed shots as the battle progressed and the enemy neared. On the battlefield English

archers stored their arrows stabbed upright into the ground at their feet, reducing the time it took to notch, draw and shoot.

Arrows were not unlimited, so archers and their commanders took every effort to ration their use to the situation at hand. Nonetheless, resupply during battle was available. Young boys were often employed to run additional arrows to longbow archers while in their positions on the battlefield.*[36] "The longbow was the machine gun of the Middle Ages: accurate, deadly, possessed of a long range and rapid rate of fire, the flight of its missiles was likened to a storm" .*[2] This rate was much higher than that of its Western European projectile rival on the battlefield, the crossbow. It was also much higher than the standard early firearms, although the lower training requirements and greater penetration of firearms eventually led to the longbow falling into disuse.

16.2.5 Treating arrow wounds

The only way to remove an arrow cleanly was to tie a piece of cloth soaked in water to the end of it and push it through the victim's wound and out the other side —this was extremely painful. There were specialised tools used in the medieval period to extract arrows from places where bone prevented the arrow being pushed through. Prince Hal, later Henry V, was wounded in the face by an arrow at the Battle of Shrewsbury (1403). The royal physician John Bradmore had such a tool made, which consisted of a pair of smooth tongs. Once carefully inserted into the socket of the arrowhead, the tongs screwed apart till they gripped its walls and allowed the head to be extracted from the wound. Prior to the extraction, the hole made by the arrow shaft had been widened by inserting larger and larger dowels of elder pith wrapped in linen down the entry wound. The dowels were soaked in honey, now known to have antiseptic properties.*[37] The wound was then dressed with a poultice of barley and honey mixed in turpentine. After 20 days the wound was free of infection.*[38]

16.3 History

16.3.1 Etymology

The first recorded use of the term 'longbow', as distinct from simply 'bow', occurs in a Paston Letter of the 15th century.

16.3.2 Origins

The origins of the English longbow are disputed. While it is hard to assess the significance of military archery in pre-Norman Conquest Anglo-Saxon warfare, it is clear that archery played a prominent role under the Normans, as the story of the Battle of Hastings shows. Their Anglo-Norman descendants also made use of military archery, as exemplified by their victory at the Battle of the Standard in 1138. During the Anglo-Norman invasions of Wales, Welsh bowmen took a heavy toll of the invaders and Welsh archers would feature in English armies from this point on. However, historians dispute whether this archery used a different kind of bow to the later English Longbow.*[39] Traditionally it has been argued that prior to the beginning of the 14th century, the weapon was a self bow between four and five feet in length, known since the 19th century as the shortbow. This weapon, drawn to the chest rather than the ear, was much weaker. However, in 1985, Jim Bradbury reclassified this weapon as the *ordinary wooden bow*, reserving the term shortbow for short composite bows and arguing that longbows were a developed form of this ordinary bow.*[40] Strickland and Hardy in 2005 took this argument further, suggesting that the shortbow was a myth and all early English bows were a form of longbow.*[41] In 2011, Clifford Rogers forcefully restated the traditional case based upon a variety of evidence, including a large scale iconographic survey.*[42] In 2012, Richard Wadge added to the debate with an extensive survey of record, iconographic and archaeological evidence, concluding that longbows co-existed with shorter self-wood bows in England in the period between the Norman conquest and the reign of Edward III, but that powerful longbows shooting heavy arrows were a rarity until the later 13th century.*[43] Whether or not there was a technological revolution at the end of the 13th century therefore remains in dispute. What is agreed, however, is that the English longbow as an effective weapon system evolved in the late 13th and early 14th centuries.

16.3.3 Fourteenth and fifteenth century

The longbow decided many medieval battles fought by the English and Welsh, the most significant of which were the Battle of Crécy (1346) and the Battle of Agincourt (1415), during the Hundred Years' War and followed earlier successes, notably at the Battle of Falkirk (1298) and the Battle of Halidon Hill (1333) during the Scottish wars.

The longbow was also used against the English by their Welsh neighbours. The Welsh used the longbow mostly in a different manner than the English. In many early period English campaigns, the Welsh used the longbow in ambushes, often at point blank range that allowed their missiles to penetrate armour and generally do a lot of damage.*[44]

Although longbows were much faster and more accurate than the black-powder weapons which replaced them, longbowmen always took a long time to train because of the years of practice necessary before a war longbow could be used effectively (examples of longbows from the *Mary Rose* typically had draws greater than 637 N (143 lb_f)). In an era in which warfare was usually seasonal, and non-noble soldiers spent part of the year working at farms, the year-round training required for the effective use of the longbow was a challenge. A standing army was an expensive proposition to a medieval ruler. Mainland European armies seldom trained a significant longbow corps. Due to their specialized training, English longbowmen were sought as mercenaries in other European countries, most notably in the Italian city-states and in Spain. The White Company,*[45] comprising men-at-arms and longbowmen and commanded by Sir John Hawkwood, is the best known English Free Company of the 14th century. The powerful Hungarian king, Louis the Great, is an example of someone who used longbowmen in his Italian campaigns.

16.3.4 Sixteenth century and after

Longbows remained in use until around the 16th century, when advances in firearms made gunpowder weapons a significant factor in warfare and such units as arquebusiers and grenadiers began appearing. Before the English Civil War, a pamphlet by William Neade entitled *The Double-Armed Man* advocated that soldiers be trained in both the longbow and pike; this advice was followed only by a few town militias. The last recorded use of bows in an English battle seems to have been a skirmish at Bridgnorth, in October 1642, during the Civil War, when an impromptu town militia proved effective against un-armoured musketeers.*[46] Longbowmen remained a feature of the Royalist Army, but were not used by the Roundheads.

Longbows have been in continuous production and use for sport and for hunting to the present day, but since 1642 they have been a minority interest, and very few have had the high draw weights of the medieval weapons. Other differences include the use of a stiffened non-bending centre section, rather than a continuous bend.

Serious military interest in the longbow faded after the seventeenth century but occasionally schemes to resurrect its military use were proposed. Benjamin Franklin was a proponent in the 1770s; the Honourable Artillery Company had an archer company between 1784 and 1794; and a man named Richard Mason wrote a book proposing the arming of militia with pike and longbow in 1798.*[47] Donald Featherstone also records a Lt. Col. Richard Lee of 44th Foot advocated the military use of the longbow in 1792.*[48] There is a record of the use of the longbow in action as late as WWII, when Jack Churchill is credited with a longbow kill in France in 1940.*[49] The weapon was certainly considered for use by Commandos during the war but it is not known whether it was used in action.*[50]

16.4 Tactics

16.4.1 Battle formations

The idea that there was a standard formation for English longbow armies was argued by Alfred Byrne in his influential work on the battles of the Hundred Years' War, *The Crecy War*.*[51] This view was challenged by Jim Bradbury in his book *The Medieval Archer*[*][52] and more modern works are more ready to accept a variety of formations.*[53]

In summary, however, the usual English deployment in the 14th and 15th centuries was as follows:

- Infantry (usually dismounted knights and armoured soldiers employed by the nobles and often armed with pole weapons such as pollaxes and bills) in the centre.
- Longbowmen were usually deployed primarily on the flanks, sometimes to the front.
- Cavalry was rarely used but, where deployed, either on the flanks (to make or protect against flank attacks), or in the centre in reserve, to be deployed as needed (for example, to counter any breakthroughs).

In the 16th century, these formations evolved in line with new technologies and techniques from the continent. Formations with a central core of pikes and bills were flanked by companies of "shot" made up of a mixture of archers and arquebusiers, sometimes with a skirmish screen of archers and arquebusiers in front.*[54]

16.5 Surviving bows and arrows

More than 3,500 arrows and 137 whole longbows were recovered from the *Mary Rose*, a ship of Henry VIII's navy that capsized and sank at Portsmouth in 1545. It is an important source for the history of the longbow, as the bows, archery implements and the skeletons of archers have been preserved. The bows range in length from 1.87 to 2.11 m (6 ft 2 in to 6 ft 11 in) with an average length of 1.98 m (6 ft 6 in)*[8] The majority of the arrows were made of poplar, others were made of beech, ash and hazel. Draw lengths of the arrows varied between 61 and 81 centimetres (24 and 32 in) with the majority having a draw length of 76 centimetres (30 in).*[19] The head would add 5–15 cm depending on type, though some 2–4.5 cm must be allowed for the insertion of the shaft into the socket.*[55]

The longbows on the *Mary Rose* were in excellent finished condition. There were enough bows to test some to destruction which resulted in draw forces of 450 N (100 lbf) on average. However, analysis of the wood indicated that they had degraded significantly in the seawater and mud, which had weakened their draw forces. Replicas were made and when tested had draw forces of from 445 N to 823 N (100 to 185 lbf).*[9]

In 1980, before the finds from the *Mary Rose*, Robert E. Kaiser published a paper stating that there were five known surviving longbows:*[2]

- The first bow comes from the Battle of Hedgeley Moor in 1464, during the Wars of the Roses. A family who lived at the castle since the battle had preserved it to modern times. It is 1.66 m (65 in) and a 270 N (60 lbf) draw force.*[56]

- The second dates to the Battle of Flodden in 1513 ("a landmark in the history of archery, as the last battle on English soil to be fought with the longbow as the principal weapon..." *[57]). It hung in the rafters at the headquarters of the Royal Scottish Archers in Edinburgh.*[2] It has a draw force of 360 to 410 N (80 to 90 lbf).

- The third and fourth were recovered in 1836 by John Deane from the *Mary Rose*.*[58] Both weapons are in the Tower of London Armoury and Horace Ford writing in 1887 estimated them to have a draw force of 280 to 320 N (65 to 70 lbf).*[59] A modern replica made in the early 1970s of these bows has a draw force of 460 N (102 lbf).*[60]

- The fifth surviving longbow comes from the armoury of the church in the village of Mendlesham in Suffolk, and is believed to date either from the period of Henry VIII or Queen Elizabeth I. The Mendlesham Bow is broken but has an estimated length of 1.73 to 1.75 m (68 to 69 in) and draw force of 350 N (80 lbf).*[61]

16.6 Social importance

The importance of the longbow in English culture can be seen in the legends of Robin Hood, which increasingly depicted him as a master archer, and also in the "Song of the Bow", a poem from *The White Company* by Sir Arthur Conan Doyle.*[62]

During the reign of Henry III the Assize of Arms of 1252 required that all "citizens, burgesses, free tenants, villeins and others from 15 to 60 years of age" should be armed.*[63] The poorest of them were expected to have a halberd and a knife, and a bow if they owned land worth more than £2.*[64] This made it easier for the King to raise an army, but also meant that the bow was a weapon commonly used by rebels during the Peasants' Revolt. From the time that the yeoman class of England became proficient with the longbow, the nobility in England had to be careful not to push them into open rebellion.*[65]*[66]

It has been conjectured that yew trees were commonly planted in English churchyards to have readily available longbow wood.*[67]

16.7 See also

- Archery
- Infantry in the Middle Ages

16.8 Notes

[1] Bacon 1971, p. 16.

[2] Kaiser 1980.

[3] Levick 1992

[4] Kaiser 1980 footnote 5, citing "The Berkhamsted Bow", Antiquaries Journal 11 (London), p. 423

[5] Kaiser 1980 footnote 6, citing Major Richard G. Bartelot, Assistant Historical Secretary, Royal Artillery Institution, Old Military Academy, Woolwich, England. Letter, 16 February 1976

[6] Longman & Walrond 1967, p. 132.

[7] Bradbury 1985

[8] Staff 2007, p. 6.

[9] Strickland & Hardy 2005, p. 17

[10] Strickland & Hardy 2005, pp. 13,18.

[11] A review of *The Great Warbow* "The power of a bow is measured in its draw-weight, and these days few men can pull a bow above 80lb... and skeletons retrieved from the wreck show spinal distortions, indicating just what it took to be a proper archer" (Cohu 2005).

[12] Trevelyan 2008, pp. 18,88.

[13] Trevelyan 2008, p. 18 quoting W. Gilpin (1791) *Forest Scenery*

[14] Oakeshott 1960, p. 294.

[15] *Statutes at Large* **3**, 1762, p. 408, ...because that our sovereign lord the King, by a petition delivered to him in the said parliament, by the commons of the same, hath perceived That the great scarcity of bowstaves is now in this realm, and the bowstaves that be in this realm be sold as an excessive price...

[16] Hageneder 2007, p. .

[17] Strickland & Hardy 2005, p. 42.

[18] Wadge 2007, pp. 160–161.

[19] Staff 2007, p. 7.

[20] Jessop, Oliver. "A New Artefact Typology for the Study of Medieval Arrowheads".

[21] Wadge 2007, pp. 184–185.

[22] Dr. A.J. Stirland. Raising the Dead: the Skeleton Crew of Henry VIII's Great Ship the Mary Rose. (Chichester 2002) As cited in Strickland & Hardy 2005, p.

[23] Oakeshott 1960, p. 297.

[24] Loades 2013, p. 32.

[25] Loades 2013, p. 33.

[26] Strickland & Hardy 2005, p. 18, Appendix 408–418

[27] Loades 2013, p. 65.

[28] Pope 2003, Chapter IV.--Archery in general, p.30.

[29] "Royal Armouries: 6. Armour-piercing arrowheads".

[30] Bane 2006.

[31] Loades 2013, pp. 72-73.

[32] Kaiser 2003.

[33] *Itinerarium Cambriae*, (1191)

[34] Strickland & Hardy 2005, pp. 272–278.

[35] Strickland & Hardy 2005, p. 31.

[36] The statistics on rates of shot are taken from *Agincourt: Henry V and the Battle That Made England* (Barker 2006).

[37] Israili ZH. "Antimicrobial Properties of Honey". NIH PubMed 23782759

[38] Cummins 2006.

[39] Strickland & Hardy 2005, pp. 34-48.

[40] Bradbury 1985, pp. 14-15.

