«GREEK FIRE»: PROBLEMS CONCERNING THE USE OF THE «SECRET» WEAPON OF THE BYZANTINE NAVY

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Amongst the many and sophisticated weapons used by Byzantium against its enemies, «Greek Fire» is, without a doubt, the most famous, not only because the primary sources that mention its use extend throughout most of the years of the Empire, but also because «Greek Fire» was used in some of the Empire's most dramatic moments. However, despite the fame that has made it a legend, this naval weapon remains almost unknown to us, a fact that can be mainly attributed to the ambiguity of the primary sources that mention the weapon and its deployment[1]. In this paper, I will summarize the results of my most recent research concerning the question of ejection of the «Greek Fire» against enemy ships, results which are presented in the third edition of my book on the «Greek Fire»[2], that was published recently.

Since this is only a brief summary, I will not discuss the problem of the composition of the «Greek Fire» but simply mention the opinion presented by Davidson, Haldon and Byrne who maintained that «Greek Fire» was based almost exclusively on crude oil, opinion which is generally accepted.

ATTEMPTS TO EXPLAIN HOW THE «GREEK FIRE» WAS LAUNCHED

Although the issue of the composition of «Greek Fire» seems to be more or less resolved, things are not as clear when we confront the question of how the Byzantines were able to project their incendiary mixtures against enemy ships. Despite its significance, this problem has not, until recently, attracted the attention of scholars, and no serious attempts were made in the past to solve it. There were, however, some attempts to explain how the various mixtures were launched, usually related to one of the theories regarding their composition. The suggestions that have been made fall into the following categories:

a) Projection by means of a force-pump

This view was expressed by H.L. Hime, who maintains that the term «σίφων» (=siphon) that we meet in the primary sources indicates a force-pump, and that «Greek Fire» was projected by means of such a pump[3].

The German scientist E.O. von Lippmann similarly asserts that «Greek Fire» was projected against enemy ships «through long pipes made of metal, pushed by the pressure produced by a force-pump». He also accepts that «siphon» means a pump and reminds us that Ktesibios had already invented such a pump in Alexandria in the year 200 B.C. However, he gives no further explanation concerning the engine he proposes[4]. The same or similar views were also proposed by R.J. Forbes and J.R. Partington, but they, too, failed to describe the particular machine and did not explain its mode of operation.

b) Projection as a result of an explosion caused by gunpowder

This view was supported by C. Zenghelis, who wrote that «the composition of the incendiary mixture known as «liquid fire» or «Greek Fire», was undoubtebly based on saltpetre, and was used to eject incendiary material through pipes that were placed on the bow of the ship»[5]. Similar views were also expressed by M. Mercier[6].

c) Projection as a result of heating the incendiary mixture

This position was expressed by E. Davidson in a paper that deals almost exclusively with the problem of the ejection of «Greek Fire». Davidson believes that the composition of «Greek Fire» was based on crude oil, and after rejecting the views that «Greek Fire» could be ejected with the help of catapults, pumps or as a result of a chemical reaction, proposes that projection was achieved after heating the mixture almost to its boiling point[7].

d) Projection as a result of the combination of heat and pump

This hypothesis was presented by J. Haldon a historian and M. Byrne a physicist. Its basic novelty is that the authors attempted to construct an apparatus for projecting the «Greek Fire», based on the laws of mechanics (engineering).

Before dealing with the problems of their suggested apparatus, they concluded that the ejected material was «certainly crude oil», and they refer to the way and the area from which it was collected, which they position in the Donbaχ region north-east of the Black Sea[8].

The apparatus that Haldon and Byrne constructed according to their hypothesis consists of three parts: a) a bronze «siphon», which they assume was a force pump, b) a bronze-bound swivel tube through which «Greek Fire» was projected against the enemies in any direction and c) a small hearth used to heat the oil in its sealed container. According to Haldon and Byrne, «The oil was heated gently before combat began, more fiercely as the need to use the weapon arose. Pressure was built up both by heating the oil in its sealed container and by use of the pump. Once the pressure was high enough, a tap or valve in the container was opened, allowing the oil to be forced out through the swivel tube, at the mouth of which it was ignited»[9].

All the above theories have been met with scepticism which can be summarised as follows:

a) The proposed launching of the «Greek Fire» with the help of a force-pump is not persuasive because it does not explain how the proposed engine worked, and more important to what distance a force-pump powered by hand could propel such a thick mixture.

b) The opinion that the launching of «Greek Fire» was accomplished as a result of an explosion caused by a primitive form of gunpowder was also rejected, because the only primary source that mentions the saltpetre, the «Liber ignium» of Marchus Graecus, cannot be dated with accuracy and certainly not as far back as the seventh century[10].

c) The view proposed by E. Davidson was also questioned because her description of the procedure of launching was rather vague and because she did not explain where the force necessary for the shooting of the mixture came from.

d) Haldon and Byrne's suggestion that the launching of «Greek Fire» could be achieved by means of a force-pump combined with heat is not very convincing either. Despite the fact that this study is the only serious attempt focusing specifically on the projection of «Greek Fire» and raises some important questions, it does not offer persuasive and acceptable solutions, especially with regard to the problems of practical application that arise when the apparatus that they suggest is put to work.

