Arms & Armour, Vol. 3, No. 1, Spring 2006, 79–90

The myth of the mangonel: torsion artillery in the Middle Ages

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Medieval siege artillery has been a subject of fascination since the antiquarians of the 19th century re-discovered the Middle Ages and then re-created it as an image of their own imagination, in the process generating many false ideas. Most of these myths have been corrected. But one that remains to this day is that the torsion-powered late Roman onager lived on for another millennium in the form of the mangonel.

Medieval siege artillery

Before cannon finally superseded older siege weapons around the end of the 14th century (in Europe), artillery had taken a wide variety of shapes and sizes and an even greater — and extremely confusing — number of names. It was based, however, on a very small number of basic designs, chiefly distinguished by different means of propelling the missile.

The 'stone-thrower' (Greek *petrobolus*, Latin *petraria*, French *perrier*, Arabic *majdanik*, etc.), where the missile was projected from a sling at the longer end of a beam held in a frame, the other end of which was pulled down by teams of operators hauling on ropes, was the most common. It was in widespread use from as early as the turn of the 7th century: the first recorded appearances in the former Roman world were in the Byzantine empire, whence it spread rapidly to the rest of Europe. In the Middle East, it was taken up rapidly by the conquering armies of the followers of Mohammed. Some time around 1200 (the exact date remains disputed) the trebuchet arrived, similar in design except for the important distinction that human power was replaced by a counterweight.[1] The increased power and ballistic force of the trebuchet enabled the construction of the most destructive artillery yet known. Where the manually powered stone thrower would only rarely be able to breach a well-built wall or rampart, the trebuchet could smash breaches in most walls, partly as a result of its accuracy in being able to strike the same point time and again. Both weapons remained in use, side by side, for another two centuries or so. The name mangonel (or one of its many variants) was often given to the first type (figure 1).

 DOI 10.1179/174962606X99155

The third means of propulsion for medieval weapons was tension, the force that operated the bow, the crossbow, and also its larger cousin, usually called the ballista, that needed a strong frame and machinery to wind back the cord (figure 2).

Torsion power?

However, anyone consulting Bradbury's *Routledge Companion to Medieval Warfare* (2004) will find mangonels described as stone-throwing catapults powered by the torsion effect of twisted ropes and that they were in use throughout the Middle Ages. Other equally respected historians continue to make the same assertion. There is a working replica to demonstrate to visitors at Caerphilly (Caerffili) Castle in Glamorgan (figure 3).

But the truth is that there is no evidence for its medieval existence at all. Of course, it is hard to prove that something was not there (as opposed to proving that something was), but this is not a new finding: a considerable body of learned research dating back to the 19th century had reached that conclusion. But it has not stopped the transmission of the myth to the present day. There *was* a torsion-powered weapon in medieval times, but it took the different form of the springald, and enjoyed a period of popularity in Europe between around 1250 and 1350, as we will show. Of the torsion-powered stone thrower descended from the onager of the ancient world, there was no sign after the final collapse of the western Roman empire (Chevedden 1995).

Roman torsion weapons

We are fortunate to have the kind of detailed contemporary technical descriptions of Roman siege weapons that are rare indeed in medieval writings. There are descriptions of the early torsion-powered ballista that provided the artillery of republican and early imperial Rome — and had been around much longer — in the texts of Vitruvius (writing about 25 BC), and these allow a reconstruction of the device.[2] In shape, it was a very large crossbow, with the difference that coiled sinews or ropes, made from a number of different possible materials, were held vertically in the frame with one arm of the weapon bound into each. The arms were drawn back and the stone or other missile placed in a pouch. On release, the immense force generated by the torsion could hurl a missile a substantial distance with great force. Research suggests an extreme range of up to 300 metres for a bolt, and between 180 and 300 for a small rounded shot.[3] Detailed descriptions of their effectiveness by the writer Josephus when the Romans besieged Jerusalem in AD 70 confirm its devastating impact, as did a reconstruction in 2002 by a team led by Professor C Wise and Dr C Bailey (broadcast by BBC2).