[41] Strickland & Hardy 2005, pp. 37-38, 48.

[42] Rogers 2011.

[43] Wadge 2012, pp. 211–212.

[44] Rothero 1984, 4:The Welsh Wars 1277–1282 "one arrow could pierce a mail hauberk, breeches and saddle of an armoured knight and pin him by the thigh to his horse's flank. The Welsh fought [in] a well-planned ambush".

[45] Conan Doyle 1997.

[46] John Norton, letter dated 5 October 1642. As printed in The Garrisons of Shropshire during the Civil War, Leake and Evans publishers, Shrewsbury, 1867, page 32. "every man from 16 to 50 and upwards, gott himself into such armes as they could presently attaine, or could imagine be conduceable for the defence of the towne". "some companies of foote.. with their musketts... began to wade foarde, which being descried, we, with our bowes and arrows did so gaule them (being unarmed men) that with their utmost speed they did retreate" https://play.google.com/store/books/details?id=4HBMAAAAMAAJ&rdid=book-4HBMAAAAMAAJ&rdot=1 accessed 7 August 2012

[47] Heath 1980, pp. 208-9.

[48] Featherstone 1973, p. 154.

[49] Featherstone 1973, pp. 157–158.

[50] Heath 1980, pp. 215-216.

[51] Burne 1991, pp. 37–39.

[52] Bradbury 1985, pp. 95–98.

[53] Bennett 1994, p. 1–20.

[54] Strickland & Hardy 2005, p. 403.

[55] Strickland & Hardy 2005, p. 6.

[56] Kaiser 1980 cites: Gordon, Henry; Webb, Alf (1972). "The Hedgeley Moor Bow at Alnwick Castle". *Journal of the Society of Archer-Antiquaries* **15**: 8, 9.

[57] Heath ??, p. 134

[58] Kaiser 1980 cites: Gordon, Paul H. (1939). *The New Archery*. New York: D. Appleton-Century Co. p. 183.

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[61] Kaiser 1980 cites: W.F. Paterson, Chairman, Society of Archer-Antiquaries. Letters, 5 May 1976.

[62] Conan Doyle 1997

[63] Kruschke 1985, p. 31

[64] *The right to keep and bear arms: report of the Subcommittee on the Constitution of the Committee on the Judiciary, United States Senate, Ninety-seventh Congress, second session*, U.S. G.P.O., 1982 p. 46 (see also: David T. Hardy, Partner in the Law Firm Sando & Hardy *Historical Bases of the Right To Keep and Bear Arms)*

[65] Andrzejewski 2003, p. 65 "It is surely not accidental that the only peasant revolt in England which succeeded took place at the time of the predominance of the long bow".

[66] Trevelyan 2008, p. 18 "The good yeoman archer 'whose limbs were made in England' was not a retrospective fancy of Shakespeare, but an unpleasant reality for French and Scots, and a formidable consideration for bailiffs and Justices trying to enforce servile dues or statutory rates of wages in the name of Law, which no one high or low, regarded with any great respect".

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Chapter 17

Arbalest

Not to be confused with Arbalist (crossbowman).

The **arbalest** (also **arblast**) was a late variation of the crossbow coming into use in Europe during the 12th century. A large weapon, the arbalest had a steel prod ("bow"). Since an arbalest was much larger than earlier crossbows, and because of the greater tensile strength of steel, it had a greater force. The strongest windlass-pulled arbalests could have up to 22 kN (5000 lbf) of force and be accurate up to 300 m. A skilled arbalestier (arbalester) could loose two bolts per minute.

17.1 Nomenclature

The term "arbalest" is sometimes used interchangeably with "crossbow". "Arbalest" is a Medieval French corruption from the Roman name *arcuballista*, which was then used for crossbows, although originally used for types of artillery; Modern French uses the word *arbalète*, which is linguistically one step further from the stem (disappearance of the *s* phoneme in the last syllable before *t*). The word applies to both crossbow and arbalest (the latter may be referred to as a *heavy crossbow*, but an actual heavy crossbow may not be the same as an arbalest). In some cases, the word has been used to refer to arbalists, the people who actually used the weapon.

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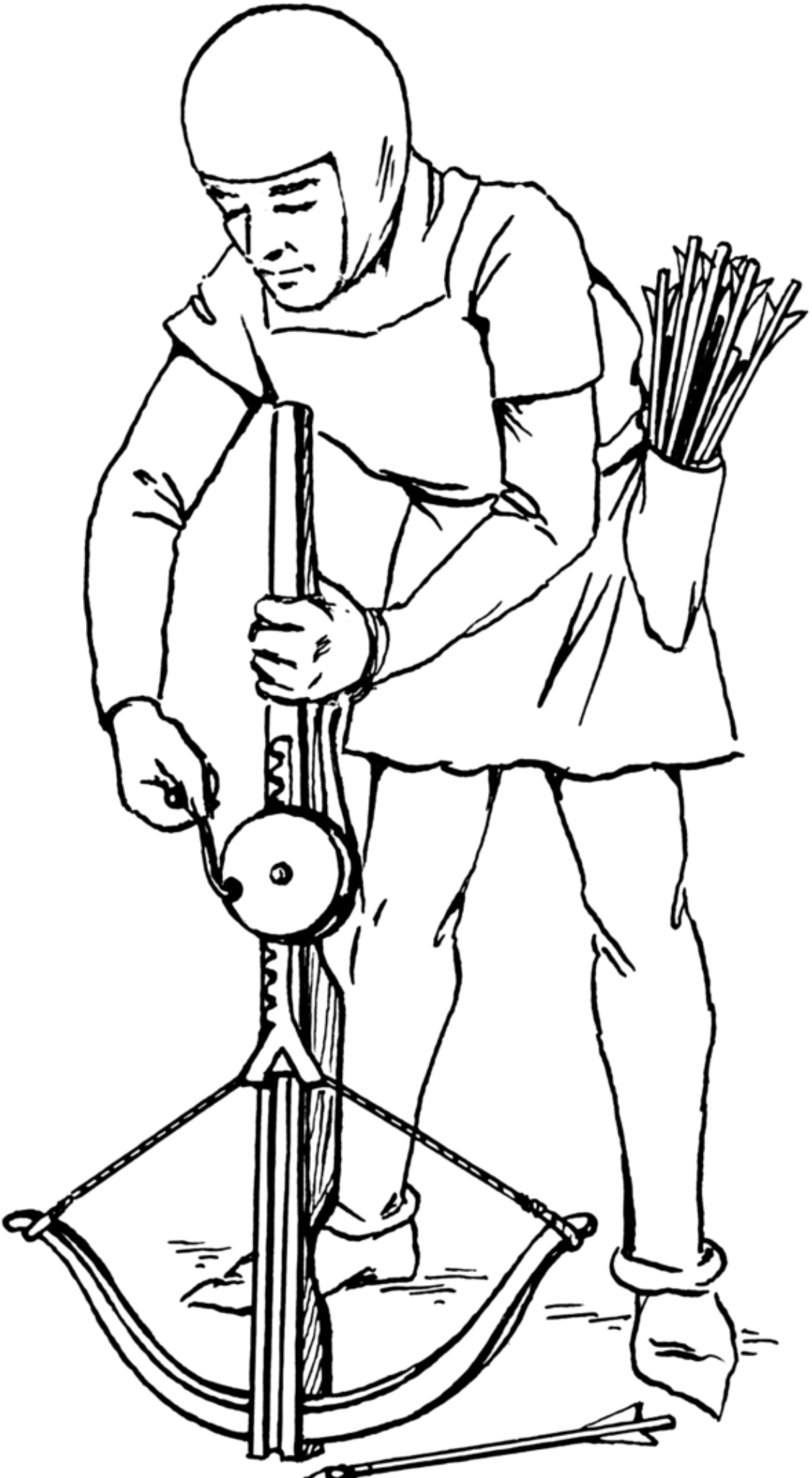

Chapter 18

Cable-backed bow

A **cable-backed bow** is a bow reinforced with a cable on the back. The cable is made from either animal, vegetable or synthetic fibers and is tightened to increase the strength of the bow. A cable will relieve tension stress from the back of the bow by raising its neutral plane: the border between the back of the bow that stretches and the belly of the bow that compresses when bent. A good cable-backed bow can thus be made of poor-quality wood, weak in tension. The material, the diameter, the distance from the back of the wooden element, and the level of stress (tightness) of the cable determines how much it relieves tension stress from the wooden element of the bow and increases the power of the shot.

The Inuit of the Arctic used sinew cables on their short bows of driftwood, baleen, horn or antler to make them unlikely to break in tension, and to increase their power. The cables are attached to the bow at several points on each limb with a series of half-hitches and then tightened by inserting a small toggle in the bundle of strings and twisting. These bows could be reflexed, deflexed, decurved, or straight.

One variety of cable-backed bow is the Penobscot bow or Wabenaki bow, invented by Frank Loring (Chief Big Thunder) about 1900.*[1] It consists of a small bow attached by cables on the back of a larger main bow.

18.1 See also

- Flatbow
- Longbow
- Composite bow

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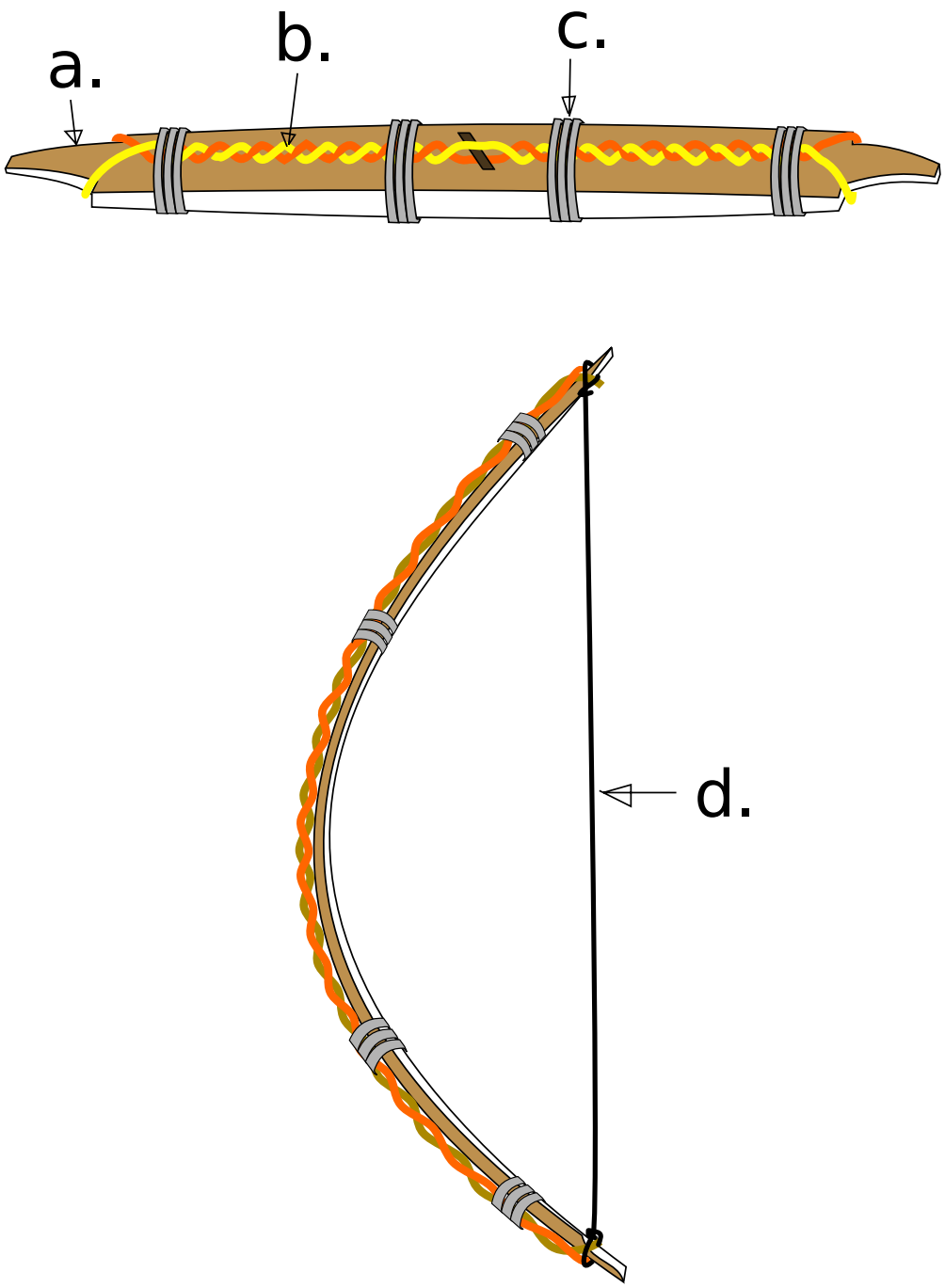
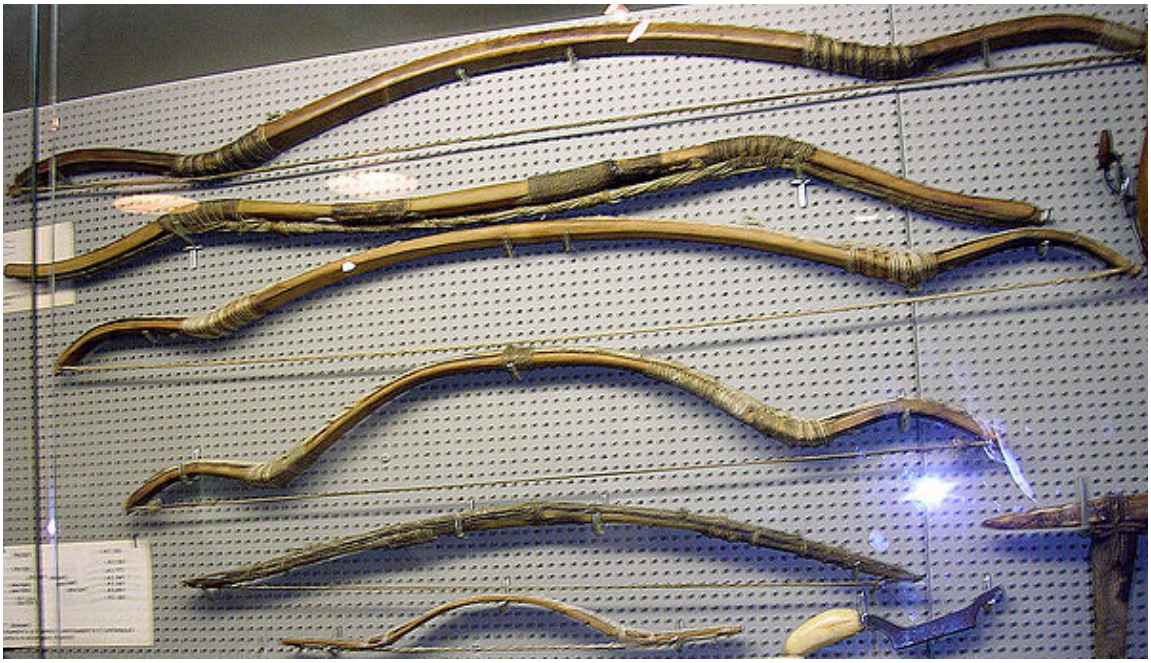


The cable backed bow, showing the bow (a) bearing the tensioned cable (b) along the face of it, attached by bindings (c). Finally, the bow strung with the main string (d).



