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Rich Names: Implications of Terminology in Ancient Greek Rhetoric, Medicine, and Siege Lore

Abstract: This chapter discusses 'rich' terminologies, that is, terms that are coined with a view toward connotations, and some of their implications in four different fields of theoretical Greek knowledge (mathematics, rhetoric, medicine, and belopoeics). In each case, 'rich' terminologies exceed the purely functional ones, which I call 'lean':[1] e.g., they can tell us something about the field and the actors involved. In addition, the chapter argues that certain aesthetical aspects, connotations perhaps, of the terms adopted add to their significance. These aspects are fragmentary self-descriptions of the activities they are meant to designate and, in some cases, even contribute toward reconstructing the perspective of the actors onto their own practices. To some extent, a notion of field memory emerges. In short, rich terminologies can present additional aspects and perhaps do always imply certain associations that go beyond purely functional concepts of terminology.

By way of introduction, let me begin with geometrical terminology. It is well known that the ancient Greek mathematician's lexicon contains many elements from practical mathematics, e.g., *teinō* for the positioning of lines, *gnōmōn* for the perpendicular, or *epharmozein* for the notion of congruency.[2] The first must have been a surveyor's term, the second was originally a tool used in construction, and the third designates in general the concept of fitting something to something else. Thus, Greek theoretical mathematics reveals in some of its terms a past that has more to do with measurement or even the constructing crafts than with abstract contemplation, let alone timeless proofs.[3] It seems that the master narrative of how philosophers saw theoretical mathematics slowly emerge from measuring and the crafts utilize and even stress the gap between such terms' connotations and their elitist, abstract practice.[4] This holds certainly for Athenian mainstream mathematics in the Euclidian tradition which at some point came under

1 "Descriptive" is the term adopted by Schironi 2019, 239. See, however, Fleck 1979 [1935], 132f. for how descriptive terms can take on symbolic dimensions.

2 Ubiquitous in Euclid and Hellenistic mathematics, see Mugler 1958, esp. p. 13 on γνώμων.

3 Among others, pointed out by Burkert 1982.

4 See, e.g., Aristotle, *Metaph*. A 1, 981 b13–25 and Proclus, *In Eucl.* prol. II, pp. 64.3–68.23 Fr. (based upon Eudemus' lost history of geometry, on which cf. Zhmud 2002).

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Platonic spell. There is, however, a different kind of Hellenistic mathematics, to which Reviel Netz has attached the label of 'ludic'. Netz has shown that, apart from busying themselves with ludic problems and proofs arranged with a view to suspense, these mathematicians have a certain propensity toward 'ludic' naming, that is, they use colorful, metaphorical expressions from everyday life to designate abstract constructs.[5] These terms I call 'rich' because they carry a load of connotations that are foreign to the mathematical objects they designate. For example,[6] Eratosthenes calls his method of finding prime numbers the 'sieve' (*koskinon*), Nicomedes a new curve 'shell-like' (*konchoeidēs*), some other mathematician, perhaps Diocles, according to Proclus, called another curve 'ivy-like' (*kissoeidēs*),[7] and Archimedes seems to have named a certain mathematical object *arbēlos* (the word designates a cobbler's knife), another one *salinon* (probably 'salt cask').[8] We can compare terms in the Euclidean tradition; I choose some from the ones defined in the beginnings of the respective books: e.g., *eutheia* (*Elem.* I, Def. 2), *tmēma kuklou* (*Elem.* III, Def. 6), *euthugrammon* (*Elem.* IV, Def. 1), *hupsos* (*Elem.* VI, Def. 4), or *summetra megethē* (*Elem.* X, Def. 1). These terms attempt to be accurate and free from any notion foreign to mathematics (in opposition to 'rich', we could thus call them 'lean'). The 'rich' terms Netz discovered in ludic mathematics, however, exhibit a certain playfulness: First, they are all metaphorical. Second, while these terms usually describe humble objects of everyday life or unremarkable objects in nature (shells, ivy, and ordinary tools),[9] the mathematical discourse they take a part in, in this case, could not be farther removed from the humble and the everyday. Ludic mathematics and its hybrid aesthetics are part of the games social elites play and, in Hellenistic times especially, of the courts.[10] Therefore, these terms actually draw attention to the elitism of the practice precisely by choosing names drawn from lowly life. One is tempted to compare certain kinds of Hellenistic poetry of the time that stages the simple life for elite audiences in an extremely stylized way.[11] In Archimedes' case, a certain practical joke is played upon the recipient, because the rich term designating a certain mathematical object is, at the same time, a very rare word, philologically recherché (as far as we can say). Therefore, unlike 'lean' Euclidian terms, the rich terms of ludic mathematics hint at a certain way these mathematicians wanted to be conceived of by their readers.

5 On metaphors in ancient Greek lexica, see Schironi 2019, 234.

6 The following examples I take from Netz 2009, 149–157 ("a vignette: the scientific name").

7 On these two see, in a morphological context, Schironi 2019, 232, 237.

8 See Netz 2009, 156, quoting Dijksterhuis, E.J. 1987. *Archimedes*. Princeton, 404. Archimedes used both terms in a treatise called *Lēmmata* which is lost in Greek but transmitted in Arabic. While *arbēlos* is used in Pappus twice, *salinon* is a *hapax*.

9 One might object that ivy was associated with symposia. While this is true, the symposiac does not fit in with these other terms listed by Netz.

10 See Berrey 2017, e.g., 134–137.

11 One may think of Callimachus' *Hecale* or Theocritus' poems on herdsmen and their inner life. This is certainly not just *bathos* (*pace* Netz 2009, 159).

To be sure, it is not always possible to explore terminology's inner life in such a way. However, we can at least gather some cases in which terminology goes beyond the purely functional and thus becomes 'rich'. In what follows, I intend to illustrate this approach's productivity by presenting three examples culled from different fields and contexts: fourth-century theory of rhetoric, Roman imperial medicine, i.e., anatomy and pulse lore, and Hellenistic siege engines.

1 Rhetorical Branches: Licymnius, Aristotle, and Ambivalent Taxonomies

It is well known that in some realms of ancient Greek theoretical discourse, an agonistic climate was part of the culture, most notably in rhetoric and in medicine. Part of the competition of which many texts bear witness was terminology, as contested as almost anything else. Suffice it to briefly hint at two cases, both tiny if remarkable details in a large canvas.