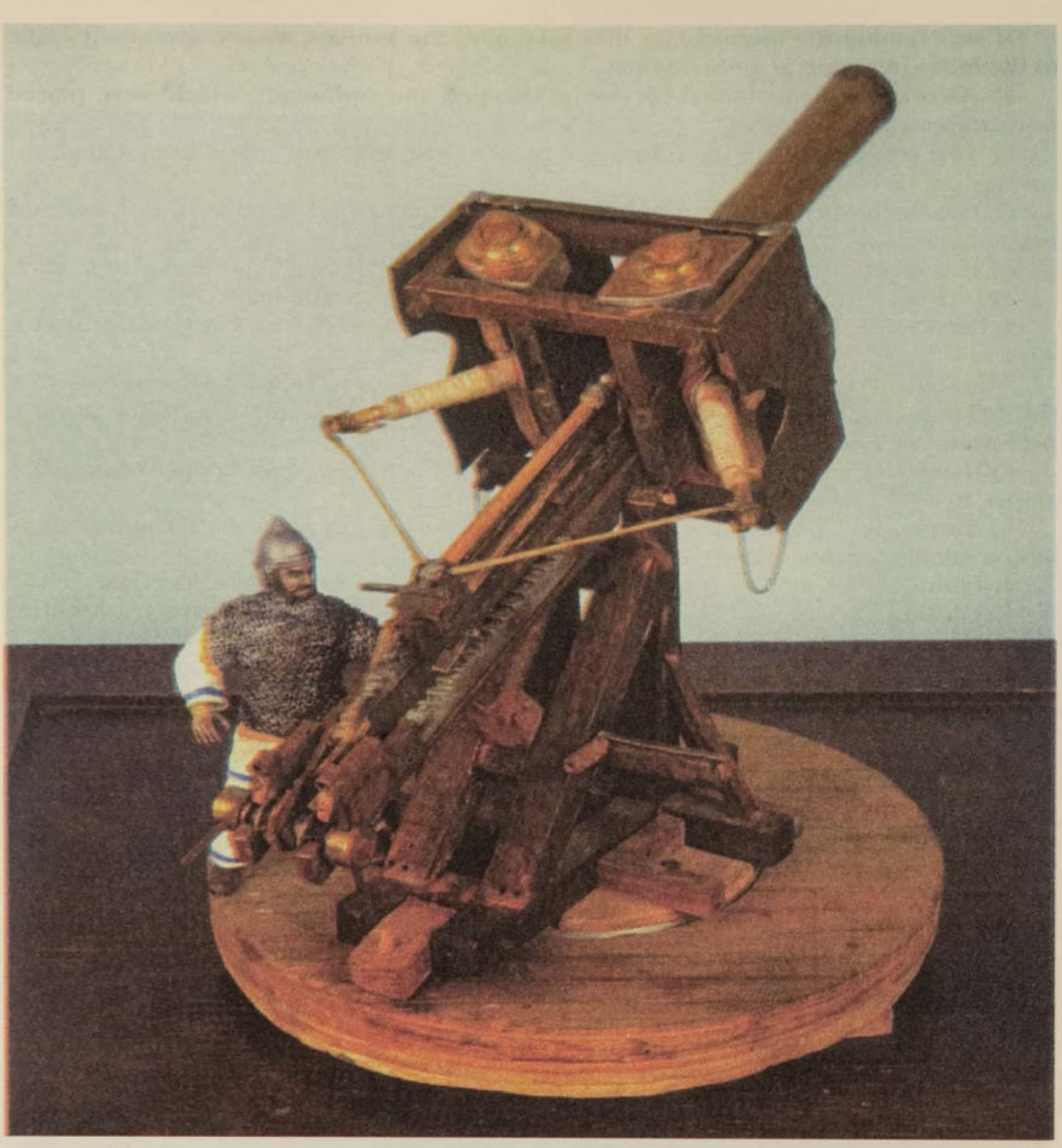
Commenting on the practical problems, I would like to notice that the apparatus, or, better, the system suggested by Haldon and Byrne, raises the following questions:

a) Was it really possible for the Byzantines to produce, sustain and control the considerable pressure that should have been created inside the system in order to project crude oil to any distance?

b) Was it really possible for them to ignite crude oil while it was ejected from the pipes, as Haldon and Byrne suggest?

c) To what distance was the apparatus able to project this crude oil?

d) Was it possible for the operator in charge to synchronize all the components of the system during battle and while pursuing the enemy ships?