Several Inuit cable-backed bows. The shapes of the top four are an interesting mix of deflex, reflex, and decurve.

Chapter 19

Gakgung

The **Korean Bow** (Korean: 각궁, Gak-gung) is a water buffalo horn-based composite reflex bow, standardized about 1900 CE from the variety of such weapons in earlier use. It uses with thumb draw. The Korean Thumb ring is different from the Manchu, Mongol, or the Turkish Thumb Ring. It comes in two styles, male and female. Male thumb ring sticks out as an extra appendage, while the female thumb ring covers the front joint of the thumb only.*[1] Also, the arrow is laid on the right side of the bow, unlike the western bow, where the arrow is laid on the left side of the bow.

Gungsul, also written *goongsul*, literally means "the Craft of the bow." It is also called Korean traditional archery.

19.1 History of Military Origin and Usage

Korean Horse Back Archery in 5th-century

The reflex bow had been the most important weapon in Korean wars with Chinese dynasties and nomadic peoples, recorded from the 1st century BCE.*[2] Legend says the first king and founder of the Goguryeo, Go Jumong, was a master of archery, able to catch 5 flies with one arrow. Park Hyeokgeose, the first king of the Silla, was also said to be a skilled archer. Rumors of archers in Goguryeo and Silla presumably reached China; the ancient Chinese gave the people of the north east, Siberia, Manchuria and the Korean Peninsula, the name of Dongyi (東夷), the latter character (夷) being a combination of the two characters for "large" (大) and "bow" (弓).*[3]

However, the word 夷 was first used in Chinese history referring to the people South of Yellow River over 5,000 years ago. Later, when Yi 夷 people joined the tribes of Hua Xia [華夏] Chinese, 夷 meant outsiders. By that time, DongYi refers to Korean, as in Outsiders from the East.

With the Mongol Conquest of Korea, archery became the main stay of Korean military. Sword and spear of Korea and China did nothing to stop the Mongol archery, so were quickly discarded in favor of the ultimate weapon, the composite bow. Yi Seonggye, the founding king of Joseon was known to have been a master archer. In a battle against Japanese pirates, Yi Seonggye, assisted by Yi Bangsil, killed the young samurai commander "Agibaldo" with two successive arrows, one arrow unhelmeting the warrior, with the second arrow entering his mouth. In his letter to General Choi Young, Yi Seonggye lists as one of five reasons not to invade Ming Dynasty as during the monsoon season, glue holding together the composite bow weakens, reducing the effectiveness of the bow.

Founding of Joseon dynasty saw the retention of the composite bow as the main stay of the Joseon military. Archery was the main martial event tested during the military portion of the national service exam held annually from 1392 to 1894. Under Joseon, archery reached its zenith, resulting in the invention of pyeonjeon, which saw great service against the Japanese in 1592 and against the Manchus in early 1600s.

Until the Imjin wars, archery was the main long-range weapon system. During that war, the tactical superiority of the matchlock arquebus became apparent, despite its slow rate of fire and susceptibility to wet weather.*[4] However, it was the Korean composite bow, referred to as the "half bow" by the Japanese, that halted the Japanese at the Battle of Haengju as well as at the Battle of Ulsan. Although Joseon adopted the arquebus during the Imjin War, the composite bow remained the main stay of its Army until the reforms of 1894. Under King Hyojong's military reforms, an attempt was made to revive horse archery as a significant element of the military. It was also practiced for pleasure and for health, and many young males - including the king - and a some many females would spend their free time practicing it.

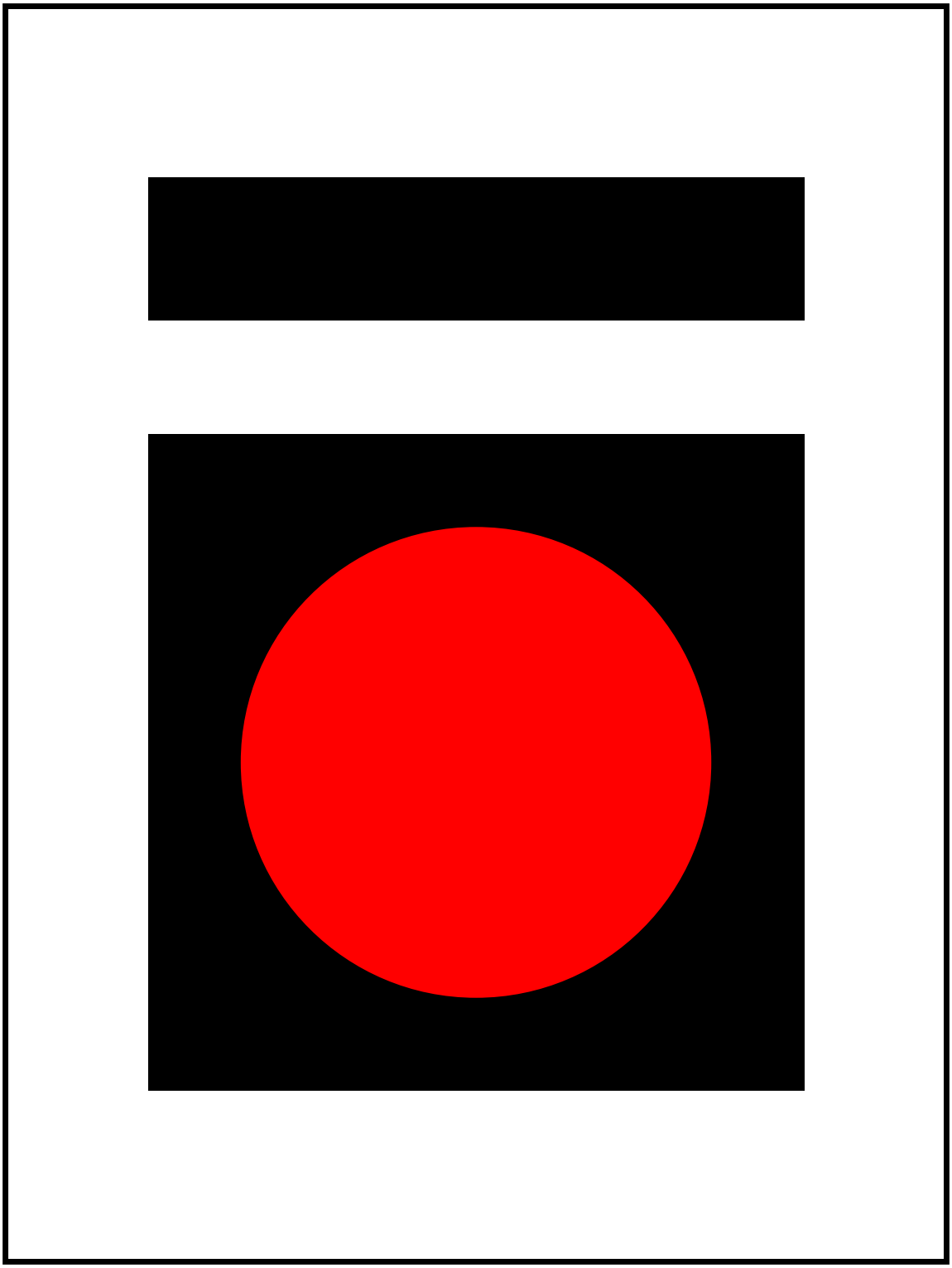
19.2 Transition to Recreational Sport

In 1899, the visiting Prince Heinrich of Prussia expressed his astonishment to Emperor Gojong at a traditional archery demonstration. The Prince, hailing from a militarized Prussian culture, sought out demonstrations of Korean martial arts, and Archery was the most impressive among the arts demonstrated. He was familiar with Turkish and Hungarian Archery of Europe, which were similar to Korean Archery. Prince Heinrich suggested sporterizing the art to make it a national sport. The emperor, convinced by the Prince, decreed "let people enjoy archery to develop their physical strength" and established an archery club. In the subsequent standardization of Korean archery, the nature of the bow and the arrow was standardized, as was the range of the targets. Korean traditional archery now uses one specific type of composite bow, bamboo arrows, and a standard target at a standard distance of 120 bo (about 145 meters). Korean Archery as a sport developed under the Japanese Occupation, its textbook, "Joseon eui Goongdo" being published in 1920.

19.3 Construction and competition

The traditional Korean bow is a highly reflexed version of the classic Eurasian composite bow. The core is bamboo with sinew backed to prevent the bow breaking and to add a pulling strength to the limbs, with oak at the handle. On the belly is water buffalo horn which significantly increases the power by pushing the limbs. This combination of horn which pushes from the belly and sinew that pulls from the back is the defining strength of the bow. The siyahs, the stiffened outer ends of the limbs, are made of either mulberry or black locust spliced (v-splice) onto the bamboo. The glue is made from isinglass. Over the sinew backing is a special birch bark that is imported from Northeast China. It is soaked in sea water (possibly for one year). It is applied to the back using diluted rubber cement (using benzene as the solvent). No sights or other modern attachments are used.

The draw weights vary, but most are above twenty kilograms. The cost for this type of bow is in the US$800 range.



Standard gungdo target

For a similar modern version made of laminated fiberglass, the cost is US$200–300. For most competitions, either bow may be used, with carbon-fiber arrows, but for national competitions, only the composite bow and bamboo arrows may be used. Korean archers have also been very successful in Olympic and other competitions with more modern types of bow.*[5]

The sukgung, a kind of crossbow, and the Gak-gung are a small but very powerful bow. A sukgung can shoot up to 400 meters while a Gak-gung can shoot up to 350 meters.

Master Heon Kim

The art of constructing traditional Korean bows was designated an Important Intangible Cultural Property in 1971.[*][6]

19.4 See also

- Composite bow
- Hungarian bow
- Turkish bow
- Mongol bow
- Pyeonjeon
- Singijeon

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19.6 External links

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- The Way of the Bow
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- Korean Traditional Archery Documentary

Chapter 20

Holmegaard bow

The Holmegaard bows are a series of self bows found in the bogs of Northern Europe dating from the Mesolithic period.*[1] They are named after the Holmegaard area of Denmark in which the first and oldest specimens were found, and are the oldest bows discovered anywhere in the world.

20.1 Description

The shape of the Holmegaard bows is their distinctive feature, having wide, parallel limbs and a biconvex midsection with the tips ending in a point. The handle is deep, narrow and remains stiff while the bow is drawn. The bows are generally between 150 and 170 cm in length and less than 6 cm wide.*[1] The oldest specimens are made of elm and some of the more recent examples are made of yew. The tiller of a Holmegaard style bow is more circular than that of a Longbow since only the inner limbs are bending.*[2]*[3]

20.2 Use

Initially, the Holmegaard bows were believed to be made "backwards", that is with wood removed from the back and the belly made convex.*[1] This may be the result of a comparison with the English Longbow that has a flat back and a convex belly. Many successful replicas were made in this fashion even though working the back of the bow cuts the wood fibres and endangers the bow.

Subsequent analysis suggested the back may have instead been convex with the flattened surface being the belly. This is far more efficient for woods like elm which are relatively strong in tension. The compression strain on the belly is evenly distributed on the flat surface which reduces string follow.*[3] The yew bows are generally narrower, yew being better suited for narrow bows than elm.*[1]

The length of the bow as well as the stiff outer limbs contribute to having a low string angle at the tips. This reduces stacking: the exponential increase in draw weight at longer draw lengths. A lower stacking bow is smoother to draw.*[4]

20.3 Efficiency

The Holmegaard bow can shoot an arrow faster and farther due to the light, long and stiff outer limbs that act as levers when propelling the arrow. This is the same principle that explains why a dart can be propelled faster from an Atlatl than from throwing alone.

Holmegaard style bows are very commonly used at flight archery competitions. For flight bows, an optimum between the length of the stiff tips and the draw force of the bow is desired. If the outer limbs are too long, their weight exceeds the capacity of the energy stored in inner limbs. The outer limbs can also become unstable if made too thin. In modern Holmegaard-style bows, the outer limbs are much thicker than the inner limbs to prevent the outer limbs from bending excessively.*[5]*[6]

The original specimens were not finished for such high performance. There is even doubt as to whether the biconvex shape of the mid-limbs is due to poor preservation in the bogs. The more recent Holmegaards do not have well defined "shoulders" at all and have more semblance to the American flatbow.*[7]

Because of the wide working limbs, Holmegaard bows can be made from more common, lower density woods such as maple, ash, oak and elm.