In his *Rhetoric*, Aristotle presents himself as an innovator who is coming late to an already well-developed field. His discourse teems with criticism of technical, perhaps to a large extent 'sophistic', literature that was apparently already available and circulating. In a well-known passage (*Rhet.* III 13, 1414^{b}15–18),[12] Aristotle takes issue with some of Licymnius' (whose date and place are uncertain) more daring terminological choices:

> δεῖ δὲ εἶδός τι λέγοντα καὶ διαφορὰν ὄνομα τίθεσθαι· εἰ δὲ μή, γίνεται κενὸν καὶ ληρῶδες, οἷον Λικύμνιος ποιεῖ ἐν τῇ τέχνῃ, ἐπούρωσιν ὀνομάζων καὶ ἀποπλάνησιν καὶ ὄζους.
>
> One needs to make genus and differentia explicit when coining a term. Otherwise, the discussion becomes pointless and loquacious, as does Licymnius in his *tekhnē* who coins the term 'gust of favorable wind' and 'divagation' and 'branches'.

Although Aristotle's criticism is not entirely clear to me, it appears that he is concerned here with a recommendation of how to coin terms for parts of dihaereses (εἶδος καὶ διαφορά). Thus, when he, a little above the quote, criticizes Theodorus for introducing too many and Licymnius for coining either too metaphorical terms or more than one term per definable entity, he implicitly talks about his own methodological standards. At stake are terminologies for parts of oratorical discourses, certainly in the context of *tekhnē*. Unfortunately, Aristotle does not present a glossary of Licymnius so that we cannot know exactly what part of discourse Licymnius called 'gust of favorable wind' or 'branch'. However, with respect to Licymnius' unusual choices, two points merit acknowledgment: first, Licymnius probably does not coin these risky terms out of the

12 One of the main 'fragments' of Licymnius, *Artium Scriptores* B XVI 4, p. 118 Radermacher.

blue. There were terminologies around that were already well-established. Presumably, Licymnius wanted to present his terms as a stark contrast to established terminological coinages. His metaphorical extravagance serves a need for distinction in a contested field, in which terminology becomes a means among others. Second, if this is correct, Licymnius must have carefully chosen these striking terms. (I admit that we do not know whether all these terms were pulled from the same context.) What did he have in mind? Licymnius might have thought of movement in space, perhaps travel (the first two remind us vaguely of Odyssey-like narratives), the third perhaps of horticulture (or Dodona?). Although this becomes somewhat speculative in light of the scarce evidence, one might suggest that Licymnius wanted us to think about his terminology, provided he did not explain his striking choices. Apart from 'wandering astray' (ἀποπλάνησις) which is clear enough, due to the conventional metaphor 'an argument is a way', 'branches' and 'favorable winds' are rather puzzling. In addition, the latter is a *hapax legomenon*. It is remarkable that the terms introduced by Licymnius who is said to have composed dithyrambs, too,[13] reminds us remotely of Aristophanes' playful criticism of the dithyrambic poet Kinesias in *Birds* and elsewhere.[14] Whatever connotations Licymnius aimed for, they seem deliberately taken from realms remote from rhetoric and sophistic practice for which metaphors culled from the crafts recommended themselves.[15] Aristotle meant to say that one needs to give a definition of any term introduced (εἶδός τι λέγειν καὶ διαφορὰν) and then gives an extreme example: we should avoid the practice of Licymnius who not only does not define his terms by genus and difference but adopts terms of which one cannot even guess where they belong in his taxonomic system. While Aristotle elsewhere in the *Rhetoric* duly criticizes the taxonomic practice of technical authors to go for ever more detailed divisions,[16] here the terms themselves appear to be at stake. With Aristotle and Licymnius, we see two actors employing different terminological strategies, the first what one might call a 'systematic' one,[17] the second a metaphorical one that leaves more room to the reader's imagination, perhaps to the degree of violating genre conventions by exuberant metaphor. Licymnius, it seems, wished for some visual component to add some color to his terms: While 'wind' and 'divagation' carry some associations that lead toward images of travel and change, perhaps innovation, perhaps ship-wreck, 'branch' on the other hand, leads us toward associations of horticultural growth, accumulation, and harvest. It seems that Licymnius has inscribed into his terminologies the ambivalence of rhetoric itself – which does not sit well with our Platonically informed picture of sophistic actors.

13 See ibid. p. 117.

14 Aristophanes, *Ran*. 1373ff. and Dunbar, N. 1995. *Aristophanes: Birds*. Oxford, 660–670.

15 As is, again, perhaps best illustrated by Aristophanes' derision (see my 1997, 176 and index s.v. 'Handwerksmetaphorik').

16 Rapp 2002 ad loc. takes this to be the point of critique here.

17 On 'systematicity' see my 2016.

2 Competition, Colorful Terms, and Consensus: Medical Terminology

For the success of theories, in social-historical as in epistemic respects, coining terms and naming them cleverly play an important role. While Aristotle had famously criticized Empedocles' terminological practice for using metaphors, albeit in passing, Galen directs strong criticism against competitors who, according to him, do not handle terms the right way. He often attributes naming practices to non-epistemic motives, most explicitly in *On Medical Terms* 85r-v (pp. 9.5–8 Meyerhof & Schacht 1931).[18] In this treatise, Galen understands terminology exclusively as a means of knowledge transmission. Thus, he judges those harshly who care more for terms than the scientific or therapeutic task demands.[19] Galen makes a point of distinguishing between heated and fruitless discussion over terminologies and arguments over the medical facts themselves (86r, pp. 10.31–33 M&S). He even clearly states that the polemics concerning terms differs from the polemics concerning medical facts and arguments (87r, 12.1–3 M&S). Nonetheless, he engages in the former, too, and with apparent gusto. Tellingly, he denies any substantial connection between name and named thing; the example of how slave-holders name their slaves makes, to modern readers, a striking case (88r, pp. 13.10–16 M&S). Thus, for Galen, names of facts seem to be both unrelated to the named fact and to belong exclusively to the naming individual. Thus, only in the case that established names fall short, the medical writer should invent new ones (90v, p. 16 M&S), which is what Galen himself has usually done (he describes his method of naming in detail on p. 16 f. M&S, 91rv). In a vivid scene of dispute, prognosis is the means to go beyond fruitless discussion about terminology in which the competing physicians indulge (92v, p. 18 M&S). Only in passing does Galen mention the possibility to name a medical phenomenon, e.g., a disease such as the semitertian fever, after the physician who has discovered or described it (95v, p. 22 M&S). Differences in naming diseases do not imply differences in therapy which is why the competitive search for the right terms is fruitless (97v, p. 24 f. M&S). A consensus about names is the foundation for any discussion of medical entities (101r, p. 29 M&S). Therefore, any participant in the game who introduces new terms must appear as a saboteur of collective knowledge and thus of medical progress. At least, this is what Galen wants us to believe. For example, in the course of a discussion about the notion of 'fever' and its willful connection with various symptoms by some medical theorists, mostly pulse and complexion, Galen remarks (106r, p. 35 M&S):

18 Meyerhof and Schacht translated the title as 'On medical names'. Apparently, in the lost Greek original what led to Arabic *ismal'u* was the Greek *onomata*, which in the grammatical tradition usually means 'nouns'.

