Hiding Secrets in Greek Siegecraft: Why did Aeneas Tacticus Never Discuss the Spartan *scytale*?

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Abstract: Communication security – known as cryptography and steganography – is as important to modern states, as it is to ancient ones. The earliest known original source on ancient communication security is Aeneas Tacticus' *How to Survive Under Siege*. It is in Aeneas Tacticus' work that historians of cryptography insist that we would expect to find a discussion of the cryptographic device known as the Spartan *scytale* had its use as a cryptographic device been known to Aeneas Tacticus. However, in this article I will show that Aeneas Tacticus had other reasons for not discussing the *scytale* as a cryptograph – the main reason being that Aeneas was far more interested in steganographic practices to physically hide messages than cryptographic practices like the *scytale*, used to encipher secrets.

Keywords: Aeneas Tacticus; Greek warfare; cryptography; Sparta; *scytale*

Communication security is of major importance to our modern world. Indeed, as Gerolymatos points out, the gathering of intelligence and spying on one's enemies is essential for any government to determine the political and military direction of the state especially in times of conflict when essential information on enemies can obviously facilitate the war effort.[1] As Starr argues:

> modern superpowers need to be able to assess swiftly the potentialities of other states within a framework of rapidly technological change.[2]

Yet, since antiquity, individuals in all civilisations have been trying to encipher confidential correspondence (mainly in a military context, according to our available sources[3]), while others have been trying to decipher these messages. In fact, in the 6th century CE Procopius of Caesarea already described the practice of secretly communicating and spying as a very old one that went all the way back to the ancient Near Eastern kingdoms (Procopius of Caesarea, *Secret History*, 30: 12-14).[4] And it has been suggested that all ancient

[1] Gerolymatos 1986, 13.

[2] Starr 1974, 1.

[3] Yet, evidence for the use of secret confidential information in other contexts in antiquity might be lost.

[4] Extant evidence for the ancient application of cryptography first appears in the second millennium BCE in Egypt and Mesopotamia. In this context, ancient historians suggest that the replacing of standard writing signs for non-standard signs was most likely intended not to hide confidential information, but to impart some magical prestige and authority to a scribe's writing. No examples of cryptography and steganography are known from Egypt and Mesopotamia that appear to have had the primary purpose of sending confidential information from one person to another whereby the coding or encryption was designed such that a third party would not understand the message. Yet, it has been suggested that a cuneiform tablet from Seleucia on the Tigris (dating to 1500 BCE) containing an encrypted recipe for glass-making was a clear attempt to protect confidential information (Caubet 2008, 421; Kasten 2001, 2; ; Mollin 2005, 5.Nemet-Nejat 1998; Pieprzyk, Hardjono, and Seberry 2013, 6; Waldstein & Wisse 1995; Wisse 1979; 1980; 1981; 1982; 1983; 1989; 1990. See also Porphyry of Tyre, *Life of Pythagoras*, 11-12. Zapechnikov, Tolstoy et al. – modern cryptographers – refer to cryptography being well-known from archaeological data since 2000 BCE without referring to any sources

civilisations have been familiar with the use of cryptographic and steganographic methods and devices to conceal their confidential correspondence.[5] Sheldon accordingly argues that:

> Ancient governments, like modern ones, realised that to keep their borders safe, to control their populations and to keep abreast of political developments abroad, they needed a means to collect the intelligence which enabled them to make informed decisions.[6]

And Van Tilborg claims that:

> The protection of sensitive information against unauthorized access [...] has been of prime concern throughout the centuries.[7]

Because of the fear for interception of valuable information by the enemy, some method of concealing messages was essential. This could be achieved by completely hiding a message so that it seemed that there was no message at all, or by writing a message that could not be (easily) understood by the enemy. This concealing of information is known as cryptography and steganography, and it was among the common practices of spies in antiquity – especially in times of war.[8] Steganography, from the Greek words *στεγανός* (*steganos*) meaning 'covered' or 'concealed' and *γράφειν* (*graphein*) meaning 'to write', is the practice of concealing a message within another message, an image, or an object, without giving the idea that a secret message is hidden in it. In other words we can say that steganography is 'the practice of undetectably altering a work to embed a secret message'.[9] Cryptography, from the Greek words *κρυπτός* (*kryptos*), meaning 'hidden from' or 'secret', and *γράφειν* (*graphein*), meaning 'to write', is the practice of techniques for securing communication by enciphering a text. [10]

By far our main original source on ancient cryptography and steganography is the work *How to Survive Under Siege* written around 360-355 BCE by the Greek military author Aeneas Tacticus.[11] Chapter 31 of the work is specifically dedicated to recommendations regarding

(Zapechnikov, Tolstoy et al. 2015, 146). They may be referring to the Egyptian and Mesopotamian uses of cryptography in this case).

