

ATHENAIOS MECHANICUS

by

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ABSTRACT

The work of Athenaios Mechanicus is a little known treatise on siege machinery entitled *Περὶ Μηχανημάτων*. Although this work, along with others on the same topic, is contained in several manuscripts, during the last 250 years very little study has been devoted to it. There have been three editions (Thévenot, 1693; Wescher, 1867; and Schneider, 1912) and two translations, one in French (De Rochas, 1884) and one in German (Schneider, 1912). Schneider has also written a commentary.

Biographical information is very slight and scholars who have tried to date the work have arrived at widely varying conclusions (third century B.C. to third century after Christ).

In this thesis my objects have been:

- a) to provide an English translation of the work based on Wescher's text,
- b) to provide a brief résumé of the opinions advanced concerning the biography of Athenaios and his relationship to Vitruvius,
- c) to write a brief commentary on selected topics arising from the text.

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LIST OF ABBREVIATIONS

<u>AGW</u>	<u>Abhandlung der Gesellschaft der Wissenschaft zu Göttingen, Philos.-Hist. Klasse.</u>
<u>Berl. Sitz.</u>	<u>Sitzungsberichte der Preussischen Akademie der Wissenschaften.</u>
<u>CAH</u>	<u>The Cambridge Ancient History.</u>
<u>CQ</u>	<u>The Classical Quarterly.</u>
<u>DA</u>	<u>Dictionnaire des Antiquités Grecques et Romaines,</u> ed. by C. Daremberg and E. Saglio.
<u>FGH</u>	<u>Die Fragmente der Griechischen Historiker,</u> ed. by F. Jacoby.
<u>JS</u>	<u>Journal des Savants.</u>
<u>Klio</u>	<u>Klio, Beiträge zur alten Geschichte.</u>
<u>LSJ</u>	<u>Liddell-Scott-Jones-McKenzie, A Greek-English</u> <u>Lexicon.</u> Ninth edition, 1940.
<u>LSKPh</u>	<u>Leipziger Studien zur klassischen Philologie.</u>
<u>OCD</u>	<u>The Oxford Classical Dictionary.</u>
<u>RE</u>	<u>Paulys Real-Encyclopadie der classischen</u> <u>Altertumswissenschaft,</u> ed. by G. Wissowa <u>et al.</u>
<u>RhM</u>	<u>Rheinisches Museum für Philologie.</u>
<u>RPh</u>	<u>Revue de Philologie.</u>
<u>Vorsokr.</u>	<u>Die Fragmente der Vorsokratiker,</u> ed. by H. Diels and W. Kranz.

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CHAPTER ONE

INTRODUCTION

Siegecraft came relatively late to Greece. Even as late as the fifth century B.C., although battering-rams and other simple siege-devices were in use, the defenders of cities were usually able to take effective, if primitive, countermeasures and the sieges degenerated to mere blockades, the cities finally falling to treachery from within or starvation. Thucydides' description of the siege of Plataea (2.71-78 and 3.20-24) illustrates most clearly the state of siege-warfare at that time. For this small city, in spite of rams, siege-mounds, ladders, undermining, and moveable towers, was able to withstand the siege for two years and in the end succumbed to hunger rather than to force of arms.

Around 400 B.C. when the Greeks and Carthaginians clashed in Sicily some significant advances began to be made. The invention of the catapult was probably the most significant. At first this was employed in a purely random fashion, but the advantages of its very long range were soon realized. With them it was possible to clear the walls of defenders and in the interval before the enemy could recover to move sappers, towers, battering-rams, and other such devices right up to the walls in relative safety. There was then a good chance of demolishing the walls. The catapult was later modified for throwing large stones so that it became effective in knocking down the walls from a great distance.

Diodoros' description of Philip's siege of Perinthos¹ shows siege-warfare in a well developed state. For Philip made use of towers 80 cubits tall, battering-rams, sapping operations and various types of catapults -- a factor that he may well have exploited in his dealings with the Greek cities. The campaigns of Alexander (e.g. Tyre -- Arrian, Anab. 2.16-24) and of Demetrios Poliorketes (e.g. Rhodes -- Diod. 20.81-82 and 91-100) included some of the greatest feats of siegecraft in antiquity.

Defensive measures, however, soon caught up with the advances of technique and a balance of power was restored. Once again cities could successfully withstand a siege and had more to fear from treachery. The Romans, for their part, seem to have made little original contribution to siegecraft, which does not change significantly until the introduction of gunpowder in the late Middle Ages.

It is not surprising to find a considerable corpus of technical literature produced to record the significant advances in siegecraft during the fourth and succeeding centuries B.C. The earliest extant Greek work dealing with siegecraft is that of Aeneas Tacticus written ca. 360 B.C.² and concerned with defence rather than offence. An excellent impression of the popularity of Poliorcetics amongst Hellenistic

1. Diod. Sic. 16.74.

2. W.A. Oldfather, p.5 of introduction to Loeb of Aeneas Tacticus.

scientists may be derived from Vitruvius' list of those who have written on the subject before him (7.praef.14):

Non minus de machinationibus, uti Diades, Archytas, Archimedes, Ctesibios, Nymphodorus, Philo Byzantius, Diphilos, Democles, Charias, Polyidos, Pyrrhos, Agesistratos.

Of this list only the names of Philon, Archimedes, and Ctesibios are of any significance today. Our knowledge of the others is dependent upon scanty fragments of their writings or stray references in later authors. Biton (3rd/2nd century B.C.), Heron (2nd/1st century B.C.), and an anonymous writer usually referred to as Anonymous of Byzantium, should also be included in any list of Hellenistic poliorketik writers.

Archimedes' fame as a physicist and mathematician is well known. Although none of his own writings on siegecraft survive, his skill in inventing siege machines is well attested. It was owing to his machines that Syracuse was able to hold out so long when she was attacked by Marcellus (214-212 B.C.), who himself made great use of sophisticated siege machines. In the end, Syracuse fell to blockade and treachery and Archimedes was killed in the sack that followed.

A considerable portion (Bks. 4 and 5) of Philon of Byzantium's treatise Mechanicae Syntaxis survives. Philon lived in the early second century B.C. and was apparently used as a source by Heron.

None of Ctesibios' writings survive but his fame rests secure. His date is uncertain and even in antiquity there seems to have been some confusion concerning him. He is best

known for hydraulics and pneumatics, but Athenaios describes a siege machine that was invented by him.

The Roman contribution to Poliorcetics is modest and appears to consist rather of editing and translating the earlier works of the Greeks -- a fact tacitly acknowledged by Vitruvius when he concedes (7.praef.14)

in ea re ab Graecis volumina plura edita, ab
nostris oppido quam pauca.

Certainly the work of Vegetius (fl. ca. 420 A.D.) on the subject, the only other significant account in Latin, cannot be regarded as anything more than a résumé of earlier inventions and theories.

Athenaios Mechanicus must belong to the great corpus of Hellenistic poliorcetics. His date is completely uncertain and nothing is known about his life, although his work has survived together with other treatises on similar topics.

CHAPTER TWO

THE DATING

The dating of Athenaios is a very complex problem inextricably involved with the identity of a certain Marcellus² 1 to whom the work is dedicated. As yet no completely satisfactory solution has been found, nor do I pretend to have discovered one. The best I can do is to outline the arguments advanced by others and give my reasons for agreeing or disagreeing with them. The dates given by those scholars range from the third century B.C. to the third century after Christ.

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1. For Claudii Marcelli see Münzer, RE 3.2, 2731-2764. "Claudii Marcelli (214ff.)" esp. "C. Claudius Marcellus (216)" "C. Claudius Marcellus (217)" and "M. Claudius Marcellus (229)."

M. Claudius Marcellus cos. 331.

M. Claudius Marcellus cos. 287.

M. Claudius Marcellus

M. Claudius Marcellus cos. 222, 215, 214, 210, 208.

M. Claudius Marcellus cos. 196; cens. 189.

M. Claudius Marcellus cos. 166, 155, 152.

M. Claudius Marcellus

M. Claudius Marcellus	C. Claudius Marcellus = Iunia
aed. cur. 91	pr. 80

M. Claudius Marcellus	C. Claudius Marcellus	C. Claudius Marcellus
cos. 51	cos. 49	cos. 50

M. Claudius Marcellus	Claudia Marcella	Claudia Marcella
aed. cur. 23		

See also T.R.S Broughton, The Magistrates of the Roman Republic (New York, 1952) pp. 240, 247, and 256.

One might think that the work could be dated on linguistic and stylistic grounds, but there seems to be no agreement here. H. Diels, on the one hand, says,

Denn der Stil des Buches scheint mir vollkommen den Rokokocharakter des 2. Jahrh. n. Chr. an sich zu tragen, womit die handschriftlich erhaltenen Ionismen trefflich stimmen.²

August Brinkmann, on the other hand, assures us on linguistic and stylistic grounds that the work of Athenaios must date to the first or second century B.C., before the triumph of Atticism. ³ The linguistic evidence, then, seems open to various interpretations and can therefore lead to no definite conclusions.

It is tempting to take the Marcellus addressed in the preface as the famous M. Claudius Marcellus the besieger of Syracuse (212 B.C.). This has been the prevalent view in the past (see e.g. Christ in Müllers Handbuch and Sackur, Vitruvius, 1925, pp. 95-96). One of the reasons for this is obvious. M. Claudius Marcellus carried out what was undoubtedly the most famous siege of antiquity, in which both the Romans and Syracusans made extensive use of siege machinery.

Sackur argues from a political point of view based on (39.6-7).

Μάλιστα δὲ ἡμῶν πεπραγμάτεται κατὰ τῶν οὐχ ὑποταγησομένων τοῖς καλοῖς τῆς ἡγεμονίας νόμοις.

2. H. Diels, "Über das physikalische System des Straton" in Sitzungsberichte der Preussischen Akademie der Wissenschaft (Berlin, 1893) vol. 1 p. 111 note 1.

3. See Cichorius, "Das Werk des Athenaeus über Kriegsmaschinen," Römische Studien (1922, reprinted 1961) p. 277.

This, he says, cannot reflect a period in which the Roman hegemony was well established, but must reflect a time when Rome was first becoming active in the east.

Dating the work to this period is entirely dependent on circumstantial evidence and should therefore be accepted only with reservation.

De Rochas⁴ discounts the possibility that the work was dedicated to M. Claudius Marcellus, the conqueror of Syracuse, and posits as the earliest possible date the beginning of the second century B.C. He does this, firstly, because he takes the Apollonios mentioned to be Apollonios of Perga (fl. 220 B.C.). Apollonios' pupil Agesistratos, who is also mentioned, he argues should then be placed at the beginning of the second century B.C. Secondly, he dates Ktesibios, whom Athenaios mentions, to the second century B.C. While there is some evidence for this, there is conflicting evidence which dates Ktesibios much earlier. This controversy seems unresolvable and therefore Ktesibios cannot be dated with any degree of certainty. Having placed the work, at the earliest, in the second century B.C. De Rochas proceeds to say,

il est donc assez vraisemblable de supposer qu'il s'agit ici de M. Claudius Marcellus, un des lieutenants de Pompée qui commandait avec C. Copronius (sic) l'escadre de Rhodes, qui fut consul en l'an 51 av. J.-C. et pour lequel Cicéron composa son plaidoyer Pro Marcello.⁵

4. De Rochas, "Traduction du Traité des Machines d' Athénée," in *Mélanges Graux* (Paris, 1884) p. 182.

5. *ibid.* While it is of little importance to the argument it should be noted that De Rochas is somewhat confused here, for the M. Claudius Marcellus who was consul in 51 B.C. was not the commander of the squadron at Rhodes but rather

By fixing the identity of Marcellus in this manner De Rochas is then able to place Athenaios in the middle of the first century B.C. As we have seen he advances arguments (shaky though they may be) why the Marcellus addressed is not the besieger of Syracuse, but he has either been unable, or has not seen fit to advance any reason why the dedication should refer to M. Claudius Marcellus the consul for 51 B.C. His argument apparently represents the merest speculation.

Conrad Cichorius⁷ also dates Athenaios to the first century B.C. but his reasoning focuses on the person of Apollonios mentioned by Athenaios (8.9)

'Απολλώνιος δὲ ὁ γεγονὼς αὐτοῦ (Agesistratos),
διδάσκαλος τηλικαῦτα ἤγαγε φορτία λίθων ἐπὶ τὸ
χῶμα τὸ περὶ τὸν λιμένα τὸν ἐν Ῥόδῳ, ὥστε καὶ
ἀπορῆσαι πολλάκις τοὺς ὀρῶντας αὐτὰ πῶς ποτε εἰς
τὰς ναῦς ἀνελάμβανε καὶ τίνι τρόπῳ ἐξείλετο αὐτὰ
ἐν τῇ γῇ τῇ Ῥόδῳ.

From this Cichorius infers that Apollonios was distinguished as a military engineer famous for sieges, partly on the grounds that his pupil Agesistratos was a famous siege engineer and partly by virtue of his accomplishments at Rhodes. He argues that a military engineer would have no other purpose in transporting cargoes of stone to Rhodes than for reasons of defence. There are two famous sieges of Rhodes recorded in antiquity, one by Demetrios Poliorketes in 304 B.C. and the other by Mithridates in 88/7B.C. In the

his brother C. Claudius Marcellus who was consul in 49 B.C. (cf. note 1).

7. C. Cichorius, op. cit. pp. 271-279.

case of the latter, it is possible to conclude from Appian's account that loads of stone might have been used when *τά τε τείχη σφῶν* (the Rhodians) *καὶ τοὺς λιμένας ἐκρατύναντο*.⁸ In the belief, then, that these were the activities directed by Apollonios, Cichorius advances 88/7 B.C. as the terminus post quem for his pupil Agesistratos and hence for Athenaios since he mentions Agesistratos. This argument, so plausible at first glance and certainly neither more nor less defective than the other theories, contains several flaws.

Firstly, there is no evidence that Apollonios was famous for siege-works or indeed for anything else. For unless this Apollonios is, as De Rochas thinks, Apollonios of Perga this would seem to be the only reference to him. If indeed he is to be identified with Apollonios of Perga then his fame is unquestionable, but it is a fame based on his mathematical works and not on siege-works.

Secondly, Cichorius has assumed that towns are only fortified when sieges take place, but a town may well be fortified as the result of a threat that never materialized. There is little justification, then, for relating Apollonios' activities in Rhodes to the specific siege of 88/7 B.C.

And finally, the act of conveying stones to Rhodes gives no hint of the purpose for which it was done. They could just as well have been used for some civil project as for building defences.

8. Appian, Historia Romana; Bell. Mithr. 24.

With Athenaios firmly established in the second half of the first century B.C.⁹ Cichorius next turns to the problem of trying to identify Marcellus. He decides that he was probably M. Claudius Marcellus, the nephew and heir apparent of Augustus.

This young man was a prominent member of the "royal" household and was much celebrated, notably posthumously by Virgil (Aen. 6.860). In 25 B.C., together with Augustus, he took part in the Spanish campaigns (i.e. the Cantabrian war). Granted a date in the late first century B.C., then it is reasonable that Athenaios should dedicate his work to this Marcellus. For here is a prominent young man about to take part in his first campaign, a young man with no experience of war to whom advice such as Athenaios gives could well prove useful. Added to this is the fact that the Spanish campaigns were likely to, and in fact did, involve sieges, since the rebelling tribes were in possession of well-fortified strongholds as various accounts indicate.

καὶ ἐπειδὴ μήτε προσεχώρουν οἱ ἄτε ἐπὶ τοῖς
ἐρθιμοῖς ἐπαιρόμενοι,!

Tertio Aracelium oppidum magna vi repugnat;
captum tamen.¹¹

9. He thinks that there is a possibility that Athenaios may have been active in Rome at this time * mentioned by Strabo 14.670. There is, however, no evidence to suggest that Strabo's Athenaios was an engineer or in any way connected with sieges, so it seems best not to make the identification.

10. Dio 53.25.5-6.

11. Florus 2.33.50.

Reliquias fusi exercitus validissima civitas
 Lancea excipit, ubi cum locis adeo certatum est,
 ut, cum in captam urbem faces poscerentur, aegre
 dux impetraverit veniam, ut victoriae Romanae
 stans potius esset quam incensa monumentum.¹²

But, as we have shown, the basic premise on which this theory rests, the date of the Apollonios mentioned by Athenaios, is highly suspect and few grounds for confidence in this attribution remain. For, eminent though this particular Marcellus certainly was, the family was a distinguished one and other members of the house may well have qualified for the honour of having a book dedicated to them.

A third possibility may be mentioned. This is the Athenaios mentioned by Trebellius Pollio (*Scriptores Historiae Augustae*, Vitae Gallienorum 13.6), who, on the surface at least, appears to be a good candidate as he was without doubt a military engineer.

Inter haec Scythae per Euxinum navigantes Histrum
 ingressi multa gravia in solo Romano fecerunt,
 quibus compertis Gallienus Cleodamum et Athenaeum
 Byzantios instaurandis urbibus muniendisque prae-
 fecit, pugnatumque est circa Pontum, et a Byzantiis
 ducibus victi sunt barbari.

Gallienus was emperor from 253-268 A.D. The repair and fortification of the cities mentioned apparently took place in 267 when Gallienus learned of the invasion of the Eruli. There seem to have been few if any Marcelli, who, at that time were prominent enough to have been dedicatees of a book. The only person who seems remotely possible is the emperor

12. Florus, 2.33.57.

Marcus Aurelius Severus Alexander (222-235 A.D.), who was apparently at one time called Marcellus:

Hic Marcellum, qui post Alexander dictus est consobrinum suum Caesarem fecit.¹³

If he were the Marcellus to whom the work is dedicated, it would have been written in 235 A.D. at the latest (18 years before Gallienus) and probably before he became Caesar in 221 A.D. (32 years before Gallienus). This would mean that Athenaios would have had to be quite young at the time he wrote this work and would have been fairly old at the time he was sent out by Gallienus. This identification is not impossible; it must be admitted, though, that it does not seem very likely.

As I inferred at the beginning the problem of the date of Athenaios seems insoluble.

Closely related to the question of Athenaios' date is that of the relationship of his treatise to the tenth book of Vitruvius' De Architectura.

If the work of Athenaios is compared with Vitruvius (10.13-16) an amazing similarity is at once apparent. In fact the works are so similar that some have thought that they were copies of one another and this has prompted many editors to emend the text of Vitruvius to correspond with Athenaios and vice-versa. If one examines the works fairly carefully, however, a number of differences will be found.

13. Anon., Epit. de Caesar. 23.4 in S.A. Victor (Teubner) p. 157.

These differences are, in my opinion, significant enough to indicate that the works are not mere copies of one another.

In the first place, there is nothing in Vitruvius to compare with Athenaios' introduction (3.1 - 9.3). Secondly, there are the units of measurement adopted, apart from those sections derived from Diades 11.4-15.9 (cubits). Thereafter Vitruvius uses feet while Athenaios uses cubits and palms (ποδιαίος appears only three times in Athenaios). With regard to Diades' moveable towers, Athenaios gives a fairly complex formula for determining the arrangement of floors (11.4 - 12.11), while Vitruvius merely gives the total height and the total number of floors (10.13.4-5). In Vitruvius the small tower erected on the top of the "ram-bearing tortoise" has catapults set up on its top story and stores of water located in the others (10.13.6). In Athenaios, however, the catapults are situated in the top stories and only the bottom one contains water (13.7-9). According to Vitruvius the defensive planking for the "tortoise for filling in ditches" is best made of holm-oak, but other strong woods with the exception of pine and alder may also be used (10.14.3). Athenaios says that palm wood is best and that in addition to pine and alder, cedar must also never be used (17.14-15). Athenaios (15.12 - 16.4) describes the uses of the "tortoise for filling in ditches" (according to Philon the Athenian), while Vitruvius merely describes the construction of this machine (10.15.1-3). Also, Vitruvius' description of the

arrangement of the wheels and axles of this machine (10.14.1) differs considerably from that of Athenaios (16.8-14). Athenaios then proceeds to describe a second model of the "tortoise for filling in ditches" and also a machine which he refers to as a "mining tortoise" (18.8 - 20.3). In Vitruvius the descriptions of these two machines are combined into the description of a single machine (10.15.1). There are also some differences in the accounts of the "tortoise of Hegetör" that I have discussed in the commentary. Vitruvius' paragraphs (10.16.1-3) do not appear in Athenaios although certain of the sentiments expressed there occur either in Athenaios' introduction or epilogue. After the description of the "helepolis" built by Epimachos all similarity between the works ceases.

If these works are not copies of one another, how can their similarities be explained? The easiest explanation is to say that they were both using a common source. M. Thiel has argued this point of view most convincingly in his article "Quae Ratio Intercedat inter Vitruvium et Athenaeum Mechanicum," LSKPh 17 (1896) pp. 275-328. If they used a common source it is impossible to know what it might have been. The name Agesistratos, mentioned by Schneider and others, seems a plausible conjecture since he is mentioned as a source by both Vitruvius (10.praef.14) and Athenaios (7.7).¹⁴

14. Schneider mentions Sontheimer who maintains that there is no close relation between the texts of Athenaios and Vitruvius and therefore one should not attempt to apply the descriptions of the one in solving the gaps or problems of the other. "Selbstverständlich darf Athenaios in solchen Fällen nicht zur Gestaltung des Vitruvtextes beigezogen werden." The differences are to be regarded as real differences in design, not variants of a common source.

CHAPTER THREE

THE TEXT

The text given here is an exact copy of Wescher's. Those places where I do not agree with his readings are fully discussed in the commentary but I have left his text unchanged. It should be noted that contrary to the normal usage [] indicates a conjectural addition rather than a deletion.

Principal Manuscripts

- M Codex Parisinus vetustissimus Suppl. Gr. 607.
- V Codex Vaticanus 1164.
- P Codex olim Medicaeus nunc Parisinus 2442.
- C Fragmentum in codice Coisliniano 101.
- F Fragmenta Vindobonensia in codice ms. philosoph.
graec. olim 113 (Lambec.) nunc 120 (Nessel).

Editions

- Thévenot, M., Mathematicorum Veterum (Paris, 1693).
- Wescher, C., Poliorcétique des Grecs (Paris, 1867).
- Schneider, R., Griechische Poliorketiker III (Göttingen, 1912).