19 See, e.g., the Zenon joke (85v, p. 10.10f. Meyerhof & Schacht); cf. *Anat. admin.* VI 13, vol. 2, p. 581 Kühn.

> Whenever complexion or pulse change due to one of these factors, anybody can call this 'fever'. Doing this, however, he would do what Erasistratus did who has remarkable habits and newly introduces remarkable terms without explaining or accounting [*logismos*, according to the editors] for any of them, neither from the term itself or from how it is being used among men.[20]

According to Galen, this is an instance of bad practice because it puts medical communication at risk. Erasistratus, however, triggered Galen's discourse by postulating a new connection between pulse and fever, understanding the latter as a certain quality of the former (p. 35, 106v M&S). Galen does not waste a moment on reflecting upon Erasistratus' motives in re-coining the long-established term 'fever'. In his derisive use of the term 'sophist' for physicians who indulge in such coinages (p. 36 f., 107rv M&S), he probably hints at the terminological choice's purely strategic character. However, Erasistratus may have had systematic aims in mind, such as coherence and clarity of 'lean' terminology.[21]

While it seems that Galen usually describes situations that emerge from contexts of discoveries that require new terms, or engages in disputes that result from the clash of formerly unreconciled terminological traditions, there are also medical realms where terms appear to be firmly established and are unanimously shared: For example, the well-known treatise of Rufus of Ephesus on anatomical terminology (*Peri onomasias tōn tou anthrōpou moriōn*; late first century CE) hardly registers any terminological dissent. That is why the list of terms given, *a capite ad calcem*, almost maps a description of the human body. In the rare cases where there are alternatives for anatomical terms, Rufus treats them like a lexicographer rather than a physician-philosopher, that is, he does not decide between them. Take, for example, the anatomy of the nose (*Nom. part. hom.* §31–34, pp. 137.7–11 Daremberg & Ruelle):

> Ἀπὸ δὲ τοῦ μεσοφρύου τέταται ἡ ῥίς. Ταύτης δὲ τὰ μὲν τρήματα, μυκτῆρες καὶ ῥώθωνες· Ἀθηναῖοι δὲ καὶ μύξας ὀνομάζουσιν. Ἱπποκράτης δὲ τὸ διὰ αὐτῶν φλεγματῶδες περίσσωμα ἰὸν μύξαν καλεῖ· Ἀθηναῖοι δὲ τὸ περίσσωμα τοῦτο κόρυζαν καλοῦσιν.

20 Translated from the German of Meyerhof and Schacht (not from the Arabic, as would be more desirable): "Der Mensch kann, wenn wegen eines dieser Dinge in der natürlichen Farbe oder dem Arterienpuls eine Veränderung eintritt, es Fieber nennen; dann aber ähnelt er in diesem seinen Tun dem Erasistratos, der erstaunliche Gewohnheiten hat und erstaunliche Namen neu einführt, ohne für irgendetwas davon eine Erklärung und einen λογισμός beizubringen, weder aus dem Hinweis des Wortes selbst noch aus dem Sprachgebrauch des Menschen." Apparently, Galen distinguishes between an etymological explanation of terminology ("aus dem Hinweis des Wortes selbst"; in p. 36, 106v/107r Galen mentions Prodicus as a positive instance) and one that relies on its denotations in its actual use. Remarkably, Galen does not seem to miss a definition in Erasistratus' introduction of new terms.

21 See my 2015, 53f.

> From the space between the eyebrows the nose extends. It has hollows, the nostrils and *rhōthōnes*.[22] The Athenians, however, call them *muxai*. Hippocrates calls the phlegm-like secretion that runs through them *muxa*; and the Athenians call this secretion *koruza*.

For the front part of the nasal cavity, we get three terms, one of them regional. In addition, Rufus regales us with a linguistic remark about geographically differentiated usage and two terms for nasal secretion, one of them merely philological, observing Hippocratic language, and the other one, again, on Athenian usage. He does not offer any discussion of which of the competing terms would be preferable and for what reasons. It is, however, interesting that Rufus who does not write in Athens (and probably not in Rome, either) provides Athenian terms as implicitly opposed to non-Athenian terminological practices and probably as competing with Hippocratic usage. The latter turns out to be an argument against the Athenian use of certain terms. In cases where there are no established terms, terminological discussion becomes more poignant (e.g., §133–135, pp. 150.13–151.6 D&R on cranial sutures, i.e., the anatomy of the skull):

> Δύο δὲ ἄλλαι τοῖς ὀστοῖς τῶν κροτάφων, ὥσπερ λεπίδες ἐπιπεφύκασιν. Ὀνόματα δὲ αὐτῶν παλαιὰ οὐκ ἔστιν, ἀλλὰ νῦν ἐτέθη ὑπό τινων Αἰγυπτίων ἰατρῶν φαύλως ἑλληνιζόντων· στεφανιαία μὲν τῇ πρὸς τὸ βρέγμα, λαμβδοειδὴς δὲ, τῇ περὶ τὸ ἰνίον, ἐπιζευγνύουσα δὲ, τῇ μέσῃ· λεπιδοειδεῖς δὲ, ταῖς τῶν κροτάφων. Οὗτοι δὲ καὶ τῶν ἄλλων ὀστῶν μόρια ὀνομάζουσιν ἀνώνυμα τοῖς πάλαι, ἃ ἐγὼ οὐ παραλείψω διὰ τὴν εἰς τὰ νῦν τῶν ἰατρῶν δήλωσιν.
>
> There are two others [cranial sutures = *rhaphai*] at the bones of the temples; like scales they are grown together. They do not have ancient designations, but have just now been named, by some Egyptian physicians who know their Greek badly: ‚coronal' (is the name for the suture) towards the front part of the head, ‚lambda-like' (the one for the suture) around the occiput that joins at the middle (of the head). And then, the 'scale-like (sutures)', at the temples. These physicians assign names also to the parts of other bones that have been left unnamed by the physicians of old, which I will not pass over in silence because of the explanation with respect to contemporary medicine.