But the ballista did not survive in this form. The torsion crossbow was itself replaced by a weapon that had the same name, but was instead powered by the tension from drawing back the arms of the crossbow, on the same principle that this type of weapon would retain from then on. Its Greek name, *toxobolistra*,

Figure 1 Reconstruction of a medieval mangonel at Castelnaud (Dordogne) that is representative of the manually propelled stone thrower (perrier) in common use throughout the medieval period. Author's photograph.

translates as 'bow ballista', reflecting this change. By the 4th century, its place as a torsion-powered stone thrower had been taken by the onager, a rather simpler version operating on the same principle. This time, inside a wooden frame that had to be of massive proportions, a single arm was held in a twisted skein of sinew or horsehair. It was loaded by pulling down the arm and placing the missile in the cup at the end, and, on release, the arm flew up to send the missile on its way. The arm was stopped when it hit the necessarily strong crossbeam. Its optimum range was estimated at about 130 metres (Payne-Gallwey 1903: 290–303). Although it might reach much further, by then the force of the impact would have been much reduced. The 2002 reconstruction managed to throw a 26 kg limestone ball 90 yards before the timber of the weapon disintegrated after its second shot.

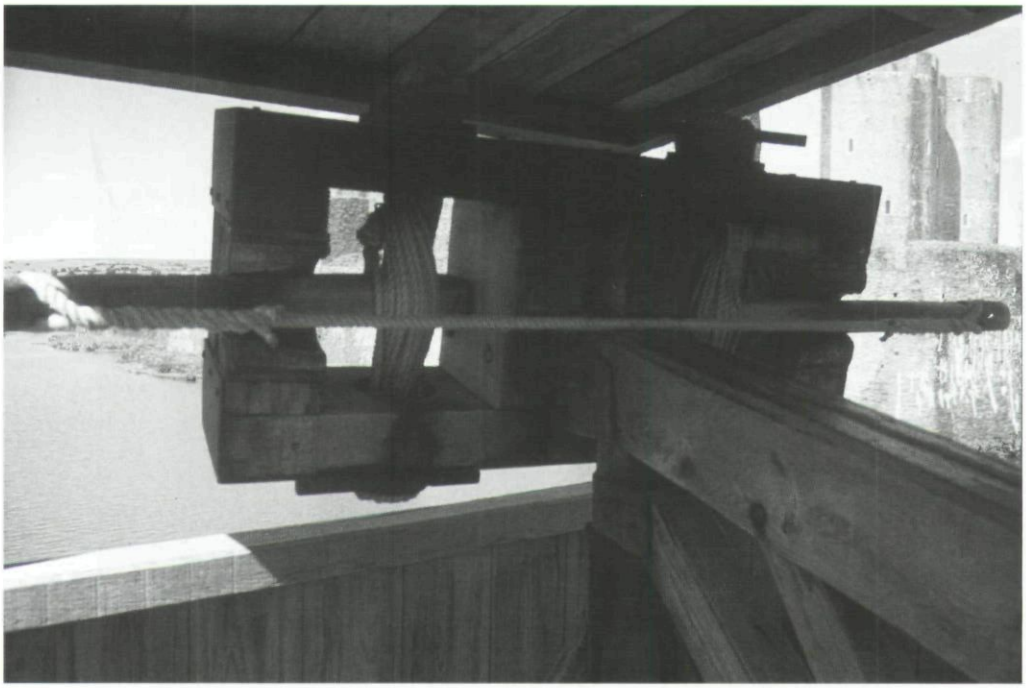

Figure 2 Reconstruction of a torsion-powered ballista at Caerphilly Castle, Glamorgan. The Roman version looked like this, but the medieval equivalent was the springald, which had a different design of frame. Note the vertical skeins that provided the energy. Author's photograph.