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- 3 Ὅσον ἐφικτὸν μὲν ἀνθρώπῳ τοὺς ὑπὲρ μηχανικῆς ποιούμενῳ λόγους, ὃ σεμνότατε Μάρκελλε, ἐμνήσθην τοῦ Δελφικοῦ παραγέλλματος ὡς ἔστι θεῖόν τι τὸ ὑπομιμνήσκον ἡμᾶς χρόνου φεῖδεσθαι· ὡς ἔστι σχεδὸν εἰπεῖν ἅπαντα καταχρώμεθα ἀφειδῶς εἰς τὰς κατεπειγούσας τῷ βίῳ χρείας. Καὶ χρημάτων μὲν καὶ τῶν ἄλλων τῶν δοκῶντων ἡμῖν εἶναι πολυτελῶν μὴ τὴν τυχοῦσαν ἐπιστροφὴν καὶ φυλακὴν ποιησώμεθα, ἀλλὰ τοῖς τῶν ἀρχαίων προσέχωμεν συντάγμασι· καὶ αὐτοὶ τε μικρὸν ἐπιτείναντες ἑαυτοὺς οὐκ ἀσκόπως εὐρήσομεν, καὶ παρ' ἄλλων ῥαδίως ἂν μεταλάβωμεν. Τοῦ χρόνου δὲ μεταβλητοῦ γε ὄντος καὶ ῥευστοῦ ἀφειδοῦμεν,
- 4 ὡς εὐχερὲς τὸ τέλος· καὶ ταῦτα τῆς φύσεως νέμειν μὲν ἡμέρας δύναμιν τινα εἰωθυῖης εἰς τὸ κατεργάσασθαι τι τῶν ἐν τῷ βίῳ χρησίμων, ὕπνον δὲ νυκτὸς ἀλλὰ πάντως ἀναρριπνόν. Ὁ γὰρ μόνος κληθεὶς δικαίως ποιητῆς οὐδὲ τὸν δοθέντα παρὰ τῶν θεῶν εἰς τὴν ἀνάπαυσιν ἡμῖν τοῦ σώματος ὕπνον παννύχιον εὐδεῖν ἔῃ· ὅϋτω πολλὴν φαίνεται ποιούμενος πρόνοιαν τοῦ μὴ καταργεῖσθαι τὴν διάνοιαν ἐπὶ πολὺν χρόνον. Οἱ δὲ γράφοντές τι ἢ παραγέλλοντες ἡμῖν καὶ τῆς ὠφελείας εἵνεκα δοκοῦντες αὐτὸ πράττειν, οὐκ ἂν εἰκότως πολυγραφοῦντες, εἰς οὐκ ἀναγκαίους λόγους καταναλίσκουσι τὸν χρόνον, ὅπως ἐμφήνωσι τὴν ἑαυτῶν πολυμάθειαν· παρεμβάσεων γὰρ πληρώσαντες ἀπολείπουσι τὰ βιβλία· καὶ ταῦτα τῶν ἀρχαίων φιλοσόφων καλῶς εἰρηκότων τὰ τοῦ καιροῦ μέτρα δεῖν εἰδέναι ὡς ὑπάρχοντος ὅρου τῆς φιλοσοφίας. Τουτὶ

5 γὰρ ἂν τις εἰς πραγμάτων λόγον ὠφελῆθεις ἀπέλθοι, ἐπιμελῶς ἐπιστήσας ἑαυτὸν, ἐκ τοῦ Δελφικοῦ ἐκείνου παραγγέλματος ἢ ἐκ τῶν Στράτωνος καὶ Ἑστιάου καὶ Ἀρχύτου καὶ Ἀριστοτέλους καὶ τῶν τῶν παραπλήσια ἐκείνοις γεγραφότων. Νεωτέροις μὲν γὰρ φιλο- [ἄλλων] μαθοῦσιν οὐκ ἄχρηστα ἂν εἴη τοῦ στοιχειωθῆναι. τοῖς δὲ βουλομένοις ἤδη τι πράττειν μακρὰν παντελῶς ἂν εἴη καὶ ἀπηρτισμένα τῆς πραγματικῆς θεωρίας. Ὅθεν οὐ κακῶς δόξειεν ἂν πρὸς αὐτοὺς εἰρηκέναι Κάλανος ὁ Ἰνδός. Ἑλλήνων δὲ φιλοσόφοις οὐκ ἐξομοιούμεθα παρ' οἷς ὑπὲρ μικρῶν πραγμάτων πολλοὶ λόγοι ἀναλίσκονται. ἡμεῖς δὲ, φησὶν, ὑπὲρ τῶν μεγίστων ἐλάχιστα εἰώθαμεν παραγγέλλειν, ὅπως εὐμνημόνευτα πᾶσιν ᾗ. Κατανοήσῃ δ' ἂν τις τοῦτο ἀκριβέστατα ἐκ τῶν Δηϊμάχου Περσικῶν καὶ τῶν δι' αὐτοῦ ἀκολουθησάντων Ἀλεξάνδρῳ, καὶ ἔτι τῶν ὑπὸ Πύρρου τοῦ

6 Μακεδόνης γραφέντων πολιορκητικῶν ὀργάνων, ὅσῃν τὴν διαφορὰν παράλληλον ἐκεῖνος ἔχει. Ἀλλὰ γὰρ ἵνα μὴ καὶ αὐτοὶ πολυγράφοι φαινώμεθα, ἐπανάξομεν ἐπὶ τὸ προκείμενον, ὀλίγα προσπα-
ραστησάμενοι διὰ τοὺς εἰωθότας εὐθύνειν πικρῶς τὰς συνθέσεις τῶν λέξεων. Οὐ γὰρ ὑπολαμβάνω καθήκειν ἐξεργαζόμενον
αὐτὰς ὑστερῆσαι τῆς προθέσεως. καθάπερ συνέβη Ἰσοκράτει τῷ ῥήτορι ἐν τῷ συμβουλευτικῷ ἐπιστολίῳ τῷ πρὸς Φίλιππον αὐτῷ γραφέντι. ἐλύθη γὰρ πρότερον ὁ πόλεμος ἢ ἐκεῖνος ἐτέλεσε τὴν συμβουλίαν. Λέγει γ' οὖν αὐτὸς οὕτως. Ὅντος γὰρ ἐμοῦ περὶ τὴν πραγματείαν ταύτην ἔφθητε τὴν εἰρήνην ποιησάμενοι πρὶν ἢ με ἐξεργάσασθαι τὸν λόγον. Ἔτι δὲ καὶ καλῶς ἔχειν μοι δοκεῖ

5.6 Read ἀπηρτημένα for ἀπηρτισμένα. 5.12 Obelize δι' αὐτοῦ.

6.2 Read παρ' ἄλληλα ἐκεῖνα for παράλληλον ἐκεῖνος.

7 τοῖς ὀρθῶς παραινουῖσι πειθεσθαι περὶ τῶν τοιούτων. Ὁ μὲν γὰρ ἱστοριογράφος Καλλισθένης φησὶ δεῖν τὸν γράφειν τι πειρώμενον μὴ ἄστοχεῖν τοῦ προσώπου, ἀλλ' οἰκείως αὐτῷ τε καὶ τοῖς πράγμασι λόγους θεῖναι. Ὁ δέ γε περὶ τοιαύτης τέχνης γινόμενος πᾶς λόγος συντομίας τε καὶ σαφηνείας ἐπιδεισθαί μοι δοκεῖ, τῶν δὲ ῥητορικῶν παραγγελημάτων οὐκ οἰκείος εἶναι. Διὸ, ὅσα περ' ἀνεγνώκαμεν τοῦ μηχανικοῦ Ἀγησιστράτου, περὶ αὐτῶν διέξιμεν.

Ἀναγκαιότατον μὲν οὖν ἀποφαίνεται εἶναι ἐμπειρίαν γραμμῶν ἔχειν. οὕτω γὰρ τὰ πρὸς πολιορκίαν συστησάμενον ὀρθῶς ἀντιμηχανᾶσθαι, πάλιν καὶ πρὸς ταῦτα ἀκολουθῶς τὰ πρὸς πολιορκίαν μηχανήσεσθαι. Τοῦτο μέντοι οὐκ ἂν ῥαδίως ἐστὶ τὸν τυχόντα ποιῆσαι, ἀλλὰ μόνον τὸν καλῶς μαθόντα τὴν τέχνην καὶ διὰ πάντων ὄντα τῶν ἐπιβαλλόντων αὐτῇ μαθημάτων, τὰ τε ὑπὸ τῶν πρότερον ἀνδρῶν [γεγραμμένα] ἢ γεγονότα πρὸς τὴν τοιαύτην

8 χρεῖαν μὴ παρέργως κατανοήσαντα. Τοῖς γὰρ καλῶς εὐρεθεῖσι πολλάκις χρηστέον καὶ οὐκ ἐν παντὸς τρόπου καινοτομητέον, ἐὰν μὴ τινες βούλωνται τοὺς ἰδιώτας ἀπατᾶν, ἐλόμενοι τὸ δοκεῖν μᾶλλον τῆς ἀληθείας αὐτοῖς [ἐπεῖναι]. Τοῦτο δέ μοι καλῶς εἰρηκῶς φαίνεται. Ἐν γὰρ τοῖς Βελικοῖς τοσοῦτο τοὺς πρότερον ὑπερήγαγεν ὥστε καὶ τὸν ἐξαγγέλλοντα ὑπὲρ αὐτοῦ μὴ ῥαδίως πιστεῦεσθαι. Ὁ γὰρ τρισπίθαμος αὐτοῦ καταπάλτης ἔβαλλε τρία στάδια καὶ ἡμιστάδιον ἔχων τόνου μνᾶς δυνάδεκα. Ὁ δὲ τετράπηχος, παλίντονος ὢν, τέσσαρα στάδια. Ἀπολλώνιος δὲ ὁ γεγωνὴς αὐτοῦ διδάσκαλος τηλικαῦτα ἤγαγε φορτία λίθων ἐπὶ τὸ χῶμα τὸ περὶ τὸν λιμένα τὸν ἐν Ρόδῳ ὥστε καὶ ἀπορῆσαι πολλάκις τοὺς ὀρῶντας αὐτὰ πῶς ποτε εἰς τὰς ναῦς ἀνελάμβανε καὶ τίνι τρόπῳ ἐξείλετο αὐτὰ ἐν τῇ γῇ τῇ Ρόδῳ. Ὅς μετὰ ταῦτα ἠκολούθησεν αὐτῷ, εὕρισκεν τι χρήσιμον ἐν τοῖς πολιορκητικοῖς αὐτοῦ ὀρεγόμενος. Δηλοῖ δ' ἡ κριο-

8.4 Obelize αὐτοῖς ἐπεῖναι.

- 9 φόρος αὐτοῦ χελώνη καὶ τὸ πρὸς αὐτὴν ἀντιμηχάνημα. Διόπερ οὐκ ἀπιστητέον τῷ τοιοῦτῳ ἀνδρὶ κατεφαίνεται ἐν τοῖς ὑπὲρ τῆς τέχνης παραινουμένοις.

Κριδὸν μὲν ἔφασκεν εὐρέθῃναι πρῶτιστον ὑπὸ Καρχηδονίων ἐν τῇ περὶ Γάδειρα πολιορκίᾳ. Χωρίδιον γάρ τι προκαταλαβανομένων αὐτῶν καὶ καθαιρούντων εἰς ἔδαφος τὰ τεῖχη, νεανίσκους τινὰς οὐθὲν ἔχοντας ἄρμενον εἰς τὴν καθαίρεσιν δοκὸν λαβόντας διὰ χειρῶν ἐνσεΐειν εἰς τὸ τεῖχος καὶ ῥαδίως ἐπὶ πολὺν τόπον καθελεῖν. Ὅθεν συνιδὼν τὸ γενόμενον Τύριός τις ναυπηγὸς, ᾧ ὄνομα ἦν Πεφρασμένος, ἐν τῇ πολιορκίᾳ ἦν ἐποιοῦντο μετὰ ταῦτα πρὸς τὴν τῶν Γαδειριτῶν πόλιν, ἰστὸν στήσας καὶ ἄλλον ἀπ' αὐτοῦ πλάγιον ἀρτήσας, παραπλησίως ταῖς τῶν ζυγῶν φάλαγξιν ἔτυπτε τὸ τεῖχος ἔλκων ἐξ ἀντισπάστου τὸν πλάγιον. Ἀπόρως δὲ τῶν ἔνδον διακειμένων διὰ τὸ ξεῖνον τοῦ μηχανήματος, συνέβαινε αὐτὰ πίπτειν ταχέως. Γήρας δὲ μετ' αὐτὸν ὁ Καρχηδόνιος, ὑπότροχον ποιήσας

- 10 σχεδίαν, ἐπέθηκε πλάγιον τὸν κριδὸν καὶ οὐκ ἐξ ἀντισπᾶστων εἴλκεν, ἀλλ' ὑπὸ πλήθους ἀνδρῶν προωθούμενον ἐποίησέ τι ὑπότροχον σκέπασμα. Γήρας δὲ πρῶτος ὁ εὐρὼν διὰ τὴν βραδύτητα χελώνην προσηγόρευσεν. Μετὰ ταῦτα δὲ ἐποίησάν τινες ἐπὶ κυλίνδρων προωθούμενον τὸν κριδὸν καὶ οὕτως ἐχρῶντο. Ἐπίδοσιν δὲ ἔλαβεν ἡ τοιαύτη μηχανοποιία πᾶσα κατὰ τὴν Διονυσίου τοῦ Σικελιώτου τυραννίδα, κατὰ τε τὴν Φιλίππου τοῦ Ἀμύντου βασιλείαν ὅτε ἐπολιόρκει Βυζαντίους Φίλιππος. Εὐημέρει δὲ τῇ τοιαύτῃ τέχνῃ Πολύειδος ὁ Θετταλὸς, οὗ οἱ μαθηταὶ συνεστρατεύοντο Ἀλεξάνδρῳ Διάδῃ καὶ Χαρίᾳ. Διάδης μὲν οὖν αὐτὸς φησιν ἐν τῷ μηχανικῷ συγγράμματι εὐρηκέναι τοὺς τε φορητοὺς πύργους καὶ τὸ λεγόμενον τρύπανον καὶ τὸν κόρακα καὶ τὴν ἐπιβάθραν. Ἐχρᾶτο

- 11 δὲ καὶ τῷ ὑποτρόχῳ κριῶ. Γράφει γοῦν τὴν κατασκευὴν αὐτοῦ οὕτως.

Κριοῦ κατασκευή.

Τὸν μὲν οὖν πύργον τὸν ἐλάχιστον, φησὶ, δεῖ γενέσθαι τὸ ὕψος πηχῶν $\overline{\text{E}}$, τὸ δὲ πλάτος ἔχοντα πήχεις $\overline{\text{IZ}}$. συναγωγὴν δὲ τοῦ πλάτους εἰς τὸ ἄνω τὸ πέμπτον μέρος. τῶν δὲ σκελῶν τοῦ πύργου τὰ πάχη ἔχειν κάτωθεν τριπάλαιστα, ἄνωθεν δὲ ἑπταδάκτυλα. Ἐγένετο δὲ αὐτῷ ὁ τηλικούτος δεκάστεγος, περιπτέρου οὔσης ἐκάστης χώρας. Ὁ δὲ μέγιστος αὐτῶν πύργος τὸ μῆκος εἶχε πήχεις $\overline{\text{PK}}$, τὸ δὲ

- 12 πλάτος εἶχε πήχεις $\overline{\text{KC}}$. τὴν δὲ συναγωγὴν καὶ οὗτος τὸ πέμπτον ἐλάμβανεν εἰς τὰ ἄνω μέρος. τῶν δὲ σκελῶν τὰ πάχη ποδιαῖα καὶ κάτωθεν τετράγωνα εἰς ἕξ δακτύλους τὸ πᾶν συναγόμενα ἐπὶ τὰ ἄνω. Ὁ δὲ τηλικούτος αὐτῷ πύργος ἐγένετο εἰκοσάστεγος, περιδρόμους ἐχούσης ἐκάστης στέγης κύκλῳ πλάτος $\overline{\Gamma}$ πηχῶν ἔχοντας εἰς τὴν ἐκβοήθησιν τῶν ἐμπυρισμῶν. Ἡ δὲ πρώτη στέγη ἐχέτω τὸ ὕψος πήχεις $\overline{\text{ZC}}$. ἡ δὲ δευτέρα πέντε, καὶ ἕως πέντε στεγῶν τὸ αὐτὸ ὕψος λαμβανουσῶν. αἱ δ' ἐπίλοιποι τεσσάρων πηχῶν καὶ δύο παλαιστῶν τὸ ὕψος ἐγίνοντο. Ὁμοίως δὲ καὶ ἐπὶ τοῦ ἐλάττονος πύργου ἡ διαίρεσις τῶν στεγῶν τὸν αὐτὸν λόγον ἐλάμβανεν. Ἐβύρσουν δὲ αὐτὰς ἀργαῖς βύρσαις.

Τῆς δὲ χελώνης τῆς τὸν κριὸν φερούσης ἡ ἐργασία ἦν ἡ αὕτη,

12.11 Read αὐτούς for αὐτὰς.

- 13 μικρῆς τε καὶ μεγάλης. Ἡ δὲ μεγίστη ἐλάμβανε τὸ διάστημα τοῦ πλάτους πήχεις $\overline{\Lambda}$, τὸ δὲ μῆκος πήχεις $\overline{\text{M}}$, τὸ δὲ ὕψος χωρὶς τῆς ἀετώσεως τῆς ἐφισταμένης ὕστερον πήχεις $\overline{\text{I}\Gamma}$, τῆς δὲ ἀετώσεως αὐτῆς τὸ ὕψος ἀπὸ τοῦ καταστρώματος ἐπὶ ὀξύτατον πήχεις $\overline{\text{I}\Sigma}$. ὑπερέβαλλε δὲ τὴν μέσσην στέγην ὁ ἀετὸς τουλάχιστον πήχεις δύο, παρακαταβαίνων τὴν ἐπιστέγην ἕως τῶν ἐπ' αὐτῷ δοκῶν ὅπως ἡ περίδρομος ἔνκυκλος. Ἐξῆρε δ' ἐκ μέσης τῆς στέγης πυργίον τρίστεγον, καὶ εἰς μὲν τὰς ἄνω στέγας ἐτίθει καταπάλτας, εἰς δὲ τὴν κάτω ὕδατος παράθεσιν ἐποιεῖτο. Ἐγίνοντο δὲ αὐτῇ τῇ χελώνη ὀρθοστάται κύκλῳ περίδρομον ἐχούση. Ἰσταται δὲ καὶ κριοδόχην ἐν αὐτῇ,
- 14 ἐφ' ἣ τὸν κύλινδρον ἐτίθει. δι' οὗ προωθούμενος ὁ κριὸς δι' ἀντισπάστων ἐνήργει τὴν χρεῖαν. Ἐβύρσουν δὲ καὶ ταύτην ὁμοίως τοῖς πύργοις.

Τὸ δὲ τρύπανον χελώνην μὲν τὴν αὐτὴν τῷ κριῷ, λαμβάνει δὲ καὶ πᾶσαν τὴν κατασκευὴν ὁμοίως ἔχουσαν. Τίθησι δὲ ἐπὶ τῆς κρηπίδος σύριγγα παραπλησίαν τῇ ἐν τοῖς εὐθυτόνοις γινομένη καταπάλταις καὶ πλάγιον ὀνίσκον ὁμοίως ἐκείναις ἔχουσαν. Ἐκ δὲ τοῦ ἄλλου μέρους αὐτῆς ἀπὸ τοῦ ἄκρου τροχιλέας ἐμβάλλει δύο. δι' ὧν προωθεῖ τὴν ἐπιτιθεμένην ἐν αὐτῇ κεραίαν. Καὶ ἐπὶ τοῦ καταστρώματος δὲ τοῦ ἐν τῷ συριγγίῳ πυκνοὺς τίθησι κυλίνδρους, ἵνα εὐκίνητος ὑπάρχη. καὶ οὕτως βάλλει τὴν κεραίαν ἐν ἡ κριοκοπεῖ, ἐφελκόμενος αὐτὴν ἐκ τοῦ κάτω ὀνίσκου κειμένου. Βυρσοῦται

13.4 Read ἐπὶ τὸ ὀξύτατον. for ἐπὶ ὀξύτατον.

- 15 κύκλω σὺν ταῖς ἀφίσι τὴν σύριγγα, ἵνα σκεπάζεται εἰς αὐτὴν ἡ κεραία ἔσωθεν. Τοῦ γὰρ ἔργου καλῶς διατυπούμενου, τοῦ ἀρχιτέκτονος τοῦθ' εὐρίσκηται εὐδοξία· κατὰ δὲ λόγον ἐκτεθειμένου τὰ συντάγματα, μέγιστον ἔξει κλέος τοῖς ὑπομνήμασιν.

Τὸν δὲ κόρακα οὗ φημι εἶναι ἄξιον κατασκευῆς. Τὴν δ' ἐπιβάθραν ὃν τρόπον δεῖ γενέσθαι προειπὼν ἐν ἀρχῇ δηλώσειν, οὐδὲν διεσαφήνισεν· οὐδ' ὑπὲρ τῶν κατὰ θάλασσαν δὲ αὐτῷ προσαγομένων ἔργων δεδήλωται· ἀλλὰ καὶ ταῦτα παρέϊται, καίτοι σφόδρα ἐπαγγελτικῶς καὶ μεγάλως ποιησαμένου τοὺς λόγους. Ἡμεῖς δ' ἐγράψαμεν πρῶτον χελώνης χωστρίδος κατασκευὴν, εἶτα τῶν ἄλλων μηχανημάτων.

Χελώνης χωστρίδος κατασκευή.

Τοῦτο τὸ κατασκευάσμα φησὶ Φίλων δ' Ἀθηναῖος χρήσιμον

- 16 εἶναι πρὸς τε τὰς γινομένας εἰς τὴν προσαγωγὴν μηχανημάτων [παρόδους] καὶ τὰς παρεκτάσεις τῶν σταδίων καὶ τὰς συγχώσεις τῶν τάφρων· καὶ ἐάν τινα ἄλλον τόπον δέη χῶσαι. Χρήσιμον δὲ καὶ πρὸς τὰς ἐφεδρίας τοῦτο γίνεται. Πήγνυται δὲ αὐτὴ εἰς ἐσχάριον τετράγωνον, ἔχον τὴν πλευρὰν ἐκάστην πηχῶν $\overline{\text{I}\Delta}$. ἔχει δὲ καὶ διαπήγματα τέσσαρα καὶ περιπήγματα δύο, τὰ μὲν πᾶχη ἔχοντα δέκα δάκτυλα, τὰ δὲ πλάτη τριπάλαιστα.

Διάπηγμα ἕκαστον ἀπεχέτω δύο πήχεις καὶ παλαιστὴν ἓνα. λαμβάνει δὲ ἀμαξίποδας ἐκάστη χώρα τεσσάρων τῶν ἐν ταῖς γωνίαις, ἐν οἷς στρέφονται οἱ τῶν τροχῶν ἄξονες ἀποκλείομενοι σπάθαις σιδηραῖς ἵνα, ὅταν δέη παροδοποιεῖν προάγοντας (τουτέστιν εἰς τοῦμπροσθεν πλατὺν τόπον ποιεῖν ἢ καὶ ὁμαλὸν πρὸς τὸ πολεμῆσαι) ἢ καὶ παρατιθέναι τινὰ μηχανήματα, ἐξῇ ἐκσπᾶσαντα τοὺς τροχοὺς μετὰ τὸ ἀποκλεῖσαι τοὺς ἄξονας. Οἱ δὲ τροχοὶ γίνον-

15.5 Read οὗ φησι after Schneider for οὗ φημι.

16.2 Read στωδίων after Graux for σταδίων.

16.9 Read τέσσαρας after Schneider for τεσσάρων.

17 ται τέσσαρες, τὴν μὲν διάμετρον τριπλήχεις, τὸ δὲ πᾶχος ποδιαῖοι, δεδεμένοι σιδηραῖς λεπίσι ψυχρηλάταις. Ἐπιζεύγνυται δὲ ἐπὶ τὸ ἐσχάριον ξύλα δύο ἑκατέρας πλευρᾶς ὑπερέχοντα καθ' ἑκάτερον μέρος τοῦ μήκους πήχεις $\bar{\Delta}$. περὶ δὲ τὰς ὑπεροχὰς αὐτῶν περιπλήγνυται ἄλλα δύο ξύλα ὑπερέχοντα, ἓν μὲν τοῦ πρόσθεν μέρους πήχεις $\bar{\text{H}}$, ἓν δὲ τοῦ ὀπίσω πήχεις $\bar{\Delta}$. πᾶχη δὲ ἕκαστα λαμβάνει αὐτῶν καὶ πλάτη τὰ αὐτὰ τῷ ἐσχαρίῳ. αὐτῷ τ' ἐσπῆγνυνται τῷ ἐσχαρίῳ ἐπὶ τὸ πλινθίον αὐτοῦ κίονες ἑπταπήχεις διαλείποντες ἀπ' ἀλλήλων ἕκαστος κῆχυν ἓνα. Κατακλείει δὲ αὐτοὺς ἐπάνω κύκλῳ πάντας ἐπιστύλιον. καὶ ἀπ' αὐτοῦ συστάται ἴστανται εἰς ἀλλήλους ἐξερείδοντες, τὴν ἀνάστασιν τοῦ ὕφους ποιοῦντες πήχεις $\bar{\text{H}}$. ἐπὶ δὲ τῶν συστατῶν ἐπιζεύγνυται δοκός. οἱ δὲ συστάται ἀντήρεισι καὶ πλευρώμασι διαλαμβάνονται, καὶ φράττονται αἱ στέγαι πᾶσαι σανιδώμασι, μάλιστα μὲν φοινικίνοις. εἰ δὲ μὴ, τῶν ἄλλων ὅσα εὖτονά ἐστι ξύλα, πλὴν κεδρίνων, πευκίνων καὶ κληθρίνων. ταῦτα

18 γὰρ καὶ πυρά ἐστι καὶ εὐκλαστα. Καταλαμβάνεται δὲ ἄνωθεν τὸ σανίδωμα γέρροις πεπλεγμένοις λεπτοῖς καὶ πυκνοῖς ὡς ἔτι προσφάτοις. Ἐπὶ δὲ τούτοις καταλαμβάνονται βύρσαις ῥεραμμέναις ὁμοίως ταῖς στύλαις καὶ σάττεται εἰς αὐτὰς μάλιστα μὲν ἔλεια, ἢ τὸ καλούμενον θαλασσόπρασον, ἢ ἄχυρα ὅξει βεβρεγμένα. ταῦτα δὲ εἰσι χρήσιμα πρὸς τε τὰς τῶν λιθοβόλων πληγὰς καὶ πρὸς τοὺς ἔμπυρισμούς.