Anatomical discoveries present terminological challenges. 'Ancient', which I take to mean 'Hippocratic', terminology is somehow sanctioned by time and thus canonical. Recent naming decisions, however, provoke some criticism. Here, Rufus criticizes these Egyptian physicians for their lack of linguistic competence in Greek. Paradoxically, he reports the terms themselves, without indicating where precisely he sees any linguistic problem, but leaves the names of the physicians themselves to oblivion. Since Rufus mentions several, actually 10, physicians by name in his treatise, with a total of 22 mentions, we must understand his passing over of the names of the Egyptians as a sanction, as if there was, for him, a competition between Greek and Egyptian medical practitioners. As to the notion of 'Egyptian', it is difficult to think of

22 My translation is tentative. There does not seem to be a difference between μυκτῆρες and ῥώθωνες, except for the latter to be more technical.

something more Greek than the letters of the Greek alphabet, such as lambda, or the utensils of the symposium or civic rewards, such as crowns (*stephanoi*).[23] Perhaps Rufus constructs an opposition between fifth- and fourth-century mainland medicine and near-contemporary Alexandrian physicians such as Marinus whom Galen often quotes with respect to anatomical knowledge?[24] In imperial Roman Alexandrian culture, however, one would expect the ethnic borders between Greek and Egyptian to have been blurred long ago. Perhaps, Rufus saw the activities of these 'Egyptian' scientists as an intrusion into a purely Greek game of discovery and naming, the latter being taboo to non-native speakers of Greek or intruders from outside. Or did he see a problem in the admittedly rare use of *stephaniaios* as opposed to the more commonly used *stephanikos*? While it remains unclear what Rufus meant to say precisely, we can grasp here some competition for the reputation that comes with medical discovery and the establishment of terms, oddly, I think, conceived of as being positioned between old and new, Greek and 'Egyptian'.

With respect to pulse lore, the situation was different. While in anatomy undisputable discoveries simply needed a name within an already established epistemological and terminological frame, in pulse lore the phenomena themselves[25] and their interpretation as a diagnostic tool were under debate. In the context of historical terminologies, medical discussion of pulse terms is especially interesting because there are no visual or technological analogies one could proceed from, as, e.g., 'lambda-like'. Even more, the empirical basis of ancient pulse lore is quite questionable.[26] In addition, following Praxagoras' of Cos distinction between arteries and veins, pulse phenomena have been systematically observed and described for the first time by Praxagoras' follower Herophilus in third-century Alexandria which means that these concepts were subjected to the full-blown controversial culture of theoretical medicine right from the start. We read them in Galen's ample treatises covering pulse lore, themselves being situated in an agonistic position toward past and present competitors. Among the qualities of the pulse, according to Herophilus and Galen, there is, besides size, vehemence, and speed, 'rhythm', i.e., the time of the dilation as compared to the time of the contraction. As is well known, in order to conceptualize and classify 'rhythm' in pulse, Herophilus borrowed from Aristoxenus' theories, especially with respect to a basic unit of time, called the *prōtos khronos* in Aristoxenic rhythm lore and applied to

23 Perhaps Rufus plays of 'ethnic' Egyptian medicine against Alexandrian anatomy (see Gersh 2012, 73). However, why would these 'Egyptian doctors' use Greek names at all? Gersh sees here a little nostalgia for the great past of Alexandrian dissection.

24 Marinus has been pointed out to me by Orly Lewis to whom I am very grateful. On Marinus as mentioned by Galen, see Rocca 2002.

25 For an introduction, see Berrey 2017, 191–196. on Herophilus' discovery of pulses and his theories about them.

26 On this point, see Berrey 2017, 193.

the infant's pulse by Herophilus.[27] It seems to me that such an appropriation implies the statement, whether Herophilus actually made it or not, that there is some kind of over-arching unity in scientific concepts of music and medical research.[28] Another possible implication would be the claim that Herophilean pulse lore has some affinity with the Peripatetic system of knowledge.

Greek pulse theorists classify pulses according to specific combinations of several criteria. Thus, the emerging taxonomy turns out a large number of kinds of pulses in need of names. However, since the discovery of pulse has been a post-Hippocratic achievement, in this field there is no canonized tradition of names. In addition, there are no visual analogies that could make the naming act obvious; yet, one needs names for these complexes of several criteria. The terminological situation becomes even more interesting as pulses, being one of the most prominent diagnostic tools and thus a central element of contacts between patients and physicians, must have been one of the important issues of agonistic debate. It is interesting that in this situation, the established names of pulse kinds come from different areas and follow different logical methods of naming. Accordingly, naming practices and failed attempts at finding suitable terms constitute important points in Galen's targeting of predecessors and competitors throughout the greater part of his book *On Distinct Types of Pulse* (*Diff. puls.* II–IV).[29] Most of the terms for the taxonomy are rather straightforward, that is, 'lean', such as *takhus* (quick), *iskhnos* (weak), or *puknos* (frequent), and thus, most pulses do not have their own names, but have to be described by three or four categories ('the quick, weak, and frequent pulse'). Toward the end of Galen's own complex taxonomy in *Diff. puls.* I, however, we come across three more colorful, i.e., 'rich', terms, this time used as proper terms for single kinds of pulse. Among the uneven pulses, there is the 'wave-like' (*kumatōdēs*, I 25, 8.549 f. K.), discussed in some detail: With this pulse, the physician feels the artery distending in wave-like dimensions and patterns. In the same class follow the 'one that moves like worms' (*skōlēkizōn*) and the 'one that moves like ants' (*murmēkizōn*). On these, Galen says (*Diff. puls.* I 26, 8.553 K.):