Critical problem

There were a number of problems with these weapons. One, familiar to anyone who has witnessed the onager at Caerphilly being discharged, was the shock effect of the arm hitting the crossbeam: the whole weapon, despite its great weight, shivers and jumps at the impact. Its Latin name meant 'wild ass' and that is a fair description of the effect. The strain on all its component parts was enormous, requiring massive parts. In defence, it could be mounted only on the strongest wall, for fear of shaking loose the stones, so most of the time it had to be placed on solid ground. Moving it is hindered by its weight, but even changing aim means moving the whole engine.

Both the original ballista and the later onager also suffered what really was the critical problem: how to maintain the torsion springs, including (with the twin-armed ballista) the importance and difficulty of keeping both skeins 'in tune' with each other. Different materials were tried, animal sinews were found to be powerful but could be difficult to secure and harder to work, and horsehair was a popular substitute.[4] Women's hair was tried too, but not recommended! It was difficult enough to wind the springs together to produce the desired torsion, but no less hard to maintain that tension in the skein. The problem became much

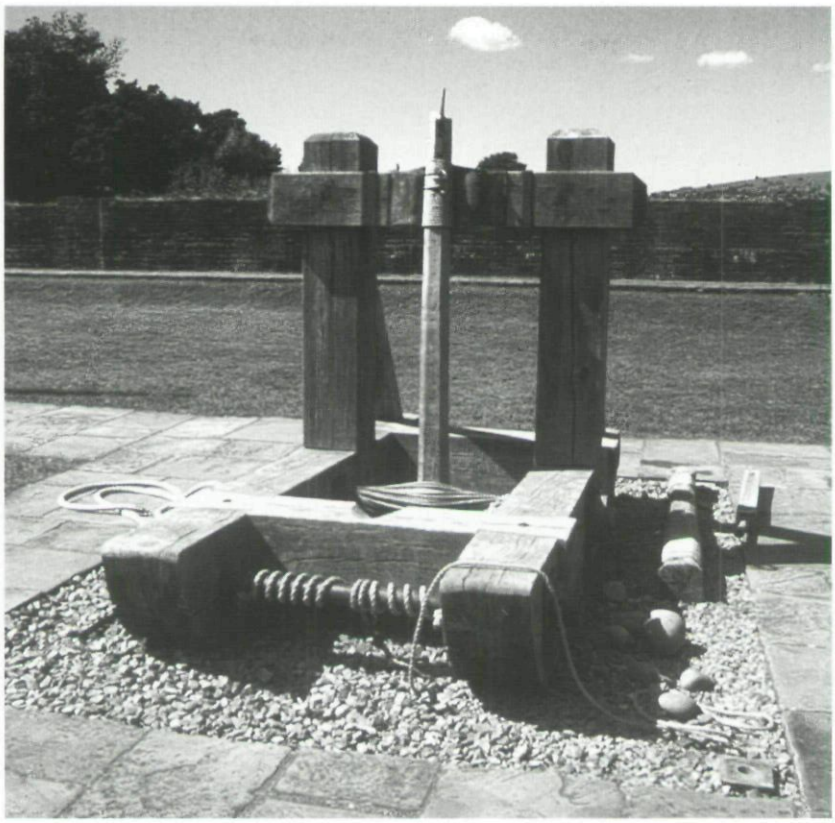

Figure 3 *Reconstruction of a torsion-powered late Roman onager at Caerphilly Castle, Glamorgan, incorrectly called a mangonel.* Author's photograph.

worse when wet, significantly increasing the likelihood of damage in rainier climates. The late Roman writer Vegetius stressed that great skills were called for to build, maintain and operate this weapon (Milner 1991: 126). These skills were already in short supply when the torsion ballista was replaced with the single-armed onager. By the time the western empire was in terminal decline, people who had the necessary experience and training would be rare indeed. With the collapse of the central military structures went the factories where artillery had been made and the arsenals where they and their spare parts were stored, and the training provided for their operators. There is no evidence from the 5th- or 6th-century histories that the Goths, Franks, Vandals (etc.) who were laying the foundations of the successor states had the use of Roman artillery, and no evidence that they had any of their own devising. Even when facing the East Roman empire, which continued to deploy the onager and the (tension) ballista, there is no evidence that the Ostrogoths ruling Italy had access to the skills required to use artillery against the armies of emperor Justinian (AD 527–565).