"Ἄλλη δέ τις ἐστὶ χωστρίς χελώνη, τὰ μὲν ἄλλα παραπλησίως ταύτῃ πεποιημένη καὶ κατακλείσεις τὰς αὐτὰς ἔχουσα, πλὴν τοὺς συγκύπτας οὐκ ἔχει. ἀλλὰ κύκλῳ ἐπάνω τῶν κιόνων καὶ τῶν ἐπιστυλίων θωράκιον καὶ ἑπαλεις ἐκ σανίδων καὶ γέρρων. καὶ ἐπὶ τῶν σελμάτων σανίσιν ἰσχυραῖς περιβέβληται. κατείληπται δὲ καὶ πηλῷ τετριχωμένῳ πᾶχος ἔχοντι ὥστε τὸ πῦρ μὴ ἐνοχλεῖν. καὶ ἔστιν αὕτῃ χρησίμη οὐ μόνον εἰς χῶσιν, ἀλλὰ καὶ εἰς τὰς ἐφέδρας. οἱ γὰρ στρατιῶται ἐμβαίνοντες εἰς αὐτὴν προσάγουσι πρὸς τὸ τεῖχος ὥστε ἐντὸς βέλους γενόμενοι ἐφεδρεύειν. αὕτη δὲ γένοιτ' ἂν ὀκτά-

18.4 Read τύλαις from M for στύλαις.

- 19 τροχος ἡ χελώνη. Ἄλλα τοιαῦτα μηχανήματα ἔξεστι μετασκευάζειν τῷ τεχνίτῃ ἐμβλέποντι εἰς τοὺς τόπους τῶν προσαγωγῶν.

Περὶ ὀρυκτρίδος χελώνης.

Τὸ δὲ τῆς ὀρυκτρίδος χελώνης γένος τὰ μὲν ἄλλα παραπλησίως ταῖς πρότερον ὁκονόμηται, τὴν δὲ ἔμπροσθεν ὀρθὴν ἔχει

- 20 προσαγωγὴν, ὅπως προσελθοῦσα πρὸς τὸ τεῖχος ἀπαρτίσῃ αὐτῷ, καὶ μὴ παρειαπίπτῃ ἀπὸ τοῦ τείχεος τὰ ἀφίεμενα βέλη, ἀλλ' ἀσφαλῶς οἱ ὑπορύττοντες ἐν αὐτῇ ὄντες ἐργάζονται.

- 21 [Ἑγήτορος χελώνη.]

Τῆς δὲ ὑπὸ Ἑγήτορος τοῦ Βυζαντίου ηὔρημένης χελώνης γίνεται τὸ μὲν μῆκος τοῦ ἐσχαρίου πηγῶν \overline{MB} , πλάτος δὲ \overline{KH} . Τὰ δὲ σκέλη τὰ ἐπὶ τοῦ ἐσχαρίου πηγνύμενα τέσσαρα τε συντίθεται, καὶ ἕκαστον ἐκ δύο ξύλων συνημμένον, τὸ μῆκος μὲν ἐχόντων πήχεις \overline{KD} , τὸ δὲ πάχος \overline{E} παλαιστὰς, τὸ δὲ πλάτος πηχυαῖα. Τροχοὶ δὲ γίνονται ἐν αὐτῇ ὁκτὼ, δι' ὧν ἀνάγεται τὸ σύνπαν ἔργον. Τὸ μὲν ὕψος αὐτῶν εἰς πήχεις \overline{AC} , τὸ δὲ πάχος πήχεις B . Συμβάλλονται κατὰ πλά-

- 22 τος καὶ πάχος ἀμφαλλάξ καὶ δεσμεύονται λεπίσι ψυχρηλάταις στρέφονται δὲ ἐν ἀμαξίποσιν. Κίονες δὲ πηγνυνται ἐπὶ τοῦ ἐσχαρίου δωδεκαπήχεις, πλάτος μὲν ἔχοντες παλαιστὰς $\overline{\Gamma}$, πάχος δὲ δέκα δακτύλους. Ἀπέχει δὲ ἄλλος ἀπ' ἄλλου κίων παλαιστὰς \overline{Z} , καὶ ἐπιζεύγνυνται ἐπ' αὐτῶν ἐπιστύλια κύκλῳ πλάτος ἔχοντα παλαιστὰς $\overline{\Delta}$, πάχος δὲ $\overline{\Gamma}$. Ἐπὶ δὲ τῶν ἐπιστυλίων πηγνυνται συνκύπται τὸ ὕψος ἑξαίρουντες πήχεις \overline{H} . καὶ ἐπ' αὐτῶν δοκὸς ἐμπήγνυται πλαγία εἰς ἣν πᾶσαι αἱ κορυφαὶ τῶν συνκυπτῶν πηγνυνται καὶ γίνονται δύο πλευραὶ κεκλιμέναι. καὶ λοιπὸν τὸ πᾶν ἔργον σаниδοῦται καὶ σκεπάζεται παραπλησίως ταῖς χωστρίσι χελώναις. Ἔχει δὲ καὶ μέσσην στέγην ἐπὶ τῶν στύλων ἀναπαυομένην, ὅπως ἡ βελοστασία ἐπ' αὐτῆς ἔῃ. Ἰστανται δὲ ὀπίσω τῆς κριοδόχης σκέλη δύο
- 23 συμβεβλημένα ὀρθία ἐν μέσῳ τῆς χελώνης, ἔχοντα κατὰ τὸ μῆκος τριάκοντα πήχεις. τὸ δὲ πάχος αὐτῶν πηχυαῖον. τὸ δὲ πλάτος τριπαλαιστιαῖον. Ἐφαρμόζεται δὲ ἐπ' αὐτὸ περικεφάλον καὶ μέσον ἄλλο διὰ τῶν σκελῶν διάπήγμα. Καὶ ἀνάμεσον τοῦ τε περικεφάλου καὶ τοῦ διαπήγματος πηγνυται ξύλον ὀρθιον καὶ ἐφ' ἑκατέρου μέρους τοῦ ξύλου τοῦ παγέντος καὶ τῶν σκελῶν ἐμβάλλονται ὀνίσκοι τετορνευμένοι, ἐξ ὧν τὰ ὄπλα ἐξήρτηται τὰ ἀνέχοντα τὸν κριόν. Ἐπὶ δὲ τοῦ περικεφάλου καὶ τῆς κριοδόχης πηγνυται θωράκιον ὥστε ἐν αὐτῷ ἀσφαλέστατα δύνασθαι ἐστάναι τοὺς ἐφοπτεύοντας τὰ ἀποστελλόμενα ἐκ τῶν ἐναντίων πρὸς τὸν κριόν. Τοῦ δὲ κριοῦ τὸ σύμπαν γίνεται μῆκος πήχεις \overline{PK} . ἐκ δὲ πτέρυγης πάχος μὲν ποδῶν \overline{B} , πλάτος δὲ \overline{E} παλαιστῶν. εἰς ἄκρον δὲ

- 24 συνήκται αὐτοῦ τὸ μὲν πάχος ποδιαῖον, τὸ δὲ πλάτος τριπαλαι-
στιαῖον. ἔχει δὲ καὶ στόμα σιδηροῦν ὅμοιον ἐμβόλῳ προμήκει. Τὸ
δὲ σῶμα αὐλωτὸν, καὶ ἀπ' αὐτοῦ ἔλικες ἀποτείνουσι σιδηραῖ
προσηλωμέναι τῷ κριῷ τέσσαρες ἐπὶ πήχεις $\overline{\Gamma}$. Ὑποζώννυται δὲ
ὅλος ὁ κριὸς ὅπλοις ὀκταδακτύλοις τρισὶ, καὶ διαλαμβάνεται κατὰ
μέσον ἐκ τριῶν διαλειμμάτων ἀλύσεσι πηχυαύαις. Ὁ δὲ δεσμός,
ὁ ἐν μέσῳ τὸν κριὸν ἔχων, ἐπὶ παλαιστὰς $\overline{\Xi}$ λαμβάνει τὸν ἐλιγμὸν
ἐν τῷ κριῷ. Βυρσοῦται δὲ κύκλῳ, ὅταν κατελιχθῇ, βύρσαις ἀρ-
γαῖς. τὰ δὲ ὅπλα, ἀποτεταμένα ἐκ τῶν ὀνίσκων τῶν ἐκ τῆς κριο-
δόχης καὶ ἀνέχοντα τὸν κριὸν, ἔχει τὰς ἀρχὰς ἀλύσεσι σιδηραῖς
- 25 τετραπλαῖς πεπλεγμένας. Καὶ περιβεβύρσωνται αἱ ἀλύσεις πρὸς
τὸ μὴ ὀρᾶσθαι.

Γίνεται δὲ καὶ ἐπιβάθρα σανίδος ἐφηλωθείσης τῇ προφορᾷ
τοῦ κριοῦ, καὶ ἐπὶ ταύτης γίνεται ἐκ τριτημορίων δίκτυον πεπλεγ-
μένον, ἔχον τὰς ὅπας παλαιστιαίας πρὸς τὸ ῥαδίως ἀναβαίνειν ἐπὶ
τὸ τεῖχος δι' αὐτοῦ. ἔχει δὲ καὶ παραδείγματα ἕξ ἐκατέρου μέ-
ρους ὁ κριὸς, ἐπειδὴ τὰ ταῖς κάσαις παραπλήσια Κινήσεις

- 26 δὲ τὸ ἔργον λαμβάνει ἕξ, τὴν εἰς τὸ ἔμπροσθεν, καὶ τὴν εἰς τὸ ὀπίσω,
καὶ τὰς εἰς τὰ πλάγια, καὶ τὴν ἀνάνευσιν, καὶ τὴν ἐπίνευσιν. Κα-
θαίρει δὲ ἀπὸ ἐβδομηκονταπήχους ὕφους, καὶ εἰς τὰ πλάγια
παρασύρει ἐπὶ πήχεις ἐβδομήκοντα. οἰακίζεται δὲ ὑπὸ ἀνδρῶν
 $\overline{\Psi}$, ἔχουσα τὸ σῶμα βάρους τάλαντα τετρακισχίλια.

25.6 Read παραπήγματα after Thévenot for παραδείγματα.

25.7 Obelize ἐπειδὴ τὰ ταῖς κάσαις παραπλήσια.

Ἡ δὲ ὑπὸ Ἐπιμάχου τοῦ Ἀθηναίου γενομένη ἐλεπόλις, ἦν Δημήτριος ὁ Ῥοδίου πολιορκῶν προσήγαγε τοῖς τείχεσιν αὐτῶν, ἔστι τοιάδε. Τὸ μὲν ὕψος λαμβάνει πήχεις \bar{q} · τὸ δὲ πλάτος, πήχεις \bar{H} . Γίνεται δὲ τῷ σχήματι πυργοειδὴς ὑπομένει δὲ πληγὴν ὡς τριαταλάντου λίθου.

Αἱ δὲ ἐκ τῶν πλοίων μηχαναὶ, ἃς τινες σαμβύκας προσαγορεύουσιν, οὐκ ἔχουσί τι ἄξιόν γραφῆς διὰ τὸ πᾶσιν αὐτὰς εὐγνώσους εἶναι, καὶ τοσοῦτον ἕκαστον διαφορεῖν οἶομαι τούτων ὥστε μὴ γενέσθαι πολλάκις αἰρετώτερόν ἐστιν ἢ κατασκευασθῆναι κακῶς. Οἱ γὰρ ἐν τῇ περὶ Χίον πολιορκίᾳ, ἀστοχήσαντες καὶ μείζονας τῶν

- 28 πύργων τὰς σαμβύκας κατασκευάσαντες, ἐποίησαν τοὺς ἀναβάντας ἐπ' αὐτὰς ὑπὸ τοῦ πυρὸς ἀπολέσθαι, μὴ δυναμένους ἐπιβῆναι ἐπὶ τοὺς πύργους, χαλάσαι τε οὐκ ἦν οὐδενὶ τρόπῳ αὐτάς· εἰ δὲ μὴ, κατεστρέφετο τὰ πλοῖα ἐξ ὧν ἐμετεωρισθησαν, ἔξω τοῦ βάρους τοῦ φορτίου γινομένου. Διόπερ, μετὰ καὶ τῶν ἄλλων, τοὺς μηχαναῖς μέλλοντας χρᾶσθαι τεχνίτας δεῖ μὴ ἀπείρους εἶναι τῶν Ὀπτικῶν.

Καλλιστράτῳ δὲ τῷ γράφαντι ὑπὲρ τῶν Μηχανικῶν πλησίον τι συνέβη ἐν τῇ ἀγωγῇ τῇ εἰς τὸ ἱερὸν τὸ ἐν Ἐφέσῳ ἀγομένων ὑπ' αὐτοῦ λίθων. Οὐ γὰρ συνείδεν ὅτι ἔνια ἐπὶ τῶν μικρῶν παραδειγμάτων τὴν φαντασίαν ποιούσιν· οὐ γὰρ γίνονται εἰς αὖξιν τὰ τοιαῦτα· πάλιν δὲ ἐπ' ἐνίων μικρὰ παραδείγματα οὐ δύναται γενέσθαι, ἀλλὰ τὰ ἐνεργοῦντα εὐθὺς κατασκευάζονται. Καὶ γὰρ ἐκεῖνο τὸ τρίγωνον τὸ γεγνημένον παράδειγμα πρὸς τὴν

29 ἀγωγὴν τῶν λίθων ἠύδοκίμει· αὐτὰ δὲ τὰ φορτία οὐκ ἡδυνήθη τῷ αὐτῷ τρόπῳ ἀχθῆναι.

Κατεσκεύασαν δὲ τινες ἐν πολιορκίᾳ κλιμάκων γένη παραπλήσια τοῖς τιθεμένοις ἐν τοῖς θεάτροις πρὸς τὰ προσκήνια τοῖς ὑποκριταῖς· ἐφάνησαν μέντοι οὐδὲν χρήσιμον. Ἡμεῖς δὲ κατεχωρίσαμεν αὐτὰς, διὰ τὸ ἐνίους τῶν νῦν μηχανικῶν ποιήσαντας παραδείγματα αὐτοῦ τοῦ ξένου τούτου θαύματος ἐξαπατᾶν ἐπιχειρεῖν.

Κτησίβιος δὲ ὁ Ἀσκληπιδίου ὁ ἐν Ἀλεξανδρείᾳ μηχανικὸς ἐν τοῖς Ὑπομνήμασι κατεχώρισεν ὥστε ἐπὶ τὸ τεῖχος ἄνευ κλίματος ἀναβαίνειν διὰ μηχανήματος τοιούτου. Φησὶ δὲ κατασκευάσαι ἄμα ξαν τετράκυκλον καὶ ἐπ' αὐτῆς στῆσαι ξύλον πλάγιον τετράγωνον, ἐκκοπὰς ἔχον στρογγύλας ἐξ ἐκατέρου μέρους, κινούμενον εἰς δύο ξύλα ὀρθία, καὶ περὶ αὐτὸ σύριγγα περιθεῖναι κηλωνευομένην τηλικαύτην τῷ μεγέθει ὥστε χωρεῖν ὀρθὸν ἄνδρα, ῥαδίως εἰσελθόντα εἰς τὴν σύριγγα, ὅτε μὲν προπορεύεσθαι ἐν αὐτῇ, ὅτε δὲ

30 ἀναχωρεῖν· οὗ τε γενομένου, μετεωρίζεσθαι τὴν σύριγγα ἐξ οὐπερ βούλει μέρους. Πίπτοντος γὰρ ἐπὶ τοῦ ἐδάφους ἑνὸς μέρους τῆς σύριγγος, διὰ τὸ ἐπὶ τὰς ἐκκοπὰς τοῦ ξύλου καθ' ἑτέραν αὐτοῦ πλευρὰν στρέφεσθαι, κηλωνεύεσθαι δὲ τὴν σύριγγα, ὅταν γένοιτο τὸ στόμα αὐτῆς κατὰ τὸ τεῖχος, προσαχθείσης τῆς τετρακύκλου

31 πρὸς αὐτὸ, διανοίξαντα τὸν ἔνδον ὄντα τὴν θύραν αὐτῆς ἐπιβῆναι ἐπὶ τὸ τεῖχος. Μέτρα δὲ τούτων οὐ συντεταχέναι φαίνεται. Γενναίου δὲ τοῦτο ἄξιον οὐθένος, ἀλλ' ἐκ θαυμάτων τὸ μηχανήμα συγκείμενον, καὶ μάλιστα τὸν τεχνίτην τὸ θαυμάσαι Καὶ τοῦτο κατετάξαμεν.

Περὶ δὲ ὑπορύξεων καὶ στωϊδίων κατασκευῆς καὶ τῆς περὶ αὐτὰ πραγματείας ὃν τρόπον δεῖ γίνεσθαι γεγραφότος Πύρρου ἐν τοῖς Πολιορκητικοῖς, οὐκ ἔκρινον τοῖς καλῶς εἰρημένοις ὑπ' αὐτοῦ ἀντιλέγειν· ὅπερ τοὺς πλείστους ὁρῶ ποιοῦντας ἐν τοῖς ἐπιτηδεύμασιν.

Ὅσα μὲν εἴρηται τοῖς ἐπάνω καλῶς, πάντα νενόηταί μοι ἐπ' ἀκριβὲς περὶ ἐκάστου τὴν ἐξεργασίαν πεποιημένῳ· καὶ αὐτὸς δὲ πεφιλοτίμημαι προσευπορήσαι τοῖς πρὸς μηχανουργίαν χρησίμοις. Οὐ γὰρ μόνον δεῖ τὰ καλῶς εὑρεθέντα ὑφ' ἑτέρων εἰδέναι,

32 ἀλλ' ἐπεὶ περ ἐστὶν εὐκίνησις περὶ τὴν ψυχὴν, καὶ αὐτὸν εὐρίσκειν δεῖ.

Ἐπὰν γὰρ πόλιν ἐνθάλασσον ἐλεῖν προαιρῶνταί τινες τῶν ἀρχιτεκτόνων, ὑποζυγώσαντες ὀλκάσι τὰ μηχανήματα ἐν ταῖς γαλήναις, εἰώθασι προσάγειν ἐν τοῖς τεύχεσιν. ἔαν δὲ καταληφθῶσιν ὑπὸ τοῦ πνεύματος καὶ τεθραμμένον ὑποδύῃ τοῖς σκάφεσι κῦμα, ἀναπολάζει τὸ ἐπηρεισμένον μηχανήμα, τῶν σκαφῶν οὐχ ὁμοίαν ποιουμένων κίνησιν. ὅθεν, θραυομένων τῶν μηχανημάτων, ὑπὸ τῆς αὐτεπιβουλεύτου μηχανῆς τοῖς ἐκ τῆς ἐναντίας θάρσος καθίστησιν. Δεῖ οὖν ἐν τῇ ἐσχάρῃ τῇ ἐπερειδομένη ταῖς ὀλκάσιν ἀρμόζειν μέσον τὸ λεγόμενον πιθήκον, ἵνα παντὶ κλίματι σαλεύοντος τοῦ κλύδωνος ὁρθὸν μένη τὸ μηχανήμα· πρὸς δὲ τοὺς ἀνέ-

33 μους καὶ τὸ ἐμπάρασκευον ἔχειν ἀμυντήριον, μικρὰς ποιήσαντας ἐλεπόλεις τῷ μεγέθει. Ἐπὰν ἄσσον γένωνται τὰ πλοῖα τοῦ τείχους, τότε δὴ ἐν αὐτοῖς διὰ πολυσπάστων ἀνίστανται μηχανήματα.

^{Ἐνταῦθα τὸ πλοῖον.}
Ἀρέσκει δέ μοι πάση χελώνη καὶ παντὶ μηχανήματι πρό-

34 τροχον κατασκευάζειν χάριν τοῦ σκολιάς ποιεῖσθαι τὰς προσαγωγὰς, ὅπως κατὰ τοῦ αὐτῶν σκοποῦ οἱ πετροβόλοι μὴ προσπέμπωσιν. Κατασκευάζεται δὲ ἐκ τοῦ ἐσχαρίου κατὰ μέσον τὸ μέτωπον καὶ προβάλλεται ἡ λεγομένη θερμαστρίς, μῆκος ἔχουσα πηχῶν τριῶν, ἔχουσα μασχάλην συνδεδεμένην λεπίσι ψυχρηλάταις, εἰς ἣν ἀρθρεμβολεῖται ὁ λεγόμενος ὁδηγός, ᾧ ἐναρμόζεται ὁ πρότροχος σφαιροειδής. Διὰ δὲ τοῦ ὁδηγοῦ ὄπλον διώσται νημα-

35 τικὸν ἑκκαίδεκαδάκτυλον, οὗ αἱ ἀρχαὶ ἔνδον κατακλείονται περὶ τὸν ἄξονα, ὥστε, ἐφ' ἣν ἂν βούλωνται πλευρὰν ἐπιστρεφομένου τοῦ ἄξονος, ἐκεῖ τὴν πορείαν ποιεῖσθαι.