> Ὥσπερ δὲ τὸν κυματώδη σφυγμὸν ὁ σκωληκίζων διαδέχεται μικρότερον γενόμενον, οὕτω τὸν σκωληκίζοντα ὁ μυρμηκίζων, ὅταν ἀπολλυμένων τῶν κινήσεων τῶν πολλῶν εἰς μίαν, καὶ ταύτην παντελῶς μικρὰν τελευτήσῃ, καὶ διὰ τοῦτο οὐδ' ἀνώμαλος παντελῶς φαίνεται, καίτοι πιθανόν ἐστιν ἐκ τοῦ γένους αὐτῶν εἶναι τῶν ἀνωμάλων, ἀλλὰ διὰ τὴν μικρότητα λανθάνει ἡ ἀνωμαλία. κέκληται δ' οὗτος ὁ μυρμηκίζων ἀπὸ τῆς πρὸς τὸ ζῶον τὸν μύρμηκα ὁμοιότητος, ὡς μέν τινές φασι κατὰ σμικρότητα, ὡς ἕτεροι δὲ διὰ τὸν τρόπον τῆς κινήσεως, ἵν' ὁμοίως τῷ σκωληκίζοντι καὶ δορκαδίζοντι, καὶ οὗτος ᾖ κεκλημένος. ἐκεῖνοί τε γὰρ ὁμοιότητι κινήσεως τῆς πρὸς τὰ ζῶα ὧν

27 See, e.g., Herophilus fr. 183.1–11. v. Staden; Berrey 2017, 196–202.

28 Unlike Berrey 2017, 208, who understands the Herophilean appropriation along the lines of 'hybridization' and thus as partaking in the aesthetic discourse of court science.

29 See the recent study of these passages by Lewis 2022 who gives a concise overview of Galen's eight treatises on pulse lore.

> τὴν ἐπωνυμίαν ἔχουσιν ἐκλήθησαν, οὗτός τε αὐτὸς ὁ μυρμηκίζων οὕτως. τινὲς δὲ καὶ δι' ἄμφω φασὶν αὐτὸν οὕτως ὀνομάζεσθαι, διά τε τὴν μικρότητα καὶ τῆς κινήσεως τὸ εἶδος.
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> Just as the moves-like-worms pulse follows upon the wave-like one when it (the wave-like pulse) becomes weaker, so the moves-like-ants pulse follows upon the moves-like-worms pulse when the many movements diminish into one and this becomes very small in the end. And thus, it does not even seem to be uneven (although it is plausible that it belongs to the class of the uneven ones), but due to its being small the unevenness goes unnoticed. This pulse is named 'moves-like-ants' after the similarity to the animal ant – some say after its tinyness, but others because of the way it moves – in order that it be similarly named to the moves-like-worms and the moves-like-deer ones. For these pulses are named according to the similarity to the ways the animals which they carry the names of, move, and this very one, the moves-like-ants, in the same way. And some say that this pulse is called this way due to two (analogies), because of its tinyness and the kind of movement.

The moves-like-deer pulse ("galloping," according to Montanari's dictionary) had been termed that way already by Herophilus, Galen says a little later (ch. 28, 8.556 K.). There, Galen accurately describes how this pulse is, in its being uneven, singularly analogous to the jumping movements of deer which, Galen/Herophilus say, exhibit a certain double movement (*diplēn tina kinēsin*) of which the second is faster and fiercer (*ōkutera te kai sphodrotera tēs proteras*). Beyond all anatomical and zoological problems, Galen's remarks hint at a discussion of terms among pulse theorists who were interested not only in meaningful terms but also in a certain coherence of naming principles.[30] One might speculate that the moves-like-deer pulse was termed by Herophilus as the first of the pulses named after animals that might be indicated by Galen's rather detailed discussion of that pulse and quote, and then others followed in his vein.[31] Clearly, in the struggle for patients and reputation it meant a great deal to have appropriate and even catchy names for diagnostic phenomena and to be able to account for them in a convincing way.

The pulses in these diagnostic systems do not carry names that follow a coherent system. Many single pulses apparently do not have names (even classes go without name, such as in Archigenes' taxonomy), or bear the rather nondescript designation of *meson* between two named extremes.[32] Thus, it is remarkable that in the class of 'unevenness', these pulses bear colorful names. Perhaps they were more prominent

30 See also his polemical remarks in *Diff. puls*. I 2, 8.498, on pulse theorists who are spending too much time and effort on logical-taxonomical questions. At the same time, one sees Greek theorists devoting their energies to the systematicity effect, not only for epistemic reasons, but also in order to enhance their authority.

31 See Lewis 2022, 205, for a similar conclusion with regard to Archigenes quoting Herophilus. Netz 2009 discusses two instances of Herophilean naming in the field of anatomy and hints at G.E.R. Lloyd's idea of Alexandria as "the main site for Hellenistic naming."

32 For μέσον, see Lewis 2022, 201f. In Galen's system of pulse classifications, three classes remain 'nameless' (ἀνώνυμα). Archigenes himself states that two classes (regularity/irregularity and evenness/unevenness) better be left without names (ἀκατονόμαστα, *Diff. puls*. II 6, 8.592f. K.). Galen's criti-

than others in diagnostic practice. Vivid, 'rich' terms might have proved advantageous for various reasons: first, since these names are all metaphoric, they are not open to polemics about taxonomy and logical classes. Second, they refer patients to sign-systems beyond medicine: The 'wave-like' pulse indicates the sea, that is, a certain menace, certainly an area of the imagination not easily associated with the human body. Similarly, deer point to nature, the non-human, and non-domesticated. Deer are known for their being elusive: health is an unstable status that can be gone quickly. Provided the mentioning of 'deer' evokes a notion of hunting among the elite, physician and patient will find themselves in a new metaphorical frame to think about pulses, disease, and medicine. With worms and ants one will associate not imminent danger, but decay. When it comes to tactile sensation, it is clear in both cases that the associations are unpleasant,[33] but not leading to expectations of imminent death or severe suffering. In all three cases, the terminology, due to its being 'rich', directly speaks to the experiences of lay patients who can relate to the pulse names without having any knowledge of the taxonomical system itself. It seems that these terms even protect the system against patient insight, because they do not give away anything about the logical structure of the taxonomy.[34] As far as I can see, the terms *kumatōdēs*, *murmēkizōn*, *skōlēkizōn*, and *dorkadizōn* enjoyed a certain success: Since the days of Herophilus, they were accepted and transmitted despite their metaphorical unclarity. We have seen that in the lines given above Galen refers to long-standing discussions about the precise meaning of these terms. It is quite surprising that all the participants of this discourse, over hundreds of years, have preferred to discuss the precise meaning of these terms rather than doing away with them. Thus, one might understand the specific metaphorical quality of these terms, their 'richness', as a means of aiming at consensus despite fundamental disagreement.

