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Notes on Two Manjaniq Counterweights from Mamluk ash-Shawbak

The Site and the Finds

The castle of ash-Shawbak is located in Jordan few kilometers to the North of the homonymous town, along the road connecting aṭ-Ṭafīlah to Wādī Mūsā. A first archaeological campaign has been conducted by Robin Brown in the eighties in order to investigate the Late Islamic horizon of the settlement (Brown 1988). Since 2000 the Archaeological Mission *'Medieval' Petra. Archaeology of the Crusader-Ayyubid settlement in Transjordan* by the University of Florence started a new research in the area[2]. The results gathered since then show that the Crusader installation was preceded by a Late Roman-Byzantine fortified settlement whose curtain wall is partially preserved in the inner part of the castle. Baldwin I, king of Jerusalem, in 1115 built the castle, apparently taking advantage of the remains of the previous fortification, as part of the defensive apparatus of the eastern frontier of the Latin Kingdom of Jerusalem, protecting the southern part of Transjordan and the road towards the Red Sea. Mentioned in western written sources as Montréal due to its royal foundation, the castle became the political and military baricenter of southern Transjordan and the success of this role is also expressed by its urbanistic development. After its fall in 1189 into Muslim's hands, as an aftermath of the defeat at Ḥiṭṭīn (1187), the regional political importance of the castle was strengthened under the Ayyubids who added monumental and productive buildings. According to written, epigraphic and archaeological sources, few years after the dismantling of the fortifications accomplished by the Mamluk sultan al-Ashraf Khalil, his successor Lajin built up in 1297-1298 a new and strong defensive apparatus, including new bastions and towers (FIG. 1) (Nucciotti 2007: 45, 48; Walker-Dotti-Nucciotti 2009).

Prior to the start of the research by the 'Medieval' Petra Mission, in the nineties of the last century the Department of Antiquities of Jordan accomplished a clearance campaign in the area of the major monumental buildings

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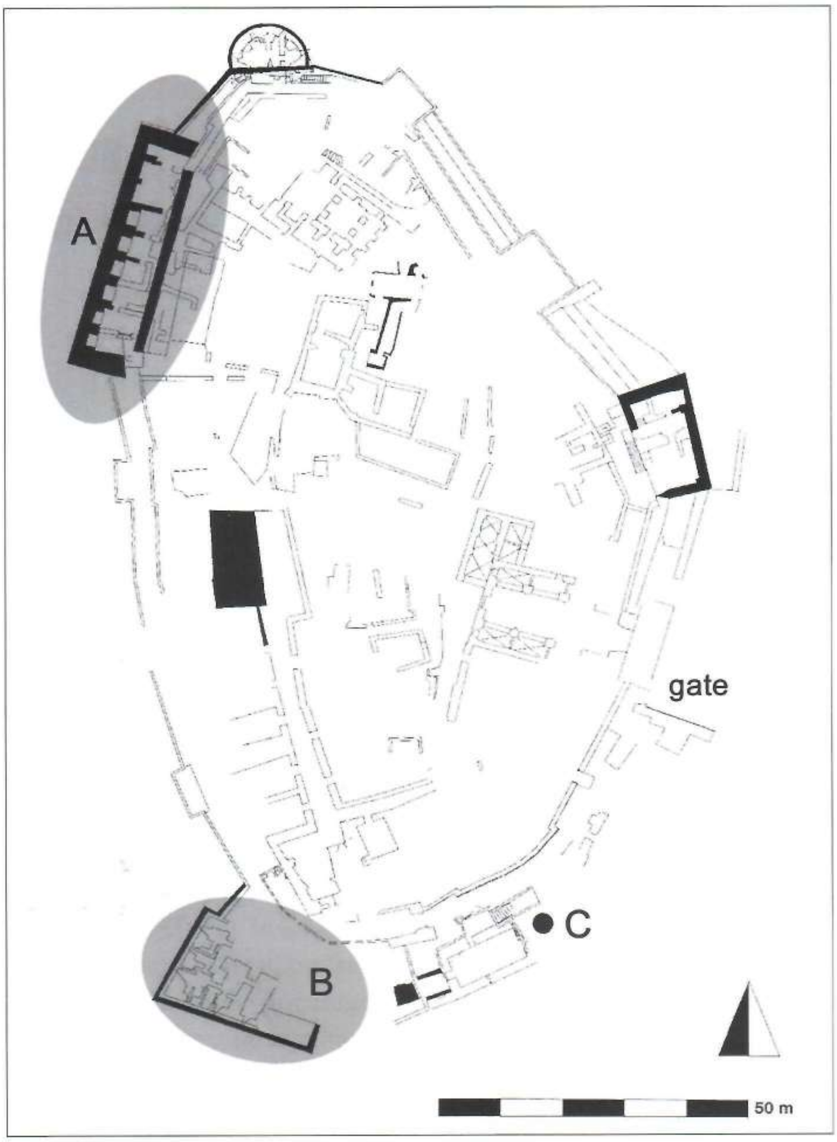
2. The research at ash-Shawbak is part of the wider project 'Medieval' Petra. Archaeology of the Crusader-Ayyubid settlement in Transjordan started in 1986 by the University of Florence. On the goals, method and results of the whole project see Vannini 2007, Vannini-Nucciotti 2009 and Vannini-Nucciotti 2012.