Haldon and Byrne tried to answer the first question but left the rest unanswered. Indeed, the problem of the system's resistance to pressure is understood by them, who admit that «heating the oil without any sort of pressure gauge, which we must assume, was highly dangerous and could result in an explosion». And although they believe that under these circumstances «accidents must surely have occured», they insist on their views claiming that «the evidence we have will allow no other practicable solution»[11].

Finally, the writers did not consider the problem that the residues of the mixture could cause to the suggested apparatus, namely, blockage of the pipes and explosion.

The obvious weakness of research to give a complete and persuasive answer to the problem of launching the «Greek Fire» can certainly be attributed to the difficulties one faces when attempting to decipher the Byzantine sources that refer to it. The references of the sources relevant to «Greek Fire» are too few and too ambiguous, and that is why they breed so many and such contradictory interpretations[12].

If we examine the fragmentary information of the sources, we can eventually come to the following general observations:

a) «Greek Fire» was launched «by or through the siphons»[13], which were placed on «dromons and biremes».

b) The «siphons» were placed on the prow of the ship and «their frontal side was covered up by copper»[14].

c) The discharge of the «Greek Fire» was accompanied by «a noise of thunder and fiery smoke»[15].

d) «Greek Fire» could be hurled at the enemies ships in pots[16] that broke on impact.

e) It could also be hurled by hand, that is, by the «hand-siphons»[17].

f) Finally, the Byzantines could control the direction of «Greek Fire» and project it «upwards, downwards and sideways»[18].

The study of the primary sources regarding the ejection of «Greek Fire» reveals that the following basic conditions have to be explained in order for the device to have performed as described. These conditions regard:

a) Range: The shooting of incendiary materials from πυρφόροι δρόμωνες (i.e., fire ships), to a safe distance for the Byzantine ships.

b) Targeting: The shooting of these incendiary materials from the Byzantine ships with a relative degree of accuracy.

c) Ignition: The description of the mode of igniting the incendiary materials.

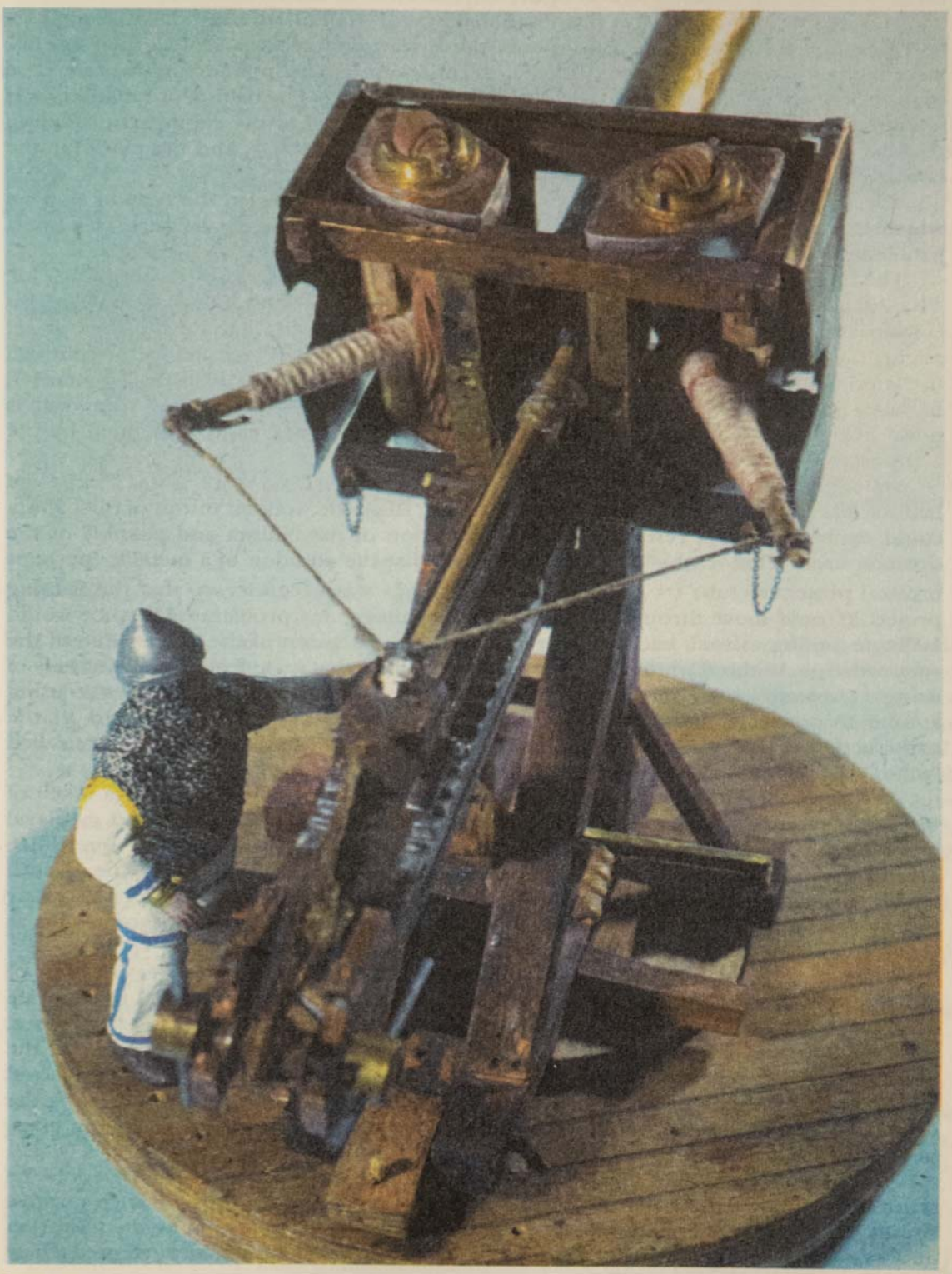
Regarding the question of the range that «Greek Fire» could achieve, Admiral K. Alexandris among others believes that it should have been between 50 and 75 m.[19].