3 Names, Terms, and Field Memory: The Case of Siege Technology

Inventions need a name, because without names one could not even communicate about them; the more so, since inventors strive for recognition which leads to public reputation or patronage. As is well known, artillery and siege technology saw a signif-

cism of Archigenes and his established terminology is similarly with respect to pain: see Roby 2016, 307–312, and her great discussion of Galen's ideas on terminology.

33 In poetic-polemical debates on 'new music' ant-based metaphors are attested since Aristophanes and Pherecrates (Aristophanes, *Thesm*. 100 and fr. 155.23 PCG, resp., see my 1997, 42–45, where I maintain that the two fields, pulse lore and music criticism, and these terms have a connection. Now, I am less confident).

34 See Lewis 2022, 216.

icant increment of inventorial activity all through the fourth century, but especially in the decades after Alexander's death.[35] At the same time, probably first in Alexandria, a genre of writing emerged, the *belopoïika* ('construction of artillery'), that preserved and transmitted abstract knowledge and certain machines. To us, this genre is represented by extant writings of Philo of Byzantium (third century BCE), one Biton (uncertain, perhaps second century BCE),[36] some chapters in Vitruvius, an Athenaeus (perhaps first century BCE), and Heron of Alexandria (first century CE) who all refer to further authorities on siege engines. It is far from clear whom these writings, many of which invoke patrons ranging from Attalus to Augustus, are actually addressing.[37] Due to the knowledge at stake, it is interesting to look at the naming practices in these treatises.

In all of them, large stretches of text, brimming with numbers, seem to be written for the fellow technician. We are led to the same conclusion as these texts teem with technical terms that make them quite difficult to follow (which is why those modern readers who have attempted to actually rebuild those machines, such as Schramm and Marsden, have often had to practically figure out the precise meaning of terms). To give an example, since torsion engines are in the focus of many of these texts, there is a lot of discussion about 'washers' (*khoinikides*) and springs (*tonoi*), the central unit of many of the engines in question. Authors have much to say about their dimensions, location, construction, maintenance, etc. These two terms, however, and so many more besides them, are never explained. In other words, authors expect their readers to know them and thus their ways in the field of siege engines and general construction lore.

On the other hand, some of our treatises single out a handful of terms for careful designation. Heron who comes latest in the series but who had actually promised that he would mention nomenclature (p. 18 Marsden = 73.11-3 Wescher) has the fullest series of terms explained, but still not more than about 12.[38] As far as I can see, most of these terms are what we call 'lean', such as *katokheis*, the 'holders', or *anapaustēria*,

35 As discussed by Cuomo 2007, 41–57.

36 See now Keyser 2022, 153–155.

37 I have tried to discuss this in my 2017.

38 Heron, *Belop*. p. 20 M. = 78.2 W.: τὰ δὲ εἰρημέα στημάτια κατοχεῖς ("what I called stanchions, the holders"). P. 24 M. = 83.11 W. τὰς καλουμένας χοινικίδας ("washers, as we call them"). P. 26 M. = 89.5 W.: καλεῖται δὲ ἀναπαυστηρία ("It is called the rest."). P. 28 M. = 91.8f. W.: Τῶν οὖν ὀρθίων τοίχων ὁ μὲν καλεῖται παραστάτης, ᾧ προσαναπίπτει ὁ ἀγκών ὁ δὲ ἕτερος ἀντιστάτης . . . ("Of the vertical walls, the one against which the arm recoils is called the side-stanchion; the other, against which the heel of the arm rests, is the counter-stanchion."). P. 28 M. = 93.7 W. καλεῖται δὲ ὑποπτερνίς ("this is called the heel-pad"). P. 30 = 97.10 W.: καλεῖται δὲ ἡ καταλειφθεῖσα ἐντορία τριβεύς ("into which what is called the lever is lowered"). P. 32 M. = 99.1 W.: διὰ τοῦ καλουμένου ἐντονίου ("what is called the stretcher"). P. 32 M. = 99.10f. W.: καλεῖται δὲ τὸ πῆγμα . . . τράπεζα ("The framework . . . is called the table."). P. 32 M.: = 100.5 W.: ἡ δὲ σῦριγξ . . . ἐπὶ μὲν τῶν εὐθυτόνων σῦριγξ κέκληται, ἐπὶ δὲ τῶν παλιντόνων κλιμακίς ("the case . . . is called the case in straight-spring engines, but ladder in V-springs . . ."). P. 32 M. = 101.7 W.: καλεῖται δὲ πτέρυξ αὐτὸ τὸ ὄργανον ὅλον. ("The whole engine is called when complete a Protector."). P. 36. M. = 107.1 W. τὸ δὲ καλούμενα ἐντόνια ("The stretcher, so-called, . . ."). (All translations from Marsden 1971.)

the 'rest'. Herons *Cheiroballistra* provides the same picture.[39] Philo, who uses partly the same terms that Heron explained, uses all terms without ever explaining any but one pair of levers (*zugides*) which he calls differently from what he perceives to be common.[40] Biton, in more than one respect the most enigmatic of our siege lore authors, never bothers to explain his terms. Vitruvius, however, who obviously makes much use of the Greek authors in his field, occasionally points out Greek-Latin equivalences, for example, in phrases such as *cuneoli ferrei quos ἐπιζυγίδας Graeci vocant* (*Arch.* X 12.1).[41] As far as I can see, these explanations do not follow any pattern. Vitruvius certainly acknowledges the Greek background of his lore and thus, probably, builds up his own authority as having read up on siege lore. Heron, who overlooks a long history of catapult-building and writes with a view to an encompassing, canonical corpus of mechanics, might be interested in ironing out terminological differences between schools, that is, different local traditions of that lore,[42] in order to come up with a unified exposition. At the same time, the more space any approach allots to terminological questions, the more clearly it differs from the purely practical and thus transcends toward a discourse within a court context.

There is another group of remarkable terms in these treatises, the names of the actual machines. Some of them are clearly 'lean' terms, e.g., *gastraphetēs* or *petrobolos* ('belly-launcher' and 'stone-thrower', respectively), which are either transparent with respect to their construction or to their virtues. Some are truly idiolectal, such as *sambukē*[43] which due to its metaphorical structure (a *sambukē* is a triangular, harp-like musical instrument) may allow for a 'rich' interplay between the poliorcetic *sambukē*'s grim purpose and its namesake's symposiastic associations. Some are clearly programmatic, such as the *helepolis* ('city-destroyer'), a name chosen as if to convince clients to purchase it.