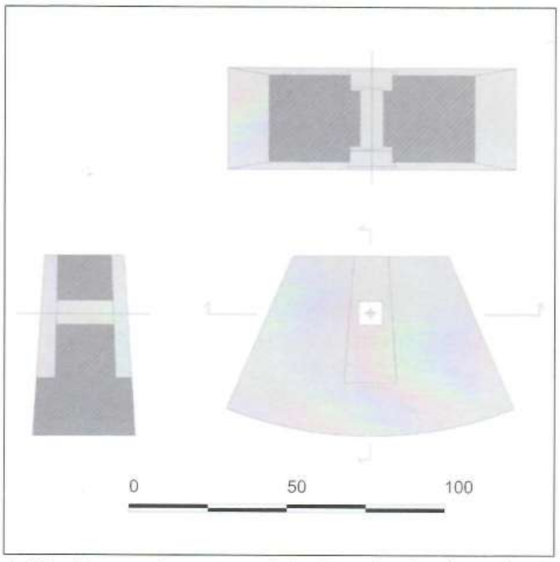
1. Plan of the castle of ash-Shawbak with the main Mamluk reinforcements of the late 13th century as indicated by the archaeological analyses (after Nucciotti 2007). Letters A and B show the probable areas of provenance of the two counterweights.

in the North-East part of the castle. During these works was unearthed a quantity of stone elements which were stored in the vaulted halls underneath the upper church of Saint Mary (FIG. 2). Among epigraphic fragments, decorative architectural elements, millstones and many spherical stone projectiles of various diameters, a particular element carved into a limestone block was recognised. Being conventionally indicated as "A" type (FIG. 3), it has a trapezoidal shape, with a convex base and a dovetail mortise carved on both faces with a square hole pierced through the thikness of the block (FIG. 4) (Vanni Desideri 2009).

Around 2000-2002 a new clearance campaign for consolidation works was accomplished by the Ministry of Energy and Mineral Resources in the southern part of the castle. During this campaign a second element of the same kind has come to light. It is conventionally indicated as "B" type and although lacking a small fragment in the upper part, the general shape is quiet similar to the A type but smaller and thinner, being every dimension about half of those of the previous one (FIG. 5). It differs from the latter in the extension of the mortise which goes from top to the base of the element and it is carved only on one face. But the more

2. The *lapidarium* where the stone elements were stored after the first campaign of clearance. Among them the A type of counterweight is visible with projectiles of various size in the background (Photograph, by the author, summer 1999).

3. The A type of counterweight (Photograph by the author, summer 1999).



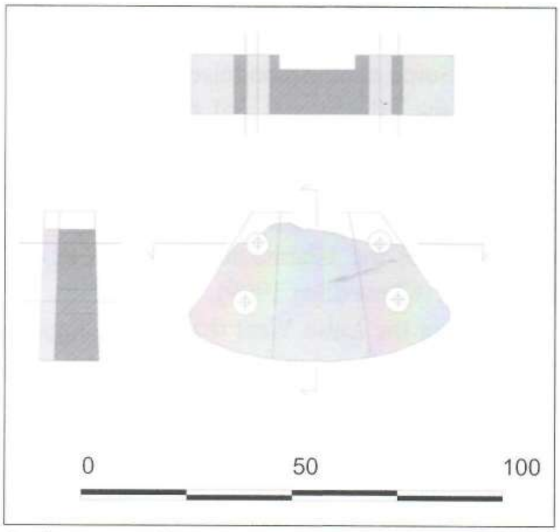
4. The A type of counterweight (Drawing by the author).

evident difference with type A is the absence of the square hole and the presence of four holes drilled through the thickness of the block and located laterally to the central mortise (FIG. 6).