Ἀρέσκει δέ μοι καὶ τὸ καρχήσιον. Παγήσεται δὲ ἐπὶ τῆς κριοφόρου χελώνης. οὗ τὰ μὲν σιαγόνια ἔσονται μελέϊνα, δεδεμένα

36 λεπίσσι ψυχρηλάταις, ἵνα ἐν ἄξονι ἐμβάλλωνται χαλκῷ, σταθμὸν ἔχοντα ἕκαστον αὐτῶν τάλαντον. Καὶ εἰς ταῦτα ἄξων ἐναρμόζεται σιδηροῦς ταλάντων τεσσάρων· ἡ δὲ λεγομένη γέρανος ἐν τούτῳ πηγνυται ἵνα ἐστὶ πρὸς τὸ ὕψος τῶν πολιορκουμένων ὡς ἡ καθ' ἡμᾶς ὄψις ὀηλοῖ. Καθηλωθήσεται δὲ ἐπάνω σύριγξι καμαρिकाῖς, ἐν ᾧ κοιλάσματι ἐναρμολογήσεται κλιμακώδεις. Ἐπὶ δὲ τοῦ κορυφώματος καταρτίζεται ἐξαιριτὶς περιπηκτὴ, κάτωθεν ἔχουσα κόρακας σιδηροῦς, ἵνα, ὅταν προσερεῖσθαι ταῖς ἐπάλξεσι τὸ μηχανήμα καὶ τοῖς ὑποτόνοις ἐξανυσθῇ τὸ κατασιεύχσμα τῆς ἐξαιριτίδος, οἱ κόρακες ἐδραῖως τῶν ἐπάλξεων ἐπιλάβωνται. Ἡ δὲ γέρανος ὑποζώννυται καὶ βυρσοῦται ὁμοίως τῷ προειρημένῳ κριῷ. Ἐπὶ δὲ τὴν ῥίζαν ἐπιτίθεται σηκώματος τάλαντα

37 χίλια, οὐδὲν ἦσπον ἐργαζομένων τῶν ἀξόνων διὰ τῆς ὑποστροφῆς. Ποιεῖ δὲ καὶ τοῦτο τὰς ἑξ κινησεις.

Ἐνταῦθα τὸ καρχήσιον.

Τοῖς δὲ δυσχερέσι τόποις καὶ στροβιλώδεσιν, ἐκεῖ οὐ προσακτέον μηχανήμα διὰ τὴν δυσχέρειαν τῶν τόπων. Μάλιστα δὲ ὀχλοῦσιν οὕτω· τῷ κατακρηνησμῷ ἀπὸ τῶν ἐπάλξεων ἀφιέντων αὐτῶν πέτρας παρμεγέθεαι καὶ σφονδύλους μεγάλους καὶ ἕτερα τινὰ τούτοις παραπλήσια, ἅτινα φερόμενα διὰ τὸν ἐπ' αὐτῶν παλμὸν

36.4 Following Schneider obelize ἵνα ἐστὶ.

36.7 Read περιπτυνκτὴ after Schneider for περιπηκτὴ.

38 ἀνυπόστατον ποιοῦνται τὴν βίαν. Εὐρηκότα οὖν δεῖ τὴν τούτων ἐνώ-
 σασθαι διαφορὰν διὰ τῆς τοιαύτης ἐργοποιίας· τριβόλους κα-
 τασκευαστέον πηχῶν Ε, πάχος ἔχοντας ζωνιαῖον, τῷ δὲ πλήθει ἱα-
 νοὺς ἵνα τὸ χωρίον περιέλθωμεν ἐκτὸς βέλους. Ἐκ δὲ τῆς καθ'
 ἐκάστην ἡμέραν γιγνομένης τῶν λίθων προσαγωγῆς, τῶν τριβόλων
 προσφερομένων, τριπλῇ ἢ καὶ τετραπλῇ ἢ τούτων θέσις ἂν γέ-
 νοιτο. Διὰ γὰρ τοῦτο τίθενται οἱ τρίβολοι, ὥστε τὰ καταφερόμενα
 προσπίπτειν αἰεὶ τούτοις, καὶ οὕτω δεῖ καθ' ἓνα ἕκαστον αὐτῶν τῶν
 τόπων παρέναι. Ἐπὶ δὲ θελήσωσιν ἄσπον γίνεσθαι τοῦ τείχους οἱ
 πολεμοῦντες, τὴν ἀρετὴν ἀνέχοντες χελώνην, δι' αὐτῆς προσθῶσιν
 τὰς κλίμακας. Ἔστι δὲ ἡ ἀρετὴ οἷα χελώνη σφῆνοειδὴς καὶ περι-
 στρόγγυλος ἄνωθεν ἐξ ἡμικυκλίου, ἵνα τὰ προσπίπτοντα κατὰ μέ-
 τωπον αὐτῆς εὐχερῶς περικυλίηται.

39 Μὴ ὑπολάβης δὲ ἡμᾶς οὕτως ὡμοῦς εἶναι ὥστε συναγαγεῖν
 τοσαῦθ' ὑπομνήματα περὶ ἀναιρέσεως πόλεων· τὰ ἐναντία δὲ δεῖ
 εἰδέναι. Ὁ δὲ προειρημένος λόγος ἀσφάλειαν ποιεῖται πόλεως·
 οἱ γὰρ ταῦτα εἰδότες φυλάξασθαι αὐτὰ ῥαδίως δυνήσονται τὰ
 λυπήσοντα.

Μάλιστα δὲ ἡμῖν πεπραγμάτευται κατὰ τῶν οὐχ ὑποταγησο-
 μένων τοῖς καλοῖς τῆς ἡγεμονίας νόμοις. Διόπερ, ἐὰν κρίνης, ἐσχη-
 ματογραφημένα πάντα ἔσται τὰ μηχανήματα· καὶ τὸ ἐν τῇ λέξει
 δύσφραστον ἐπ' αὐτῶν εὐδηλον ἔσται.

Ὅσα δὲ δεῖ πρὸς τὰ εἰρημένα ἀντιμηχανήσασθαι, ἐάν τινα
 ἀναλεξώμεθα παρὰ τῶν ἀρχαιοτέρων, πειρασόμεθά σοι κα-
 κεῖνα γράφαι. Τοῦτο δὲ εἴρηται, ὥς τινων τῇ ἰδίᾳ ἀγρία μετρούν-
 των τὴν τῶν πέλας κακοπάθειαν, καὶ οὐ φαμένων εἶναι ἐν πολλῷ

40 ἐπίγνωσιν γενέσθαι πραγμάτων, ὥσπερ τῆς ψυχῆς ἡμῶν ἀποστενο-
 χωρούντων τὴν προθυμίαν τῶν μαθημάτων.

- Ἀγησίστρατος 7,7
 Ἀθηναῖος 15,13; 27,2
 Ἀλεξάνδρεια 29,9
 Ἀλέξανδρος 5,13; 10,9
 Ἀμύντας 10,7
 Ἀπολλώνιος 8,9
 Ἀριστοτέλης 5,3
 Ἀρχύτας 5,3
 Ἀσκληνός 29,9
 Βελικά 8,5
 Βυζάντιον 10,8; 21,2
 Γάδειρα 9,5
 Γαδειρίτης 9,11
 Γήρας 9,15; 10,3
 Δελφικός 3,2; 5,2
 Δῆϊμαχος 5,12
 Δημήτριος 27,3
 Διάδης 10,10; 10,10
 Διονύσιος 10,6
 Ἕλλην 5,8
 Ἐπίμαχος 27,2
 Ἐστιαῖος 5,3
 Ἐφεσος 28,8
 Ἡγήτωρ 21,2
 Θετταλός 10,9
 Ἰνδός 5,8
 Ἰσοκράτης 6,6
 Κάλανος 5,8
 Καλλισθένης 7,2
 Καλλίστρατος 28,7
 Καρχηδόνιος 9,4; 9,15
 Κτησίβιος 29,9
 Μακεδών 6,1
 Μάρκελλος 3,2
 Μηχανικά 28,7
 Ὀπτικά 28,6
 Περσικά 5,12
 Πεφρασμένος 9,10
 Πολιορκητικά 31,8
 Πολύειδος 10,9
 Πύρρος 5,13; 31,7
 Ῥόδιος 27,3
 Ῥόδος 8,11; 8,13
 Σικελιώτης 10,6
 Στράτων 5,3
 Τύριος 9,9
 Ὑπόμνημα 29,10
 Φίλιππος 6,7; 10,7; 10,8
 Φίλων 15,13
 Χαρίας 10,10
 Χίος 27,11

CHAPTER FOUR

TRANSLATION

3 Highly esteemed Marcellus.

So far as anyone who writes about machines can generally follow it, I have taken into consideration the Delphic precept, that there is some divine power that reminds us that we should be sparing with time. One might almost say that we always squander it lavishly on the pressing necessities of life. And so, let us not devote any casual attention or concern to money and the other things that seem valuable to us; but rather let us pay attention to the precepts of the ancients. At the expense of only a small degree of effort we shall earn our living in no random way and easily get a share from others. But instead we waste time that is subject to change and flows
4 away since the end comes all too soon. And we do this even though it is nature's way to provide us by day with some faculty for acquiring each of life's necessities, and by night with sleep, though it be altogether brief. For the one man who alone has rightly been called a poet does not allow sleep (the gift of the gods for the relaxation of our bodies) to last all night. In this way he is clearly taking great forethought to prevent the mind from lying idle for a long time.

Those authors who describe some topic or have some instruction to give us, even when they seem to be doing it for our benefit, waste time quite unreasonably in

unnecessary words in order to display their great learning. For they leave behind books filled with digressions, even though the ancient philosophers gave good advice when they said that one should know the measure of life's opportunity
 5 since this is the end of wisdom. In this way, in respect to a treatise on technical matters, a man by carefully applying himself to it, would derive some benefit from that Delphic precept rather than from the writing of Straton, Hestaios, Archytas, Aristotle, and the others who have written like them. For while, to young men eager for knowledge, their writing would be useful in acquiring basic principles, to those who want to accomplish something immediately it would be completely divorced from an inquiry that leads to results.

Therefore Kalanos the Indian's remark to them would seem to be right. He says, "We do not compare ourselves to the Greek philosophers who waste many words on inconsequential matters but we are accustomed to say very little about even the gravest matters so that they may be easily remembered by all." One can understand very accurately how great the difference is between the oriental works and the Greek ones from the Persika of Deimachos, from those who followed Alexander, and even more from Pyrrhos of
 6 Macedon's work on siege-machines. But so that I myself may not appear verbose I shall return to the matter in hand adding a few embellishments to satisfy those who are accustomed to examine pedantically the style of

expression. For I do not assume that it is suitable for a man working out these refinements to fall behind in his purpose. This is exactly what happened to the orator Isokrates in the case of the letter of advice that he sent to Philip. The war was resolved before he had finished his advice. Therefore he says, "While I was concerned with this business you made peace before I had finished it." Furthermore, it is my opinion that
7 we should obey those who give good advice in such matters. For the historian Kallisthenes says that the man who is attempting to write something must not miss the point but must arrange his words to suit both himself and his subject matter. I think that every treatise on a technical subject of this sort requires conciseness and clarity and is not suitable material for the laws of rhetoric.

For this reason I shall go through in detail what I have read in the works of the engineer Agesistratos. "Therefore it appears to be very necessary to have experience in blueprints. For in this way it is possible for someone devising measures for a siege to devise also the correct countermeasures and conversely to devise measures against the countermeasures. This, however, the common man cannot do easily but only a man who has learned mechanics well, is steeped in all the studies dealing with them, and has carefully considered the

works written by earlier men or produced in relation to
8 this matter.

For it is often profitable to use the good inventions from the past and not in every case to be an innovator, unless one is intent on deceiving the laymen by preferring the appearance of truth to the truth itself."

This seems to me well said. For in his work Belika Agesistratos so far surpassed his predecessors that even the man who proclaims his merits is not easily believed. For his catapult of three spans (0.66m) with twelve minas (7.37 Kg.) of torsion gut had a range of three and one-half stades (621.60m) and the four cubit (1.78m) one, which was a palintone, had a range of four stades (710.4m).

Apollonios, who was his teacher, brought such a great cargo of stones for the mound around the harbour of Rhodes that witnesses were often at a loss to know how he ever loaded it into the ships and unloaded it again in Rhodes. After this Agesistratos followed Apollonios striving to find something useful in his
9 treatise on siege-techniques. His "ram-bearing tortoise" and the counterdevice illustrate this. Therefore it seemed that the advice such a man gives about mechanics should be trusted.

He said that the very first "ram" was invented by the Carthaginians at the siege of Gades. For when they

were seizing a certain outpost in advance and were knocking the walls down to the foundation, some young men, who had no tools for its destruction, took hold of a beam in their arms and beat it against the wall and in this way easily destroyed a great length of it. A certain Tyrian ship-builder, by the name of Pephrasmenos, witnessed the event. In the siege which they later conducted against the city of Gades he set up a vertical beam and from this he suspended another beam at right angles to it, similar to the beams of a balance, and he began to strike the wall by hauling the horizontal beam by means of a pulley-rope. Since those inside were perplexed owing to the strangeness of the machine, the walls soon fell. After this man, Geras, the Carthaginian, made a frame on
10 wheels and put the "ram" on it sideways. Rather than hauling it with a pulley-rope he arranged for a wheeled cover to be pushed forward by a large number of men. And Geras, who first invented this, called it a "tortoise" on account of its slowness. After this some men arranged for the "ram" to be pushed forward on rollers and used it in the same manner.

The construction of engines of war of this kind improved in general under the tyranny of Dionysios of Sicily and under the reign of Philip the son of Amyntas when he was besieging Byzantium. Polyeidus the Thessalian was successful in the field of mechanics and his pupils, Diades and Charias, campaigned with Alexander. Diades

himself says, in his writing on mechanics, that he invented moveable towers, the machine known as the "trypanon," the "crow," and the scaling-ladder. He also made use of the
 11 "ram" mounted on wheels, or at any rate he describes the construction of it as follows.

Construction of a "Ram"

[followed by Wescher's fig. I, cf. commentary 39.9]

He says that the smallest tower must have a height of 60 cubits (26.60m) and a width of 17 cubits (7.55m), the width decreasing by one-fifth towards the top. The thickness of the side poles of the tower should be three palms (0.22m) at the bottom and seven fingers (0.13m) at the top. He constructed a tower of this size with ten stories each of which was surrounded by a gallery.

The largest of his towers had a height of 120 cubits
 12 (53.25m) and a width of $23 \frac{1}{2}$ cubits (10.41m). The width of this tower also decreased by one-fifth towards the top. The side-poles were a foot square at the base decreasing to 6 fingers (0.11m) at the top. His tower of this size was twenty stories tall and for protection against fire each story was surrounded by a parapet, the width of which was three cubits (1.33m). Let the first story have a height of $7 \frac{1}{2}$ cubits (3.33m), the second five (2.22m), and those up to the fifth story the same, the rest were four cubits and two palms (1.93m) in height. But for the smaller tower also the division of floors followed

the same proportion. These towers were covered with undressed hides.

The construction of the "ram-bearing tortoise" was
 13 the same whether it was small or large. The biggest had a width of 30 cubits (13.30m) and a length of 40 cubits (17.80m), and the height, not including the gabled roof that was put on later, was 13 cubits (5.77m). The height of the pediment itself, from the floor to the peak, was 16 cubits (7.12m). The gable rose up above the middle of the roof at least two cubits (0.88m) projecting the roof timber at the side as far as the main beams of the gable in order to make a gallery along the sides. From the middle of the roof he erected a small three story tower and placed catapults in the top stories and a supply of water in the bottom one. Uprights were arranged around the edge of the actual "tortoise" and it had a parapet. Inside it he placed a battering-ram frame on
 14 which he placed the cylinder through which the "ram" was propelled by means of a pulley-rope, thus activating the machine. And it was covered with hides in the same way as the towers.

The "trypanon" has the same "tortoise" and exactly the same construction as the "ram". On the frame he places a barrel very similar to that found in a euthytone catapult and having a windlass placed across it just as they do. At the other end he fixes two pulleys by means of which the beam placed in the groove is thrust forward.

And on the floor of the groove he places numerous rollers so that the beam may move with ease. And in this manner, by means of the windlass set at the bottom end of the groove, he hurls forward and draws back the beam that
 15 batters down the wall. The groove is surrounded with skins arranged on a framework of arches with the intention of protecting the beam inside it.

If the work is well outlined the engineer may acquire a good reputation, but if he puts down all the details in a full length work he will achieve very great fame thanks to his writings.

Diades says that the grappling-hook is not worth building. Although at the beginning of his work he stated that he would describe how one should construct the scaling-ladder, he failed to do so. Also no information has been given about the machines that he introduced on the sea. But they are also passed over, although he promised most solemnly that he would discuss them. But I first wrote a description of the "tortoise for filling up ditches" and then of other machines.

Description of "Tortoise for Filling Ditches"

Philon the Athenian says that this machine is use-
 16 ful for constructing roads for the approach of machines, for laying out sheds, and for filling up ditches or any other depressions that should be filled in. It is also useful for establishing observation-posts.

It is constructed on a platform 14 cubits (6.22m)

square, which has four cross-bars and two longitudinal bars, all ten fingers (0.19m) thick and three palms (0.22m) wide. Let each crosspiece be located at intervals of 2 cubits and a palm (1.60m). Each of the corner compartments contains four axle-blocks, in which the axles of the wheels turn, sheathed with iron plates so that whenever one has to move them forward to build approaches (i.e. to make a broad and level area in front for fighting) or set up machines in line, the wheels may be drawn out after disengaging the axles. There are four
 17 wheels three cubits (1.33m) in diameter, one foot (0.30m) thick, and reinforced with cold-forged plates of iron.

To the frame are fixed two pieces of wood projecting 4 cubits (1.78m) from each side of the frame at each end of their length. Two other pieces of wood, projecting for a length of 8 cubits (3.55m) at the front and 4 cubits (1.78m) at the rear, are attached to these projections. The thickness and breadth of these are the same as for the base.

Jointed into the frame itself on the base are posts seven cubits (3.11m) high and spaced one cubit (0.44m) apart. At the top a surrounding architrave makes all these posts fast. And to this are connected rafters supporting one another and increasing the height by 8 cubits (3.55m). The ridge-pole is fastened on top of these rafters. The rafters are provided at intervals

with props and cross-rails and the whole roof is fortified with planking, preferably of palm wood, but if this is not available of some other wood that is as elastic as possible, excepting cedar, pine, and alder, which are
18 both inflammable and easily broken. The planking is then covered over with a thin compact coating of wattles as fresh as possible. On top of these there is a covering made of hides stitched together like mat^tresses and stuffed preferably with marsh-plants, or so-called sea-weed, or chaff steeped in vinegar. These coverings are effective against both the blows of catapults and fire.

There is another "tortoise for filling in ditches" constructed in the same manner as the preceding one and having the same beams except for the sloping rafters. Instead, surrounding it, above the posts and architraves, it has a breastwork and battlements built of planks and wattles. Above the timberwork there is a covering of strong planks coated with a mixture of clay and hair of sufficient thickness that fire cannot damage it. And this machine is useful not only for filling in ditches but also for purposes of observation. For the soldiers who enter it propel it towards the wall and are thus able to make observations although they are within
19 range of missiles. This "tortoise" could well have eight wheels but the engineer with an eye to suitable routes of approach may well alter such machines as required.

Concerning the "Mining Tortoise"

In all its other particulars the type of "tortoise" used in sapping operations is designed in much the same way as the preceding ones; however, it has a right-angled
 20 surface at the front so that when it has reached the wall it can fit exactly against it and the missiles hurled from the walls may not enter it from the side and the miners inside it can work in safety.

21 The "Tortoise of Hegetor"

The length of the base of the "tortoise" invented by Hegetor of Byzantium is 42 cubits (18.20m) and the width 28 (12.4m). The posts joined to the base are four in number. Each one is made out of two pieces of wood 24 cubits (10.65m) long, 5 palms (0.37m) thick, and one cubit (0.44m) wide. The whole machine moves on eight wheels. These wheels are $4 \frac{1}{2}$ cubits (2.00m) high and 2 cubits (0.88m) thick. They are made of wood joined
 22 alternately in width and thickness and are reinforced with plates of cold-forged metal. They turn in axle-blocks.

Posts twelve cubits (5.32m) high, 3 palms (0.22m) wide, and ten fingers (0.19m) thick, are set up on the base. Each post is placed 7 palms (0.52m) from the next and architraves 4 palms (0.30m) wide and 3 palms (0.22m) thick are fastened all around above them. Roof-beams are fastened on these architraves raising the height by 8 cubits (3.55m). And above these the ridge-pole, to

which all the extremities of the roof-beams are fastened, is placed horizontally so that we have two sloping roofs. Finally the whole machine is boarded over and protected in the same manner as the "tortoises for filling in ditches".

It also has a middle story resting on the uprights so that the battery of machines may be set up on it. Right in the middle of the "tortoise" behind the frame of
 23 the battering-ram, two side poles joined together, thirty cubits (13.3m) in height, one cubit (0.44m) thick, and three palms (0.22m) wide, are fastened. Two cross-bars, one at the top and the other in the middle, are fastened through these side poles. And a vertical piece of wood is fastened between the top and the middle cross-bar through their centres. On each side of this vertical bar and the side poles are turned windlasses from which the ropes holding up the "ram" are fastened. And a parapet is also attached to the top of the ram-frame so that those watching the missiles dispatched against the "ram" by the enemy can stand in it in perfect safety.

The total length of the "ram" is 120 cubits (53.25m). At the butt-end it is 2 feet (0.60m) thick and 5 palms
 24 (0.37m) wide but towards the point the thickness diminishes to one foot (0.30m) and the width to 3 palms (0.22m). And it has an iron point similar to the protruding beak of a ship. The body is pipe-shaped and from it extend four

iron spirals 10 cubits (4.44m) long that are nailed to the "ram". The whole "ram" is undergirded with three ropes eight fingers (0.15m) thick and is grasped around the middle by cubit long (0.44m) chains in three intervals. The binding holding the "ram" in the middle follows the winding on the beam for a distance of 5 palms (0.37m). When it is wrapped up it is surrounded by raw hides. And the ropes that stretch from the windlasses of the ram-frame and hold up the "ram" have their ends bound with fourfold iron chains. And the chains too are surrounded with hides so that they may not be seen.

25 There is also a scaling-ladder made of boards nailed on to the front end of the "ram" and a net woven from thick rope with a mesh of one palm's breadth (0.07m) is fastened to this so that using it one might easily climb on to the wall. The "ram" also has pieces attached to both sides

26 The machine admits of six movements: forward, backward, right and left, and up and down. It can clear a wall up to a height of 70 cubits (31.05m) and can sweep sideways for a range of 70 cubits (31.05m). It is managed by 100 men and has a total weight of four thousand talents (147,440 Kg.).

27 Description of Helepolis

The Helepolis was invented by Epimachos the Athenian and brought to the walls of Rhodes by Demetrios when he was besieging the Rhodians. It is constructed as follows. Its height is 90 cubits (40m) and its width

8 cubits (3.55m). It is like a tower in form and can endure the impact of a stone weighing approximately three talents (111 Kg.).

The naval machines that some people call "sambykai" are not worth describing since everyone is well acquainted with them and I think that they differ so much from each other that often it is preferable that they not be built at all rather than that they be built badly. For the men
 28 besieging Chios, because they miscalculated and built the "sambykai" higher than the city's towers, caused the death by fire of those who ascended them because they were unable to reach the towers, and because there was absolutely no way to lower the "sambykai"; for otherwise the ships from which they were suspended would have overturned with the centre of gravity of the load being shifted. Therefore, in common with other craftsmen, engineers who intend to make use of siege machines should not be ignorant of optics.

A similar thing happened to Kallistratos, the writer on machines, while he was directing the transportation of stones to the temple at Ephesos. For he did not realize that some things represented in models on a small scale produce an optical illusion since such things cannot be reproduced on a large scale. On the other hand, it is sometimes impossible to make small models of some things but these can only be constructed immediately in life size. In that case, for example, the triangle that had

29 served as his model for the transport of the stones seemed quite good, but the actual loads could not be conveyed in the same way.

For a siege some men have constructed sorts of ladders similar to those erected in the theatres against the proskenia for the actors. However, they have appeared useless. But I have mentioned them owing to the fact that a number of contemporary engineers, who have made models of this strange wonder, are attempting to deceive people.