It is remarkable that in the treatises of Biton, Vitruvius, Athenaeus, and Heron, the names of the machines usually come with those of their inventors and sometimes

39 Heron, *Cheirob.* 214 M. = 128.3 W.: κατεσκευάσθευσαν δὲ καὶ τὰ καλούμενα καμβέστρια τρόπωι τοιῷδε. ("Prepare what are called the field-frames in the following way."). 131.1 W. "Τὸ δὲ καλούμενον κλιμάκιον ἔστω ("Let what is called the little ladder . . .")."

40 Philo, *Belop.* 122 M. = 60.3 f. W. (conj. R. Schöne): . . . μέσαι δ' ἐπ' αὐταῖς αἱ καλούμεναι τίθενται ἐπιζυγίδες, ἡμῖν δὲ κληθησόμεναι καταζυγίδες . . . ("over these, in the middle, are placed what are called upper-levers, but what I shall call under-levers . . .") Schironi 2019, 237, draws attention to Philo's metaphorical terms for his engine parts, terms that indicate that these engines are seen as living beings.

41 Similarly *Arch.* X 10.3 *Canaliculi qui Graece σῦριγξ dicitur . . . regularum, quas nonnulli bucculas appellant . . . quae . . . vocitatur scamillum seu, quemadmodum nonnulli, loculamentum . . . . 4 σχαστηρία sive manucla dicitur . . . 5 Posterior minor columna, quae Graece dicitur ἀντίβασις.* 11.7 . . . *ei membro quod Graeci χελώνιον vocant . . . basis quae appellatur eschara.* 14.1 *arbusculae quae Graece ἀμαξοπόδες dicuntur.* 15.1 *ὄρυγγες Graece dicuntur.*

42 See Marsden 1971, 157, n. 8, reacting to Schramm 1918, 16 f. who regarded these terminological differences as 'arbitrary' ("willkürlich.").

43 See Keyser 2022, 166–169, for its shape and development.

even some remarks about the historical-geographical context in which or for which it was designed. Here are three typical examples: Biton introduces his stone-thrower with the remark, "This stone-thrower was designed in Rhodes by Charon of Magnesia";[44] Philon an 'automatic catapult' with "A certain Dionysius of Alexandria constructed in Rhodes what is called a repeating catapult, which has a unique and very intricate arrangement";[45] and Athenaeus introduces the *helepolis* with "The city-destroyer made by Epimachus the Athenian, which Demetrius the besieger of the Rhodians deployed against their walls, is like this."[46] Sometimes, the name of the engine designates a class rather than an individual machine which is then individuated by inventor's name (Biton, *Constr*. p. 72 M. = 57.1–58.1 W.):

> Ἐχομένως δὲ τῶν προγεγραμμένων ὑπογράψομέν σαμβύκης κατασκευήν. φέρει γὰρ καὶ τοῦτο τὸ ὄργανον ἐν τοῖς πολεμικοῖς ἀγῶσι μεγάλων πραγμάτων κινήσεις. ὑπογράψω δέ σοι ὃ ἠρχιτεκτόνευσε Δᾶμις ὁ Κολοφώνιος.
>
> Following upon what has been already written, we shall describe the construction of a sambuca. This instrument, in martial engagements, offers opportunities for great exploits. I shall describe for you the one which Damis of Colophon designed.

When a place is added to the inventor's name, a certain siege seems to be in the writer's mind. Apparently, the machine had been successful in that context. Again, this is an example taken from Biton (Constr. p. 76 M = 65.1–3 W.):

> Τούτου δ' ἐχόμενόν σοι τὸν ὀρεινοβάτην γαστραφέτην ὑπογράψομεν· ἔχει γὰρ τόνδε τὸν τρόπον. ἐκθήσω δέ σοι, οἷον ἠρχιτεκτόνευσε Ζώπυρος ὁ Ταραντῖνος ἐν Κύμῃ τῇ κατ' Ἰταλίαν.
>
> Following this, we shall describe for you the mountain belly-bow. It has the following form. I shall explain for you the one which Zopyrus of Tarentum designed at Cumae in Italy.

Biton gives this kind of information at the outset of all the engines that he describes, four non-torsion catapults, a *helepolis*, and a *sambukē*.[47] Other treatises, however, use the same convention, even if less coherently: For example, Vitruvius and Athenaeus, in their discussion of 'turtles' (*khelōnai*) pay homage to 'the turtle of Hegetor'.[48] Conceivably, to the competent mechanic, the name of the machine gave general hints as

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44 Biton, *Constr*. p. 66 M. = 45.1f. W.: ἔστι δὲ τοῦτο τὸ πετροβόλον ἐν Ῥόδῳ ἠρχιτεκτονευμένον ὑπὸ Χάρωνος τοῦ Μαγνησίου.

45 Philo, *Belop*. 146 M. = 73.21f. W.: Διονύσιος δέ τις Ἀλεξανδρεὺς κατεσκεύασεν < ἐν > Ῥόδῳ τὸν καλούμενον πολυβόλον καταπάλτην ἰδίαν τινὰ καὶ πάνυ ποικίλην ἔχοντα κατασκευήν.

46 Athenaeus, *Mech*. 27 (p. 56 W.-B.): Ἡ δὲ ὑπὸ Ἐπιμάχου τοῦ Ἀθηναίου γενομένη ἑλέπολις, ἣν Δημήτριος ὁ Ῥοδίους πολιορκῶν προσήγαγε τοῖς τείχεσιν αὐτῶν, ἔστι τοιάδε.

47 Except for the ones already mentioned these are: the *lithobolos* of Isidorus of Abydos, designed in Thessalonica (p. 68 M. = 49.1f. W.); the *helepolis* constructed by Posidonius the Macedonian for Alexander, son of Philip (p. 70 M. = 52.1 f. W.) and the *gastraphetēs* (belly-bow) designed at Miletus by Zopyrus of Tarentum (p. 74 M. = p. 61.2–62.1 W.).