Discussion

If we consider the two specimen from ash-Shawbak, although the archaeological context has been lost and a preliminary search for archaeological published comparison didn't succeed, their apparent similarity with drawings of counterweight artillery guided the research, in order to specify the type of engine to which the artefacts belonged, to propose a reconstruction of the coupling system and their chronology, starting from a concise review of Arab military treatises and related iconography[3].

5. The B type of counterweight (Photograph by the author, November 2012).



6. The B type of counterweight (Drawing by the author).

3. A preliminary bibliography on Arabic military literature was provided by Rahman Zarky 1965. On Islamic military technology see also: al-Hassan-Hill 1984: 93-120; Hill 1998: 99-115 specifically dedicated to trebuchet. See also the recent work by Tami 2012 dedicated to the cultural and technical aspects of warfare during the Crusades on both sides.

As regard to terminology, the hurling engines to which the elements most probably belonged are indicated by the Arab terms *'arrada* and *manjaniq*, according to some author recflecting their different size, being the *'arrada* smaller (Finò 1972). More recently, some scholar, on the basis of the description by al-Tarsusi, thought that the *'arrada* consisted in a pole-framed and the *manjaniq* a trestle-framed engine (Chevedden 2000: 95).

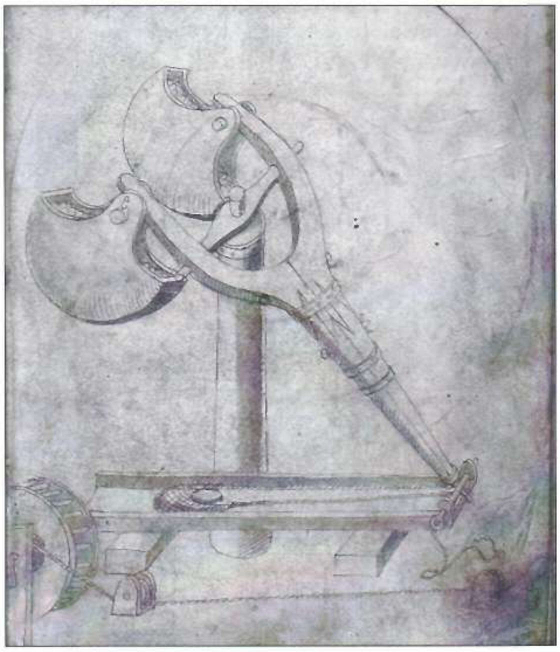
Originated probably in China as a traction powered engine, this weapon appeared in the Mediterranean area among Byzantine army, even in its hybrid design, combining human traction with gravity power (Chevedden 1999: 36; Chevedden 2000). Soon reaching the Islamic milieu, it was used increasingly often during the Islamic conquest from the siege of Mecca (683) to Baghdad (865).

A more advanced and effective counter-weight type, the *trabuchium* or *biffa* of western written sources, was developed in the Mediterranean area by the end of the 12th century[4]. From this type, rapidly disseminated by Arab engineers towards the Far East, there evolved around the mid-13th century the pivoting counterweight engine, or *biffa*, as it was called by Egidio Colonna in the *De re militari veterum ad mores praesertim medii aevi* (Colonna 1724, I: 1-69). Some author recognised a relationship between the effectiveness of this new design and the change in the planning of passive (fortifications) and active (weapons deployment) defence of castles and cities starting with the renovation of the Islamic fortifications in the Latin East (Chevedden 1999).

It was in the Latin West that a new engine, powered by twin pivoting counterweights and therefore called *bricola*, originated. His fortune spread in a relatively short time eastward and lasted until the Renaissance when Francesco di Giorgio Martini gave two of the most famous and detailed, although latest (1472-1477), graphic descriptions of this engine in his *Opusculum de architectura* (FIG. 7).

Following the diffusion of the *bricola* from the West Mediterranean area towards China, three main steps have been recognised. It seems that from Latin West the technical and practical knowledge of this design was first transmitted to the East Mediterraean thanks to the emperor Frederick II who, according to Caffaro's *Annales*, in 1242 sent some engines to the Near East (Chevedden 2000: 110, n. 143). Later on the new and more efficient artillery, since then called *manjaniq ifranjī* or *manjaniq firanjī* (mangonel of the Franks) because of its origin, was introduced as an updated ordnance in the Mamluk army (Chevedden 2000: 109). The third step eastward was accomplished by Muslim artillerists serving in the Mongol army who transmitted the *bricola* to China where its name was changed into *hui-hui phao*, or muslim trebuchet[5].