Did the onager survive?

The histories written by Justinian's contemporary, Procopius, confirm that 6th century Byzantium used the onager. At the end of that century, in the numerous wars of the Byzantines with Avars, Slavs and Persians, contemporary sources confirm continued use of a stone thrower that *may* still have been the onager. Meanwhile, however, the new stone thrower, operated by human traction, had already made an appearance at the Avar siege of Thessalonike in AD 597, its presence confirmed by the detailed description provided by a witness. How it arrived, and who in the west used it first, is another story; it almost certainly came via Central Asia from China, where this type of artillery was already standard. The point is, however, that its greater simplicity and easiness of construction and operation suited it perfectly to the more limited technical and mechanical resources of the states of that age. A wide variety of sizes was possible, each propelling different weights of shot. Although it was important to get the proportions of the arm and sling right, this was a skill that could be learnt from experience. The component parts, timber and rope, were readily available. Engines could be constructed on the spot, and often were, although they could also be held in store and transported when needed, sometimes in parts. An onager could less easily be built on site.

Sometime between around AD 600 and the writings of the Emperor Leo VI (AD 886–912), the onager certainly disappeared from use in the East Roman empire, and the author's judgement is that it was earlier rather than later. It was no longer in Byzantine arsenals in the 10th century. Whereas in the Emperor Maurice's (AD 582–602) textbook on war (the *Strategikon*), it is possible that the onager featured (it lacks the description to confirm that when he wrote of stone throwers, this was what he meant), the next surviving textbook — Leo VI's *Taktika* (about AD 906) — ignores it. In the middle of the 10th century, his son the emperor Constantine VII Porphyrogenitus (AD 913–959) listed and described the variety of Byzantine artillery in use for an expedition to Crete. They are all variants of the traction-powered stone thrower, called by a variety of names including that of *manganikon* (mangonel). Other writers of this age offer the same conclusion. The only exception is an anonymous text going under the name of 'Heron of Byzantium', which was largely based on Leo's and various ancient classical texts, which repeated ancient descriptions of the onager, but its drawings, tellingly, illustrate only the traction stone thrower. In the Byzantine Empire, which had held onto the onager for longest, the mangonel was now the traction powered stone thrower, not the torsion.

If the eastern empire had abandoned the onager and replaced it with something more suitable, what about the west? None of the increasing number of chronicle accounts of warfare in the Frankish realms of the Merovingians and early Carolingians are much help in telling us what kind of equipment was available. Where they do give any detail, the onager is never mentioned. In the late eighth century, accounts of the wars of Charlemagne (AD 768–814) suddenly start using the word *petraria* (stone thrower). Logic suggests that, after the long gap where artillery had disappeared from the record in western Europe, this must be

the traction-powered stone thrower. It was already common in areas controlled or disputed by Byzantium, and was also routinely part of the Muslim arsenals faced by the Christian rulers in the south and Iberia. Certainly, every future description and illustration confirms this. The earliest west European reference to the mangonel was the *mangana* in Abbo's now famous verse account of the Danish attack on Paris in AD 885. This leaves little doubt that he meant stone throwers, and although the Latin text is obscure, it appears to describe the traction machine rather than the onager (Abbon 1942: lines 362–368).

No evidence

To sum up the argument: although it cannot be proven definitively that some of the references to stone throwing artillery in the accounts of the centuries after the dissolution of the western Roman empire do not mean the onager, there is no evidence whatever to suggest positively that any such reference does mean it. The last historical accounts specifically identifying it date from the 6th century, by which time siege artillery of any character had disappeared in the west along with the technical knowledge needed to built, maintain and operate it. By the time artillery reappears in the record, for all the reasons given, it must be the traction-powered stone thrower in both east and west. We cannot give a firm date, of course, but the onager had had its day by no later than around AD 600 in Byzantium, and considerably earlier in the former western provinces of the Roman empire.