48 Vitruvius, *Arch*. X 15.2, Athenaeus, *Mech*. 21 p. 52 W.-B.

to its construction,[49] whereas the one of its inventor and of the place of its first construction and, presumably, successful use triggered the technicians' collective memory as to more specific and more complex information (the kind of siege, specific problems overcome by certain inventions, etc.). While usually the name of the inventor is mentioned in a clearly acknowledging manner, Philo shows how it can rather be used to induce some skepticism as to whether two rather extravagant engines really work: On the *khalkotonon* and the *aērotonon*, both invented by Ctesibius, Philo mentions in the first case that he has rebuilt the machine without Ctesibius' plans and takes pain to ascertain by eye witnesses that his machine differed greatly from Ctesibius' one.[50] In the second case, he makes an effort to convince his addressee Aristo of the fact that the machine actually works (which modern experts have doubted).[51]

Thus, the terminological system of two or three names (class of engine, inventor, place) allowed for an efficient way to transmit complex mechanical information and was even able to negotiate the author's own stance vis-à-vis the mentioned inventor's one. As we might gather from vague modern parallels,[52] the inventors' names alone would exert a certain zeal in the readers of these treatises. *In nuce*, authors and readers work, by using these names for these machines, on a fragmentary history of that field, a kind of shared disciplinary memory. We can only speculate that the addressees, powerful players in the Hellenistic or Roman worlds such as Attalus or Augustus, who were just planning their own campaigns, were meant by the authors to relate to the historical situations conjured up by the place names mentioned in connection to certain siege engines, which means that in the background of even these treatises there is a paradigmatic view of history at work, certainly sketchy, but comparable to what we see in Plutarch's parallel lives. In some cases, the terminological system even opens up to narrative: Vitruvius can come up with a Peripatos-inspired history of knowledge that eventually led to the siege engine called *aries*/*krios* (*Arch.* X 13.1–3) or turns the situational knowledge contained in these terms and names into anecdotic narratives of paradigms for intelligent stratagems or cautionary tales (*Arch.* X 16ff.) and thus, to a certain extent, into frame-tales of his own project.[53] To add another modern parallel: Present-day mathematicians exhibit a certain tendency toward creating terminology based on personal names, such as 'Gauss-Bonnet theorem', 'Hardy-Littlewood maximal inequality', 'Mandelbrot set', or 'Riemannian manifolds'.[54] It is evident that such terminology adopts

49 See, e.g., Vitruvius, *Arch*. X 13.3 who quotes Diades with four machines that carry five names (*turres ambulatoriae*, *terebra*, *ascendens machina*, *corvus demolitor* = *grues*). In 13.6, there follows the *testudo* of Diades.

50 Philo, *Belop*. 134f. M. = 67.28–68.3 W.

51 Philo, *Belop*. 152 M. = 77.9–12 W. See Schramm 1917, 62f.; Marsden 1971, p. 184. For such machines, see the remark in Athenaeus 15, p. 50, 10–13 W.-B. (on 'machines on paper').

52 Traweek 1999, 525, 531.

53 For the term and its meaning, see my 2011, 92.

54 I take these from the index of Gowers 2005.

an ideology of monumentalization, while at the same time expressing the idea that mathematics is a group effort. There is a certain tension between the famous discovery encapsulated in the coinage of the term, and its (potentially) epigonal user in the present. The same might be true of the one who puts 'Hegetor's turtle' to use after having read up on it in siege engine literature.[55]

⁂

To sum up: Unfortunately, when the history of ancient Greek knowledge is concerned, we cannot follow the process and struggles of how terminologies emerged and either prevailed or disappeared. However, we do get some glimpses of such constellations: Apparently, Aristotle criticized the inappropriate richness of Licymnius' terms and theirs, according to his own standards, being improperly introduced. While it would be rash to conclude that this is the reason of why Licymnius' treatise and rhetorical system have vanished, it affords an impression of less sober terminologies than Aristotle's. Why Licymnius opted for rich terms instead of lean ones, we cannot tell. However, considerations of the competitive structure of theoretical rhetoric might have been part of the story.

For Galen, caught up in constant struggle with competitors past and present, terminologies can easily turn into moral questions that allow for judgments of fellow medical writers' character. Whoever does not play according to the harsh rules laid down by Galen risks medical communication altogether and, according to Galen, acts irresponsibly. As Rufus shows, however, there exist less confrontational ways to deal with terminological differences: different anatomical terms can simply coexist in local traditions, e.g., Athenian versus Hippocratic. However, even Rufus lets himself get carried away when 'Egyptian' doctors name new discoveries, namely cranial sutures, badly. Unlike and more efficiently than Galen, however, Rufus helps forgetting them by not even mentioning their names or contexts of discovery (on the other hand, his criticism remains unclear). I have briefly discussed pulse lore because the field quickly emerged, needed many new terms, and ended up with an interesting terminological mix. It seems that the diagnostic performances Galen and his medical competitors engaged in could have profited from 'lean' just as well as from 'rich' terms. The curious fact that 'rich' pulse terms as fuzzy as *murmēkizōn* established themselves hints at the fact that they offered ways of consensus precisely due to their being fuzzy.

55 I cannot help wondering about the different ways modern soldiers, admittedly not technicians, call their guns, cannons, and engines. As it seems, their names attempt to create intimacy, sometimes vaguely sexual, and certainly carry an air of quasi-human relationships. See Bergmann 1916, 6–12, who, among others, lists: "dicke Bertha," "schlanke Emma," "kurzer Gustav," "langer Schorsch," "Wauwau," "schwarze Säue," "Marie auf Socken," "Gurgel-August," and many more. With all due respect for different circumstances of class and media, I find the differences quite striking.

Turning to ancient siege technology, I have looked at the treatises of the belopoeic tradition and the large number of technical terms they offered. While the vast majority of terms is simply being taken for granted by the authors, some are explained, perhaps motivated by the consideration that their texts might transcend local technical communities (which is most clearly the case in Vitruvius who occasionally equates Latin with Greek terms). The more often this is the case, the more probable it is, in my view, that authors saw technicians among their readers. I believe that we can say, for example, that Biton is probably rather targeting audiences who decide about machines, while Heron apparently thought that at least a portion of his readership would actually build machines.[56] Besides terminological details, these siege lore experts developed a naming system for machines that strikingly combined technological with historical information about the machine's invention. The latter transcends my provisional divide between 'lean' and 'rich' terms and allows for a, albeit fragmentary, glimpse at how these technicians saw themselves: caught up not only between powerful clients and technical, economical or even military constraints, but also in a competition with great inventors past.

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56 On the difference, see my 2017, 29–36 and 40–44, respectively.

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