If we agree with the above estimate, and we should if «Greek Fire» is to be classified as an offensive weapon, it becomes obvious that we must search for a different solution than the one suggested by Haldon - Byrne and all those who believe that «Greek Fire» was discharged by the force produced basically by a hand-pump, because not enough pressure could be generated this way to achieve the aforementioned range.

Having established that «Greek Fire» had to have a sufficient range, I believe that this would be possible only if it was enclosed in some kind of container, e.g. clay-pots. Then I will attempt to answer the question of how the Byzantines could discharge those pots full of inflammable and incendiary materials, that were described by the general term «Greek Fire». According to my estimation, the answer is simple and implied by C.W.C. Oman in his classical book «The Art of War in the Middle Ages», when he notes the following: «It will be observed that no long account of «Greek Fire» has been given.... This neglect is from a conviction that, although its importance ... in naval fightings was considerable, it was, after all, a minor engine of war, and not comparable as a cause of Byzantine success to the excellent strategical and tactical system. Very much the same conclusion may be drawn from a study of the other purely mechanical devices, which existed in the hands of the Imperial generals. The old skill of the Roman engineers was preserved almost in its entirety, and the armouries of Constantinople were filled with machines, whose deadly efficacy inspired the ruder peoples of the West and East with a mysterious feeling of awe... the catapult, onager and ballista, were as well known in the tenth century as in the first. They were undoubtedly employed, and employed with effect, at very siege»[20].

It is well known that the Hellenistic technology of building war engines was preserved and improved during Roman times, to be continued later in Byzantium[21]. Therefore, the answer to the question of how the Byzantines succeeded in launching their incendiary materials may be found if we examine the military technology of the Hellenistic past[22].

Thus, I believe that the ballistae, catapults etc., (well-known since Hellenistic times) could easily throw missiles to a sufficient range with considerable accuracy, especially when ballistae were used[23]. Accuracy is especially essential when the target is not very big and above all stable (walls or tower), but small, moving and manoeuvrable (ship). For the reasons mentioned above, I believe that this combination of the Hellenistic



military tradition and experience in war machines, coupled with the innovations of the architect Kallinikos in the technique of launching incendiary material, which are mentioned below, was the «secret» of the «Greek Fire» of the Byzantines.

Let us see now what the proposed ballista of Kallinikos must have been like, and examine whether the innovations of the Syrian architect, as well as their results, were really so impressive as to justify the exclamations of Theophanes and his reference to «Greek Fire» as the «new» weapon of the Byzantine navy. The ballista of Kallinikos was a palintone stone-throwing catapult, probably an invention of the engineers of Philipp II of Macedon[24], which in Roman times was known as Ballist(r)a[25], and was placed in the bow and both sides of the Byzantine dromons.

The size of the Byzantine ballista could vary proportionally to the type of ship on which it was used, because the construction of smaller or bigger ballistae was not a problem, provided that its various parts were kept in proportion[26].

The process of projecting «Greek Fire» was not complicated at all. The «σιφωνάτωρ»[27] armed the mechanism of the ballista with the assistance of his collaborators, placed the pot with «Greek Fire» on the piston, lighted the wick or set alight the whole pot, which could be wrapped with flax[28] soaked in naphtha[29], the «πρόπυρον» of the Byzantine sources. After he had aimed the ballista at the target, he launched the siphon which contained the «Greek Fire» at the enemy ship «with a noise like thunder and fiery smoke»[30] and flames, which are easily explained by the composition of the liquid in which the flax was soaked.