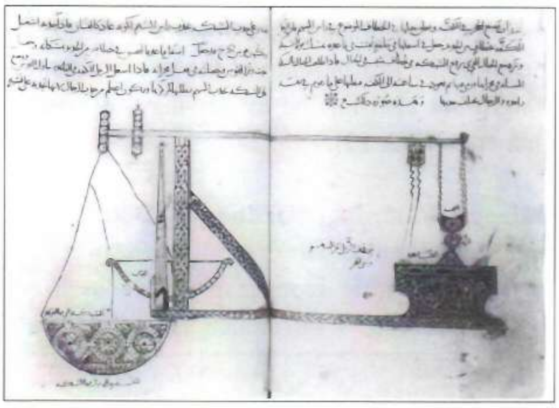
From the iconographic point of view, the most complete description and the earliest available illustration of a counterweight *manjaniq* is the



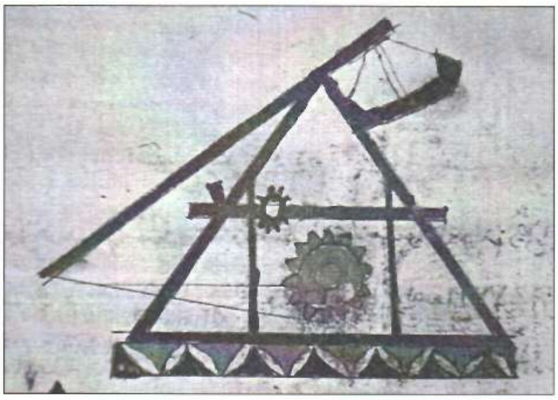
7. Francesco di Giorgio Martini drawing of a *bricola*.

4. For a discussion on the terminology see Chevedden 2000, passim.
5. About the diffusion of the counterweight trebuchet see Chevedden 2004: 102-106. A first glance on throwing engine in medieval and postmedieval China was provided by Needham 1976. For an overview on China medieval military technology see Needham-Yates 1995.

one displayed in the *Tabsirat Arbāb al-Albāb fi kaifyiat al-najāt fi al-hurub* (Instructions of the Masters of the Skills of the Methods of Salvation in Wars) by Murda bin Ali ibn Murda al-Tarsusi, written around 1187 and dedicated to Saladin[6]. The author specifies the details of the designs used among different peoples, including the Europeans, but the drawing is scarcely useful because of its too schematic representation of the engine (FIG. 8). As to the transmission of this design, al-Tarsusi attributes it to an Armenian master of weapons captured by the Fatimid army who offered his collaboration in change of his life and explained the principles of the new machine in Alexandria[7].



8. The counterweight *manjaniq* represented in Murda bin Ali ibn Murda al-Tarsusi's *Tabsirat Arbāb al-Albāb fi kaifiyat al-najāt fi al- hurūb*, around 1187 (after ...).



9. A counterweight *manjaniq* in Najm al-Din Hassan al-Rammah's *Kitab al-Furusiyya wa al-Manasib al-Harbiyya*, 1280 (after al-Hassan-Hill 1998, P. 110, fig. 4.15).

The *Kitab al-Furusiyya wa al-Manasib al-Harbiyya* (Book of Military Horsemanship and Ingenious War Devices) written by Najm al-Din Hassan al-Rammah around 1280 (al-Hassan 1998) contains the drawing of a launching engine (FIG. 9) recognisable as a pivoting counterweight *manjaniq*. The counterweight has a nearly trapezoidal shape with a reinforced base connected to a vertical central element coupled to the beam, possibly indicating a wooden structure with a reinforcing metal frame.

The *Jāmi' at-Tawārīkh* (Collected histories) by Rashid ad-Din Habīb, composed around 1306, provides the more detailed and abundant representations of *manjaniq*[8]. The plate depicting the siege of a town by the Mongol army gives a very interesting description of a ready to shoot engine (FIG. 10). The trestle frame appears particularly strong and provided with several buttresses, giving the idea of a *manjaniq* of great dimension able to project the round shells visible on the left. The hanging system of the triangular pivoting counterweight is very similar to the one which is possible to suppose for our A type. A possibly metallic keyhole shaped plate is clearly visible coupled by means of a cylindrical joint pin provided with a cotter. On the contrary, the represented distance between

10. A Muslim counterweight *manjaniq* firing against the curtain walls of a town as represented in Rashīd al-Dīn Ṭabīb's *Jāmi' at-tawārīkh*, 1306.