What the pictures tell

There is another way of confirming the absence of torsion artillery during most of the middle ages. In the enormous quantity of surviving illuminated manuscripts, the illustrations have always given us valuable clues about warfare. In all this mass of illustrations, there are numerous depictions of manually operated stone throwers, then of trebuchets and, finally, of bombards and other types of weapon and siege equipment. Taking into consideration the constraints under which the monastic artists were working, and their purpose (which was not, of course, to provide a scientifically precise depiction of a particular siege), such illustrations are often remarkably accurate. Not once, however, is there an illustration of the onager. Unless there was some extraordinary global conspiracy to deny the existence of such weapons, one can only conclude that they were unknown to medieval clerics.

The springald

Torsion power had not been completely forgotten though it was not in use. The ancient texts that described it, such as, in particular, that of Vegetius, continued in use throughout medieval times to train future commanders. Suddenly, during the 13th century, somebody returned to the idea and devised an entirely new

weapon that quickly came into use across Europe. The precise origin of the springald remains obscure, but the references to it appearing in the texts and in the surviving state records indicate that its adoption was rapid (figure 4). It has been suggested by a modern student of the weapon (J Liebel) that its appearance may have been connected with the invention in Europe of the spinning wheel around 1250, as this would have made much easier the winding of the skeins (Liebel 1998: 8–9). Liebel found the earliest reference to the springald in France in 1249, while an earlier scholar, Gessler, noted its presence in the arsenal at Reims in 1258. In England, at Henry III's siege of the followers of Simon de Montfort in Kenilworth castle in 1266, we find an order to supply the royal forces with '56 lbs of horsehair for springalds in two canvas sacks' — the first evidence of the return of torsion to the king's arsenal, the specifying of the sacks an interesting confirmation of the importance of keeping the material dry (Gessler 1922: 189–203; Calendar of Liberate Rolls, Henry III, V, 230).

The springald had the basic design of the ancient torsion ballista, with two arms each held in a skein of twisted sinew or hair, although, unlike the torsion ballista, it more often seems to have been housed in a rectangular, box-like timber frame (figure 5). Unlike the original Roman weapons, its missile was a bolt. It developed, and was often used alongside, powerful giant crossbows. Liebel suggests that it improved on the Roman version by having better quality metalwork, and by using a mechanical screw to wind back the string, thus permitting even greater force. Using computers and a model, he estimated that a springald could propel a 1.4-kg bolt around 180 metres if mounted on a tower top at an elevation of 15 degrees. Health and safety considerations have ruled out testing a full size replica, so these calculations need to be treated with some caution, but contemporary accounts tell of its devastating powers of penetration. Neither armour nor palisade could stop it. At the siege of Stirling by Edward I, in 1304, Thomas Gray recorded it as a matter of note that his father had survived being hit in the face by a springald: presumably this was at the limit of its range (Gray 1907: 25–26).

With these qualities, it is no surprise to find that, normally, springalds were housed in or on towers to defend fortifications against attack. Most often, they were sited to cover gates. Interestingly, the evidence confirms one of the weaknesses of the design: to protect the skeins against wet weather, it was considered best to deploy them inside towers rather than in the open air. This had among its consequences that unless a wide opening was created, there would be a restricted field of fire, not to mention a restricted view for the operators, who would have to stand even further back to work the machine. A second consequence was that in being situated lower down, it would lose some of its range. On the other hand, it has been suggested by students of the weapon, locating the weapon on top of towers would be fine for long-range shooting, but problematic at close range, since if it was tilted at too much of an angle, the bolt might slide out. A further problem was that they were complex pieces of machinery, like their Roman ancestors, slow and expensive to construct: Liebel calculated that machines built for the Pope at Avignon cost the equivalent of six months' wages for an unskilled labourer.