Setting afire an incendiary projectile during launching, and while it was still on the ballista, has puzzled me from the very beginning, since the wooden piston of the ballista could easily catch fire, resulting in the destruction of the ballista and possibly of the dromon itself. That is why I became convinced that the addition of a metallic (perhaps bronze) protective tube (= siphon) on the «σῦριγξ» was necessary, so that the flaming projectile could move through the tube without causing any problems. The tube would facilitate aiming as well, because it would act as an extension of the aiming line of the «σιφωνάτωρ». Without underestimating the difficulties that arise from the hypothesis of using a protective tube on the ballista, I would like to point out that the idea of using a tube to assist the launching of a projectile was not new, but preexisted in the construction of bows that used tubes (σωληνάρια) to shoot small arrows that were called "μυίαι" = flies[31].

The practical verification of my hypothesis became eventually possible as a result of my co-operation with Mr. Nik. Orphanoudakis, a researcher of ancient and medieval war technology, and provided affirmative answers to these questions. Mr. Orphanoudakis, following my hypothesis and using materials known in the seventh century, constructed a working model of a Hellenistic ballista on which a copper or bronze siphon (tube) was placed. This model, when tested, yielded very good results as regards range and aiming[32].

Summarizing, we observe that Kallinikos' ballista gives positive answers to most of our questions. It can shoot a projectile (a pot full of incendiary materials) from a safe distance against the enemy ships with considerable accuracy. Furthermore, the launching of «Greek Fire» from Kallinikos' ballista seems to agree with the descriptions in the Byzantine sources which mention that «Greek Fire» was projected «through bronze siphons»[33], where siphon = tube for the launching, or «with the siphons»[34], where siphon = pot. The projectile siphons were made of clay or glass, but they could also be made of copper when bigger siphons were needed.

Summarizing, we may note that the innovations on the ballista which could be attributed to the engineering genious of Kallinikos seem to have brought such positive results in the deployment and use of that weapon, that it could justify the identification of «Greek Fire» with the name of Kallinikos and the belief that he actually invented a new weapon.

NOTES

1. For the basic research on «Greek Fire» see Berthelot, M., *La Chimie au Moyen Age,* Paris 1893q; Hime, H.W.L., *Gunpowder and Ammunition,* London 1904; Idem, *The Origin of Artillery,* London 1915; Zenghelis, C., «Le feu grégeois et les armes à feu des Byzantins», *Byzantion* 7, 1932, 265-286; Cheronis, N.D., «Chemical Warfare in the Middle Ages: Kallinikos' Prepared Fire», *Journal of Chemical Education* 14, 8, 1937, 360-365; Mercier, M., *Le feu grégeois,* Paris 1952; Partington, J.R., *A History of Greek Fire and Gunpowder,* Cambridge 1960; Forbes, R.J., *More Studies in Early Petroleum History,* Leyden 1959; Davidson, E., «The Secret Weapon of Byzantium», *BZ* 66, 1973, 61-74; Haldon, J. - Byrne, M., «A Possible Solution to the Problem of Greek Fire», *BZ* 70, 1977, 91-99.
2. Korres, Th., *«Hygron Pyr». A Weapon of the Byzantine Naval Warfare*[3], Thessaloniki 1995, (in Greek).
3. Hime, H.L., *Gunpowder* 47. See also Hall, A.R., *The Oxford History of Technology* II, Oxford 1956, pp. 375-376.
4. von Lippmann, E.O., *Zur Geschichte des Schiesspulvers* (Abhandlungen und Vorträge zur Geschichte der Naturwisse), 1906, p. 131.
5. Zenghelis, C., *Le feu grégeois,* 277 ff.
6. Mercier, M., *Le feu grégeois,* 25 ff. See also Korres, Th., *Hygron Pyr,* 39 ff.
7. Davidson, E., *Secret Weapon,* 71 ff. It must be noted that Davidson introduces a new reference related to «Greek Fire» from a Scandinavian source, Yngvars' Saga Vidfötla, (ed. E. Olsen, Copenhagen 1912). Haldon, Cf.J. - Byrne, M., *A Possible Solution,* 93, note 8.
8. Halson, J. - Byrne, M., *A Possible Solution,* 92.
9. Haldon, J. - Byrne, M., *A Possible Solution,* 93-94.
10. Marchus Graecus, *Liber ignium ad comburentos hostes,* ed. F. Foefer, *Histoire de la chimie,* vol. 1, Paris 1842, pp. 491-497.
11. Haldon, J. - Byrne, M. *A Possible Solution,* 96.

12.See Korres, Th., *Hygron Pyr, Appendix of primary sources,* 131 ff.