6. The treatise was first edited and translated into french by Cahen 1948 and more recently edited by Sander 1998.

7. Quoted in Chevedden 2000: 104-105.

8. For a recent study on the manuscript see Kamola 2013.

the counterweight and the fulcrum of the beam is not realistic, being too short to be effective, but the fact could be explained with the general tendency to *orror vacui* demonstrated by the author, trying to fill the illustrations of the manuscript with as many details as possible.

A drawing included in the *Kitāb Anïq fi al-Manājanïq* (An Elegant Book on Trebuchets) composed by Yūsuf ibn al-Zaradkāsh in 1462-'63 depicts a *manjaniq* with details similar to those in the latter document (FIG. 11). The beam is supported by the same kind of frame and the counterweight, whose shape is similar to the two elements from ash-Shawbak, is sustained by a presumably metallic element with an upper joint pin functioning as turning point.

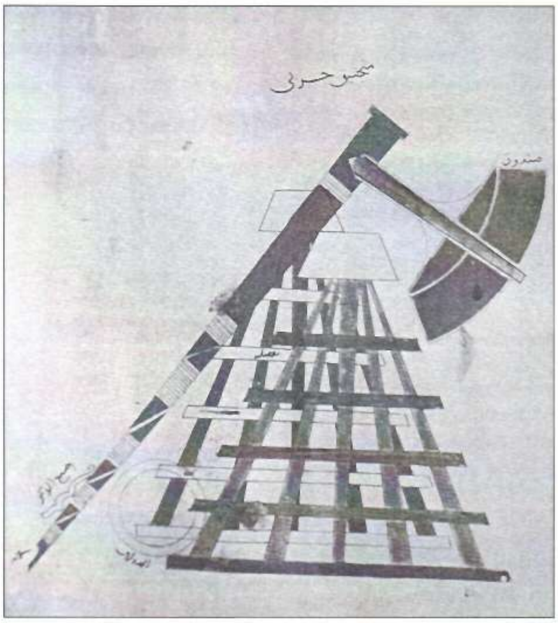
The two later documents are the most useful for the interpretation of the mortises and holes on the two counterweights from ash-Shawbak and the reconstruction of their coupling system. In particular, the supporting system represented in Rashïd ad-Din's manuscript helps us to understand the functional meaning of some detail.

Taking into consideration the mortises and the holes carved into the trapezoidal-monolithic counterweights and comparing it with the illustrations of *manjaniq*, their different coupling system could be reconstructed as follows. In the A type, two probable metal plates with a key-hole shape were placed into the corresponding dovetail mortises where a joint kingpin with a square section, passing through the thickness of the block was fastened by cotter pins. A second joint pin with a round section passing through the round holes in the upper end of the plates should have hung the counterweight to the beam (FIG. 12).

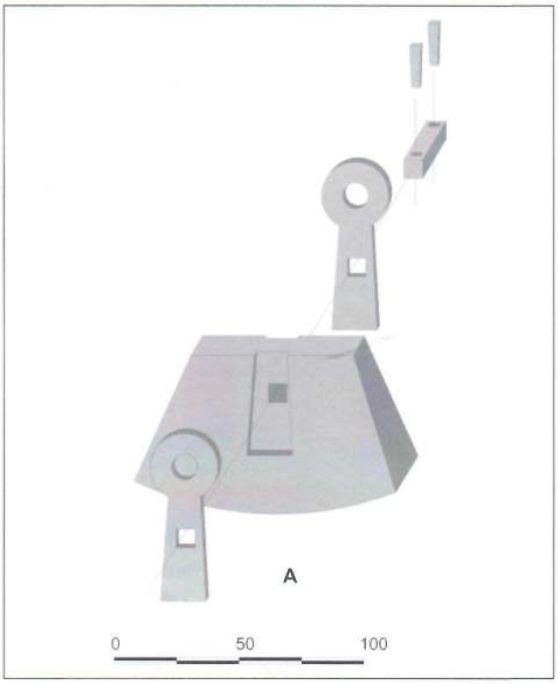
In the case of the B type, the presence of only one dovetail mortise reveals that for its correct coupling and use it was necessary at least a second element while the four holes were probably meant at the fast moving of the heavy counterweight but also for the assemblage of the two elements (FIG. 13).