20.4 References

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Chapter 21

Laminated bow

A **laminated bow** is an archery bow in which different materials are laminated together to form the bow stave itself. Traditional composite bows are normally not included, although their construction with horn, wood, and sinew might bring them within the above definition. This term usually refers to bows made of wood, fiberglass, or other modern materials. Such bows may have any side-view profile; the modern recurve bow is one example, commonly made mainly of fiberglass, and many modern longbows and recurves are made by laminating wood.

The technique has many advantages as compared to making a self bow. It enables the bowyer to use materials on the back of the bow that are particularly strong in tension, and materials strong in compression on the belly; it is also easier to apply powered machinery to the manufacturing process so as to save time. The bow may be curved during lay-up, so that different bow shapes can easily be achieved. Lamination may make it possible to apply a strong backing to wood that would not otherwise make a good bow. A laminated backing may also save a great deal of time that would be spent following the grain of a natural stave in order to make a self bow.

Other bow construction techniques include cable-backed bow and compound bow.

21.1 History

Laminated bows were rare in most of the world before modern waterproof glues became widely available, almost unknown before about 1900CE, and outside Japan and Northern Asia they have never formed a significant proportion of traditional bows. The modern Japanese bow however is a laminated bow, as is the Korekawa bow from the late Jōmon period in Japan,[*][1] and the Saami and their neighbours[*][2] across Northern Eurasia [*][3] also made laminated bows for centuries. Insulander speculates that these may have been a step in the evolution of the composite bow.[*][2] Hijāzi Arabs may also have used a laminated bow.[*][4]

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Chapter 22

Mongol bow

Mongolian Archery during Naadam, 2014

The **Mongol bow** is a recurved composite bow renowned for its military effectiveness. The old Mongolian bows that were used during the times of Genghis Khan were smaller than the modern weapons used at most Naadam festivals today. The Mongolian archery tradition may be continuous, but mounted archery was officially outlawed*[1] in Mongolia after it was conquered by the Manchu dynasty.*[2] Manchu soldiers entered gers and broke any bows that they found. Over two hundred years of enforcement these changes stuck and the ancient art of bow making was nearly lost along with a majority of archery games and traditions. Modern Khalkha bow resembles the Manchu bow while the Buryat and Uriankhai (khavchaahai) bows resembles the ancient Mongol bows; Archery came back to Naadam and was organized for the first time in many years by the newly founded Mongolian National Archery Association (1940). This was the beginning of the sports standardization in the modern era.*[3]

22.1 Construction

Main article: Composite bow

Hulagu Khan with the older composite bow used during the time of the Mongol conquest. It is smaller in size and has no string bridges

Ancient and modern Mongol bows are part of the Asian composite bow tradition. The core is bamboo, with horn on the belly (facing towards the archer) and sinew on the back, bound together with animal glue.*[4] As animal glue is dissolved by water, composite bows may be ruined by rain or excess humidity; a wrapper of (waterproof) birch bark may give limited protection from moisture and from mechanical damage. The bow is usually stored in a leather case for protection when not in use.

22.2 The arrows

Birch is a typical material for arrows. The normal length of an arrow is between 80 and 100 cm, and the shaft's diameter is around 10 mm.

As for fletchings, tail feathers of crane are favored, but tail feathers of all birds are usable. Eagle feathers make a particularly exclusive arrow, but since eagles are rare most arrows obviously cannot have fletchings from eagle's tail feathers. Feathers taken from the wings are said to flow less smoothly through the air, so if given the choice tail feathers are picked. The Mongols characteristically pay close attention to minutest of details. The placement of the fletchings in relation to their size, and what part of the bird they were taken from, is of great importance for correct rotation and good balance in the air. Consequently these factors are painstakingly considered when making arrows after the Old Mongol standard.

The arrowheads, or points, could be everything from wide metal blades used for big game (or in war) to bone and wooden points, which are used for hunting birds and small animals. The high impact of this bow ensures that a bony point will be lethal when hitting the body of a smaller animal or a bird. In addition to these kinds of arrows, whistling arrows are useful during hunting, because the effect on animals of an arrow whistling away high above the ground is often to make it stop, curious to see what is in the air. This gives the hunter time to launch a second arrow, this time with a game head to kill the animal. These whistling arrows made by inserting an arrowhead of bone in which air channels have been created. When shot, such arrowheads make a very audible sound through the air.

A Timurid depiction of an Mongol archer. (Signed (lower right): Muhammad ibn Mahmudshah al-Khayyam, early 15th century).

22.2.1 String bridge

The principal difference between the modern Mongol bow and other composite bows is the presence of a "string run" (or "string bridge") - an attachment of horn, leather, or wood used to hold the string a little further apart from the bow's limbs at the base of the siyah (stiffened tip). This attachment aids the archer by increasing the draw weight in the early stages of the draw, thus slightly increasing the total energy stored by the draw and available to the arrow. String bridges are not attested at the time of the Mongol empire, appearing in Chinese art during the later Manchu Qing dynasty.*[5] The armies of Genghis Khan would have used the composite bows typical of their various nationalities at the time.

22.3 Range

An inscription on a stone stele was found near Nerchinsk in Siberia: "While Chinggis (Genghis) Khan was holding an assembly of Mongolian dignitaries, after his conquest of Sartaul (Khwarezm), Yesüngge (the son of Chinggis Khan's brother) shot a target at 335 alds (536 m)."

In the historical novel "Khökh Sudar" Injinashi, the Mongolian philosopher, historian and writer, imagines the competition amongst all Mongolian men in about 1194-1195: five archers each hit the target three times from a distance of 500 bows (1 bow = at least 1 metre).

22.4 Mongolian draw and release

Main article: Bow draw

The Mongolian draw, or thumb draw, uses only the thumb, the strongest single digit, to grasp the string. Around the

Mongol archers during the time of the Mongol conquest used a smaller bow suitable for horse archery.

back of the thumb, the index and/or middle fingers reinforce the grip. This is traditional across the Asian steppes, as well as in Korea,*[6] Japan, Tibet, China, Turkey, India and recent Persia.*[5] It was also used by Ishi, the last of the Yana, with his short bows.

It gives a narrower grip on the string, as only one digit is used, and this may help to avoid "string pinch" with shorter bows such as the composite bows normally used from horseback. Mongol archers would wear a thumb ring made from leather, bone, horn, and in some cases silver to protect the thumb.*[7] It may also avoid a problem occasionally faced by archers using the Mediterranean release, when the three fingers do not release at exactly the same time and thus foul the draw. This release is normally used with the arrow on the right side of the bow for a right-handed archer, and on the left side of the bow for a left-handed archer.

A Mongolian draw

22.5 See also

- Composite bow
- Turkish bow
- Korean bow
- Bow draw
- Bow string
- Mounted archery

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Chapter 23

Yumi

This article is about the Japanese bow. For other uses, see Yumi (disambiguation).

Yumi (弓) is the term for Japanese asymmetrical bows, and includes the longer **daikyū** (大弓) and the shorter **hankyū** (半弓) used in the practice of kyūdō and kyūjutsu, or Japanese archery. The *yumi* was an important weapon of the samurai warrior during the feudal period of Japan.

23.1 History of the yumi

Early Japanese used bows of various sizes but the majority were short with a center grip. By the 3rd century BC, the bow length had grown to nearly 2 meters. This bow was called the *maruki yumi* and was constructed from a small sapling or tree limb. It is unknown when the *asymmetrical* yumi came into use but the first written record is in a Chinese manuscript from the 3rd century AD which describes the people of the Japanese islands using *a wooden bow with upper and lower limbs of different lengths, and bamboo arrows with points of bone or iron*. The oldest asymmetrical yumi found to date was discovered in Nara and is estimated to be from the 5th century.*[1]

During the Heian period (794-1185) the length of the *yumi* was fixed at a little over two meters and the use of laminated construction was adopted from the Chinese. By the end of the 10th century the Japanese developed a two piece bamboo and wood laminated *yumi*. Over the next several hundred years the construction of the *yumi* evolved and by the 16th century the design of the *yumi* was considered to be nearly perfect. The modern bamboo *yumi* is practically identical to the *yumi* of the 16th and 17th centuries.*[2]

23.2 Shape

The yumi is exceptionally tall, standing over two meters, and surpassing the height of the archer (*ite*, 射手). They are traditionally made by laminating bamboo, wood and leather, using techniques which have not changed for centuries, although some archers (particularly beginners) may use a synthetic yumi.

The yumi is asymmetric; According to the All Nippon Kyudo Federation, the grip (*nigiri*) has to be positioned at about two thirds of the distance from the upper tip.

The upper and lower curves also differ. Several hypotheses have been offered for this asymmetric shape. Some believe it was designed for use on a horse, where the yumi could be moved from one side of the horse to the other with ease, however there is evidence that the asymmetrical shape predates its use on horseback.*[3]

Others claim that asymmetry was needed to enable shooting from a kneeling position. Yet another explanation is the characteristics of the wood from a time before laminating techniques. In case the bow is made from a single piece of wood, its modulus of elasticity is different between the part taken from the treetop side and the other side. A lower grip balances it.

The hand holding the yumi may also experience less vibration due to the grip being on a vibration node of the bow. A perfectly uniform pole has nodes at 1/4 and 3/4 of the way from the ends, or 1/2 if held taut at the ends – these positions will change significantly with shape and consistency of the bow material.

23.3 String

The string (*tsuru*) of a yumi is traditionally made of hemp, although most modern archers will use strings made of synthetic materials such as Kevlar, which will last longer. Strings are usually not replaced until they break; this results in the yumi flexing in the direction opposite to the way it is drawn, and is considered beneficial to the health of the yumi. The nocking point on the string is built up through the application of hemp and glue to protect the string and to provide a thickness which helps hold the nock (*hazu*) of the arrow (*ya*) in place while drawing the yumi. But can also be made of strands of waxed bamboo. .

23.4 Care and maintenance

A bamboo yumi requires careful attention. Left unattended, the yumi can become out-of-shape and may eventually become unusable. The shape of a yumi will change through normal use and can be re-formed when needed through manual application of pressure, through shaping blocks, or by leaving it strung or unstrung when not in use.

The shape of the curves of a yumi is greatly affected by whether it is left strung or unstrung when not in use. The decision to leave a yumi strung or unstrung depends upon the current shape of the yumi. A yumi that is relatively flat when unstrung will usually be left unstrung when not in use (a yumi in this state is sometimes referred to as being 'tired'). A yumi that has excessive curvature when unstrung is typically left strung for a period of time to 'tame' the yumi.

A well cared-for yumi can last many generations, while the usable life of a mistreated yumi can be very short.

23.5 Bow lengths

23.6 Yumi history

The Korekawa bow, from the late Jōmon period which ended about 400 BCE, is laminated.*[4]

23.7 Gallery

- Moto hazu (bottom nock)
- Nigiri (grip)
- Ura hazu (top nock)
- Tsurumaki (string holder) and tsuru (string)
- Antique hankyū (small yumi)
- Antique daikyū (large yumi)and hankyū (small yumi)
- Yumi bukuro (cloth cover)

23.8 See also

- Azusa Yumi—a "Catalpawood Bow"
- Hama Yumi—a "Evil Destroying Bow"
- Shigehto Yumi—a "Unity Bow"

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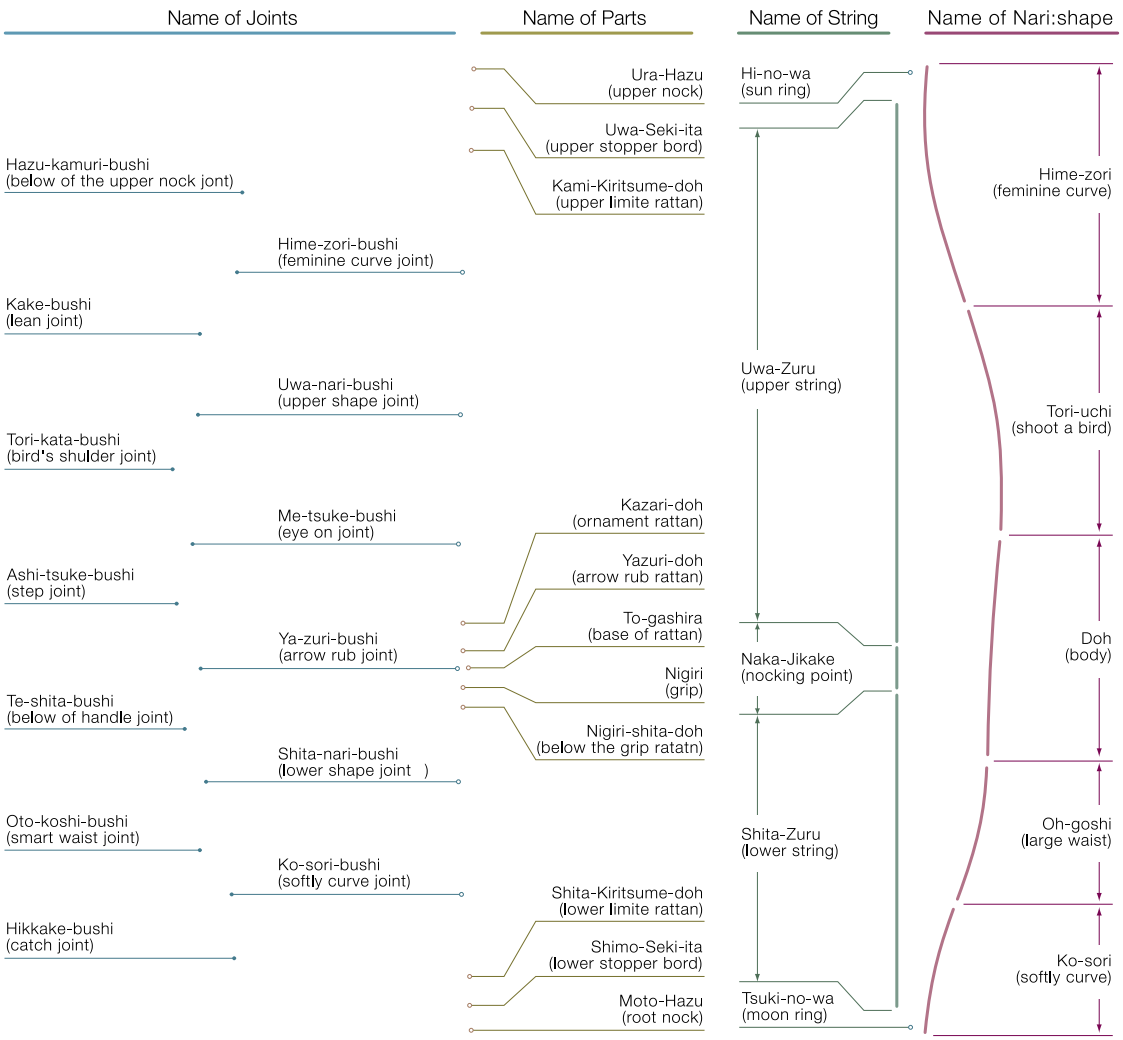
23.11 External links