In his Commentaria, Ktesibios, of Askra, the Alexandrian engineer, told how, with the use of the following machine, one can climb on to a city wall without using a ladder. He says that one should build a four-wheeled cart and mount crosswise on this a square piece of wood with round mortises on each end of it fitting into two upright pieces of wood. Around this one places a large tube suspended on a pivot -- large enough that a man can easily
 30 enter it standing upright and walk to and fro. When this has been done, the tube should be raised at whichever end one wishes. For when one end of the tube touches the ground the other end rises because the tube revolves in the notches of the piece of wood on each of its two sides and is suspended on a pivot. And whenever the four wheeled vehicle has been brought up so that the end of the tube is right against the wall, the man inside
 31 should open the door of it and climb onto the wall. Ktesibios apparently did not give the dimensions of the components. This machine is of no great worth but is

designed merely as a contrivance to win admiration for the inventor. . . . And for this reason I have described it fully.

Concerning the construction of tunnels for undermining walls and of protective sheds and the manner of dealing with them, although Pyrrhos, in his work Poliorketika, has described how to build them, I did not think it proper to contradict his excellent account; which is what I see most people doing in their writing.

In composing an accurate discussion on each machine I have very carefully considered everything that my predecessors gave a good description of. And besides, I have prided myself in the fact that I have contributed additional information for the construction of engines of war. For one ought not only to be acquainted with the
 32 clever inventions of others, but also, since he is still enthusiastic, to invent something oneself.

For some engineers, whenever they propose to capture a city on the sea, are wont to strap the machines on freighters and in calm weather to push them up to the walls. But if they are caught by the wind and the waves swell and break over the hulls, the machine, supported by them rolls about because the hulls do not share the same movement. Then, as the machines break up because of the self-destructive character of their design, the enemy take heart. Therefore it is necessary to fit the so-called *πλῆκτρον* into the middle of the platform that rests upon the ships so that, in spite of

the surging of the waves, the machine may remain upright in any weather. For protection against the winds it is
 33 also necessary to have a windscreen and to limit heelpoleis to small dimensions. Whenever the ships approach the walls the machines are set up on them by means of compound pulleys.

Here is the Boat

[followed by Wescher's fig. VIII, cf. commentary 39.9]

It also seems a good idea to me to furnish a fore-
 34 wheel for every "tortoise" and siege-engine so that its progress may follow a crooked course. This ensures that the rock-throwers may not hit their mark. The so-called $\theta\epsilon\rho\mu\alpha\sigma\tau\rho\acute{\iota}\varsigma$ is constructed in the middle of the front of the base and projects forward three cubits (1.33m). It is fitted with a $\mu\alpha\sigma\chi\acute{\alpha}\lambda\eta\nu$ bound together with cold-forged metal, into which the rudder is inserted. The spherical fore-wheel is then attached to the rudder. A plaited rope 16 fingers (0.30m) thick is put through
 35 the rudder and its ends are attached on the inside around the axle so that as the axle turns the machine moves in the desired direction.

I think that the "chamber" is also a good idea. It will be placed on the "ram-bearing tortoise", the side
 36 pieces of which will be ash wood bound with cold-forged metal plates so that they may be inserted into a metal axle. Each one of them will weigh one talent (36.86 Kg.). And the iron axle, which weighs four talents (147.5 Kg.), is inserted into them. The machine called a "crane" is

fixed into this in such a way that so far as one can estimate by eye it reaches the top of the besieged walls. Above this are to be nailed vaulted tubes, inside of which a wicker mat will be fitted. At the top end a folding ladder with iron hooks underneath is fastened so that whenever the machine presses against the city-battlements, the ladder-apparatus may be brought into use by means of ropes and the hooks may firmly grab hold of the battlements. The "crane" is undergirded and covered with skins in the same manner as the "ram" already discussed. A counter-
 37 weight of one thousand talents (36,860 Kg.) is placed at the rear end. The axles, however, operate just as efficiently by means of the screw. This machine can also move in six directions.

Here is the "Chamber"

[followed by Wescher's fig. XII, cf. commentary 39.9]

In difficult and rough terrain the machine should not be brought forward. For in these circumstances the enemy are especially troublesome, throwing headlong from the battlements immense rocks, large stone drums, and other similar objects. These missiles, borne along by their
 38 own impetus, produce an irresistible force. In such circumstances, then, one must counteract their impetus with the following device. Triple spikes 5 cubits (2.22m) long and as thick as a girdle must be set up in sufficient number that we may surround the place out of missile range.

And since the triple spikes are pushed forward as a result of the daily rush of stones the spikes should be placed three or even four deep. The reason for this arrangement of the spikes is to ensure that the missiles rolling down will always hit them because they have to pass through several ranks of them.

When the besiegers wish to be nearer to the wall they bring up the "areté tortoise" and using this will set up ladders. The "areté tortoise" is wedge-shaped and has a perfectly round roof above in the shape of a hemispherical dome so that anything that falls on its roof readily rolls off it.

39 But do not imagine that I am so harsh as to bring together all these notes for the destruction of cities, when, in fact, the opposite is the case. The treatise that I have just compiled makes cities safe, for those who are acquainted with these devices will easily be able to guard against the very things that are liable to harm them.

I have written this especially against those who refuse to obey the fine laws of the realm. Therefore, if you approve, all the machines will be illustrated with figures and what is difficult to explain in words will thus become obvious.

With regard to what contrivances one should make to counteract those described above, when I find any details in the works of older writers, I shall attempt to describe them also to you. This is said because some

people measure the misery of their neighbours by their
40 own sloth and claim that a knowledge of practical affairs
cannot be acquired even over a long period of time, just
as if scientific knowledge were bound to have a dulling
effect on our enthusiasm.

CHAPTER FIVE

COMMENTARY

- 3.2 Μάρκελλε. For a discussion of the identity of this Marcellus see my chapter on the dating.
- 3.4 ὥς ἔστι. Schneider emends this to ᾧ ἔστι which makes easier sense but is not strictly necessary.
- 3.6 τῶν ἄλλων τῶν δοκούντων ἡμῖν. Restored by Wescher from a collation of M (τῶν ἄλλων τῶν ἡμῖν) with the other MSS. (τῶν ἄλλων δοκούντων ἡμῖν), which is also what Schneider reads and seems to make perfect sense. There is no reason for Wescher's restoration since the reading of the other MSS. seems quite acceptable.
- 4.3 Ὁ γὰρ μόνος κληθεὶς δικαίως ποιητῆς. This certainly refers to Homer and in particular to a passage of the Iliad 2.24 οὐ χρὴ παννύχιον εὐδεῖν βουλευφόρον ἄνδρα.
- 4.12 Clement of Alexandria, Stromateis, 1.36 [II 23,22 St.] gives Anaxarchos as the source of this advice:
εὖ γοῦν καὶ Ἀνάξαρχος ὁ εὐδαιμονικὸς ἐν τῷ Περὶ Βασιλείας γράφει . . . χρὴ δὲ καιροῦ μέτρα εἰδέειν σοφίης γὰρ οὗτος ὅρος. (Diels, Vorsokr. 2.239)
- Anaxarchos of Abdera accompanied Alexander the Great on his Asiatic campaigns and was later put to death by Nicocreon the tyrant of Cyprus because he had insulted him at a banquet. See Diog. Laert. 58-60 and Arrian, Anab. 4.10-11.

- 5.3 Στράτωνος καὶ 'Εστιαίου καὶ 'Αρχύτου. The Straton mentioned here is probably Straton of Lampsacus, about whom not a great deal is known. He lived ca. 328-269 B.C. He was a pupil and successor of Theophrastus. He became head of the school in the 123rd Olympiad (288-285 B.C.) and continued in that capacity for 18 years leaving the school to Lycon, in his will, in the 127th Olympiad (272-269 B.C.). He taught Ptolemy Philadelphos and was known as Στράτων Φυσικός. Diogenes Laertius gives the titles of 44 of his works and also mentions some lecture notes of dubious authorship and some letters (5.59-60). Polybios, who has a low opinion of him, says:

Παραπλήσιον γὰρ δὴ τι τοιοῦτο συμβέβηκε καὶ Στράτωνι τῷ φυσικῷ καὶ γὰρ ἐκεῖνος ὅταν ἐγχειρήσῃ τὰς τῶν ἄλλων δόξας διαστέλλεσθαι καὶ ψευδοποιεῖν, θαυμάσιός ἐστιν ὅταν δ' ἐξ αὐτοῦ τι προφέρηται καὶ <τι> τῶν ἰδίων ἐπινοημάτων ἐξηγῇται, παρὰ πολὺ φαίνεται τοῖς ἐπιστήμοσιν εὐθεέστερος αὐτοῦ καὶ νωθρότερος.

(Polybios, 12.25 c3)

For further information about Straton see Diog. Laert.

5.58-64, Suidas s.v. "Στράτων," Capelle in RE 4A1, 278-318 s.v. "Straton (13)," and Wilamowitz-Moellendorff, Hellenistische Dichtung, vol. 1, p. 161 (Berlin, 1962).

Practically nothing is known about Hestaios except the fact that he was a pupil of Plato. This is reported by Diogenes Laertius in Bk. 3.46:

Μαθηταὶ δ' αὐτοῦ Σπεύσιππος 'Αθηναῖος, Ξενοκράτης Καλληδόνης, 'Αριστοτέλης Σταγειρίτης, Φίλιππος 'Οπούντιος, 'Εστιαῖος Περίνθιος

Evidently he further developed Plato's 'ideal numbers.' (Theophrastus fr. 12.13). See Natorp in RE 8.2, 1314 s.v. "Hestiaios (7)".

Archytas is probably Archytas of Tarentum, the son of Mnesagoras or Hestiaios. He seems to have been a very talented man and is often mentioned throughout antiquity. He lived in the fourth century B.C. and must have been an approximate contemporary of Plato as he corresponded with him. He was general for seven years even though there was a law that forbade generals to succeed themselves. Archytas was, according to Diog. Laert. 8.83, the first to bring mechanics to a system by applying mathematical principles. For further information on Archytas, see Diels, Vorsokr. 1.47; Diog. Laert. 8.79; and E. Wellmann in RE 2.1, 600-602 s.v. "Archytas (3)", and Suidas s.v. "Ἀρχύτας".

The Aristotle mentioned here is the famous Aristotle, pupil of Plato and tutor of Alexander (384-322 B.C.).

- 5.6 ἀπηρτισμένα MPV; ἀπηρτημένα L³. LSJ s.v. ἀπαρτίζω II.2 'to be complete, to fit exactly, square with, etc.' This seems to be exactly the opposite of what is intended. LSJ s.v. ἀπαρτάω II 'detach, separate.' This fits the sense of what he is saying and is surely the correct reading here.

- 5.8 Κάλανος ὁ Ἰνδός. Kalanos was an Indian philosopher who belonged to a group called the gymnosophists

(because they went around naked). He accompanied Alexander on part of his journey, but when he fell ill he had himself burned alive on a funeral pyre. The reference here is perhaps to a letter that he wrote to Alexander. This¹³ is quoted by Philon (Judaeus), Quod Omnis Probus Liber Sit, 14:

— . . . Ἑλλήνων δὲ φιλοσόφοις οὐκ ἔξομοιούμεθα ὅσοι αὐτῶν εἰς πανήγυριν λόγους ἐμελέτησαν, ἀλλὰ λόγοις ἔργα παρ' ἡμῖν ἀκόλουθα καὶ ἔργοις λόγοι βραχείαν ἔχουσι δύναμιν καὶ μακαριότητα καὶ ἐλευθερίαν περιποιούντες.

The suicide of Kalanos is an "oft told tale." See Strab. 15.715-718; Diod. 17.107; Plut. Alex. 69; Athen. Deipn. 10.437a; Lucian Peregr. 25; see also M. Hadas, Hellenistic Culture, pp. 178-179 (1959); Kroll in RE 10.2, 1544-1546 s.v. "Κάλανος"; Arrian Anab. 7.3. Plutarch tells us that his name was not really Kalanos but Sphines. He says that he was called Kalanos because he greeted everyone he met with καλέ an Indian word of salutation (Plut. Alex. 65.3).

- 5.12 τῶν Δηϊμάχου Περσικῶν. Very little is known about Deimachos except for the fact that he was sent by the Syrian king Antiochus Soter (293-261 B.C.) to Palimbothra (on the Ganges river) as an ambassador to the Indian king Amitrochates (Ἀμιτροχάτην Ath. Deipn. 14.652 or Ἀλλιτροχάδην Strabo 2.70) and wrote a history of India that was held in very low repute:

"Απαντες μὲν τοίνυν οἱ περὶ τῆς 'Ινδικῆς γράφαντες
ὥς ἐπὶ τὸ πολὺ ψευδολόγοι γεγονόνασι, καθ' ὑπερβολὴν
δὲ Δαίμαχος.

He was apparently a Plataean (Δαίμαχος ὁ Πλαταιεύς
Plut. Comp. Sol. et Publ. 4; and Δαίμαχος δ' ὁ Πλατωνικός
Diog. Laert. 1.30, emended to Δαίμαχος δ' ὁ Πλαταιεύς
by Casaubon). Besides his history of India he also
wrote a work called Περὶ εὐσεβείας and according to
Stephanos of Byzantium (s.v. " Λακεδαίμων ") a work on
sieges:

ὥς φησι Δαίμαχος ἐν πολιορκητικοῖς ὑπομνήμασι
λέγων.

5.12 ἐκ τῶν Δηιμάχου Περσικῶν καὶ τῶν δι' αὐτοῦ ἀκολου-
θησάντων 'Αλεξάνδρω Wescher.

ἐκ τῶν Δηιμάχου Πολιορκητικῶν καὶ τῶν Διάδου καὶ
Χαρίου τῶν ἀκολουθησάντων 'Αλεξάνδρω Schwartz.

σετικῶν V¹ corrected in margin to Περσικῶν, περσετικῶν

MPV. Although the MSS. readings appear closer to
Περσικῶν than to Πολιορκητικῶν we have a reference to
a Πολιορκητικά of Deimachos (see above) and no reference
to a Περσικά. The manuscript evidence, then, would
seem to favour Περσικῶν while the other evidence
favours Πολιορκητικῶν. The evidence for either, however,
is rather scanty and on the basis of it no definite
conclusion can be reached. The introduction of Διάδου
and Χαρίου from 10.10, however, is rather suspect.
Schwartz has obviously proposed this because of the
similarity between δι' αὐτοῦ and Διάδου and because

it is very difficult to see what δι' αὐτοῦ should mean. Furthermore at 10.10 we are told that Diades and Charias campaigned with Alexander, which fits in very well with the phrase ἀκολουθησάντων Ἀλεξάνδρῳ. A far simpler method of dealing with the difficulties presented by the phrase δι' αὐτοῦ is simply to excise it and read:

ἐκ τῶν Δηϊμάχου Περσικῶν (ὁρ Πολιορκητικῶν)
καὶ τῶν ἀκολουθησάντων Ἀλεξάνδρῳ.

5.13 Πύρρου τοῦ Μακεδόνης γραφέντων πολιορκητικῶν.

Pyrrhos was not really a Macedonian but an Epirot. He was king of the Molossians and lived 319-273 B.C. During his eventful life he was several times at war with the Macedonians. He was, however, very popular with the Macedonian troops and great numbers of them went over to him. In fact at one time he was proclaimed king of Macedon:

ἐπελθὼν δὲ ὁ Πύρρος ἀμαχεὶ παρέλαβε τὸ στρατόπεδον
καὶ Βασιλεὺς ἀνηγορεύθη Μακεδόνων. (Plut., Pyr. 11.6)

He spent his whole life in military exploits and was a very capable general who apparently left behind some writings on military matters:

Τῆς δὲ περὶ τάξεις καὶ στρατηγίας ἐπιστήμης αὐτοῦ
καὶ δεινότητος ἔνεστι δείγματα λαβεῖν ἐκ τῶν γραμ-
ματῶν ἃ περὶ τούτων ἀπολέλοιπε. (Plut., Pyr. 8.2)

For further information see Plut. Pyr.; Jacoby FGH 2B, 229; and Dietmar Kienast in RE 24, 108-165 s.v. "Pyrrhos (13)".

6.2 παράλληλον ἐκεῖνος MSS.; παρ' ἄλληλα ἐκεῖνα

Schwartz. Schwartz's reading is to be preferred, for if we read ἐκεῖνος it must surely refer to Kalanos whereas if we read ἐκεῖνα it refers to the works rather than to the person. This agrees better with the rest of the sentence, as it is talking about the works rather than about the authors.

6.6 καθάπερ συνέβη Ἰσοκράτει. This passage refers to Isokrates' Philippos 7. The text given here differs slightly from the text which is found in editions of Isokrates:

ὄντος δ' οὖν ἐμοῦ περὶ τὴν πραγματείαν ταύτην ἐφθητε
ποιησάμενοι τὴν εἰρήνην, πρὶν ἐξεργασθῆναι τὸν λόγον.

7.1 Ὁ μὲν γὰρ ἱστοριογράφος Καλλισθένης. The historian Kallisthenes was a nephew of Aristotle who accompanied Alexander's expedition as an official historian. He quarrelled with Alexander over the question of obeisance and was eventually executed for alleged complicity in a plot against Alexander. For further information see W. Kroll in RE 10.2, 1674-1726 s.v. "Kallisthenes (2)"; Arrian, Anab. 4.10-11; Plut. Alex. 52-55; Diog. Laert. 5.4-5; and Suidas s.v. "Καλλισθένης".

7.3 προσώπου. None of the usual meanings of προσώπον seems to make much sense here. The meaning required is, however, fairly obvious from the context. It must mean something like "purpose".

7.7 τοῦ μηχανικοῦ Ἀγησιστράτου. See my chapter on dating.

8.4 αὐτοῖς ἐπεῖναι conjectured by Wescher; αὐτοῖς ἀπ' ἧ Μ; αὐτῆς ἐπὶ F; αὐτοῖς ἐπὶ other MSS. The simplest thing to do here is to obelize the phrase since the sentence makes perfect sense without it.

8.7 In this thesis, wherever measurements occur, I have adhered to the following system:

1 πῆχυς (cubit) = 6 παλαισταί (palms) = 24 δάκτυλοι (fingers)

1 πούς (foot) = 4 παλαισταί = 16 δάκτυλοι

1 σπιθαμή (span) = 3 παλαισταί

1 στάδιον (stade) = 600 ft. (πούς)

1 talent = 60 minae = 6000 drachmae = 36,000 obols.

For purposes of conversion I have used the following:

1 πῆχυς = 44.4 cm. (W. Becher RE 19.1, 6 s.v. "πῆχυς")

and 1 talent (Attic-Euboic) = 36.86 Kg. (F.N. Pryce

OCD s.v. "Weights").

8.7 ὁ γὰρ τρισπίθαμος αὐτοῦ καταπάλης. The compound adjective τρισπίθαμος occurs first in Hesiod, Op. 426, but the noun σπιθαμή is first used by Herodotus 2.106. τρισπίθαμος means 'three spans long' (i.e. 66.66cm.). The question now arises what was three spans long in a τρισπίθαμος καταπάλης ? Vitruvius 10.10.1 tells us,

Omnes proportiones eorum organorum ratiocinatorum
ex proposita sagittae longitudine, quam id organum
mittere debet

Thus it would seem that τρισπίθαμος must refer to the length of the arrow. Vitruvius explains how the

dimensions of every part of the catapult are related to the length of the arrow and therefore by applying his rules we can arrive at a fairly accurate representation of a catapult.

It is known from the ancient sources that there were basically two types of catapults, the euthytone and the palintone. It is further known that all rock-throwers were of the palintone type and most dart-throwers of the euthytone type although some of these were also palintones. However, it is not known what the difference was between these two types of catapult. The only statement we possess that seems to shed any light upon the situation is that of Heron who says,

τὰ δὲ εὐθύτονα τὰ μὲν ἄλλα πάντα τὰ αὐτὰ ἔχει τῷ
παλιντόνῳ πλὴν ὅτι τὰ δύο ἡμιτόνια εἰς ἓν πλινθίον
σὺγκειται ἀπέχοντα ἀλλήλων τὸ τῆς διώστρας πλατος.

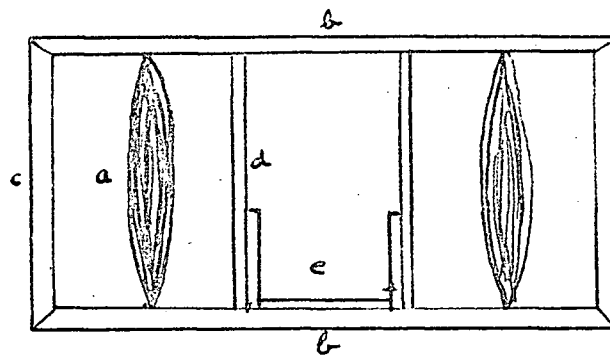
Köchly and Rüstow (Griechische Kriegsschriftsteller) did not think that this was a great enough difference to distinguish two classes of machines and they therefore posited a theory of their own. They said that the κλιμακίς of the palintone catapult raked downward at an angle of 45° and was fastened to the ground. This means that the palintone catapult would have a fixed range and furthermore it would mean that all shots would be lobbed in on a rather high trajectory, which is hardly suitable for such tasks as knocking down walls. This suggestion seems quite ludicrous.

For why would anyone build such a comparatively use-
less machine when a much more useful one could be
built with only minor adjustments?

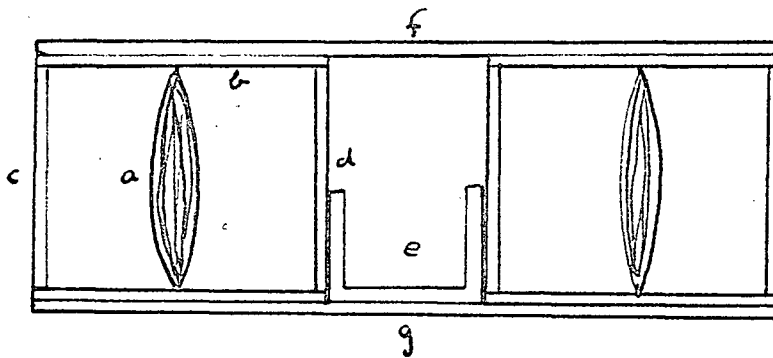
Barker (" Παλίντονον καὶ Εὐθύτονον " CQ 14 (1920)
pp. 82-86) takes the statement literally. He says
that all ancient catapults were really palintones by
virtue of the fact that their springs worked in opposite
directions. His theory seems to be that the main
difference was one of size, for ancient machines were
constructed of very large heavy timbers and were
disassembled for transport. As the size of the machines
increased, the size of the component parts increased,
sometimes to such an extent that transport would become
impossible. If this happened the pieces would have to
be modified in order to make transport practicable.
Barker says that in an euthytone catapult the two
springs were contained in a single frame (πλινθίον)
which consisted of:

a beam top and bottom, each comprising in
itself bore-beams and bed or couplers, two
side posts, one at each end, outside the
springs, and two mid-posts (μεσοστάται)
between the springs at a distance from each
other allowing for the breadth of the διώστρα
or the σύριγξ.