[5] The only exception may have been ancient China because of the complexity of the Chinese ideogram alphabet (Pieprzyk; Hardjono and Seberry 2013, 6). Yet, Al-Kadi presumes that even in ancient China cryptography was used (Al-Kadi 1992, 103). Historians of cryptography are, therefore, arguably over-confident in claiming that the earliest civilisations certainly did not encrypt messages to secure confidential information or that it was unquestionably the Egyptians who first invented cryptography for the purpose of securing confidential information (Kasten 2001, 2; Mollin 2005, 5).

[6] Sheldon 2008, 8.

[7] Van Tilborg 2006, xiii.

[8] Besides its use in a military context, other ancient uses of cryptography and steganography include its use in love letters, its use to increase the level of mysticism in inscriptions, and its use in magical and religious texts (Ausonius, *Epistles*, 28.21-22; Ovid, *Ars Amatoria*, 3.627-630; Pliny the Elder, *Natural History*, 26.39 (62)). See also: Pieprzyk; Hardjono, and Seberry 2013, 6; Waldstein & Wisse 1995; Wisse 1979; 1980; 1981; 1982; 1983; 1989; 1990.

[9] Cox, Miller et al. 2008, 2. See also Johnson, Duric et al. 2001, 1; Kahn 1996a, 1; Schaathun 2012, 15; Singh 1999, 5; Whitiak 2003, 1.

[10] Bauer 2013, xix; Hodges 1985, 146; Reba & Shier 2015, 479-480; Reinke 1962, 113; Seyfarth 1970, 181; Smith 1955, 16.

[11] Little is known about the life (and therefore of the direct military, cryptographic or steganographic experiences) of Aeneas Tacticus. He is often identified as Aineias of Stymphalos, an Arcadian general from the 4th century BCE who is mentioned in Xenophon's *Hellenica* (7.3). A date around 360-355 BCE makes Aeneas Tacticus' work not only the oldest known military manual in history but also the oldest known work on cryptography and steganography (Barends 1955; 171; Bliese 1994, 108; Brownson 1918, 281; Chaniotis 2013, 441;

the use of cryptographic and steganographic devices and methods during sieges. In the course of chapter 31 the author discussed twenty-one different methods for secret communication, offering us a detailed catalogue of methods for ancient communication security.[12] It is in Aeneas Tacticus' work that historians of cryptography insist that we would expect to find a discussion of the cryptographic device known as the Spartan scytale – a device discussed by Plutarch and Aulus Gellius (Plutarch, *Life of Lysander* 17.9; Aulus Gellius, *Attic Nights* 17.9.6-16) – had its use as a cryptographic device.[13] However, in this article I will show that Aeneas Tacticus had other reasons for not discussing the *scytale* as a cryptograph.

The Spartan *scytale*

When we look at a comprehensive survey of the extant sources which discuss the *scytale*, the first thing that strikes us is the wide variety of different devices and artefacts to which the label *scytale* seems to apply. *Scytalae* – literally 'sticks' – were used for a number of purposes including as authentication device for messengers (*On the Different Meanings of Words; Greek Iambic Poetry: From the Seventh to the Fifth Centuries BC*; Fragment 185; Pindar, *Olympian Odes*, 6.91-93); to keep records during commercial, financial, and contractual processes (*Biblioteca Apostolica Vaticana*; *Vat. Gr.* 2306; Diodorus Siculus, *Library of History*, 8.27.2; 13.106.8-9; Photius, *Lexicon*, entry: *σκυτάλη* (II)); as military name tags (Diodorus Siculus' *Library of History*, 8.27.2; Polyaenus, *Stratagems of War*, 1.17); as weapons to strike an enemy or a person of lower rank (Aristophanes, *Birds*, 1280-1285; Photius, *Lexicon*, entry: *σκυτάλη* (I)); and even as a reference to a phallus (Aristophanes, *Lysistrata*, 985-992).[14] Plutarch and Aulus Gellius suggest that scytalae were also used by the Spartans for secret communication in the 5th and 4th centuries BCE (Plutarch, *Life of Lysander* 17.9; Aulus Gellius, *Attic Nights* 17.9.6-16)

Although these earliest sources on the *scytale* are highly ambiguous, offering no concrete evidence on whether the *scytale* was also used for secret communication, the Athenian historian Thucydides in the second half of the 5th century BCE ostensibly offers a slightly clearer picture. In chapter 1.131 of the *History of the Peloponnesian War* Thucydides discusses how the Spartans summoned their general Pausanias home, because of misbehaviour, by sending him a *scytale* message. After being dislodged from Byzantium by the Athenians, instead of returning home, Pausanias had settled in the Troad (Anatolia) where he was tarrying for no purpose and intriguing with local inhabitants when he received a *scytale* summoning him home (1.131.1). Because of the delicate nature of the message, and