Yumi bow names

Chapter 24

Bracer

Ketoh armguard, leather embellished with silver and turquoise, with bow

A **bracer** (or **arm-guard**) is a strap or sheath, commonly made of leather, stone, or plastic that covers the inside of an archer's arm to protect it while shooting. Bracers protect the inside of the archer's forearm against injury by the string of the bow or the fletching of the arrow. They also prevent loose clothing from catching the bow string. They normally cover part of the forearm only, but chest-guards are sometimes worn, usually by female archers, and other areas have at times been protected. With some combinations of non-baggy clothing and bows with a larger distance between the bow and the string, the archer may not need to wear any bracer.*[1]

24.1 Decorated bracers

The modern Navajo people and Hopi developed a form of bracer known as a **ketoh**, which can be decorated with silver, turquoise, and other adornments, possibly from earlier examples made of bone.*[2] Ketohs usually have a central motif, sometimes with a stone ornament, and four curvilinear shapes that radiate toward the corners. Ketohs may have a smooth leather surface on the inside of the arm and are functional, but they are normally used as items of personal and ritual adornment, or as works of art in their own right.*[3]

Stone wrist-guards from Beaker culture graves of the European Bronze Age have been thought to be archery bracers. However, they are usually found on the outside of the arm where they would have been more conspicuous. Many have only two holes which would make them difficult to fasten securely to the arm, and some have projecting rivets which would catch on the bow string and make them unsuitable for use as a bracer. Many show great skill in polishing and stone working, and few are found in areas from which their stone originates. When the objects occur in barrows, they always occur in the central primary grave, a place thought to be reserved for heads of family and other important people. They may have been status symbols of prowess in hunting or war, probably mounted as decorations on functional bracers. A few prehistoric wrist-guards made of gold or amber have also been found; scholars believe these were for ornamental rather than functional use.*[2] A review of British bracers by Hunter, Woodward *et al.* looks in detail at all the British bracers, identifying two major sources of stone from which they are made and suggesting that they may well not be connected with archery, and highlighting other potential uses.*[4]

24.2 Other uses

Bracers have also been used in other sports, including ball games such as Follis (played in ancient Rome).

In many common role-playing games, bracers are a general piece of armour rather than protective archery equipment, possibly due to confusion with vambraces.

24.3 Notes

[1] *Toxophilus - the School of Shooting*. by Roger Ascham. Read Books 2006. ISBN 1-84664-369-4 ISBN 978-1846643699

[2] Harry Fokkens, Yvonne Achterkanp, and Maikel Kuijpers, "Bracers or Bracelets? About the Functionality and Meaning of Bell Beaker Wrist-guards", *Proceedings of the Prehistoric Society 2008,* vol. 74, pp. 109-149

[3] "KETOH. Navajo. Silver and Leather", Millicent Rogers Museum of Northern New Mexico Collection, Accessed 25 February 2008

[4] Hunter and Woodward et al "An Examination of Prehistoric Stone Bracers from Britain" An Examination of Prehistoric Stone Bracers from Britain

24.4 External links

- Archer's Gear: The bracer, La Belle Compagnie Website
- Roundway G8 burial Wiltshire Heritage Museum, Devizes
- Ketohs, collection of the National Museum of the American Indian

Chapter 25

Cresting machine

"Crester" redirects here. For the fictional character, see Captain Crester.

A **cresting machine** (also called an **arrow-cresting machine**, an **arrow-crester**, or simply a **crester**[*][1]) is a machine that aids in the adding of coloured lines called *cresting* to arrows in order to identify the bowyer. Cresting machines are small lathes that consist of a chuck and an engine attached to a board.[*][2] Cresting machines do not paint the arrows themselves but are rather jigs that rotate the arrows uniformly so that a separate steadily held paintbrush can paint the cresting accurately.[*][3]

25.1 References

[1] Sam Fadala (1999). *Traditional Archery*. Stackpole Books. p. 149. ISBN 0-8117-2943-5.

[2] Jim Hamm (2000). *The Traditional Bowyer's Bible* **3**. Globe Pequot. p. 237. ISBN 1-58574-087-X.

[3] Paul C. Hougham (1958). *The Encyclopedia of Archery*. Barnes. p. 65.

Chapter 26

Finger tab

A tab worn on the right hand.

A **finger tab** or **Archer Tab** used in archery is a small leather or synthetic patch that protects an archer's fingers from the bowstring. It is strapped or otherwise attached to an archer's hand. In summertime, tabs are far more comfortable than gloves and can more conveniently use thicker material. They are also less expensive and easier to fit, and are the normal finger-protection used with bows.

The tab usually has a retaining loop on the back of the tab that fits over the middle finger, which is simply there to keep the tab on the fingers when the string is loosed. Tabs come in various forms. The simplest is made of a single patch that is placed below the nocking point between the fingers and the string. This style of shooting is called 'Three finger under'. These are most often used in barebow or longbow styles of archery.

More complex tabs have a split about one third down the leading edge so that the fingers can be placed with one finger above and two fingers below the nocking point of the arrow. This style of shooting is called split finger or Mediterranean Draw. The tab may also have a platform that is attached to the back of the tab and forms a flat cover over the top, to give the archer a hard reference point underneath the chin when the string is drawn back. Platform tabs are more common for recurve or Olympic Class target archery.

A thumb ring or thumb tab is used similarly to protect the thumb by archers practising the Mongolian draw. The Japanese yugake is a reinforced glove with a special ridge which holds the string.

In the past 25 years mechanical releases have become popular. The mechanism is usually attached to the wrist; it holds the string, and releases it when triggered.

The term "tab" is of uncertain etymology, perhaps an alteration of tag (small hanging piece).

26.1 See also

- Bow draw

A crude finger tab of the split type.

- Bracer

Chapter 27

Fletching

For the English village, see Fletching, East Sussex.

Fletching (also known as a flight) is the aerodynamic stabilization of arrows or darts with materials such as feathers,

Feather fletching - these are shield cut with barred red hen feathers and a solid white cock

each piece of which is referred to as a **fletch**. A **fletcher** is a maker of arrows.

The word is related to the French word *flèche*, meaning "arrow," via Old French; the ultimate root is Frankish *fliukka*.

27.1 Description

As a noun, fletching refers collectively to the fins or vanes, each of which individually is known as a fletch. Traditionally, the fletching consists of three matched half-feathers attached near the back of the arrow or dart's shaft that are equally spaced around its circumference. Four fletchings have also been used historically. Today, modern plastics may be used instead. Fletches were traditionally attached with glue and silk thread, but with modern glues thread is no longer necessary unless the arrow is a reproduction of a medieval war arrow. The fletching is used to stabilize the

Plastic fletching (also known as vanes*) - these are parabolic cut with pink hen vanes (the ones put oblique to the bow when nocked on the string) and a green cock (the one —or ones, with even-numbered vanes—put perpendicular to it)*

arrow aerodynamically. Feather fletches impart a natural spin on an arrow due to the rough and smooth sides of a feather and the natural curve, determined by which wing the feather came from. Vanes need to be placed at a slight angle to create the same effect, but all are there to impart stability to the projectile to ensure that the projectile does not tumble during flight.

More generally, it can refer to any structures added to a projectile to aerodynamically stabilize its flight, many of which resemble arrows in form and function. For instance, the feathers at the butt end of a dart (of the type cast using an atlatl) are very similar in purpose and construction to those used in arrows. Most of the techniques of fletching were likely adapted from earlier dart-making techniques. The fins used to stabilize rockets also work in a similar manner.

27.2 See also

- Hane, fletching of the Japanese arrow (ya).

27.3 References

27.4 Further reading

- Massey, Jim. (1992). "Self Arrows" in *The Traditional Bowyer's Bible Volume One*, (Jim Hamm, ed.). Guilford: The Lyons Press. ISBN 1-58574-085-3
- Engh, Douglas. Topic "Arrows" in "Archery Fundamentals". Human Kinetics ISBN 0-7360-5501-0
- Soar Hugh David. Straight and True. a select history of the arrow. Westholme publishing ISBN 978-1-59416-147-6

Chapter 28

Flu-flu arrow

Flu-flu fletching

A **flu-flu arrow** is a type of arrow specifically designed to travel a short distance. Such arrows are particularly useful when shooting at aerial targets or for certain types of recreational archery where the arrow must not travel too far. One of the main uses of these arrows is that they do not get lost as easily if they miss the target.

A flu-flu is a design of fletching, normally made by using long sections of feathers, in most cases six or more sections are used, rather than the traditional three. Alternatively, two long feathers can be spiraled around the end of the arrow shaft. In either case, the excessive fletching serves to generate more drag and slow the arrow down rapidly after a short distance (about 30m). Recreational flu-flus usually have rubber points to add weight and keep the flight slower.

28.1 Uses

Flu-flu arrows were and still are used to hunt birds. When taking aim at the bird the archer must lead the bird and release the arrow in anticipation of the bird's travel path. Because flu-flu arrows fly short distances, it is easy for the archer to recover the arrow if the target is missed. Special bird points are used that entangle the bird as it flies into a wire harness attached to the end of the arrow.

These arrows often have a blunt point. If shooting at squirrels or other tree dwellers, the blunt point will prevent the arrow from sticking in the branch or trunk of the tree, and thus easier to retrieve. The blunt points were also used for other reasons. "Although the first game preserves in England were established by William the Conqueror at this time, the Saxon was permitted to shoot birds and small beasts in his fields and therefore was allowed to use a blunt arrow, headed with a lead tip or pilum, hence our term pile, or target point. If found with a sharp arrowhead, the so-called broad-head used for killing the king's deer, he was promptly hanged." *[1]

Another author said: "After shooting with bows and arrows for a short time, the archer no doubt will marvel at the way an arrow can lose itself in even the shortest grass and how a pointed arrow can bury itself for an inch or so in a tree trunk or branch so that it takes a half hour or more to dig it out. For this kind of shooting, blunt arrows cannot be beat. These blunt arrows have tremendous hitting power. They do not sneak under the grass as easily as do other arrows, but the chances of getting a rabbit with a blunt arrow are much better than with a hunting point. These blunt arrows will stand a lot of hard knocks too." *[2]

Flu-flu arrows are often used for children's archery, and can be used to play flu-flu golf. Similar to Frisbee Golf, the player must go to where the arrow landed, pick it up, shoot it again, and repeat this process until he reaches a specified place.

28.2 References

[1] Pope, S. T. (1923). Hunting with the bow & arrow. San Francisco: The James H. Barry Co.

[2] Hunt, W. Ben & John J. Metz. 1936. The Flat Bow.

Chapter 29

Crossbow bolt

Modern crossbow bolt compared to a 1 eurocent coin

A **quarrel** or **bolt** is the arrow used in a crossbow.*[1] The name "quarrel" is derived from the French *carré*, "square" , referring to the fact that they typically have square heads. Although their length varies, they are typically shorter than traditional arrows.

29.1 Lighted ends

A recent advancement in quarrels is the "lighted end" which can be attached to the nock of the quarrel, and upon release, will shine a light back to the archer, showing the path and destination of the quarrel. This is used to both improve quarrel recovery, and to show flight and target patterns in shooting and hunting. "Lighted bolt ends are great for detecting errant flight and diagnosing tuning problems when sighting in. In addition, they are pivotal in animal recovery. With proper follow-through, hunters often see their bolt's impact on animals and can recover it. Noting where a bolt entered, then inspecting it after the shot, lets you know how long to wait before taking up the blood trail." *[2]

29.2 Footnotes

[1] "Quarrel" . Merriam-Webster. Retrieved 24 May 2013.

[2] Bauserman, Jace. 2014. "Better Crossbow Hunting." Bowhunting World. Volume 63 (8), page 73. ISSN: 1043-5492.

29.3 References

- Stone, George Cameron (1999) [1934]. *A Glossary of the Construction, Decoration, and Use of Arms and Armor in All Countries and in All Times.Mike*. Mineola NY: Dover Publications. p. 125. ISBN 0-486-40726-8.

Chapter 30

Quiver

For other uses, see Quiver (disambiguation).

A **quiver** is a container for arrows, bolts, or darts. Quivers can be attached in various positions on an archer's

Three quivers

body, the bow, or the ground, depending on the type of shooting and the archer's personal preference. Quivers were traditionally made of leather, wood, furs, and other natural materials, but are now often made of metal or plastic.

30.1 Types

File:Bayeux Tapestry scene51 Battle of Hastings Norman knights and archers.jpg

Norman archers depicted in the Bayeux Tapestry. The top left archer was caught unprepared and has hastily thrown his belt quiver about his shoulders, as well as forgotten his helmet.