As such a machine increased in size this frame would
become unwieldy and in order to make it more transport-
able a method was devised whereby it could be separated
into several parts and thus more easily moved. This,



- a = spring
- b = top and bottom-beams
- c = side-posts
- d = μεσοστάται
- e = διώστρα or σύριγξ

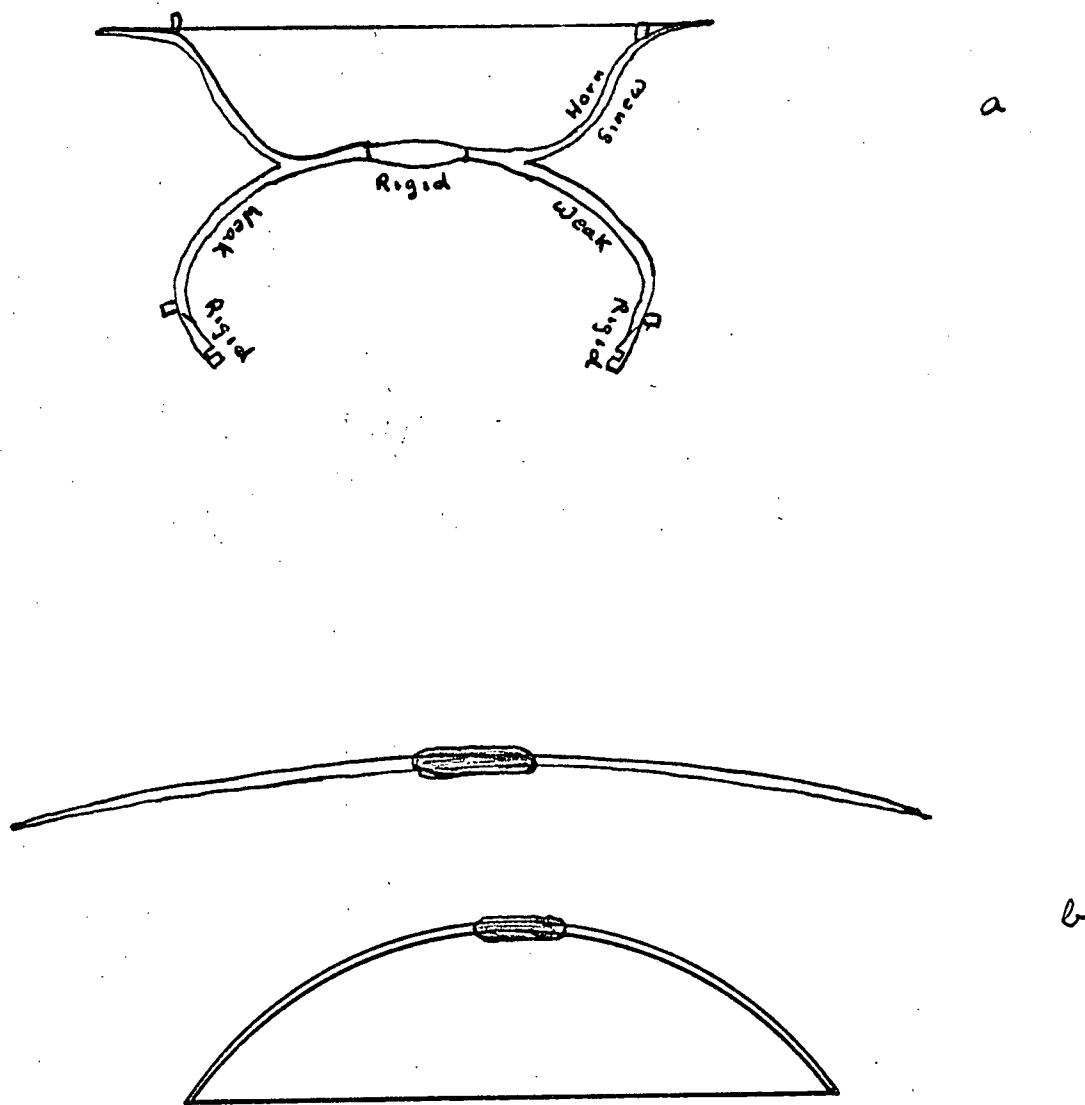


- a = spring
- b = περίτρητα
- c = παραστάτης
- d = αντίστατης
- e = κλιμακίς
- f = κανόνες
- g = τράπεζα

Barker says, is the palintone catapult in which:

each spring has its own frame (ἡμιτόνον), separately built, consisting of two bore-beams (περίτρητα) top and bottom, a side post (παραστάτης) forming the outer side of the frame when the gun is assembled and a counter-post (ἀντιστάτης) forming the inner side and facing, as its name implies, the ἀντιστάτης of the complementary spring frame on the other side of the κλιμακίς. The two frames are then placed and fixed upon a bed (τράπεζα) and secured at the top by two wooden coupling-bars (κανόνες). For transport the whole structure was usually taken to pieces except the actual spring-frames (ἡμιτόνια).

The more usual view (Lafaye in DA s.v. "Tormentum" and De Rochas, p. 783 note 1) is that in the palintone catapult the arms were directed away from the shooter while in the euthytone catapult the arms were directed toward the shooter. This is most easily understood by comparing the compound Tartar bow with the ordinary self-bow where an analogous situation exists. This explanation fits in well with what should be the meanings of παλίντονος and εὐθύτονος. LSJ s.v. παλίντονος says 'bent backward, i.e. the opposite way to that in which they were drawn, τόξα, in Hom. of the bow whether strung or unstrung'. παλίντονα τὰ military engines for throwing stones but not pointed missiles = λιθοβόλα.' Therefore εὐθύτονος should mean 'bent correctly' which LSJ does not give. Instead s.v. εὐθύτονος it says 'opp. παλίντονος, term applied to the lighter torsion engines.'



The Composite Bow Strung and Unstrung (a) as Compared with the Self-bow Strung and Unstrung (b).

Köchly and Rüstow's view (based on no evidence at all) seems almost too ridiculous to consider. Barker has taken the passage from Heron and has made good sense of it but the meanings for παλίντονος and εὐθύτονος derived by him seem to be somewhat suspect. The view of Lafaye et al. seems to have made good sense from the words παλίντονος and εὐθύτονος, but does not accord well with the passage from Heron. As Heron is the only ancient author who explains anything about the difference between the two types of catapults it seems best to accept Barker's views, which are based upon Heron; but this cannot be done without reservation.

8.9 'Απολλώνιος. See my chapter on dating.

8.13 "Ος must certainly refer back to Agesistratos.

9.4 Κριὸν μὲν ἔφασκεν εὐρεθῆναι πρῶτιστον ὑπὸ Καρχηδονίων ἐν τῇ περὶ Γάδειρα πολιορκίᾳ. This statement is quite untrue. The appearance of the battering-ram and the "ram-bearing tortoise" in ancient Egyptian paintings and in Assyrian bas-reliefs (see A.H. Layard, Nineveh and its Remains, vol. 2, pp. 366-373 (London, 1849); C. De la Berge in DA 1, 422-423 s.v. "Aries"; and J.G. Wilkinson, Manners and Customs of the Ancient Egyptians, pp. 359-364 (London, 1837)) shows that the invention of this machine took place far earlier than

Athenaios or Vitruvius, who for the most part agrees with Athenaios, had believed. Pliny (N.H. 7.57) tells us that the battering-ram was invented by Epeus during the siege of Troy, but there is absolutely nothing in Homer to support this. Others (App. Bell. Mithr. 73; Servius, Ad Aen. 9.505) have ascribed the invention to Artemanes of Clazomenae (fl. 440 B.C.). It is absolutely useless to speculate on the invention of the battering-ram for it is such a simple machine that its history must extend far back into antiquity. As the Renaissance scholar Justus Lipsius so aptly remarked:

quid opus vel a Poenis petere, quod ipsa
ubique ratio et paene natura commonstrat?
(Poliorketikon Bk. 3 dial.1).

It is, however, obvious that this machine had reached a high degree of sophistication at a period earlier than that to which Athenaios ascribes its invention.

- 9.4 Γάδερα. Traditionally founded somewhere around 1100 B.C. The date of the siege by the Carthaginians is unknown. K. Orinsky (RE 19.1, 560 s.v. "Pephrasmenos") dates it to the third century B.C. A. Schulten (CAH 7 chap. 24) says,

Further evidence of the destruction of Tartessus can be found . . . in the description given by Athenaeus (Vitruvius 10.13) of the taking of a fort near Gades and then of Gades itself. By Gades must be meant Tartessus (a confusion which is not uncommon), for the historical Gades was a Phoenician town which must have been a more or less willing ally of Carthage. The mention of the fort, too,

suggests Tartessus, for that city could only be besieged after the capture of the stronghold of Geron which commands the mouth of the Guadalquivir. The destruction of Tartessus and Maenace was complete: even their names were blotted out, for in later times Gades was generally substituted for Tartessus and Malaca for Maenace, a fact that also suggests that Gades succeeded to the trade of Tartessus, Malaca to that of Maenace.

Schulten places this destruction in the closing years of the sixth century B.C.

- 9.10 Πεφρασμένος. According to both Athenaios and Vitruvius, he was the first to improve the battering - ram by suspending it from an upright pole and swinging it back and forth. See Vitruv. 10.13.2 and Orinsky loc. cit.
- 9.15 Γήρας . . . ὁ Καρχηδόνιος. Apart from what Athenaios and Vitruvius (10.13.2) tell us, nothing seems to be known about this man.
- 10.2 Schneider wants to read as follows: ἀλλ' ὑπὸ πλῆθους ἀνδρῶν προωθούμενον ἐποίησε. Γήρας δὲ ὁ πρῶτως εὐρών τὸ ὑποτρόχον σιέπασμα ὃ διὰ τὴν βραδύτητα χελώνην προσηγόρευσεν. He has obviously done this to provide an object for εὐρών and an antecedent for the ὃ that appears in the MSS. His version certainly seems preferable to Wescher's, which has ὑπότροχον . . . σχεδίαν and ὑπότροχον σιέπασμα in the same sentence. However, his emendation is not strictly necessary as it is perfectly evident what the object

of εὐρών is even though it is not expressed. All the MSS. read εὐρὸν ὅ. In Schneider's emendation the ὅ remains, but produces a sentence without a main verb. At any rate the meaning is obvious. A passage in Josephus (Bell. Jud. 3.216) is a close parallel to this:

ἀνωθούμενος δὲ ὑπὸ πλήθους ἀνδρῶν εἰς τὸ
κατόπιν, τῶν αὐτῶν ἀθρόως πάλιν εἰς τοῦμ-
προσθεν ἐπιβρισάντων τύπτει τὰ τείχη τῷ
προανέχοντι σιδηρῷ.

- 10.3 According to Athenaios Geras called this machine a "tortoise" on account of its slowness of movement, but according to Vegetius (4.14) it is called a "tortoise" because the ram protrudes and is withdrawn in a manner similar to the head of a real tortoise.
- 10.5 Διονυσίου τοῦ Σικελιώτου τυραννίδα. He lived 432-367 B.C. and was the son-in-law of Hermocrates. After an abortive attempt by the Syracusans to relieve Agrigentum from the Carthaginians (406 B.C.), with the support of Philisteus he was elected general. Later he accused his colleagues of complicity with the enemy and managed to get himself appointed στρατηγὸς αὐτοκράτωρ. After this, by deceitful means, he obtained a body guard. He then strengthened the army and established a tyranny. To consolidate his position he fortified Ortygia and embarked upon a policy of military expansion, in the execution of

which (399 B.C.) he apparently made extensive use of war machines. Diodorus Siculus, who is the chief source for the life of Dionysios, mentions these machines several times:

Καὶ γὰρ τὸ καταπελτικὸν εὐρέθη κατὰ τοῦτον τὸν καιρὸν ἐν Συρακούσαις. (Diod. 14.42.1)

διόπερ ἀνυπέρβλητον φιλοτιμίαν εἰσφέροντες οἱ τεχνῖται πολλὰ προσεπενοοῦντο βέλη καὶ μηχανήματα ξένα καὶ δυνάμενα παρέχεσθαι μεγάλας χρείας. (14.42.2)

κατεσκευάσθησαν δὲ καὶ καταπέλται παντοῖοι καὶ τῶν ἄλλων βελῶν πολὺς τις ἀριθμὸς. (Diod. 14.43.3)

Διονύσιος δὲ τῇ πολυχειρίᾳ τῶν ἐργαζομένων συντελέσας τὸ χῶμα, προσήγαγε παντοίας μηχανὰς τοῖς τεύχεσι, καὶ τοῖς μὲν κριοῖς ἔτυπτε τοὺς πύργους, τοῖς δὲ καταπέλταις ἀνέστελλε τοὺς ἐπὶ τῶν ἐπάλξεων μαχομένους προσήγαγε δὲ καὶ τοὺς ὑπὸ τῶν τροχῶν πύργους τοῖς τεύχεσιν, ἐξωρόφους ὄντας, οὓς κατασκεύασε πρὸς τὸ τῶν οἰκιῶν ὕψος. (Diod. 14.51.1)

Apart from his military achievements Dionysios also wrote poetry, and in 367 B.C. he took first prize in the Lenaea at Athens for a play entitled The Ransom of Hector ("Ἐκτορος λύτρα"). For further information see Diodorus Siculus, Bks. 13-15 and Dietrich in RE 5.1, 882-904 s.v. "Dionysios (1)".

- 10.7 κατὰ τε τὴν Φιλίππου τοῦ Ἀμύντου βασιλείαν. This refers to Philip II of Macedon who ruled from 359-336 B.C. He was most noted for his military exploits but also made some important changes in the government and in 356 B.C. he introduced a new coinage. In 341/0 B.C. he besieged Perinthos and in the following year Byzantium. Both these sieges were unsuccessful but the following passage from Diodorus Siculus shows to what an extent he had developed

siege warfare.

συστησάμενος δὲ πολιορκίαν καὶ μηχανὰς προσάγων τῇ πόλει καθ' ἡμέραν ἐκ διαδοχῆς προσέβαλλεν τοῖς τεύχεσιν. ὀγδοηκονταπῆχεις δὲ πύργους κατασκεύασας, ὑπεραίροντας πολὺ τῶν κατὰ τὴν Πέρινθον πύργων, ἐξ ὑπεροχῆς κατεπόνει τοὺς πολιορκουμένους ὁμοίως δὲ καὶ διὰ τῶν κριῶν σαλεύων τὰ τεύχη καὶ δια' τῆς μεταλλείας ὑπορύττων ἐπὶ πολὺ μέρος τὸ τεῖχος κατέβαλεν . . . τρισμυρίους δ' ἔχων στρατιώτας καὶ βελῶν καὶ μηχανῶν πολιορκητικῶν πλήθος, ἔτι δὲ τὰς ἄλλας μηχανὰς ἀνυπερβλήτους κατεπόνει τοὺς πολιορκουμένους. (Diod. 16.74.2)

In 336 B.C. Philip was assassinated and his son Alexander came to the throne.

Alexander, himself made use of siege techniques. In 332/1 B.C. he attacked the city of Tyre, which was extremely well defended:

ἔχοντες δὲ πολλὴν δαψίλειαν καταπελτῶν καὶ τῶν ἄλλων μηχανῶν τῶν πρὸς πολιορκίαν χρησίμων ἐτέρας πολλαπλασίους κατασκεύασαν ῥαδίως διὰ τῶν ἐν τῇ Τύρῳ μηχαναποιῶν καὶ τῶν ἄλλων τεχνιτῶν παντοδαπῶν ὄντων. διὰ δὲ τούτων ὀργάνων παντοδαπῶν καὶ ξένων ταῖς ἐπινοίαις κατασκευαζομένων ἅπας μὲν ὁ περίβολος τῆς πόλεως ἐπληρώθη τῶν μηχανῶν. (Diod. 17.41.3-4)

Alexander built a huge mole in the sea to serve as an approach for his machines. When this was completed he brought up his machines and put them into action, but the Tyrians took most effective countermeasures. In the end Tyre fell to siege, but the resistance she put up was so great that at one time Alexander was on the point of giving up the siege and sailing to Egypt. For further information see Diodorus Siculus, Bks. 16 and 17; A.W. Pickard-Cambridge, in CAH 6, chaps. 8 and 9;

Fritz Geyer in RE 19.2, 2266-2303 s.v. "Philippos (7)";
K.J. Beloch, Griechische Geschichte 3.2, pp. 49-80.

- 10.9 Πολύειδος ὁ Θετταλός. He is mentioned in a papyrus fragment (Pap. Berol. P. 13044) which is dated by W. Schubart to the end of the second or beginning of the first century B.C. It has been transcribed as follows:

Μηχανικοί/ 'Επικράτης 'Ηρακλεώ-/τος (της)
ὁ τὰ [έ]ν 'Ρόδῳ ὄρ-/γανα πολεμικὰ ποι-/
ήσας Πολύειδος ὁ τὴν/ ἐλόπολιν ἐν Βυζαντίῳ
καὶ τὴν ἐν 'Ρόδῳ τετ[ρά]κυκλον/ 12 Διάδης
ὁ μετ' 'Αλεξάν-/δρο[υ] το[υ] βασιλέως/ Τύρ[ο]ν
καὶ τὰς λοιπὰς/ πόλεις πολιορκῶν//

He is also mentioned by Philon (Mech.) (Synt. Mech. 5.83.8-9) who credits him with the invention of a saw-like fortification. Vitruvius mentions him twice (7.praef.14; 10.13.3).

- 10.10 Διάδης καὶ Χαρίας. Diades is mentioned in the papyrus (cf. 10.9) fragment, but Charias is not. Athenaios and Vitruvius (7.praef.14; 10.13.3) both mention them, as does Anonymous of Byzantium (238.12). Diades would seem to be the more important, as both Athenaios and Vitruvius discuss his writings at some length, whereas all they tell us about Charias is that he was a pupil of Polyeidos and accompanied Alexander.

- 10.12 For moveable towers see 11.4 and for the "trypanon" see 14.4. The "crow", which was apparently some kind of a grappling hook and the scaling-ladder are so

simple that they are not worthy of comment.

11.2 The illustration in the text (cf. 39.9 Wescher's fig. I) under the heading $\kappa\rho\iota\omicron\upsilon \kappa\alpha\tau\alpha\sigma\kappa\epsilon\upsilon\eta$ is certainly not of a "ram" but rather of a "trypanon" (cf. 14.4). Sackur (p.102) reckons that this is the oldest of the illustrations, because it differs so drastically from all the others in that it is far clearer and much more informative.

11.4 This section presents some very great problems. It deals with two different sizes of towers (one 60 cubits high, the other 120 cubits high), but says that the division of floors follows the same pattern in both, namely that the first story should have a height of 7.5 cubits, the next five stories a height of 5 cubits, and the remainder a height of 4.3 cubits. It further states that the 60 cubit tower had 10 stories and the 120 cubit one 20 stories. If we work out the heights of these towers in accordance with the above stated scheme we find that the answers we arrive at differ drastically from the heights of 120 cubits and 60 cubits which appear in the text.

60 Cubit Tower		120 Cubit Tower	
1x7.5 cubits	=7.5 cubits	1x7.5 cubits	=7.5 cubits
5x5.0	=25.0	5x5.0	=25.0
4x4.3	=17.2	14x4.3	=60.2
	<hr/>		<hr/>
	49.7		92.7

Something is obviously wrong, but just what it is is unclear. Sackur (pp. 103-112) has presented two solutions to the problem, neither of which is completely satisfactory. He suggests that where our texts read 23 1/2 cubits and 17 cubits we should emend them to read 22 1/2 cubits and 15 cubits. Then we have a basic unity of 7.5 cubits (the figure given by Athenaios for the height of the first story). For the larger tower we then have the following scheme:

width 3×7.5 cubits ≈ 22.5 cubits

height 16×7.5 cubits $= 120$ cubits

basic unit $= 7.5$ cubits

tapering $\frac{3 \times 7.5}{5} \frac{1}{2} = 2.25$ cubits $= 54$ fingers

tapering of 19 floors above base $= \frac{54}{19} = 2.84$ fingers

total height of 19 stories if the height $=$ width

19×7.5 cubits $- 2.84 (1 + 2 + 3 \dots 19)$ fingers

$= 142.5$ cubits $- 2.84 \times 190$ fingers

≈ 142.5 cubits $- 22.48$ cubits ≈ 120 cubits

Similarly for the small tower we get a height of 60 cubits. The method, while it produces the correct solution, bears no relation to the data given in the text. Furthermore it requires an emendation of the text.

His second method follows the text more closely. It is as follows:

5×7.5 cubits ≈ 37.5 cubits

$5 \times 5.0 \quad \quad = 25.0$

$$9 \times 4.3 = \underline{38.7}$$

total 101.2 cubits

However, on the authority of Anon. of Byzantium (244.3-11)

τό τε σύμπαχον τοῦ καταστρώματος τῶν στεγῶν καὶ
τὸ κάτωθεν τοῦ ἐσχαρίου σὺν τῷ ἄνωθεν ἀετώματι
τῷ ὕψει συνηρίθμουν.

he assumes a thickness of one cubit for each floor and arrives at the following:

$$5 \times 8.5 \text{ cubits} = 42.5 \text{ cubits}$$

$$5 \times 6.0 = 30.0$$

$$9 \times 5.3 = \underline{47.7}$$

total 120.2 cubits

In the first place, the Greek cannot be construed to mean that the first five stories rather than the first story alone had a height of 7.5 cubits, and in the second place if we apply this method to the smaller tower we get the following result:

$$5 \times 8.5 \text{ cubits} = 42.5 \text{ cubits}$$

$$4 \times 6.0 = 24.0$$

total = 66.5 cubits

which gives us an error of over 10%, far too large to be allowed. Sackur may be on the right track when he suggests the basic module, as there is a considerable amount of evidence (e.g. Vitruvius 10.10) that things were constructed according to such modules, but if he is right, something is obviously wrong with the text.

- 11.7 On the basis of Vitruvius (10.13.4) which reads semi-pedalia, Schneider wants to change ἑπταδάκτυλα to ὀκταδάκτυλα. There are several other places in the text (17.8 and 24.5) where he makes similar alterations because of the reading in Vitruvius. I do not really see that the change is necessary, since there is no reason why Athenaios and Vitruvius should agree on everything and the difference between the two measurements here (1.85 cm.) is so small. It is interesting to note that in at least one place (Vitruvius 10.15.6) editors have emended Vitruvius on the basis of Athenaios (cf. 24.5).
- 12.11 αὐτάς. Wescher has supplied this by conjecture from M which reads αὐταῖς. The other MSS. read αὐτούς which certainly must be correct as it refers to the towers and πύργος is a masculine noun.
- 13.4 ἐπὶ ὀξύτατον M; ἐπὶ τὸ ὀξύτατον other MSS. The reading of the other MSS. seems best as it gives a parallel construction to ἀπὸ τοῦ καταστρώματος.
- 13.10 ἴσταται δέ. Wescher reads this from F. The other MSS. read ἴστα δέ. There seems to be little to choose between the two as both mean 'he placed'. As M's readings are generally to be preferred perhaps ἴστα δέ should be read. This would conform with the other Ionic forms that occur throughout the text.

- 14.4 Diades' "trypanon" is rather different from the one described by Apollodoros (Wescher 148.2). Apollodoros' "trypanon" was a rotary machine which drilled holes in the walls, while Diades' machine worked basically in the same manner as a battering-ram. The principal difference between this machine and the battering-ram was that it rested on rollers supported directly upon the base, while the battering-ram was suspended from the superstructure. Wescher's fig. I (cf. 39.9) shows very clearly how Diades' "trypanon" worked, or at least it coincides exactly with the description given in the text.
- 14.6 τοῖς εὐθυτόνοις . . . καταπάλταις. See comments on 8.7.
- 15.5 Schneider wants to read οὗ φησι for Wescher's οὗ φημι. This is probably the better reading. Firstly, Vitruvius (10.14,8) has Diades as the subject and secondly, Diades is the subject of the rest of the paragraph and therefore it makes for better continuity to have him as the subject.
- 15.13 Φίλων ὁ Ἀθηναῖος. Ch. Graux, "Philon de Byzance," RPh 3 (1879) p.99, maintains that this must surely be a mistake and that it is Philon of Byzantium who is actually referred to. This, in fact, is almost

certain, since in the text of Philon of Byzantium

(5.97.25) we read:

καὶ τὰς στοὰς οἰκοδόμει καὶ τοὺς ἐπιτη-
δείους τόπους ὑπόρυττε, ἔαν μὴ ὑπομβρος
ἢ ὁ τόπος ἢ χελώνας κατασκευασάμενος χως-
τρίδας, τὰς τάφρους χώννυε τὴν χώραν μὴ
φθείρων.