13.*Naumachica,* ed. A. Dain, 1.59 «οἷον καὶ τὸ ἐσκευασμένον πῦρ μετὰ βροντῆς καὶ καπνοῦ προπύρου *μετὰ τῶν σιφώνων* πεμπόμενον». De Administrando Imperio, ed. G. Moravcsik - R. Jenkins, 13.73 ff. «Ὡσαύτως χρή σε καὶ περὶ τοῦ ὑγροῦ πυρός, *τοῦ διὰ τῶν σιφώνων ἐκφερομένου* μεριμνᾶν τε καὶ μελετᾶν ...».

14.*Naumachica,* 1.6 «Ἐχέτω δὲ πάντως τὸν σίφωνα κατὰ τὴν πρῴραν ἔμπροσθεν χαλκῷ ἠμφιεσμένον, ὡς ἔθος, δι' οὗ τὸ ἐσκευασμένον πῦρ κατὰ τῶν ἐναντίων ἀκοντίσει». Anna Komnena, *Alexiade,* XI.X.2.

15.*Naumachica,* 1.59. See also Nicephoros Ouranos, *Taktika* (A.Dain, in *Naumachica*) 6.56: «οἷον καὶ τὸ σκευαστὸν πῦρ, ἤγουν τὸ λαμπρὸν μετὰ βροντῆς καὶ καπνοῦ τῶν προπύρων πεμπόμενον διὰ τῶν σιφώνων καὶ κατακαίοντα».

16.*Naumachica,* 1.64: «Ἡμεῖς δὲ κελεύομεν καὶ πυρὸς ἐσκευασμένου πλήρεις ἀκοντίζεσθαι καὶ χύτρας κατὰ τὴν ὑποδειχθεῖσαν μέθοδον τῆς αὐτῶν σκευασίας ὧν συντριβομένων ἐμπρήσεσθαι ῥαδίως τὰ πλοῖα τῶν πολεμίων».

17.*Naumachica,* 1.65: «Χρήσασθαι δὲ καὶ τῇ ἄλλῃ μεθόδῳ τῶν διὰ χειρὸς βαλλομένων μικρῶν σιφώνων ὄπισθεν τῶν σιδηρῶν σκουταρίων παρὰ τῶν στρατιωτῶν κρατουμένων, ἅπερ χειροσίφωνα λέγεται, παρὰ τῆς ἡμῶν βασιλείας ἄρτι κατεσκευασμένα· ῥίψουσι γὰρ καὶ αὐτὰ τοῦ ἐσκευασμένου πυρὸς κατὰ τῶν προσώπων τῶν πολεμίων».

18.Komnena, A., *Alexiade,* (B. Leib) XI.X.4: «οὐδὲ γὰρ ἐθάδες ἦσαν τοιούτων σκευῶν ἡ πυρὸς ἄνω μὲν φύσει τὴν φορὰν ἔχοντος, πεμπομένου δ' ἐφ' ἃ βούλεται ὁ πέμπων κατά τε τὸ πρανὲς πολλάκις καὶ ἐφ' ἑκάτερα».

19.Αλεξανδρής, Κ., *Η θαλασσία δύναμις εις την ιστορίαν της βυζαντινής αυτοκρατορίας,* Αθήναι 1956, p. 154.

20.Oman, C.W.C., *The Art of War in the Middle Ages A.D. 378-1515,* London 1898, reprint Ithaca N.Y. 1968, p. 55.

21 The achievements of Hellenistic technology in inventing and constructing artillery engines are described in the excellent work of E.W. Marsden, *Greek and Roman Artillery:* vol. I., *Historical Development,* vol. II., *Technical Treatises,* Oxford 1969-1971. On the use of catapults in the Hellenistic period, see ibid. vol. I. 73-77, and for the Roman period vol. I. 83-85. Finlay, Cf.G., *History of Greece,* 7 vols., Oxford 1877, vol. II. 18, who writes the following regarding the Byzantine capabilities in building war engines: «The Byzantine army was superior to every other in defending fortresses. The Roman arsenals, in their best days, could probably have supplied no scientific or mechanical contrivances unknown to the corps of engineers of Leo's army, for we must recollect that the education, discipline and practice of these engineers had been perpetuated in uninterrupted succession from the time of Trajan and Constantine».

22.Similar thoughts seem to have puzzled M. Berthelot, *Sur la force des matières explosives,* Paris 1894, vol. II., p. 355, who, although he had expressed the opinion that the propelling force for «Greek Fire» was generated by an explosion, writes the following: «One wonders to what extent the propelling force of the gases was added to that generated by the twisted cords that provided, after all, the basic pushing force?». Zenghelis, Cf.C., *Le feu grégeois,* 278. The possibility of ejecting «Greek Fire» by means of catapults is also accepted by Κ. Αλεξανδρής, *Θαλασσία δύναμις,* 153, who, however, considers it a secondary way.