30.1.1 Belt quiver

The most common style of quiver is a flat or cylindrical container suspended from the belt. They are found across many cultures from North America to China. Many variations of this type exist, such as being canted forwards or backwards, and being carried on the dominant hand side, off-hand side, or the small of the back. Some variants enclose almost the entire arrow, while minimalist "pocket quivers" consist of little more than a small stiff pouch that only covers the first few inches.

30.1.2 Back quiver

Back quivers are secured to the archer's back via straps, with the nock ends protruding above the dominant hand's shoulder. Arrows can drawn over the shoulder rapidly by the nock. This style of quiver was used by Native American tribes of North America and tribes in Africa. The Japanese Samurai also used quivers on their backs, called Yebira, while both on foot and horseback. While popular in cinema and 20th century art for depictions of medieval European characters (such as Robin Hood), this style of quiver was rarely used in medieval Europe.*[1] The Bayeux Tapestry shows that most bowmen in medieval Europe used belt quivers.

30.1.3 Ground quiver

A ground quiver is used for both target shooting or warfare when the archer is shooting from a fixed location. They can be simply stakes in the ground with a ring at the top to hold the arrows, or more elaborate designs that hold the arrows within reach without the archer having to lean down to draw.

30.1.4 Bow quiver

A modern invention, the bow quiver attaches directly to the bow's limbs and holds the arrows steady with a clip of some kind. They are popular with compound bow hunters as it allows one piece of equipment to be carried in the field without encumbering the hunter's body.

30.1.5 Arrow bag

A style used by medieval English Longbowmen and several other cultures, an arrow bag is a simple drawstring cloth sack with a leather spacer at the top to keep the arrows divided. When not in use, the drawstring could be closed, completely covering the arrows so as to protect them from rain and dirt. Some had straps or rope sewn to them for carrying, but many either were tucked into the belt or set on the ground before battle to allow easier access.

30.1.6 Japanese quivers

Yebira refers to a variety of quiver designs. The Yazutsu is a different type, used in Kyudo. Arrows are removed from it before shooting, and held in the hand, so it is mainly used to transport and protect arrows.

30.2 Gallery

- An Ottoman Turk with a rear-canted belt quiver designed for mounted archery
- |Japanese archery equipment including a variety of quivers
- Fujiwara no Hidesato shooting the giant centipede (Tsukioka Yoshitoshi, 1890)

30.3 References

[1] Gerry Embleton; Clive Bartlett (1995). *English Longbowman 1330-1515Ad (Warrior, No 11)*. Osprey Publishing (UK). p. 28. ISBN 1-85532-491-1.

- *Archery*. Irving, Texas: Boy Scouts of America. 1986. ISBN 0-8395-3381-0.
- Glover, Daniel S.; Grayson, Charles Jackson; French, Mary; O'Brien, Michael J. (2007). *Traditional archery from six continents: the Charles E. Grayson Collection*. Columbia: University of Missouri Press. ISBN 0-8262-1751-6.

Chapter 31

Thumb ring

This article is about the protective archery equipment. For the ordinary jewelry items worn on the thumb, see Ring (jewelry).

A **thumb ring** is a piece of equipment designed to protect the thumb during archery. This is a ring of leather, stone,

Thumb ring made from a plastic billiard ball.

horn, wood, ivory, metal, ceramics, plastic, or glass which fits over the end of the thumb, coming to rest at the outer edge of the outer joint. Typically a flat area extends from the ring to protect the pad of the thumb from the bowstring; this may be supplemented by a leather extension.

31.1 Use

When drawing a bow using a thumb draw, the thumb is hooked around the bowstring just beneath the arrow and its grip reinforced with the first (sometimes second) finger. The bowstring rests against the inner pad of the archer's thumb and the thumb ring protects the skin. The bowstring rests against the flat of the ring when the bow is drawn. This technique is referred to as the "Mongolian Release" or the "Mongolian Draw". Today, thumb rings are used by archers practicing styles from most of Asia and some regions of northern Africa. Ishi, the "last wild American Indian", used a thumb draw, but no skin protection.

31.2 Historic specimens

Thumb rings have been in use in Asia since the Neolithic period. The first examples were likely made of leather, but all-leather artifacts do not survive thousands of years later. Surviving artifact rings are made of bone, horn, or stone; presumably most would have incorporated a leather guard. Comparison with historical and modern rings shows little functional change over the millennia. The archer's thumb ring is an example of ancient technology that has survived down to the modern period.*[1]

The author of "Arab Archery" refers to rings as being usually made of leather.*[2] Possibly, most ordinary archers historically used tabs of leather, much cheaper and easier to make, for this purpose, but such rings are not likely to survive.

Many surviving historic thumbrings are hardstone carvings in jade and other gemstones, or are made of precious metal. Most are very practical but some have the release surface so ornamented as to be unusable. The rings could be displayed on a cord from the belt, or, in China, in a special box. In the 16th century court of the Ottoman Empire they had the extra function of being "used when executing disgraced officials to tighten a handkerchief wound round the throat".*[3]

31.3 References

[1]

[2] Arab Archery. An Arabic manuscript of about A.D. 1500 "A book on the excellence of the bow & arrow" and the description thereof. Translated and edited by Nabih Amin Faris and Robert Potter Elmer. Princeton University Press, 1945. http://www.sacred-archery.com/arab%20archery%20anno%20domini%201500.pdf

[3] Rogers J.M. and Ward R.M.; *Süleyman the Magnificent*, 1988, British Museum Publications ISBN 0-7141-1440-5, page 152.

31.4 External links

- A collection of thumbrings at the University of Missouri Museum of Anthropology
- How do I use a Thumb-ring with a Mongolian Draw?
- Making a thumbring from a billiard ball
- Ancient Chinese thumb rings, Shang Dynasty to Han Dynasty
- Thumbring galleries and articles
- On using cylindrical Chinese / Manchu style thumb rings

31.5 Text and image sources, contributors, and licenses

31.5.1 Text

- **Bow and arrow** *Source:* http://en.wikipedia.org/wiki/Bow%20and%20arrow?oldid=650366792 *Contributors:* Grouse, Rmhermen, William Avery, Ray Van De Walker, SimonP, KF, Ubiquity, Patrick, Ixfd64, Stevenj, Julesd, Glenn, Gavri, Hashar, Dcoetzee, Janko, Denni, Andrewman327, Tpbradbury, Hyacinth, Wetman, Francs2000, PuzzletChung, Robbot, PBS, Cek, Buster2058, DocWatson42, Pmaguire, Wiglaf, Yak, Muke, Everyking, Per Honor et Gloria, Bobblewik, Golbez, John Abbe, Kudz75, Antandrus, Evertype, Melloss, Pembers, Sanbec, Ultranol, Mrtrey99, Sam Hocevar, Drnnivel, A-giau, Discospinster, Solitude, Rich Farmbrough, Hidaspal, Cnyborg, Dbachmann, JemeL, ESkog, Kbh3rd, Petersam, CanisRufus, Kwamikagami, Triona, Bendono, Thuresson, Bobo192, Yonghokim, Smalljim, AlphBetaFive555111, The strategy freak, Conny, Jumbuck, Storm Rider, Anthony Appleyard, Arthena, Riana, Pion, Titanium Dragon, Wtmitchell, Velella, Ronark, TaintedMustard, Gene Nygaard, HGB, Shrap, Simetrical, Bellhalla, Jonathanbishop, WadeSimMiser, BlaiseFEgan, Tom M, MarcoTolo, Ae7flux, Palica, LeoO3, Mandarax, Gettingtoit, Magister Mathematicae, Josh Parris, Sjö, Koavf, Sdornan, Makaristos, XR-CatD, Yamamoto Ichiro, FlaBot, Lebha, Celestianpower, RexNL, Kolbasz, Chobot, The Rambling Man, YurikBot, Wavelength, Matanya (renamed), GBMorris, LizL05, RussBot, Sputnikcccp, Pigman, RadioFan, Gaius Cornelius, Ksyrie, Pseudomonas, Wiki alf, Grafen, Aaron Brenneman, Anetode, Nate1481, Mysid, Kortoso, Bota47, Craigkbryant, Wknight94, JakkoWesterbeke, Pawyilee, Durak, JereKrischel, Mev532, 21655, WikiY, Closedmouth, JoanneB, Croat Canuck, LeonardoRob0t, JLaTondre, Warreed, Allens, Katieh5584, John Broughton, GrinBot, DVD R W, BonsaiViking, SmackBot, Ariedartin, Anastrophe, RedSpruce, Ace of Risk, AKismet, Commander Keane bot, Gilliam, Mr Barndoor, Andy M. Wang, Durova, Tyciol, Chris the speller, Bk22, Jprg1966, Thumperward, Snori, SchfiftyThree, Hibernian, Sadads, L clausewitz, DHN-bot, The1exile, Darth Panda, Trekphiler, Can't sleep, clown will eat me, Cplakidas, OrphanBot, Rrburke, SundarBot, Nahum Reduta, Nakon, Xyzzy n, Just plain Bill, Latebird, Where, Skinnyweed, ArglebargleIV, Vriullop, Markjeff, DA3N, DO11.10, Copeland.James.H, Pat Payne, Statsone, IronGargoyle, Mr. Vernon, Vincentpang, Incognit000, Kiver16, Peter Horn, Jose77, Norm mit, Octane, SohanDsouza, Civil Engineer III, Jedihjc, Srain, Mrjahan, Luke c, JForget, TheHerbalGerbil, Ken Gallager, Richard Keatinge, No1lakersfan, Slazenger, Abeg92, ChristTrekker, Gogo Dodo, Tawkerbot4, Nabokov, Knight45, Lysandros, Oyo321, Wandalstouring, Epbr123, Hawkes, 54gsze4ghz5, Dfrg.msc, Dpenguinman, RoboServien, Oreo Priest, AntiVandalBot, Luna Santin, CZmarlin, Tigeroo, DWolf2k2, Farosdaughter, Ingolfson, JAnDbot, Tigga, Ndyguy, Chanakyathegreat, Trebor trouble, Leolaursen, Barefact, Kerotan, Bongwarrior, VoABot II, JNW, Dor Posner, Crunchy Numbers, Fang 23, Darkrangerj, Sumitsoren, Glen, DerHexer, Yeahsoo, MartinBot, FlieGerFaUstMe262, STBot, Mr Wednesday, Jim.henderson, Osirishotep, GeorgHH, Anaxial, Kostisl, J.delanoy, MRFraga, Trusilver, AstroHurricane001, Bogey97, KiwiBiggles, Rwebb1991, Erik Springelkamp, Thomas Larsen, NewEnglandYankee, Knulclunk, KylieTastic, Inwind, Izno, Llamanator, Phoenix264, Idioma-bot, Ariobarzan, VolkovBot, CWii, Uyvsdi, Nburden, Nik Sage, VasilievVV, Guardian Tiger, TheOtherJesse, Philip Trueman, TXiKiBoT, Mu$hroom, Edchant, Traumrune, Andreas Kaganov, Melsaran, Sirkad, Raymondwinn, Hey jude, don't let me down, Bowzzz, Kehrbykid, Symane, Uifareth Cuthalion, NHRHS2010, TheXenocide, Mjepson, Gaelen S., SieBot, CsikosLo, Tiptoety, Oxymoron83, Antonio Lopez, Ealdgyth, Mm.w0mbat, Dabomb87, DRTllbrg, Randy Kryn, Explicit, ClueBot, The Thing That Should Not Be, Phoenix999, Hostile Amish, Niceguyedc, Lbeben, Excise, Nick19thind, Jagdfeld, Superdummy999, LeoFrank, Phileasson, Gnome de plume, Alexbot, Machoman11, Diaboli, MartinFields, Jotterbot, Dekisugi, Mikaey, Arqueira, Thingg, Aitias, Berean Hunter, Johnuniq, Egmontaz, Slayerteez, Grizzley 118, DumZiBoT, XLinkBot, Bill98762222, Mjangels, Dthomsen8, Sergeant Sevorg, RyanCross, HexaChord, Addbot, Guoguo12, Fyrael, Morning277, Editforfun, Blaylockjam10, Tide rolls, Al3xil, Bobtheglob, Luckas-bot, Yobot, Mmxx, THEN WHO WAS PHONE?, KamikazeBot, AnomieBOT, 732SOUTHPAW, Breadchastick, Materialscientist, The High Fin Sperm Whale, E2eamon, ArthurBot, Anna Fruehwirth, Xqbot, Arghof, Ched, J04n, Abce2, RibotBOT, Wikieditor1988, Amaury, Brutaldeluxe, Wōdenhelm, Shadowjams, Iswearius, Green Cardamom, Lateral mu, Fisheatsbear, Perdman, Bowman with microw midas 4, Phoenix000, Orangeace, Hchc2009, Pinethicket, I dream of horses, Rameshngbot, SpaceFlight89, Fumitol, Orenburg1, FoxBot, Firefang95, Fox Wilson, SeoMac, Stalwart111, Weedwhacker128, Vinnyzz, EmausBot, Opus 113, Katherine, Samuraiantiqueworld, Ilovekgsr, Wikipelli, Alexrocks13, Melakavijay, FunkyCanute, ZéroBot, Josve05a, Imperial Monarch, Zelbava, Erianna, Dfdffddfdffddffdffdfd, Jay-Sebastos, Bill Wilde, Hunter4739984, Tboby12, HIST406-10rgomez, Sonicyouth86, Mehmet709, ClueBot NG, Satellizer, Wagner Texas Ranger, The High Fin Sock Whale, Rezabot, Theopolisme, Helpful Pixie Bot, Calabe1992, Gob Lofa, Lowercase sigmabot, Footmikyd, Player017, Carlstak, Altaïr, Aranea Mortem, Earendil56, Tamara Ustinova, Glacialfox, 22hockey, Britehit23, HueSatLum, WOLfan112, OKLR, Comatmebro, A.J.Johnny, Sonarboy, Canadianredneck383, Iammrsmellark, Abdesk2008, Lugia2453, Frosty, Brandvenkatr, BOBBYBOB789, Portelli9, Jakec, 1Halpo1, Ugog Nizdast, Z3GY, Snowsuit Wearer, Aaronknowsitall, JaconaFrere, Yoshi24517, Ianc43, Ivandabomb, Puuuuj, Amortias, Za dom spremi, TranquilHope, Krjohn, Trash bag765927, Emiliemldavidson, Masonsnider, Mason snyder, Markclarkjones and Anonymous: 602
- **History of archery** *Source:* http://en.wikipedia.org/wiki/History%20of%20archery?oldid=655739666 *Contributors:* Julesd, Michael Devore, Per Honor et Gloria, Chowbok, Mike Rosoft, D6, Xezbeth, Dbachmann, Bender235, Bendono, Smalljim, Bart133, ReyBrujo, Woohookitty, Spettro9, Kurzon, GregorB, Rjwilmsi, Bedford, Aaron Walden, JFD, Donald Albury, Dspradau, Katieh5584, SmackBot, Jagged 85, Gilliam, Hmains, Mr Barndoor, Durova, Kfroog, Freedom skies, Hibernian, Fuhghettaboutit, Attys, Gobonobo, Dl2000, Norm mit, Ken Gallager, Richard Keatinge, Cydebot, Max Ackerman, ChristTrekker, Ghostexorcist, Arwen4014, הסרפד, Nick Number, Northumbrian, KConWiki, Philg88, Mattinbgn, Vamooom, Anaxial, R'n'B, Erik Springelkamp, Pal0165, Nwbeeson, Rosenknospe, DadaNeem, BrettAllen, KylieTastic, The Kings Yeomanry, Einar Ragnarsson, Master of the Oríchalcos, Insanity Incarnate, Moerou toukon, StAnselm, Flyer22, Randy Kryn, ClueBot, GorillaWarfare, CounterVandalismBot, Excirial, Jusdafax, MartinFields, UltimateDestroyerOfWorlds, Audaciter, Berean Hunter, Heironymous Rowe, Blast Ulna, Addbot, Some jerk on the Internet, CL, Dcb1101, Lightbot, Сергей Олегович, Ben Ben, Yobot, KamikazeBot, AnomieBOT, Hadden, Jim1138, E2eamon, SassoBot, Berylcloud, WebCiteBOT, Kak Dela?, Haploidavey, HamburgerRadio, Pinethicket, Koakhtzvigad, Cnwilliams, Readability, RjwilmsiBot, Hello1107, GoingBatty, MikeyMouse10, Érico Júnior Wouters, CurtisKeim, Will-is-here, Noodleki, Donner60, Petrb, ClueBot NG, Jtma, Widr, Helpful Pixie Bot, Emayv, TheGeneralUser, Marcocapelle, Glacialfox, Rutebega, ChrisGualtieri, Khazar2, Lugia2453, Juzumaru, Faizan, Bananasoldier, Captain-Fox501st, Jackmcbarn, Wiloy22, Filedelinkerbot, Vieque, Nitebradley, Kaitlyn153, Boehunter and Anonymous: 137
- **Arrow** *Source:* http://en.wikipedia.org/wiki/Arrow?oldid=653999067 *Contributors:* Marj Tiefert, Koyaanis Qatsi, PierreAbbat, Ktsquare, Montrealais, Stevertigo, Patrick, JohnOwens, Cprompt, Schneelocke, Emperorbma, Jay, Wetman, Jusjih, Riddley, Gregors, Blades, Altenmann, Rholton, Buster2058, Oberiko, Mintleaf, Bkonrad, Duncharris, Chowbok, Antandrus, Vanished user 1234567890, Adamsan, Schnits, Joyous!, Sonett72, D6, Freakofnurture, Eyrian, Rich Farmbrough, Rama, Dbachmann, Bender235, FirstPrinciples, El C, Luckyluke, Anthony Appleyard, Ahruman, Mac Davis, Pjm, Bart133, Velella, Stephen, Jtmjtm, RHaworth, Merlinme, Polyparadigm, David Levy, Kbdank71, Rjwilmsi, Quale, FlaBot, Old Moonraker, Margosbot, Chobot, Sus scrofa, YurikBot, RattusMaximus, RobotE, Wolfmankurd, RussBot, WritersCramp, Petrus4, Aaron Walden, Chaser, Stephenb, Gaius Cornelius, David R. Ingham, ENeville, Kvn8907, Ragesoss, Scs, Cinik, LeonardoRob0t, Hitchhiker89, SmackBot, Incnis Mrsi, Reedy, Ariedartin, Eskimbot, Paxse, Alex earlier ac-