Defence Planning, Ordnance Deployment and Effectiveness

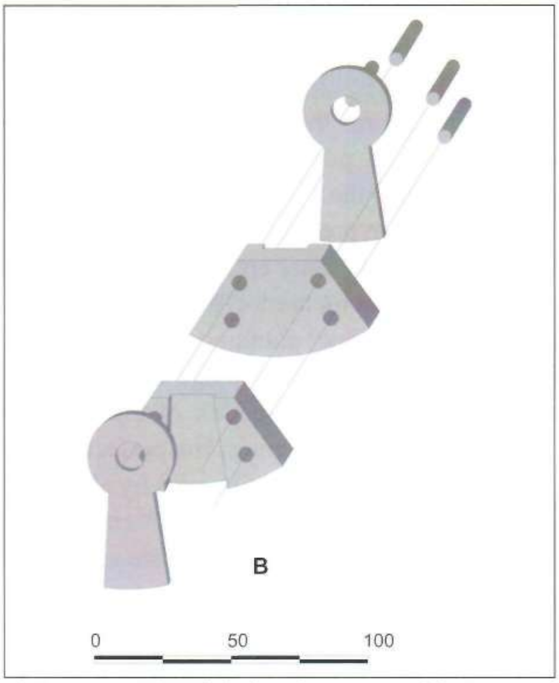
But comparing iconographic and archaeological sources, a difference is to be noted:



11. A *manjaniq* represented in *Kitāb Anïq fi al-Manājanïq* by Yūsuf ibn al-Zaradkāsh, 1462. Topkapi Sarayi Muzesi, Istambul (after al-Hassan-Hill 1998, P. 101, fig. 4.7).



12. Reconstruction of the hanging system of the A type of counterweight (Drawing by the author).



13. Reconstruction of the hanging system of the B type of counterweight (Drawing by the author).

while the manuscript by Rashid ad-Din doesn't show a connection between the keyhole metal plate and the counterweight, the A type element bears a square hole in midst of the mortise. Apparently the difference could only be explained with the different materials of the two counterweights, *i.e.* the monolithic limestone element from ash-Shawbak and the probable wooden box structure described in al-Zaradkāsh's and Rashid ad-Din's manuscripts. Actually a wooden box counterweights was the simpler and more convenient solution to increase rapidly and easily the propelling mass using any kind of material, and both features were obviously an advantage during siege activities when more specific material couldn't be available[9]. Such considerations show that the two solid limestone counterweights and related engines were not meant as offensive weapons to be used during an attack or siege, which should have requested a certain flexibility of use, but most probably they belong to a defence deployment.

The *manjaniq* were installed on the bastions of the castle, on the basis of a detailed reconnaissance and knowledge of the surrounding landscape. The limited possibility of adjustment provided by solid stone counterweights, means that the performance and the locations of the two *manjaniq* were carefully planned and specifically designed. In fact, combining the possible direction of an attack, the needed firing range and the more suitable positions of the engine, it was possible to precisely plan the performance of the artillery avoiding the building up of a more versatile but greater engine.

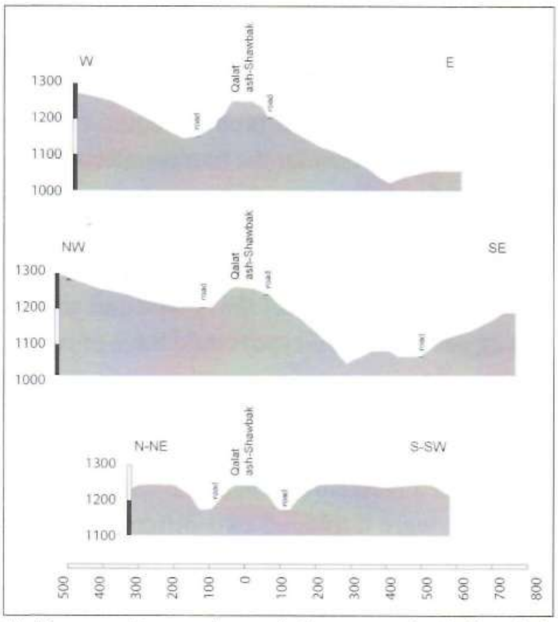
In comparison with iconographic sources, it is clear the counterweights from the castle of ash-Shawbak belong to the more advanced gravity artillery, *i.e.* the pivoting counterweight type. But if we take into consideration how the two are precisely realized, we can assume that their mass couldn't be easily increased and, as a consequence, it wasn't possible to adjust their performances. For both artillery pieces only limited adjusting operations were possible: moving the counterweight along the beam or modifying the calibre of the shells, consequently changing the shooting range. But even then, their mass wasn't sufficient to hurl effective projectiles, weighing type A around 450 kg and type B around 62 kg only. This problem could only be explained if we consider the two counterweights as parts of a different and more advanced kind of engine. In the case of a *manjaniq firanji,* the *bricola* of western origin, twin counterweights (of about 450 kg each for the A type and around 150 kg each for the B type) could have provided a more adequate gravity power, granting at the same time the balance and stability to the engines, thus increasing their accuracy.