23.See Marsden, E.W., *Greek and Roman Artillery*: vol. I., *Historical Development,* vol. II., *Technical Treatises,* Oxford 1967-1971, I.188, who observes that «the ballista could be adapted for shooting bolts if exceptionally high performance was required».

24.Marsden, E.W., *Artillery,* I, 58, notes the following: «Indeed, though definite information simply does not exist, a good deal of circumstantial evidence suggests that the principle of torsion was first discovered in Macedon under the auspices of Philip II». Similarly P. Connolly, *Greece and Rome at War,* London 1981, p. 280, observes:


τὸν τῶν ἱναντίφιλον.

«Torsion stonethrowers make their appearance during Alexander's siege of Halicarnassus in 334».

25. According to E.W. Marsden, *Artillery*, I, 188, «Ballista was the equivalent of a «καταπέλτης λιθοβόλος or πετροβόλος», being a palintone, two-armed stone thrower».

26. See *Biton's construction of war machines and artillery*, (ed. E.W. Marsden II. 61-103) p. 76, where Biton assures, writing probably in the third quarter of the third century B.C., that the construction of bigger or smaller types of ballistae was not a problem, provided that the proportions were kept «τὴν ἀναλογίαν φυλάττειν τὰ δὲ σχήματα προγέγραπται». See also Liutprandus, *Antapodosis*, ed. P.L. 136, col. 883c, where it is mentioned that the Byzantines «Sed et argumentum, quo Ignis projicitur, non in prora solum, verum etiam in puppi, insuper in utrisque lateribus ponite», which indicates that those engines that were put on the sides were probably smaller.

27. Nicephorus Ouranos, *Taktika*, 6.7.

28. *De Cer.*, ed. I. Reiske, 658.12-14, mentions: «περὶ τοῦ ἑτοιμασθῆναι λινάριον λόγῳ τῶν προπύρων». Haldon Cf.J. - Byrne, M., *A Possible Solution* 93 note 8. Αλεξανδρής, Κ., *Θαλασσία δύναμις*, 153.

29. On naphtha / «Greek Fire», one may consult the article of V. Christides in the *Encyclopaedia of Islam*, 2 VII, 1993, cols. 884-886, where the author summarizes the results of recent research.

30. *Naumachica*, 1.59: «μετὰ βροντῆς καὶ καπνοῦ προπύρου».

31. According to the *Strategikon* des Mavrikios, ed. G.T. Dennis, XII.5.4 ff.: «σωληνάρια ξύλινα μετὰ μικρῶν σαγιττῶν καὶ κουκούρων μικρῶν, ἅπερ καὶ ἐπὶ πολὺ διάστημα ῥίπτονται διὰ τῶν τοξαρίων καὶ τοῖς ἐχθροῖς ἀχρεῖά εἰσιν». Similarly, *Naumachica*, I.60, also note: «Καὶ τοξοβαλίστραι δὲ ἐν ταῖς πρύμναις καὶ ταῖς πρῴραις καὶ κατὰ τῶν δύο πλευρῶν τοῦ δρόμωνος ἐκπέμπουσαι σαγίτας μικρὰς τὰς λεγόμενας μυίας». See Dennis, G.T., «Flies, Mice and the Byzantine Crossbow», *Byzantine and Modern Greek Studies*, 7, 1981, 1-5. Nishimura, D., «Crossbows, Arrow-Guides and Solenarion», *Byzantion*, 38, 1988, 422 ff. See also Kolias, T.G., *Byzantinische Waffen*, Wien 1988, pp. 242-243. Idem, «Η πολεμική τεχνολογία των Βυζαντινών», *Δωδώνη* 181, 1989, 32-33. Finally, it is worth noting that in an Arabic translation of the *Naumachica*, the term «siphon» is denoted as a «tube». Christides, V., «New Light on the Naval Warfare in the Eastern Mediterranean, the Red Sea and the Indian Ocean (6th-14th cent. A.D.)», *Nubica* III.1, 1994, 4 ff.

32. The results of the tests run on the model of the ballista showed that the accuracy that was demonstrated can be basically attributed to the addition of the protective tube on the case (σῦριγξ) of the ballista. As was observed, the placement of the tube on the case of the ballista not only made the aiming easier but also eliminated any deviation from the aiming line. That is because the diameter of the tube was slightly bigger, just enough to let the projectile through, and thus any side oscillations (waverings) generated during the launching were corrected by the walls of the tube, and the projectile was aligned to the intended projection line. Finally, according to our calculations, such a ballista, of a size that would allow it to be placed on the prow of a Byzantine dromon, which according to the estimations of R.H. Dolley, «The Warships of the Later Roman Empire», *Journal of Roman Studies*, 38, 1948, 48, had a length of 45 metres, could launch a missile of 20 kl. to a distance of about 180 metres. See Korres, Th., *Hygron Pyr*, 121 ff.