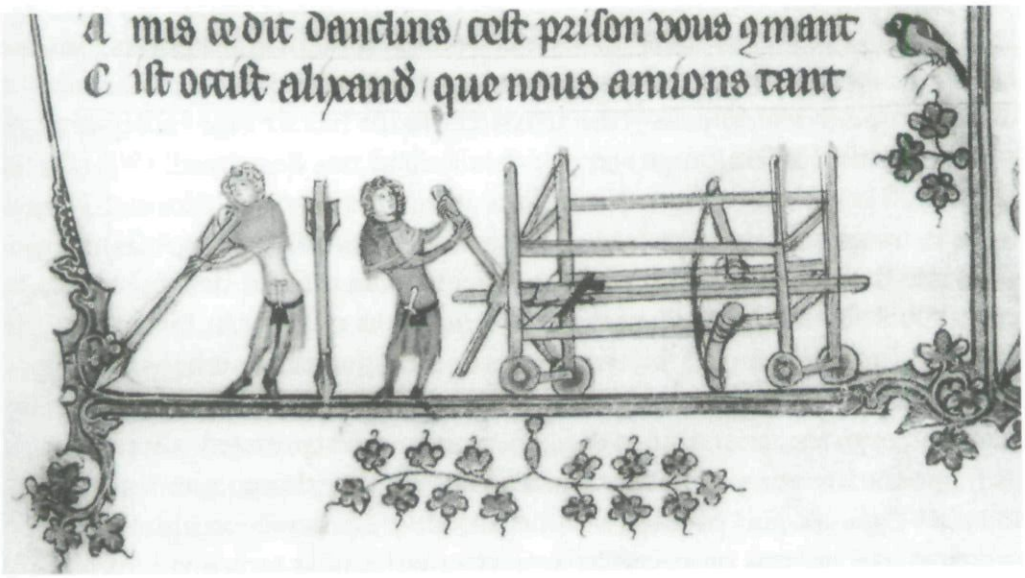

Figure 4 This wheeled springald from the Romance of Alexander *(MS Bodleian 264, f. 201r) shows both the large wooden frame required by the weapon, the screw device for winding it, and the very large bolts used as ammunition. The MS dates from 1338–44.*
Courtesy of The Bodleian Library, Oxford.

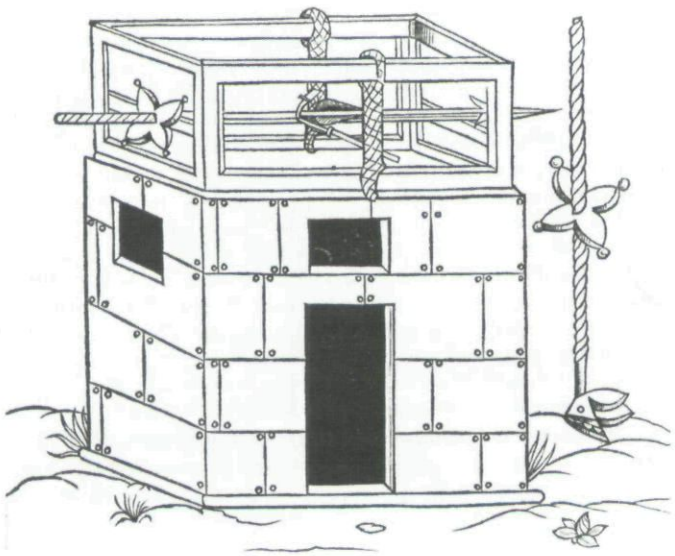

Figure 5 This mid 15th-century illustration from Valturio (MS 491, f. 71v) shows a springald loaded with an incendiary bolt and a different type of screw for winding back the cord, but the frame is very similar to that shown in the mid 14th-century MS.
Courtesy of Bibliothèque Municipale, Colmar.

Despite these drawbacks, the springald was soon a standard weapon. At Berwick Castle in 1298, an inventory noted that three springalds were not in store, but were deployed on the ramparts 'with all their furniture' (Stevenson 1870: 323–325). Detailed records survive of the otherwise little known war of St Sardos, fought between France and the English kingdom in Gascony in 1323–25. The English government sent order after order to local lords and bishops to provide the fortified towns (chiefly Bordeaux) and frontier castles with supplies and equipment, and the most prominent and most frequently mentioned was the springald. The popularity of the torsion weapon was confirmed by the command that, if there was no time to construct a sufficient number of the device, they should — instead — cut down trees to construct stone throwers (Chaplais 1954: 65–66, 92–93, 136, 157). At Dover Castle in 1344, the inventory recorded three large and eight small springalds and, in 1361, it had nine, all in good working order (unlike many of the other weapons in the arsenal) (Way 1854).