Philon of Byzantium is a fairly well known mechanician who wrote at the end of the third or the beginning of the second century B.C. A portion (dealing with war machines) of his work, Mechanicae Syntaxis, is preserved. For further information see Orinsky, Neugebauer, Drachmann in RE 20.1, 53-54 s.v. "Philon (48)".

- 16.1 Graux, loc. cit., reads πρὸς τε τὰς γινομένης προσ-
αγωγὰς τῶν μηχανημάτων καὶ τὰς παρεκτάσεις τῶν στωδίων
καὶ. . . Schneider reads πρὸς τε τὴν προσαγωγήν τῶν
μηχανημάτων καὶ τὰς παρεκτάσεις τῶν στωιδίων καὶ ...

Both these readings, as well as Wescher's, require only slight emendations of the text and as the meaning of all three is the same there is little to choose between them. Wescher's σταδίων, however, cannot stand as it is practically meaningless in this context. Graux's στωδίων makes very good sense and should certainly be read here. The word στωίδιον or στώδιον also appears elsewhere in the text (Ath. Mech. 31.6).

- 16.9 τεσσάρων. The MSS. read ᾤ here and it is unclear whether this goes with ἀμαξίποδας or χώρα. Wescher reads τεσσάρων putting it with χώρα, 'each compartment

of the four in the corners . . .'. Schneider reads τέσσαρας making it agree with ἀμαξίποδας, 'each compartment of the ones in the corners holds four axle blocks'. Both these readings seem possible and if one examines the diagram (cf. 39.9 Wescher's fig. II) it will be seen that both can be supported. For while the four corner compartments each contain the axle blocks, each one contains four, so the question must remain in doubt. Personally I am inclined to agree with Schneider since it seems to me to be somewhat redundant to say 'each compartment of the four in the corners'. There are only four in the corners and the same meaning is conveyed by saying 'each of the corner compartments'. If we do ^{not} take $\bar{\Delta}$ with ἀμαξίποδας we have no way of knowing (apart from the diagram) that there were four axle blocks in each corner. Thus, although its position may be rather unorthodox the $\bar{\Delta}$ should be taken with ἀμαξίποδας. Taken in this way it contributes to our information; taken with χώρα it is redundant.

- 16.10 Schneider (p.60) says that the axle-blocks (ἀμαξόποδες) have a semi-circular form and open upwards. Sackur (p.67) agrees on the semi-circular form but has them opening downwards. This seems a more logical arrangement. For if the axle were placed in semi-circles opening upward, the total weight of the machine would

tend to lift the axle out of the axle-blocks and some method that would require a relatively strong structure would have to be found to stop the axle from coming out of the axle-block. If, on the other hand, the axle-blocks opened downwards as Sackur suggests the entire weight of the machine would tend to keep the axle in the axle-block. Both Sackur and Schneider agree that sideways motion of the axle in the axle-blocks was prevented by iron plates. With Sackur's arrangement it would be an easy matter to disengage the iron plates, turn the axle 90° and reattach the iron plates. The machine could then move at right angles to its original line of travel.

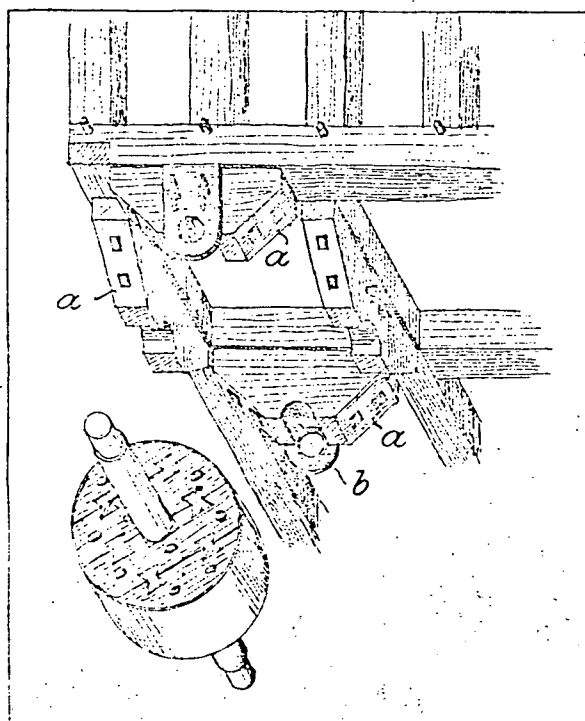


Abb. 36.

The machine described by Vitruvius (10.14.1) seems to be a somewhat refined model of that described by

Athenaios. His machine was capable of oblique movement as well as of sideways and forward and backward motion. Sackur has devised a simple method whereby this might be accomplished and furthermore this method is in accordance with that described by Vitruvius.

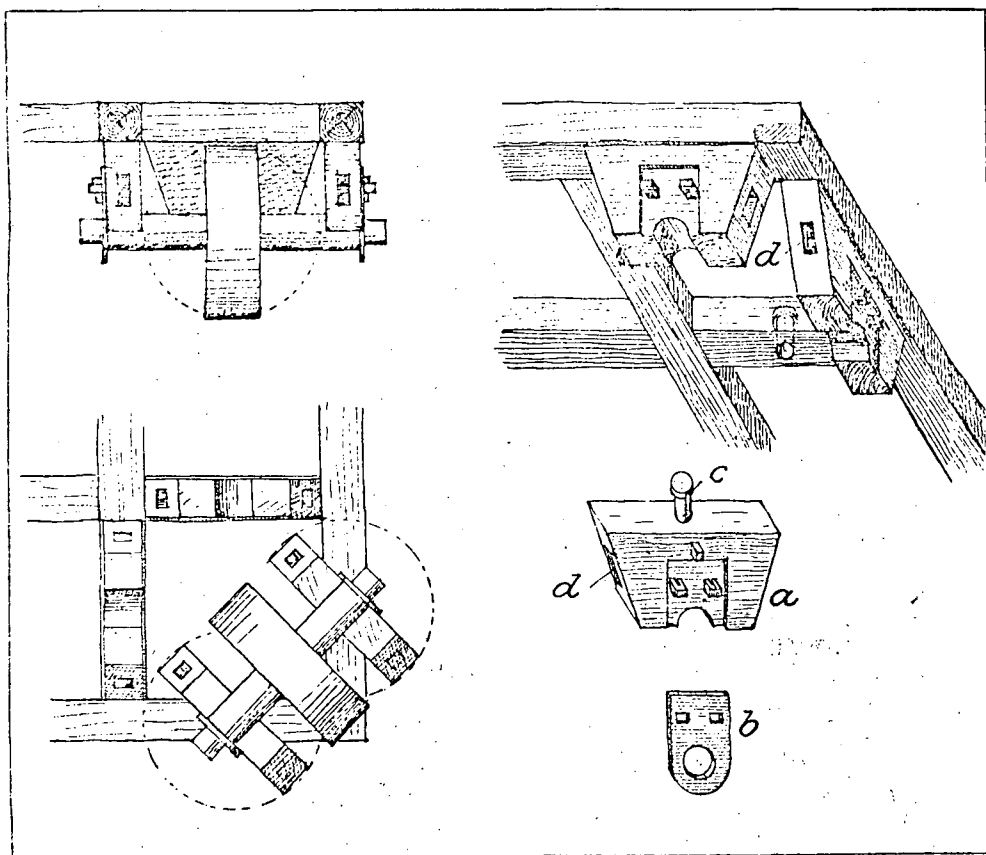


Abb. 37.

- 17.2 ψυχρηλάταις M; ψυχρηλάτοις F. Wescher follows M but Schneider follows F. The adjective is clearly supposed to agree with λεπίσι which, according to LSJ s.v. "λεπίς" is a feminine noun. Ψυχρήλατος (q.v. in LSJ) is an adjective of two terminations and therefore the dative feminine plural form would normally be ψυχρηλάτοις and F's reading should be accepted.
- 17.2 Choisy (Vitruve, Paris, 1909, Pl.81 and p.282) thinks that the beams described here served as a kind of outrigger to help balance the machine on rough terrain. Sackur (p.66) has projected his roof-timbers down to these projecting pieces presumably so that the machine will present no flat, easily broken sides to the enemy but only angular ones which missiles, rams, etc. will tend to glance off. While Sackur may be right, it should be noted that, using the dimensions given in the text or even emending ἑπταπήχεις to ἑξαπήχεις (cf. 17.8), his restoration is mathematically impossible. The roof beams will not meet the side-extensions.
- 17.8 ἑπταπήχεις M. Schneider, following Rose, reads ἑξαπήχεις on the basis of Vitruvius (10.14.2) "Cardines pedum VIIII." Applying the conversion factors (cf. 8.7) nine feet is found to be equal to six cubits. The difference between the two figures is not very large and there is no reason why one of these machines could not be built with pillars seven cubits high and another with pillars six cubits high.

The MSS. are unanimous in favour of seven cubits and there seems to be no valid reason why this should not be accepted (cf. 11.7 and 24.5).

- 18.4 ὁμοίως ταῖς στύλαις καὶ σάττεται F. Schneider, following M reads τύλαις. Why Wescher prefers the ridiculous reading of F to the reading of M, which he generally prefers, is a complete mystery. His text is translated into English as 'stitched together like pillars', a patently ridiculous statement. Reading τύλαις instead of στύλαις we get the eminently more sensible 'stitched together like mat^tresses' (cf. Diod. 17.45.4).

- 20.1 τὴν δὲ ἔμπροσθεν ὀρθὴν ἔχει προσαγωγὴν. This means that the "mining-tortoise" has a plane surface at the front and is in direct contrast to what Vitruvius says (10.15.1);

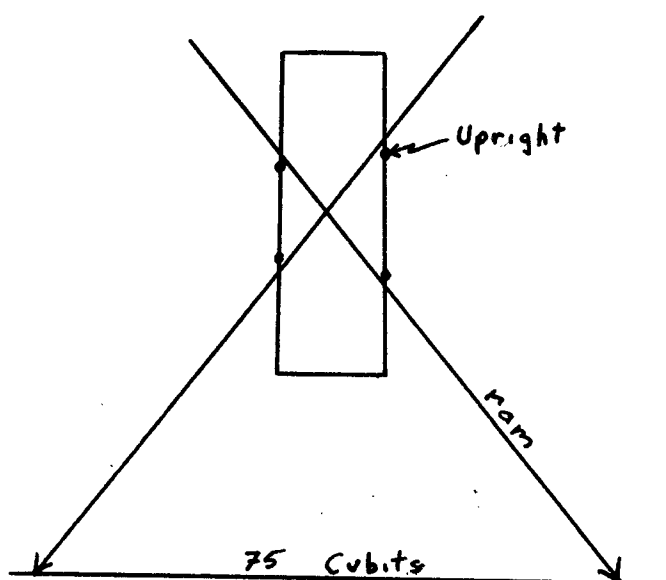
frontes vero earum fiunt quemadmodum anguli trigoniorum, uti a muro tela cum in eas mittantur, non planis frontibus excipiant plagas sed ab lateribus labentes, sine periculoque fodientes, qui intus sunt, intuentur.

Athenaios' machine then comes right up to the wall and fits tightly (ἀπαρτίση) against it. A front end such as Vitruvius describes would be useless in such a situation, ^{but} however, if for some reason it was impossible for the machine to come right up to the walls his design would be infinitely better.

21.1 The description given of the "tortoise of Hegetor" does not give us a clear picture of the machine. Sackur (pp. 75-85) on the basis of Vitruvius and Athenaios has attempted a reconstruction of this machine. His reconstruction has apparently been accepted by Granger, the editor of the Loeb, although he does not make the textual emendations necessary to support this reconstruction.

The roof, however, is not in accordance with the description given in the text. A split roof such as Sackur imagines would require two ridge-poles and the text mentions only one. If we reject Sackur's roof we are still left with the question of where the ram was situated. Was it inside the "tortoise" as A.A. Howard (Morgan, Vitruvius, 1926, facing p. 312) and Wescher's fig. IV (cf. 39.9) suggest, or was it above the roof as Choisy (Pl. 84) and Wescher's fig. V (cf. 39.9) suggest? The question seems insoluble.

Athenaios (21.2-3) tells us that the ram could sweep sideways 70 cubits. Sackur claims that four uprights make sideways motion impossible. Strictly speaking, this is not true. Four uprights do, to be sure, restrict sideways motion but they do not prevent it. In fact, with the four uprights placed as in the following diagram a sideways motion of almost 80 cubits is possible. Sackur believes that the four pieces called uprights are not actually uprights at all but rather cross-members of the base. He bases



this belief on the text of Vitruvius (10.15.2):

arrectaria, quae supra compactionem erant
quattuor conlocata, ex binis tignis fuerant
compacta, in altitudinibus singulo pedum
XXXVI, crassitudine palmopedali, latitudine
sesquipedali,

which he says is obviously corrupt since Vitruvius does not use conlocata for upright posts but rather would have said postes or arrectaria eriguntur and secondly, he does not use in altitudinibus but the genitive for lengths. On these grounds he emends the text to:

transversaria, quae supra compactionem erant
quattuor conlocata, ex binis tignis fuerant
compacta, singula pedum XXXVI, crassitudine
palmopedali, latitudine sesquipedali.

The description is now orderly; everything proceeds in the proper succession -- base, wheels, and superstructure, whereas before we jumped from base to superstructure and back again. Furthermore, we meet the same system for building foundations elsewhere (cf. "Tortoise for filling in ditches"). These four up-rights having been disposed of, two more remain (cf. 22.12-23.3). We now have a machine such as Sackur and Granger draw. Such a machine is no doubt possible but one with four up-rights is by no means so impossible as Sackur would have us believe.

The treadmills in Sackur's restoration are, as he himself admits, pure conjecture, but they are just as good a way of operating the ram as any other, so

we need not quarrel with him on that ground.

The dimensions of this machine are extremely large and in one case, at least, almost completely impossible. According to our text, this machine weighed four thousand talents (147,440 Kg.) and was operated by a total of 100 men. This means that each man would have had to push 40 talents (1,474.40 Kg.) which is clearly impossible as anyone who has ever tried to push an automobile (weight approx. 1,000 Kg.) can testify. How much more difficult must it have been to push a lumbering machine such as this on ~~wooden~~ wooden wheels over rough terrain than to push an automobile with rubber tires and well lubricated bearings along a smooth asphalt road?

As for the ram itself, while the description is somewhat confused, it is clear that it was bound up with various ropes and chains to reinforce it and prevent it from shattering. The forward end was apparently equipped with ladders and a net so that it could be used as a scaling-ladder as well as as a ram.

The six movements are illustrated very well by Sackur and the way in which they were effected is also shown clearly. The movements obviously refer to the ram itself rather than to the machine as a whole since it apparently had fixed wheels and axles and could only be made to change direction with great difficulty.

22.1 ψυχρηλάταις M; ψυχρηλάτοις FPVC. See comment on 17.2.

23.8 Ἐπὶ δὲ τοῦ περικεφάλου. The MSS. read ἐπικεφάλου which, according to LSJ s.v. "ἐπικέφαλον," means 'the head of a battering-ram'. This is obviously wrong. Firstly, the ἐπικέφαλον belongs to a κριοδόχη, 'the frame of a battering-ram', and it is clearly nonsense to say 'the head of a battering-ram of the frame of a battering-ram'. Secondly, in Wescher's fig. IV (cf. 39.9) the ἐπικεφάλη is clearly not the head of the battering-ram. It seems to refer to the winch structure that is located at the top of the two tall uprights (23.1). It should be noted, however, that περικέφαλον which appears in lines 3 and 5 (with no apparent MS. difficulties) does not appear on the diagram. Perhaps the two words περικέφαλον and ἐπικέφαλον are interchangeable.

23.10 ἐφοπτεύοντας MF; ἐποπτεύοντας PV. Miller (JS, 1868, p. 247) says that the first form is known only by a gloss while the second form, used by all writers, is Ionic, as ἀπ'οῦ for ἀφ'οῦ and ἀπήσειν for ἀφήσειν. As Wescher himself thinks that the text was written in Ionic and in many places has preferred the Ionic forms it is a mystery why he has chosen to read ἐφοπτεύοντας,

24.5 In place of τρισί Schneider, following J.G. Schneider, reads τέτρασι. This reading is based on Vitruvius (10.15.6) where funes IIII. Anon. of Byz. (230.6) reads τρισὶ σχοινίοις. As I have stated previously

(11.7) there is no reason why Vitruvius and Athenaios should agree in every detail and as there is nothing in the tradition of Athenaios that favours reading anything other than *τρισί* it can stand. It is interesting to note that several editors (Rose, Krohn, Morgan, and Granger) of Vitruvius, on the basis of Athenaios, have emended that text to funes III.

- 25.4 *τριτημορίων*. The meaning of this word, here, is somewhat obscure. Schneider makes what seems to be a very good suggestion, namely, that it refers to the thickness of the rope that was used to make the net. He compares this with the way in which we use the terms "two-ply" and "three-ply" for yarn. He imagines rope composed of three distinct strands, something with which we are all familiar.
- 25.6 *ἔχει δὲ καὶ παραδείγματα* MSS. This is absolutely meaningless as it stands, but Thévenot has made some sense out of it by emending *παραδείγματα* to *παρὰ-πήγματα*. Not only does the passage now make sense, but it is also a close parallel to *ἐπεπήγματα δύο τετράγωνα, καθάπερ σιαγόνια*, which is found in Anon. Byz. (259.19).
- 25.7 *ἐπειδὴ τὰ ταῖς κάσιαι παραπλήσια*. This is absolutely incomprehensible. There is absolutely no way of emending it to make sense and therefore the best course is to obelize it.

- 27.2 'Επιμάχου τοῦ 'Αθηναίου. Nothing more than what Athenaios and Vitruvius (10.16.4) tell us is known about Epimachos.
- 27.3 Δημήτριος ὁ 'Ροδίου πολιορκῶν. See 10.5 and my chapter on dating.
- 27.5 πήχεις \bar{H} MPV; πήχεις ὀκτώ F. Wescher, noticing that Vitruvius reads latitudo pedum LX, suggests that the Greek should read \bar{M} . De Rochas, following Graux, reads \bar{N} instead of \bar{H} . Plutarch's description (Demetr. 21.1) is as follows: ἐκάστην ἔχουσα τοῦ κάτω πλαισίου πλευρὰν ὀκτὼ καὶ τεσσαράκοντα (\bar{MH}) πήχων and Diodoros' (20.91.2) says τὴν μὲν πλευρὰν ἐκάστην ὑπεστήσατο πηχῶν σχεδὸν πεντήκοντα (\bar{N}). It appears obvious that the MSS. of Athenaios must be in error. The discrepancy between the eight cubits which they give and the 40 to 50 cubits which other sources give is too large to be accounted for by its being a different example of the same machine. Clearly a figure somewhere between 40 (\bar{M}) and 50 (\bar{N}) must be read.
- 27.7 Αἱ . . . μηχαναί, ἃς τινες σαμβύκας προσαγορεύουσιν. . . Polybios (8.4.3-11) gives a detailed account of the construction of a "sambyka" and the reason for its name. Basically this seems to have been a tower mounted on a ship in such a way that it could lie full length on the deck, protruding at the bow and

thus not tend to tip the ship over by making it top heavy. When the ship was brought up to the walls of a city the "sambyka" could be raised and by means of this men could pass from the ships onto the walls of the besieged city.

- 27.11 ἐν τῇ περὶ Χίου πολιορκίᾳ. This siege is mentioned by both Athenaios and Vitruvius but does not appear to be well known. The only siege of Chios of which I could find mention was the one of 358 B.C., by Chares and Chabrias (Diod. 16.7.3). These men besieged the city by both land and sea and were soundly defeated. There is no mention of "sambykai" in the account of this siege,

ὁ δὲ Χαβρίας προσπλεύσας τῷ λιμένι τῆς νεῶς
τοῖς ἐμβόλοις ἀναρραγείσης κατεπονείτο

so there is no way of knowing for certain whether or not this is the siege being referred to.

- 28.7 Καλλιστράτω. This seems to be the only time that this man is mentioned in ancient literature. Vitruvius (10.16.5) closely parallels the passage concerned with the effectiveness of models but makes no mention of Kallistratos.

- 29.4 Sackur (p. 91) thinks that these must have been step-ladders. His reason for thinking that step-ladders must have been used in the theatre is very sensible.

He says that by using a step-ladder an actor would be able to climb on stage without presenting his back to the audience and thus making himself a comic figure, especially when he was not supposed to be one.

The earliest occurrence of the word προσκήνιον referring to a part of a theatre would seem to be third century B.C. (IG 11(2) 153.14):

ΤΟΙΣ ΤΗΝ [C K] ΗΝΗΝ ΕΡΓΟΛΑΒΗΣΑCΙ ΚΑΙ ΤΟ
ΠΡΟΣΚΗΝΙΟΝ ΗΗΗΗΔ

Permanent stone προσκήνια do not seem to have come into existence until Hellenistic times (ca. the second century B.C.).

- 29.9 Κτησιβίος δὲ ὁ Ἀσκληνῶς ὁ ἐν Ἀλεξανδρείᾳ μηχανικός.
Ktesibios was quite famous in antiquity. Next to Archimedes he was, perhaps, the most famous engineer. He lived in Alexandria and was a barber by trade, but nonetheless was highly esteemed for his mechanical inventions. His main interests were hydraulics and pneumatics and his most famous invention was probably the water-organ. He also made water-clocks, pumps, and is even said to have made a rhyton that sounded a shrill note when the spout was opened for the flowing wine. There is some controversy about his date. Some want to date him to the third century B.C. in the reign of Ptolemy Philadelphos (285-247 B.C.) and others to the second century B.C. in the reign of Ptolemy Euergetes (170-116 B.C.). See Ath. Deipn. 11.497d and 4.174b; Pliny, NH 7.125;

Vitruvius 1.1.7, 9.8.2, and 10.7.4; and Philon (Mech.)
Synt. Mech. 4.77.12.

31.6 This passage is reminiscent of 8.1-14 where Athenaios says that it is often better to use the good inventions of others and not in every case to be an innovator. Here he is saying that he did not think it proper to contradict Pyrrhos' good work just because everyone else was doing so. These others, then, are not using the good inventions of the past.

31.7 Πύρρου. See 5.13.