count, Gilliam, Ohnoitsjamie, Hmains, Mr Barndoor, Chris the speller, Thumperward, Werrana, Rorybowman, MalafayaBot, Sadads, Chlewbot, Nakon, Dreadstar, Just plain Bill, Flip619, Ferhengvan, Intranetusa, P199, Igoldste, Tony Fox, Beno1000, Neels, Neelix, Richard Keatinge, Wingman358, Engleback, ChristTrekker, Gogo Dodo, Dougweller, DumbBOT, Thijs!bot, Epbr123, Dogaroon, SGGH, Dfrg.msc, Mercutio.Wilder, Hmrox, Yomangani, Quintote, Scepia, Ingolfson, MikeLynch, JAnDbot, Trebor trouble, Pedro, Bongwarrior, Soulbot, ClovisPt, Web-Crawling Stickler, Timefly, MartinBot, Chartinael, Rettetast, TheEgyptian, AlexiusHoratius, J.delanoy, Bogey97, Acalamari, Andareed, Spinach Dip, Warut, DorganBot, Ministry of truth 02, Llamanator, Idioma-bot, Macedonian, LokiClock, FergusM1970, TXiKiBoT, A4bot, NPrice, Gwinva, MRCorbett, BotKung, PaladinWhite, CO, Doug, Nibios, AlleborgoBot, Symane, Beligaronia, Dogah, SieBot, Gerakibot, Smsarmad, Topher385, Husenjo, OKBot, Werldwayd, Mm.w0mbat, Smilo Don, Anchor Link Bot, Randy Kryn, ClueBot, Moishe Rosenbaum, Mild Bill Hiccup, CounterVandalismBot, Lbeben, Piledhigheranddeeper, Alexbot, Eeekster, Abrech, Muro Bot, Berean Hunter, KilroyCurtis, Graevemoore, XLinkBot, Tarheel95, Fastily, Mjangels, SilvonenBot, NellieBly, Wasted(again), Addbot, Non-dropframe, Blechnic, Pedalcat, Dcb1101, CarsracBot, Kuhlio2008, Tide rolls, Lightbot, V.R.S., Legobot, Luckas-bot, Yobot, 2D, Fraggle81, Amirobot, Justinlay, AnomieBOT, Hadden, Jim1138, JohnnyB256, Xqbot, TinucherianBot II, PedanticBen, Xiphaiz, GrouchoBot, Ultimateria, Seeleschneider, Recognizance, DrilBot, Rapsar, Pinethicket, LittleWink, RedBot, Mars fenix, FoxBot, Tokyosilver, İki2bucuk, Bobiguanabob, YellowFives, Mean as custard, TjBot, EmausBot, WikitanvirBot, Nick56x, Rajkiandris, Joebiljoey, ZéroBot, Tempestsky, Dfdffddfdffddffdffdfd, Ryubromley, ClueBot NG, Lord Roem, TruPepitoM, Nikolastheo, Mrtnowns, Bigben987, Helpful Pixie Bot, Lowercase sigmabot, Daltino9, Klilidiplomus, Fame5012958, Asdwsx123124143, Justincheng12345-bot, Qpolley, YFdyh-bot, CarrieVS, Ducknish, Postrally4, EagerToddler39, Cwobeel, Frosty, SFK2, Reatlas, Destroman5, Destroman2, Eyesnore, Luxure, Hacker124816, Isabbanaifos, TheFireRises, Spencer27891, Immaboss4848, ZachRance and Anonymous: 160

- **Arrowhead** *Source:* http://en.wikipedia.org/wiki/Arrowhead?oldid=645575973 *Contributors:* Dante Alighieri, Samw, Tpbradbury, Freechild, Omegatron, Pigsonthewing, Rsduhamel, Gzornenplatz, Lucky 6.9, Chowbok, PFHLai, Joyous!, Rama, Xezbeth, CanisRufus, Geo Swan, TriNotch, Pekinensis, Bullenwächter, Eoghanacht, Neitherday, Hairy Dude, RussBot, Manop, Eleassar, Paradoja, Ragesoss, Jona, Igiffin, 21655, Elenthel, Paul D. Anderson, Jonathan.s.kt, SmackBot, Elonka, Hmains, Thumperward, Jmlk17, Only, Ocee, Nobunaga24, SCOTT FISHER, Weston123, Paulmlieberman, Sangrito, ShelfSkewed, Kalaong, Ken Gallager, Richard Keatinge, Equendil, Emuchick, Thijs!bot, Marek69, CowboyWisdom, Kbthompson, BGOSZ20, JAnDbot, Bongwarrior, ClovisPt, Mike Searson, Skier Dude, Charwinger21, Inwind, Macedonian, MCTales, Calabraxthis, Antonio Lopez, Ashishg55, Ascidian, Randy Kryn, Bat King, ClueBot, Bob1960evens, All Hallow's Wraith, Drmies, SempreVolando, EmilyELewis, Parkie1, C628, Berean Hunter, Blast Ulna, Noctibus, Superzoulou, RyanCross, FatBear1, Addbot, Yoenit, Leszek Jańczuk, Download, Lihaas, Tide rolls, Yobot, Cflm001, THEN WHO WAS PHONE?, Vibrantspirit, Richigi, AnomieBOT, KDS4444, Hadden, Helliax, The High Fin Sperm Whale, Quebec99, Locobot, Eightinc, Archaeodontosaurus, Ánforas, Evalowyn, Pinethicket, Abductive, Unbiassed, İki2bucuk, Elder32, DASHBot, EmausBot, Severemetalteen, Djembayz, Ronk01, Cedric88, EdoBot, Gwen-chan, ClueBot NG, Dangerang, Сергей 6662, Old Time Music Fan, TwoTwoHello, Joncgoodwin, Faizan, Playitagains, JamesMoose, Jeremypenguin, Jose ayala69 and Anonymous: 103
- **Bowstring** *Source:* http://en.wikipedia.org/wiki/Bowstring?oldid=650028315 *Contributors:* Hyacinth, Discospinster, Dbachmann, Bendono, CloudNine, Redvers, Thryduulf, Wavelength, Katieh5584, タチコマ robot, SmackBot, Snori, Richard Keatinge, Alaibot, JustAGal, JAnDbot, Wizymon, Dekimasu, Zahakiel, TXiKiBoT, Botev, ClueBot, Wlawson86, PixelBot, Thingg, Berean Hunter, WikHead, Addbot, LaaknorBot, Glane23, AtheWeatherman, Tassedethe, Yobot, THEN WHO WAS PHONE?, MastiBot, Samuraiantiqueworld, ClueBot NG, Mogism, Benc198 and Anonymous: 17
- **Recurve bow** *Source:* http://en.wikipedia.org/wiki/Recurve%20bow?oldid=648693560 *Contributors:* Aaron Brenneman, タチコマ robot, Thumperward, Deli nk, Damuna, Klatkinson, A Georgian, Smart Nomad, BG19bot, Syncmaster913n, Adias9684 and Anonymous: 7
- **Bow shape** *Source:* http://en.wikipedia.org/wiki/Bow%20shape?oldid=621567270 *Contributors:* Andrewman327, Zoicon5, Hyacinth, Nnh, Gregors, Buster2058, Per Honor et Gloria, Bobblewik, D6, Miborovsky, Chris huh, La goutte de pluie, Axl, BD2412, DVdm, Roboto de Ajvol, Hairy Dude, RussBot, Gertlex, ML, NawlinWiki, Borbrav, Aaron Brenneman, Durak, Gunman47, SmackBot, Thaagenson, Hydrogen Iodide, Deon Steyn, Ariedartin, Jagged 85, Evanreyes, Canonblack, Mr Barndoor, Thumperward, Moshe Constantine Hassan Al-Silverburg, Sentinel7, Chris Madeley, Latebird, Accurizer, Intranetusa, OnBeyondZebrax, Iridescent, JMK, NativeForeigner, Vanisaac, Liam Skoda, Loganfong, Richard Keatinge, ChristTrekker, Aldis90, Thijs!bot, Marek69, Mr pand, JustAGal, Davidhorman, Nick Number, Sonofecthelion, Salinix, Mikemill, VoABot II, Anterdvizer, Zahakiel, FlieGerFaUstMe262, R'n'B, CommonsDelinker, LittleOldMe old, Ncmvocalist, TheTrojanHought, Ghoort, Useight, Llamanator, Thisisborin9, Higgylm, Nik Sage, Abberley2, NPrice, Qxz, LeaveSleaves, AlleborgoBot, Flyer22, Furcalor, Oxymoron83, Lisatwo, ClueBot, Pedro Ferreira, Patriotic dissent, Sun Creator, MartinFields, Dekisugi, Muro Bot, Arqueira, Berean Hunter, Semitransgenic, Mjangels, WikiDao, Addbot, Dabonn, TutterMouse, Willanth, Kerbyman, Yobot, Vibrantspirit, Jim1138, Flewis, Team a, Archer satish, FrescoBot, Miguel Escopeta, Arenaria, Bill Wilde, ClueBot NG, Gareth Griffith-Jones, BarrelProof, Snotbot, Widr, Smart Nomad, Accountalive, MusikAnimal, Earendil56, SupperNope, Zuzerhun, MVanHoose, Syncmaster913n, Petron222, Purzo3 and Anonymous: 122
- **Self bow** *Source:* http://en.wikipedia.org/wiki/Self%20bow?oldid=638162710 *Contributors:* Hyacinth, D6, Chris huh, Woohookitty, Rjwilmsi, FayssalF, Ninly, Thumperward, Dl2000, Richard Keatinge, Mike409, MartinBot, Murderbike, Lkleinow, Zylox, Asphere, Jfromcanada, Hamiltondaniel, Feyre, MartinFields, Ghostbow, Berean Hunter, XLinkBot, Mjangels, OlEnglish, Brad101AWB, Seeleschneider, PigFlu Oink, Mentibot, Micbit, Gary Dee, Primergrey, Helpful Pixie Bot, Khazar2, BlueFenixReborn and Anonymous: 19
- **Longbow** *Source:* http://en.wikipedia.org/wiki/Longbow?oldid=655809516 *Contributors:* Rjstott, Gsl, William Avery, Tedernst, Michael Hardy, SGBailey, Ixfd64, Julesd, Hyacinth, Pakaran, Mervyn, DocWatson42, Antandrus, Eyrian, Pak21, Cnyborg, Dbachmann, Stbalbach, Bendono, Bobo192, Circeus, Alansohn, Gary, Mykej, Avenue, Hohum, Feezo, Woohookitty, Pol098, Before My Ken, Tbc2, TotoBaggins, BlaiseFEgan, Jivecat, Quietust, Ligulem, Marginoferror, Hairy Dude, RussBot, FrenchIsAwesome, Rsrikanth05, Jpbowen, Kortoso, DeadEyeArrow, JakkoWesterbeke, Mev532, Pil56, Paul Magnussen, FelixReimann, Hitchhiker89, Allens, PoshSpod, Nekura, RedDrag0n, Hydrogen Iodide, Ariedartin, Pgk, C.Fred, Bomac, Septegram, Yamaguchi 先生, Gilliam, Hmains, Durova, Bluebot, Thumperward, Addshore, BostonMA, Mytwocents, Decltype, Zearin, John, Grumpy444grumpy, IronGargoyle, Intranetusa, Thefuguestate, DabMachine, TurabianNights, Liam Skoda, Loganfong, Ballista, Richard Keatinge, No1lakersfan, Sopoforic, Peripitus, ChristTrekker, Guille2015, Gogo Dodo, Jürgens, BetacommandBot, JamesAM, Thijs!bot, Wandalstouring, Epbr123, Biruitorul, Mojo Hand, Robinbowyer, Bobblehead, Seaphoto, Golf Bravo, MER-C, Wasell, VoABot II, JNW, ArmadilloFromHell, Gun Powder Ma, Xoid, NAHID, J.delanoy, NewEnglandYankee, Knulclunk, Sheen98, Drcheezz, Tumshieheid, Signalhead, Wiseman75, Jeff G., Ph8l, Philip Trueman, Paulburnett, Sean D Martin, Bestwick15701, Chocolate Horlicks, ETO Buff, Petero9, Kelly peterson, Nagy, Uifareth Cuthalion, SaltyBoatr, Foshady, Ye Olde Luke, Akdsfhadfadsf, M.thoriyan, Grnconsulting, Enti342, AnonGuy, Nkay, Alanlemagne, Hamiltondaniel, Hoplon, ClueBot, ICAPTCHA, Binksternet, Nick19thind, 1ForTheMoney, Mearama, Berean Hunter, XLinkBot, Dthomsen8, NellieBly, Addbot, Athus, Groundsquirrel13, Kaporra, Fireaxe888, Tide rolls, Lightbot, Yobot, TaBOT-zerem, AnomieBOT, Aditya,