In 1346, a French lord (Hugues de Cardaillac) gave orders for the protection of his castle at Brioule against the English. The first weapon he listed was the springald to be placed on the first floor of the barbican in front of the castle gate. The floor above was to be armed with crossbows. If an enemy got too close, his instruction read, the two men crewing the springald were ordered to hurl down large stones on them (Forestie 1901) — confirming that the springald could not be depressed far enough to cover the base of the wall of a fortress.

In other words, as a weapon of defence, the springald had become first choice. Although they were also deployed in attack, in this role they could not replace the trebuchet with its wall-breaking powers, and most surviving references relate to defensive duties. Very quickly, however, they had disappeared from the scene. Logically enough, it would be the advent of gunpowder weapons that would make them redundant. We have already mentioned how springalds featured in French arsenals during the 14th century. In contrast, the inventories taken at the castle of the Duke of Orléans at Blois in 1418, 1421 and 1434 showed large numbers of guns of all sizes, great quantities of crossbows, but not one springald (Dupré 1867).[5] The Flemish city of Bruges was even more ahead of the game. In 1382–3, when it was undertaking a drastic strengthening of its defences, it bought hundreds of guns (*bussen*) and tons of gunpowder, alongside traditional crossbows and bows, but no springalds, in contrast to the situation 40 years before, when the gun had yet to become a decisive weapon (Severen 1875: 22–34).

It had taken some time for cannon to become sufficiently effective to take over as siege weapons of choice, both in defence and attack, but, with the improvements in the manufacture of gunpowder around the end of the 14th century, a decisive step was taken and the springald lost its purpose. Small guns would now outrange it by a large margin, rendering it useless. In central Europe, it survived longer. Gessler's researches (1922: 200–202) found it in continued use to defend city walls in Basel in 1419, and in Fribourg in 1425 and 1431, when no fewer than 18 *springulfs* were deployed alongside cannon in the town wall's towers. But it disappeared from view in (what is now) Switzerland and Germany too by the middle of the 15th century.

Conclusion

In its last centuries, the western empire of Rome switched from the complicated torsion-powered two-armed ballista used as a stone thrower, to a tension-powered crossbow-like weapon of the same name, while the stone thrower became the single-armed onager. There is no evidence whatever for the continuation of the onager in Byzantium beyond the end of the 6th century, while its absence in the 'barbarian' successor kingdoms can be shown, negatively, by the absence of any reference and, logically, from the decline in the expertise needed to build, maintain and use the machine. When the mangonel appeared in Europe from the east (initially in the Byzantine world), it was a traction-propelled stone thrower. Torsion power went out of use for some seven centuries before returning in the guise of the bolt-throwing springald, deployed not as an offensive, wall-breaking siege engine, but to defend those walls against human assailants. When cannon became sufficiently effective, the springald, and with it torsion weapons generally, disappeared forever. It is time that the myth of its continuation as the mangonel went the same way.

Notes

1. US scholar Paul Chevedden (1995) has argued the existence of a 'hybrid trebuchet' operated by both mechanisms simultaneously, on the evidence of the greater effectiveness of stone-throwers from no later than the 12th century. The present author's researches do not support this theory.
2. Granger (1983: 327–341) and Hart and Lewis (1986), applied modern mathematical calculations to determine how torsion power worked and found that 'predictions from the mathematics are in reasonable agreement' with the experimental model they constructed.
3. Marsden (1969, **I**: 80–93), summarises previous studies of ancient artillery. An excellent modern summary is provided by Watkins (2003).
4. Recent work on making the skeins was carried out by Stevenson and reported in Harpham (1997).
5. However, '*Un nombre d'espringalle*' remained in the arsenal of the Bastille when Paris was held by the English (Revue Archéologique 1855: 346–347)

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