32.5 ἐν τοῖς τεύχεσιν. The ἐν is excised by E. Miller (Poliorcétique des Grecs, "JS", 1868, p. 248) who argues that the stock phrase προσάγειν μηχανὰς, μηχανήματα, ἔργα κ.τ.λ. is always followed by the dative without a preposition. He cites the following examples:

μηχανὰς προσῆγον τῇ πόλει. (Thuc. 2.76)

μηχανῆς μελλούσης προσάξεσθαι αὐτοῖς. (Thuc. 4.115)

ὥς ἀπὸ δύο ὄνων προσάγοιτο τοῖς τῶν ἐναντίων
 τεύχεσι. (Ath. Deipn. 14.634a)

34.1 πρότροχον. The description that follows is obviously for some kind of a steering mechanism. Wescher's fig. X and fig. XI (cf. 39.9) are relatively clear and a device such as they depict could certainly be used to steer a machine. However, as Sackur (pp. 92-94) points out, the ropes mentioned (34.6) can hardly have been

16 fingers (0.30m) thick. The ἑκκαίδεκαδάκτυλον then, must refer to the length rather than the thickness of the ropes. Clearly the ropes in Wescher's figures are much more than 16 fingers long. Sackur proposes another method, as illustrated.

a = θερμαστρίς

b = μασχάλη

c = ὀδηγός

d = turning platform

e = 16 finger rope

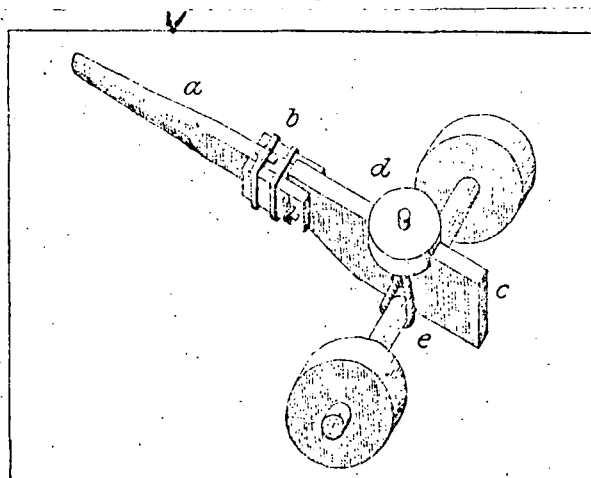
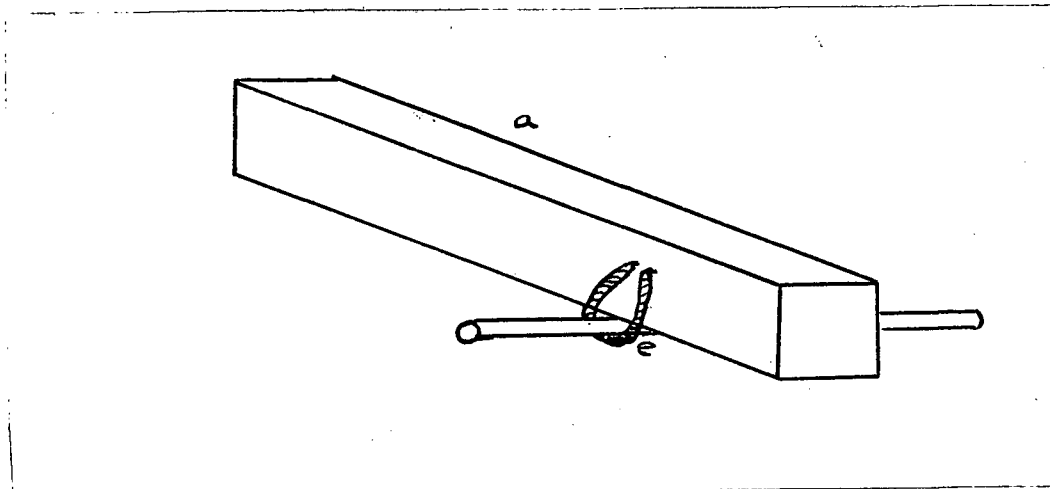


Abb. 48.

His method does not exactly fit the description in the text either. He has solved the problem of the ἑκκαίδεκαδάκτυλον rope, but has created a new one. What is the function of the ὀδηγός and the μασχάλη? In Wescher's figures the ὀδηγός as its name implies serves as a rudder; in Sackur's reconstruction it seems to serve no purpose at all. I cannot see that his system would be essentially changed if it were constructed as follows:



In this case many of the pieces mentioned in the text are missing (only the θερμαστρίς and the rope being present), but the system is not really changed at all.

Both the system in Wescher's diagrams and the system proposed by Sackur are possible but neither of them agrees completely with the description in the text. The system shown in Wescher's diagrams, however, conforms better with my understanding of the text.

34.5 ψυχηλάταις. See 17.2.

34.7 διῶσται Wescher from διέσται MV^2 and διώστε PVF. Schneider, after Schwartz, reads διέωσται. Both διῶσται and διέωσται are well attested forms, so there is little to choose between them.

36.1 ψυχηλάταις. See 17.2.

36.4 ἵνα ἐστὶ. This is difficult if not impossible to make any sense of. Therefore, following Schneider, I have obelized it.

36.6 κλιμακόδεσις F; κλιμακοδέσεις PV; κληματοδέσεις M. According to LSJ κληματόδεσις means 'wicker hurdle or mat', κλιμακόδεσις is obviously connected with κλίμαξ 'ladder'. Considering the context, either of these is possible. The purpose of the κληματόδεσις/κλιμακόδεσις is to provide footing for the men who are going to walk up the slanted beam. As wicker mats and ladders

could both serve this purpose quite effectively either reading seems equally possible. Schneider does not agree with this interpretation. He thinks that it was used as a bridge from the beam to the wall. A ladder could certainly be used for this purpose but a wicker mat does not seem particularly suited to it and as Schneider prefers the reading κληματοόδεσις his interpretation seems somewhat suspect.

- 36.7 Schneider's reading, περιπτυκτὴ seems definitely superior to Wescher's, περιπηκτὴ. Περιπηκτὴ comes from περιπήγνυμι which, according to LSJ, means 'fix round, fence round; make congeal round'. περιπτυκτὴ on the other hand means 'folding'. The adjective, whatever it may be, agrees with ἐξαιριτίς 'ladder'. Περιπτυκτὴ makes much more sense with ἐξαιριτίς than does περιπηκτὴ. If one considers the diagram (Wescher's fig. XII, cf. 39.9) one can see how this ladder appears to be fastened on in such a manner that it can be raised or lowered, a situation to which περιπτυκτὴ applies exactly.

- 36.9 ἐξανοιχθῆ PV; ἐξανολοσθῆ M; ἐξανυσθῆ F. M's reading is unattested. The readings of PV and F are both legitimate forms and both make sense in context. ἐξανοιχθῆ is from ἐξανόω which, according to LSJ means 'to lay open' or in the passive 'to be exposed'.

ἐξανύω, on the other hand, can mean 'to make effectual'. Thus whichever reading is accepted, the end result is the same. If the ladder 'is made effectual' it is let down so that it can be used, and likewise if the ladder 'is exposed' it is let down so that it can be easily seen. Therefore, regardless of which reading is accepted, the meaning of the phrase is simply 'the ladder was let down'. Presumably while the machine was being pushed up to the walls the ladder was in a retracted position, but once the machine had reached the wall the ladder was let down by ropes so that it could be used. (cf. 39.9 Wescher's fig. XII).

37.5 ὀχλοῦσιν. The subject of this verb is presumably the defenders of the besieged city.

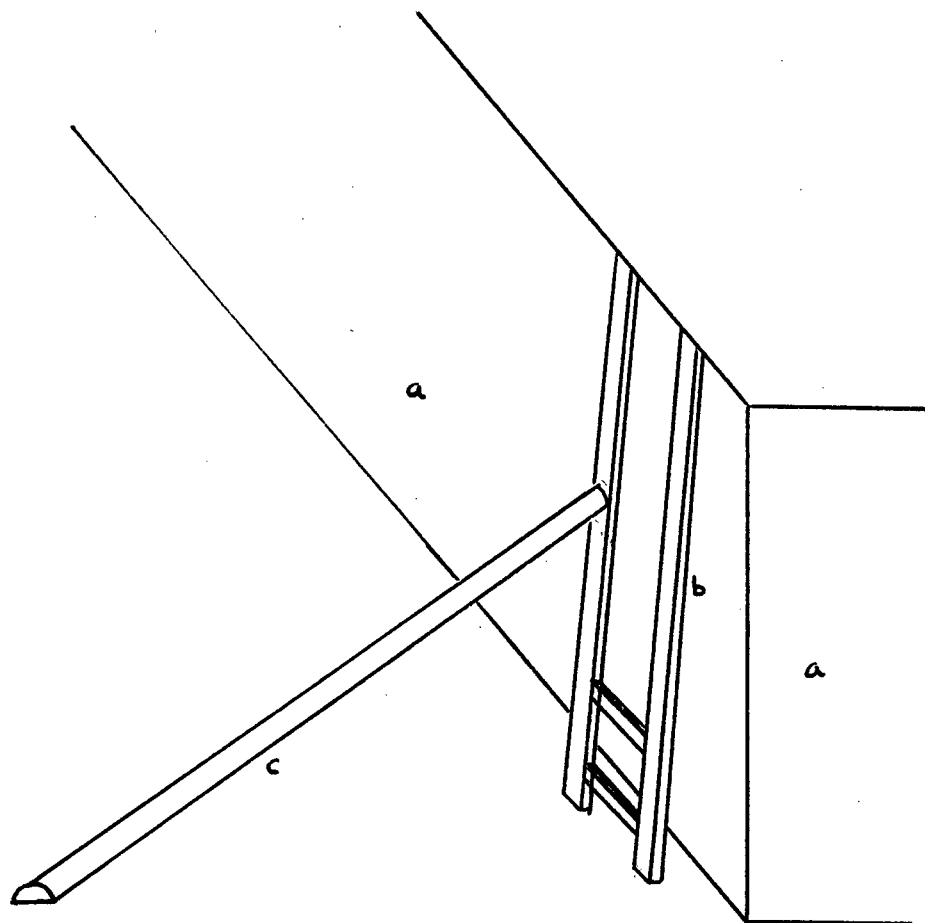
38.3 τρίβολοι. These were used by the attackers as a means of defence against rocks rolled down on them by the besieged. They were similar to the tank traps with which we are familiar. They consisted of three pieces of wood set into the ground and joined together at the top to make a pyramid-type structure. The idea was to set up rows of these around the machines so that they would stop any rocks rolled down by the enemy and thus keep the machines safe. Apollodoros (140.3) gives a detailed account of them.

38.10 τὴν ἀρετὴν χελώνην. Both Schneider and Sackur (p.95) think that ἀρετή is probably a Greek version of the Latin aries. This, however, is as far as the agreement between them goes. Schneider thinks of the ἀρετὴ χελώνη as a "tortoise" similar to the "ram-bearing tortoise" while Sackur takes the χελώνη literally and visualizes a beam with a cross section like that of a tortoise. The purpose of this beam ~~being~~^{was} merely



to prop the ladders up against the wall. If this is so it seems that there should have been something in the text to clarify the situation as nowhere else in the whole work does χελώνη refer to an actual tortoise. Schneider thinks that the sections dealing with the "areté tortoise" and the τρίβολοι are later additions because no diagrams of them appear in the MSS. and Athenaios (39.9) says that he will illustrate all the machines. There are, however, other machines which are described and not illustrated (e.g. moveable towers (11-12) and the "ram-bearing tortoise" (10)). Furthermore the fact that Athenaios says he will illustrate everything does not mean that he did so. He himself gives us the example of Diades who promised to discuss certain things and did not do so. Perhaps Athenaios thought that these things were familiar

enough to everybody that illustrations were not required.



a = wall
b = ladder
c = "areté tortoise"

39.9 The diagrams in the MSS. of Athenaios are, in general, very bad and shed little light upon the actual construction of the machines. An exception to this is Wescher's fig. I, which Sackur regards as being much older and having a much better tradition (cf. 11.2). It is certainly much better than any of the others and he may well be right on this point. He thinks that all the other diagrams are Byzantine.

The diagrams in Wescher's text are, for the most part, taken from MS. M but there are several exceptions. A description of Wescher's figures follows:

Fig. I From MS. F (fol. 28 verso). It seems to go with the title Κριοῦ κατασκευή.

Fig II From MS. M (fol. 21 recto). It shows the structure of the base of the "tortoise for filling in ditches" and the "mining tortoise". The following are labelled:

Υπεροχή πήχεις Η
 Υπεροχή πήχεις Α
 Ἀμαξίπους
 Περίπηγμα
 Διάπηγμα

Fig. III From MS. M (fol. 21 verso). Shows the superstructure of the "tortoise for filling in ditches" and "mining tortoise". It is preceded by the following:

Εἰς τὰς τέσσαρας πλευρὰς τῆς χελώνης νόει
 τὸ ὑποκείμενον σχῆμα τῶν κινόνων.

Fig. IV From MS. M (fol. 23 recto). The "tortoise of Hegetor". The following are labelled:

Πυργίον ἦτοι θωράκιον
'Επικεφαλὴ
Πλάγιον ξύλον μέσον τῶν σκελῶν
'Επιστθλίον
Κέφαλον
Κριοδόχη
Χελώνη

Fig. V From MS. P (fol. 58 verso and 59 recto). Also the "tortoise of Hegetor".

Fig. VI From MS. M (fol. 24 recto). The machine of Ktesibios.

Fig. VII From MS. P (fol. 60 recto). Supposedly the machine of Ktesibios but the drawing bears no resemblance whatever to the description contained in the text.

Fig. VIII From MS. P (fol. 61 recto). Has the title 'Ενταῦθα τὸ πλοῖον.

Fig. IX From MS. F (fol. 9 recto). Also the

Fig. X From MS. P (fol. 61 verso). Illustrates the fore-wheel described by Athenaios. The following are labelled:

ὀδηγός
τράπηξ

Fig. XI From MS. F (fol. 9 verso). Also the fore-wheel of Athenaios. This is unlabelled.

Fig. XII From MS. M (fol. 25 verso). "The Chamber". It is entitled 'Ενταῦθα τὸ καρχήσιον and the following are labelled:

καρχήσιον
 'Εξέριτις (ἐξαιριτίς)
 "Αξων
 Γέρανος.

Κεῖς κατὰ σκευή.

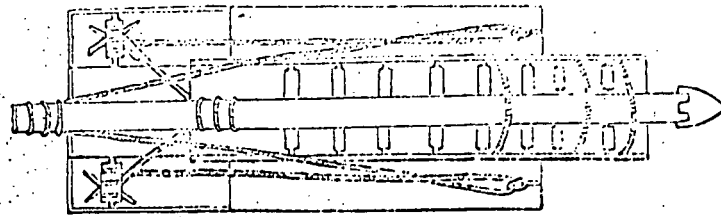


Fig. I.

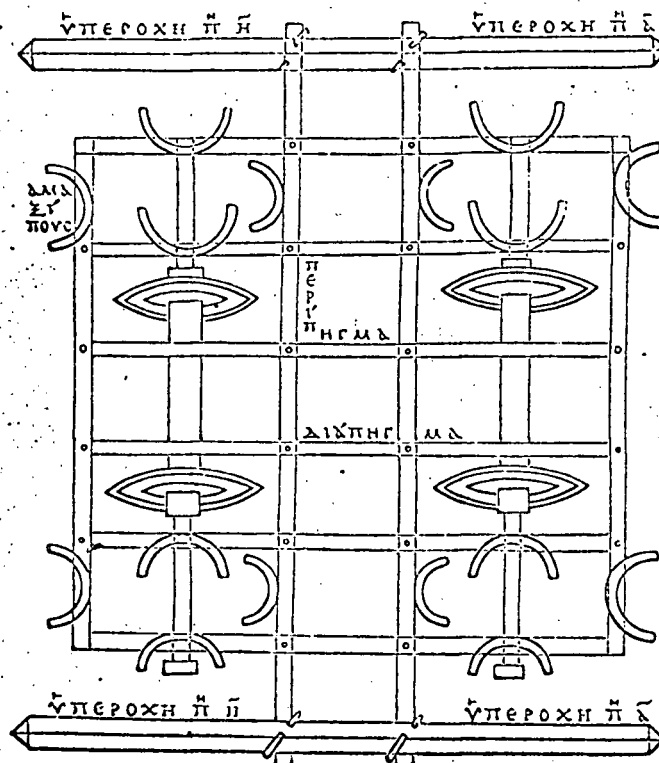


Fig. II.

Fig. V.

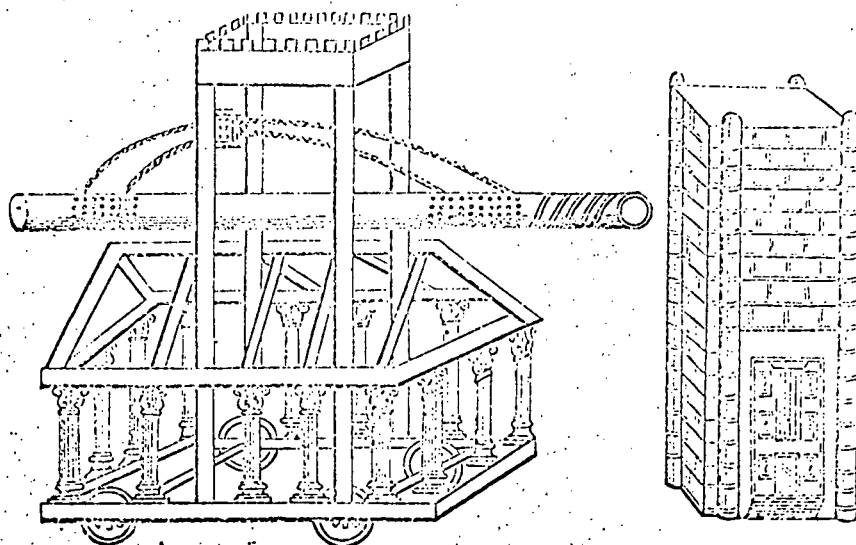


Fig. VI.

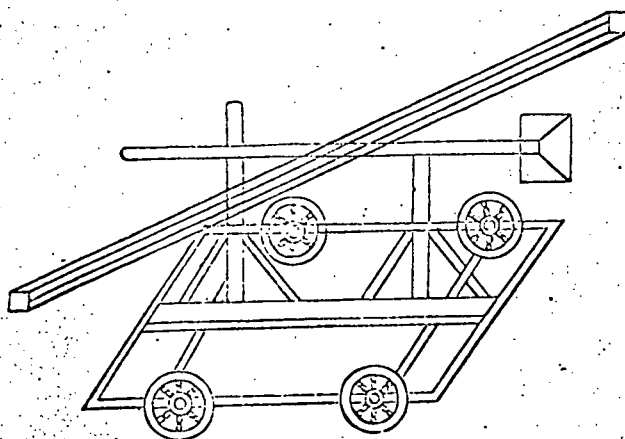
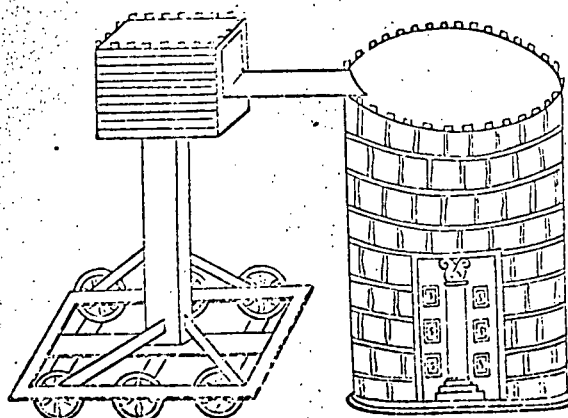


Fig. VII.



Ἐνταῦθα τὸ πλοῖον.

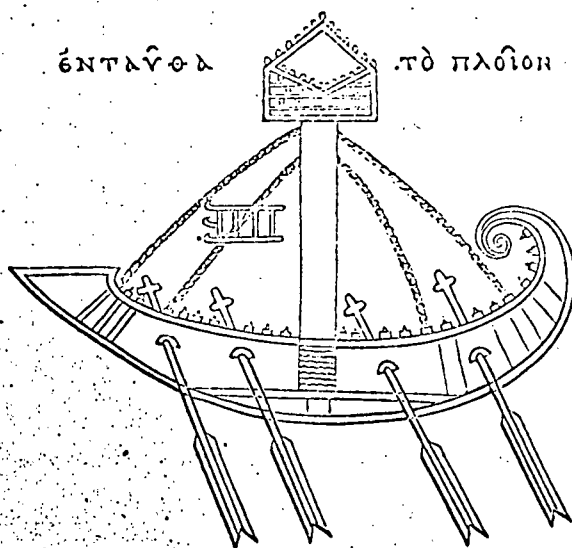


Fig. VIII.

Fig. IX.

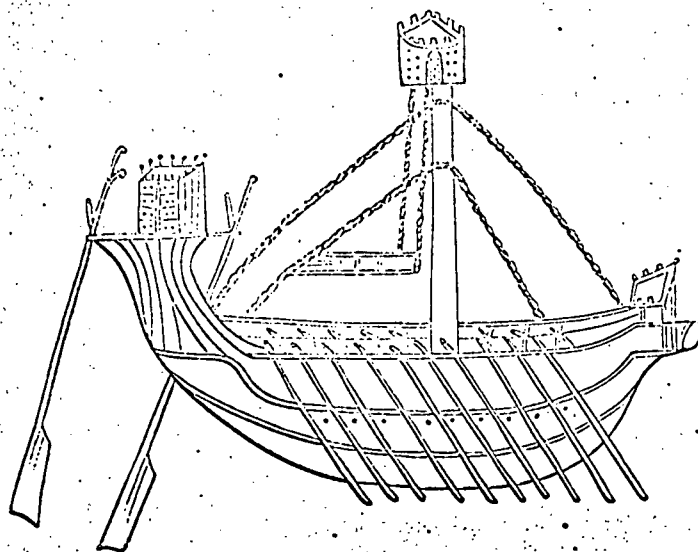


Fig. A.

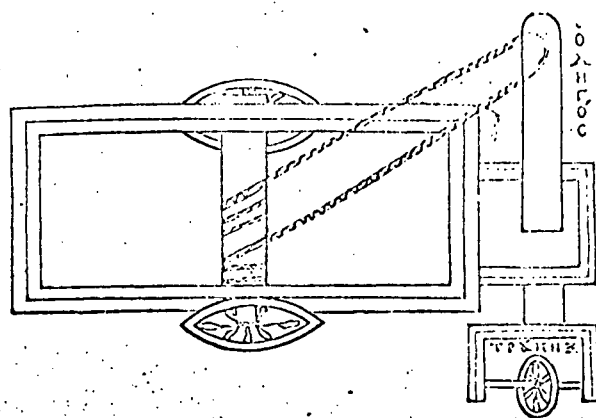
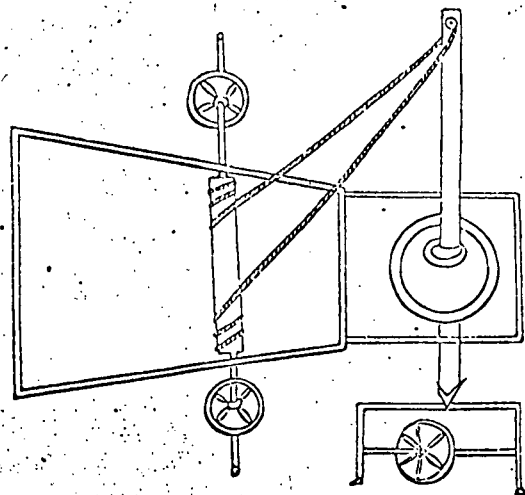
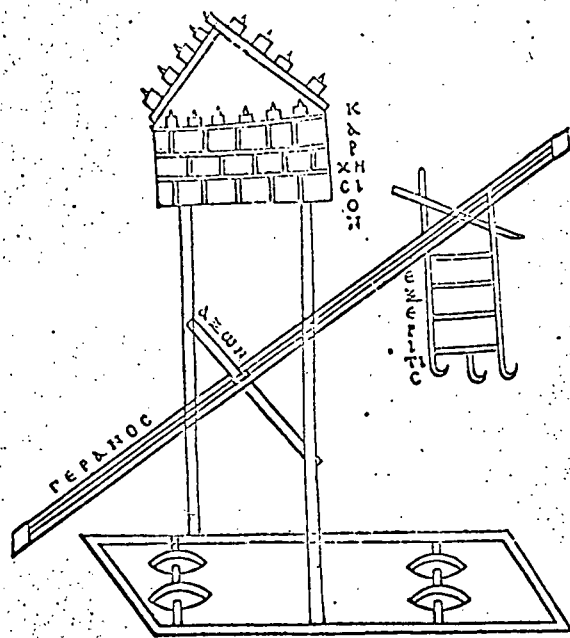


Fig. XI.



Ἐνταῦθα τὸ καρχήσιον.

Fig. XII.



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