In such a reconstruction at the castle of ash-Shawbak were deployed two different kind of *manjaniq* of the *bricola* design with sensibly different performances that could be explained as follows.

9. In this regard see the different raw material identified during the archaeological survey in the surrounding area of the battlefield of Arsuf. In particular, most of the projectiles, being limestone not available at the site, were made out of limestone blocks brought from the Samarian hills, some 15 km from Arsuf (Raphael and Tepper 2005: 87-88).

A rapid survey at the topographical features of the area around the castle, points out that the more threatening elevations are located along a N-NE/S-SW axis (FIG. 14). Two major heights of around 1200 m a. s. l. are located in the closest position, around 200 m, on both sides of the castle. Being these locations the more suitable for the positioning of artillery pieces they had to be covered by the defenders fire. Other elevations to the W and NW are suitable for an artillery attack but they are too much distant from the castle curtain walls, on the other hand the whole eastern sector is naturally protected by the slope.

Accordingly, the fortifications built by the Mamluk sultan Lajin at the end of the 13th century, included two large bastions, one facing NW and the other against a possible attack on the S-SW flank, with a flat and large roof suitable for operating the engine and both provided with batteries of arrow slits arranged in multiple rows. Combining the locations with the hypothetical shooting range deduced from the average different features of the engines (counterweights and projectiles mass, length of the beam ecc.) it is then possible to propose a reconstruction of the firing coverage of such artillery.



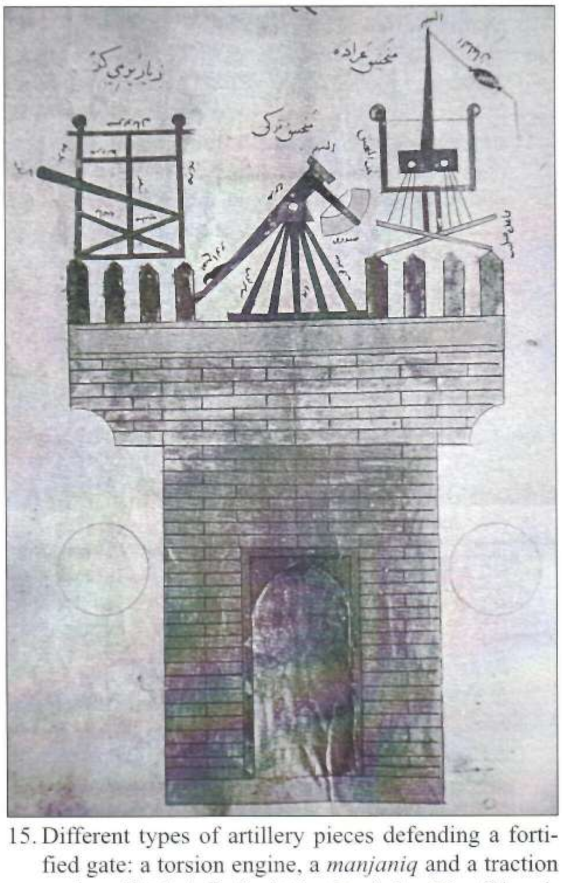
14. Topographic sections of the area of ash-Shawbak showing the more suitable elevation for an artillery attack. Elaboration by the author from the 1:25.000 "Ma'ān" map by the Royal Geographic Centre.

Judging from the place where the two elements were possibly found, the engine provided with the A type of counterweight could have been presumably placed on the NW bastion, while the other engine with the B type of counterweight on the S-SW bastion.

The whole defence planning of ash-Shawbak, based on the perfect knowledge of the logistic altogether with the evaluation of the possible locations of sieging engines, fits perfectly with the advices included in the tretaise by al-Ansari at the very beginning of the 15th century. In book twenty he writes that, once the siege take place, because of the limited resources of the defenders, they should know with the maximum precision the weapons to be used and how to get the major effects on the enemy (Al-Ansari 2012: 121).