Bradybrady, Tad Lincoln, Selfish Gene 2009, Amaury, The real Marcoman, Tuleytula, Brutaldeluxe, Phillies8008, Owainglyndwr92, ZenerV, Celtic1985, Orangeace, Waaa222, Pinethicket, I dream of horses, Abductive, Calmer Waters, Midnight Comet, Miguel Escopeta, SkyMachine, Beyond My Ken, Manray123456789, Wibblemeister, Ezioauditoredafirenze2, Immunize, RenamedUser01302013, Wikipelli, Minimoisty, IxCREATOR, John Cline, Fæ, Shuipzv3, Tolly4bolly, MedMil, L Kensington, Zeta1127,89thLegion, DASHBotAV, 28bot, ClueBot NG, ZzzTAZMAST3Rzzz, Millionwampumbaby, Widr, Iqua, Helpful Pixie Bot, Calidum, Soerfm, Snow Blizzard, Warbowarcher, Broadside Perceptor, BeeSteeBoy, Alexej67, Cymraeg Warrior, YiFeiBot, Bowlikeaboss, Archer0899 and Anonymous: 260

- **Flatbow** *Source:* http://en.wikipedia.org/wiki/Flatbow?oldid=649543361 *Contributors:* Tedernst, Hyacinth, Stbalbach, Cmprince, Pauli133, Axeman89, Woohookitty, Graibeard, GBMorris, RussBot, Gaius Cornelius, Mev532, SmackBot, Mr Barndoor, Chris the speller, Thumperward, D-Rock, Senseitaco, Richard Keatinge, Lokal Profil, ChristTrekker, Trident13, Bobblehead, Faizhaider, JaGa, FergusM1970, ClueBot, MartinFields, Berean Hunter, WikHead, AnomieBOT, Frogbit, Brutaldeluxe, Ida Shaw, BarrelProof, Primergrey, Helpful Pixie Bot, BG19bot, BeeSteeBoy, Faizan and Anonymous: 32
- **Composite bow** *Source:* http://en.wikipedia.org/wiki/Composite%20bow?oldid=649211569 *Contributors:* Ahoerstemeier, Aravindet, Hyacinth, Bluelake, PBS, Goethean, Sam Spade, Bobblewik, Xenoglossophobe, Pmanderson, Rlcantwell, D6, Hidaspal, Dbachmann, Grutness, Kbolino, K m2791, Simetrical, WadeSimMiser, Jeff3000, Tbc2, Mandarax, Rjwilmsi, Eyu100, MicTronic, Wavelength, Hairy Dude, Gaius Cornelius, Ksyrie, Rsrikanth05, Pyrotec, Caiyu, Jpbowen, CaliforniaAliBaba, Tachs, Mev532, Chase me ladies, I'm the Cavalry, Petri Krohn, GraemeL, JLaTondre, SmackBot, Jagged 85, Hmains, Betacommand, Durova, Chris the speller, TimBentley, Grimhelm, Moshe Constantine Hassan Al-Silverburg, Fuhghettaboutit, Aboudaqn, Nakon, Valenciano, Latebird, SashatoBot, Attys, Anooshahpour, A. Parrot, Skapur, Geoffg, Mrjahan, Andkore, Richard Keatinge, Themightyquill, ChristTrekker, Albert0, Aldis90, Thijs!bot, Highlandlord, Marek69, Bobblehead, Aquilosion, Tigeroo, Ingolfson, Kruckenberg.1, Dream Focus, Dekimasu, Zioroboco, KConWiki, LorenzoB, Winterbadger, E104421, Yeahsoo, Pax:Vobiscum, R'n'B, GonenMB, Jsmith86, Svetovid, APoincot, Nik Sage, Wugo, Lubossekk, Master of the Oríchalcos, Austriacus, SieBot, WereSpielChequers, WRK, Jfromcanada, Emk (ja), ClueBot, Bob1960evens, Tony Rotondas, Lartoven, MartinFields, Arqueira, Berean Hunter, Slayerteez, DumZiBoT, XLinkBot, Classicbow, Mjangels, NellieBly, Addbot, Glane23, Jake8138, Lightbot, Ben Ben, Yobot, TaBOT-zerem, PZJTF, AnomieBOT, Hadden, 1exec1, Piano non troppo, Aditya, Wcoole, CompliantDrone, Jstampfl, FrescoBot, Vincenzo80, J.nomadia, Diomedea Exulans, Miguel Escopeta, İki2bucuk, Drterrabyte, Arrow Trail, RjwilmsiBot, Ripchip Bot, Solarra, Wikipelli, ClueBot NG, Jtma, Tomtyi, Helpful Pixie Bot, Smart Nomad, BG19bot, Llandale, NodBot, Abdesk2008, Salako1999, Ndej, Jodosma, Monkbot, Vieque, MEMaxE, Steven85028 and Anonymous: 102
- **Takedown bow** *Source:* http://en.wikipedia.org/wiki/Takedown%20bow?oldid=647726139 *Contributors:* Sam Sailor and WobbleyOne
- **Compound bow** *Source:* http://en.wikipedia.org/wiki/Compound%20bow?oldid=654165889 *Contributors:* Ansible, Ray Van De Walker, Michael Hardy, CesarB, Julesd, Tobyvoss, Hyacinth, Robbot, PBS, Stewartadcock, Buster2058, DocWatson42, DO'Neil, Bobblewik, Utcursch, Estel, Aerion, Aknorals, Solitude, Hidaspal, Rvanhoose, Pmcm, Kross, Bobo192, Chris huh, TaintedMustard, Gene Nygaard, BlaiseFEgan, Nneonneo, Pyb, N0YKG, Algebra, Bubbleboys, YurikBot, Sceptre, Phantomsteve, Gaius Cornelius, NawlinWiki, Mconst, Hayaku, Wsiegmund, Fram, Jchoyt, SmackBot, Ariedartin, Mr Barndoor, Ewok Slayer, Chris the speller, Jprg1966, Thumperward, Txinviolet, Flyguy649, E. Sn0 =31337=, Dreadstar, Theantonio, Trieste, JHunterJ, NativeForeigner, Rnb, Swfong, ChrisCork, Andreas Willow, Sir Vicious, JohnCD, Richard Keatinge, ChristTrekker, Zalgo, Thijs!bot, Hawkes, Sinn, Kokkokanta, AntiVandalBot, Toronto-SMOF, Sonofecthelion, Eamonnca1, Canadian-Bacon, Magioladitis, Ajsteffl, Zioroboco, Crunchy Numbers, LiamSch, Dblomberg, Pjries, MartinBot, STBot, RenniePet, Nik Sage, Pksings, Buddysystem, Kilmer-san, Purgatory Fubar, Gth759k, Steven Weston, TolkienGeek, Neil Smithline, Triaged, Umrguy42, Dchild, Lightmouse, Nancy, Paiev, ClueBot, Gtmax93, Osterreicher179, RafaAzevedo, ZSOU1, Razorflame, La Pianista, Aeastclub, Agnamus, Berean Hunter, DumZiBoT, Beprepn, Semitransgenic, Mjangels, Granite Snake, Kintaro, Zachsg, Mrkww, ZooFari, Addbot, Mr. Wheely Guy, LaaknorBot, SpBot, Luckas-bot, Donfbreed, AnomieBOT, RibotBOT, Amaury, Shadowjams, Rwc5017, FrescoBot, TonyAustria, DrilBot, Pinethicket, Edderso, Miguel Escopeta, ItsZippy, Jjnrs40, Nascar1996, DARTH SIDIOUS 2, Acather96, Oleary39, Tolly4bolly, Bill Wilde, Gilead Maerlyn, ClueBot NG, Faneb25, BarrelProof, In actu, Tnophelia, Rhall596, RudolfRed, ChrisGualtieri, YFdyh-bot, EuroCarGT, Robster.swain, Lugia2453, Little green rosetta, Alex0092, Panzermaster3, Syncmaster913n, Sirzarr, Moonlightbambi, Shootingtime, Jimkim390, Etherealflux, Steven85028, KH-1, Tareekap and Anonymous: 184
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- **Cable-backed bow** *Source:* http://en.wikipedia.org/wiki/Cable-backed%20bow?oldid=550084161 *Contributors:* Skysmith, Hyacinth, RJFJR, George Burgess, CambridgeBayWeather, SmackBot, Richard Keatinge, Grim Revenant, Egmason, MartinFields, Berean Hunter, Jovianeye, Capricorn42 and Anonymous: 6
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- **Yumi** *Source:* http://en.wikipedia.org/wiki/Yumi?oldid=644787103 *Contributors:* Olivier, Marteau, Nikai, Emperorbma, Hyacinth, Morven, Yas, RedWolf, Yosri, Nat Krause, Bgoldenberg, Chowbok, Aknorals, JoshG, Rama, Dbachmann, Pt, El C, Bendono, Mairi, Ypacaraí, Nborders1972, Angie Y., Pearle, Dlatrex, Alansohn, Joshbaumgartner, Swift, Pax, TaintedMustard, LordAmeth, Jackhynes, OwenX, WadeSimMiser, Jeff3000, Miwasatoshi, Sango123, Chobot, YurikBot, Phantomsteve, RL0919, JSH-alive, SamuelRiv, Arthur Rubin, Katieh5584, PRehse, GrinBot, SmackBot, Deathlibrarian, Deon Steyn, Kintetsubuffalo, Hmains, Charles Nguyen, Suicidalhamster, Nyletak, Tenmiles, Vina-iwbot, Richard Keatinge, ChristTrekker, Simohell, Aldis90, Thijs!bot, Epbr123, Julia Rossi, Awien, .anacondabot, Bongwarrior, Bradford44, Iwashigumo77, Mordrid52, IceDragon64, Philip Trueman, Vipinhari, Dubtiger, DanielDeibler, Boneyard90, El bot de la dieta, Lx 121, Berean Hunter, Antediluvian67, DumZiBoT, Addbot, Fukutaro, Legobot, Yobot, AnomieBOT, Ciphers, VX, Kingpin13, Citation bot, Svarthandske, TerraHikaru, Z8, Citation bot 1, Pinethicket, RedBot, EmausBot, WikitanvirBot, Samuraiantiqueworld, H3llBot, Abbz9, ClueBot NG, ZarlanTheGreen, Frietjes, 自教育, B.dyck, Iqua, Helpful Pixie Bot, The Mark of the Beast, CitationCleanerBot, BattyBot, YFdyh-bot, 武士道 and Anonymous: 70
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