33. *De Adm.*, 13.73. Theophanis, ed. C. De Boor, 499.10-15: «Εὑρόντες γὰρ αὐτὴν (Μεσημβρία) οἱ ἐχθροὶ πεπλησμένην πάντων τῶν ὀφειλόντων πρὸς κατοίκησιν ἀνθρώπων παρεῖναι πραγμάτων, ... ἐν οἷς καὶ σίφωνας χαλκοῦς εὗρον λς', καὶ τοῦ δι' αὐτῶν ἐκπεμπομένου ὑγροῦ πυρὸς οὐκ ὀλίγον».

34. *Naumachica*, 1.59. The coincidence of the name «σίφων» tube as well as «σίφων»= projectile, that is the coincidence of the projecting engine and the projectile, is not at all new. As early as the first century B.C., Diodorus Siculus, *Bibliotheca*

Historica (ed. Loeb), 50.4, writes the following describing the fighting between the forces of Dionysus I of Syracuse and the Carthaginians: «ἀπὸ δὲ τῆς γῆς τοῖς ὀξυβελέσι καταπέλταις οἱ Συρακόσιοι χρώμενοι συχνοὺς τῶν πολεμίων ἀνῄρουν· καὶ γὰρ κατάπληξιν εἶχε μεγάλην τοῦτο τὸ βέλος διὰ τὸ πρώτως εὑρεθῆναι κατ' ἐκεῖνον τὸν καιρόν». See Marsden, E.W., *Artillery*, 54-55.

ΠΕΡΙΛΗΨΗ

ΠΡΟΒΛΗΜΑΤΑ "ΕΛΛΗΝΙΚΗΣ ΦΩΤΙΑΣ" ΣΧΕΤΙΚΑ ΜΕ ΤΗ ΣΤΡΑΤΗΓΙΚΗ ΑΝΑΠΤΥΞΗ ΤΟΥ "ΜΥΣΤΙΚΟΥ" ΟΠΛΟΥ ΤΟΥ ΒΥΖΑΝΤΙΝΟΥ ΝΑΥΤΙΚΟΥ

Θ. ΚΟΡΡΕΣ

Μεταξύ των πολλών και εξεζητημένα πολύπλοκων όπλων που χρησιμοποιήθηκαν απο τους Βυζαντινούς εναντίον των εχθρών τους, η "Ελληνική Φωτιά" είναι σίγουρα το πιο διάσημο και συναρπαστικό. Πάντως, παρά τη φήμη του, το ναυτικό αυτό όπλο εξακολουθεί ν' αποτελεί πρόκληση για ιστορικούς και χημικούς. Αυτό μπορεί κατά βάσιν ν'αποδοθεί στη σύγχυση που επικρατεί περί των πρώτων υλών του.

Έτσι, παρά τις ποικίλες θεωρίες που έχουν προταθεί, πολλά σημαντικά ερωτήματα δεν έχουν απαντηθεί ικανοποιητικά. Τέτοια είναι τα ακόλουθα:

α) Η "Ελληνική Φωτιά" εμφανίστηκε όντως στο τρίτο τέταρτο του έβδομου αιώνα;

β) Τα μυστικά της ήταν επίσης γνωστά και στους εχθρούς του Βυζαντίου;

γ) Με ποιόν τρόπο οι Βυζαντινοί χρησιμοποιούσαν το όπλο αυτό στη θάλασσα;

δ) Γιατί δε χρησιμοποιούνταν στη στεριά;

ε) Ποιό ήταν το μυστικό της σύνθεσής του;

στ) Τέλος, πώς οι Βυζαντινοί το εκτόξευαν στα εχθρικά πλοία;

Η ανακοίνωσή μου εστιάζεται στο πρόβλημα της εκτόξευσης της "Ελληνικής Φωτιάς": μετά την εξέταση σε βάθος όλης της προηγούμενης έρευνας πάνω στο πρόβλημα αυτό, καταλήγει στο συμπέρασμα ότι οι Βυζαντινοί εκτόξευαν τη "Φωτιά" τους απο κλειστά πήλινα δοχεία χρησιμοποιώντας βαλλίστρα, όμοια με αυτές που χρησιμοποιούνταν στην ελληνιστική περίοδο, εξοπλισμένη με ένα σίφωνα. Η εξαντλητική ανάλυση των πηγών που σχετίζονται με το παραπάνω πρόβλημα και η παρουσίαση της επιχειρηματολογίας μου που ακολουθεί, φιλοδοξεί να στηρίξει επαρκώς την πρότασή μου. Η τελευταία θα αποτελέσει ίσως ένα ακόμα βήμα προς την επίλυση του προβλήματος της "Ελληνικής Φωτιάς".