The use of hurling engines as a defensive weapon mounted on bastions or towers is well known from written sources: Anna Comnena quotes a *helepolis* (a kind of traction trebuchet) mounted on towers or ships (Dennis 1998: 108-109) and Eustathios, bishop of Thessalonika, in his *The Capture of Thessaloniki* remembers how in 1185 artillery deployed on the curtain walls defended the town against the siege by the Normans (Chevedden 2000: 94). In 1148 the *manjaniqs* of the Saracens defended the town of Tortosa throwing shells of around 60 kg (Settia 2002: 126). Apart from this early examples, the major development of the use of artillery as a defensive weapon coincide with the introduction of the counterweight trebuchet, much more threatening the fortifications than the traction one. The new way of planning the defences of castles and cities as a countermeasure against the increasing effectiveness of the new design of trebuchet, combined larger fortifications with the defensive use of artillery, inaugurated by al-'Ādil was later on also applied by the Crusaders (Chevedden 1999: 38-43). The new defence system. On such concerns al-ʻĀdil developed a new system of defence including thicker curtain walls and larger bastions combined with the deployment of artillery. The clearer and complete expression of this new defence planning is the citadel of Damascus, later on extended to Borsa (1218) and Mount Tabor (1215), but reinforcement based on the same concept are to be found in many Ayyubid strongholds (Chevedden 1999).

A good but late representation of this new role of artillery is provided by the al-Zaradkāsh's manuscript, which shows three different types of artillery (torsion, traction and rotating counterweight) defending a fortified gate (FIG. 15). More than three decades earlier the curtain walls of Orléans were protected by the fire of an out of date trebuchet located on top of the tower of Saint Paul, which was soon replaced by a more effective cannon (Finò 1972: 40, n. 52).



15. Different types of artillery pieces defending a fortified gate: a torsion engine, a *manjaniq* and a traction engine. *Kitāb Anïq fi al-Manājanïq* by Yūsuf ibn al-Zaradkāsh, 1462, Topkapi Sarayi Muzesi, Istambul (after al-Hassan-Hill 1998, P. 104, fig. 4.9).

In this regard, for the understanding of the castle's active defence system, the numerous limestone *manjaniq* shells found during the excavation of area 6000 assume further importance. On the back of the apse of the lower church of the castle, next to the inner gate, at least two Stratigraphic Units contained *manjaniq* shells, both included in Period 8 (Molducci and Pruno 2007). The earlier Stratigraphic Unit 6079 contained a quantity of roughly spherical shells with a diameter approximately of 35 up to 85cm, obtained by processing limestone blocks (FIG. 16), which could be interpreted as an ammunition deposit *in situ*. In a later moment, when evidently such artillery became obsolete, the floor (US 6040) underneath a vaulted ceiling (US 6052) was paved using a quantity of *manjaniq* shells as mere building material. The study of these projectiles, still in progress, will furnish important information concerning the different sizes and weights of the projectiles for determining the performance of the counterweight artillery. At the moment, their average weight, estimated in about 60kg, can be compared with the data recovered during the excavation at the site of Arsūf, where the battlefield of the siege led by Baybars has been investigated with archaeological method. Being the raw material the same, the average diameter and weight of the shells from ash-Shawbak

16. Area 6000, US 6079 under excavation (after Molducci, Pruno 2007).

correspond to the maximum used by the defenders of the fortress against the Mamluk besieging army, which mostly weights between 16 and 35kg: sensibly less than the 45kg hurled by the *ifranji manjaniq* used by the Mamluk army besieging ʻAkkā (Raphael and Tepper 2005: 87, 99-100 and. 90).

About the effectiveness of these bastion engines, normally hurling smaller projectiles as can be deduced from the description given by William the Breton of the siege of Bôves by king Philippe August "...nunc mangonellus, Turcorum more, minora saxa rotat..." (Cathcart King 1982: 460), Jean Froissart writes in his *Chroniques* that in 1340 the defenders of Montagne destroyed the great trebuchet of the enemy with three shots (Contamine 2000: 270-271). The author of the *Itinerarium peregrinorum et gesta Regis Ricardi* describes how the defenders of the town of ʻAkkā used manjaniqs to destroy the attacking trebuchets of Henry of Champagne (Chevedden 2000: 96) and the defence of the castle of Chinon, at the time of king Philippe August, also relied on a "...petraria turquesia..." (Finò 1972: 40, n. 49). Artillery of the same type was also located on movable towers during offensive activities, as reported by Jean Froissart during the siege of Bergerac by the French in 1377 (Finò 1972: 41-42).

The reconstruction of the active defence of Mamluk ash-Shawbak, as far as can be deduced by material sources, apart from the quantity of arrow slits arranged in multiple rows in the bastions, can now be completed with the deployment of a number of updated artillery as part of a wider plan accomplished in 1293-1294 under the rule of sultan Lajin. In particular, the new bastions and their locations, if intended as a consequence of the study of the surrounding landscape and the recognition of the main direction of a possible attack, seem to support this interpretation.

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