Dain & Bon 1967, vii; xii; David 1986 (I), 343; Delebecque 1957, 430; Hug 1877, 28 ff.; Hunter & Handford, 1927 ix-x.; xxii; xxiv-xxv; 264; Millett 2013, 65; Oldfather 1923 7; Rawling 2007, 13; Star 1957, 68; Vela Tejada 2004, 141-142; Usher 1970, 210-211; Whitehead 1990, 10-12; Winterling 1991, 196. See also Vela Tejada 1991; Hunter & Handford 1927; Oldfather 1928; Whitehead 1990).

[12] In a previous publication based on my research I suggested sixteen different methods (Diepenbroek 2019). I have since identified a total of twenty-one different methods catalogued in Aeneas Tacticus' work plus a method for fire signalling discussed by Polybius (*Histories*, 10.44-46) – bringing the total to twenty-two methods for secret communication plus. Sheldon mentions 18 methods in the course on this chapter (Sheldon 1988, 190). In D'Agapeyeff's work we see the name of the Roman Tacitus being connected to the invention of these methods of secret communication (D'Agapeyeff 193, 16). D'Agapeyeff potentially confuses the names Aeneas Tacticus and Tacitus, an example of how some modern historians of cryptography seem to misinterpret original sources.

[13] Kelly 1985, 141-169; Sheldon 1987, 45; West 1988, 42; Whitehead 1990, 184.

[14] On *scytale* used as authentication devices see Bowie 2019, 284; Swift 2019.

the fact that the Spartans sent a message to another Spartan, it is plausible that some kind of secret message is meant here.[15] However, although it is clear that the Spartan *scytale* discussed in Thucydides' passage conveyed some kind of official dispatch and message, and although it is plausible that a coded letter was sent – because of the politically and military sensitive content and intent of the letter – we cannot tell whether the *scytale* in this case was used for the purpose of secret communication. What we can say, however, is that here we have evidence for the sending of messages related to *scytalae* in the 5th century BCE, whether we are dealing with secret messages here.

Another passage must be discussed too: a passage from Xenophon's *Hellenica* set during the Peloponnesian War (411 BCE). At 1.1.23, Xenophon mentions a letter from the Spartan vice-admiral Hippocrates to the *ephors* in Sparta about chaos among the Spartan troops:

> [...] a letter dispatched to Lacedaemon by Hippocrates, vice-admiral under Mindarus, was intercepted and taken to Athens; it ran as follows: "The ships are gone. Mindarus is dead. The men are starving. We know not what to do." (Xenophon, *Hellenica*, 1.1.23).

In the original Greek we find the word *ἐπιστολέως* (*epistoleos*) for 'letter', instead of the word *σκυτάλη* (*scytale*).[16] However, sometimes only the wooded sticks are indicated by using the term *σκυτάλη* (Plutarch, *Life of Lysander*, 19.5-6) – while at other times the sticks, and the secret messages were both indicated by the term (Aulus Gellius, *Attic Nights*, 17.9.6-16). More importantly, the message sent from Hippocrates to the *ephors* was sent during the Peloponnesian War between Athens and Sparta. The fact that the enemy intercepted this message – as Xenophon tells us (*ἁλίσκομαι*; *aliskomai*) – makes this a far more plausible situation in which a secret *scytale* message was sent than Thucydides' example of *scytale* messages discussed previously, even though the word '*scytale*' is not mentioned by Xenophon. Yet still it is only theoretically plausible that a *scytale*-message was sent in the way Plutarch and Aulus Gellius describe it.

According to Plutarch, writing in the late 1st/early 2nd-century CE:

> When the ephors [of Sparta] send out an admiral or a general, they make two round pieces of wood exactly alike in length and thickness, [...] and keep one themselves, while they give the other to their envoy. These pieces of wood they call "*scytalae*." Whenever [...] they wish to send some secret and important message, they make a scroll of parchment long and narrow, like a leathern strap, and wind it round their "*scytale*" [...]. After doing this, they write what they wish on the parchment [...]; and when they have written their message,

[15] Smith in his translation of Thucydides' work translates the word as '*scytale* message', while Hammond translates it as 'dispatch-stick. Both scholars then align these references to the Spartan practice of using a *scytale* as a cryptograph, whereby Smith explicitly describes the *scytale* as a special staff used to send cryptographic messages (Hammond 2009, 63; Smith 1919, 220-221). Rhodes and Lattimore simply use the word '*scytale*' in their translations (Lattimore 1998, 63; Rhodes 2014, 161; 271). Rhodes adds that the *scytale* stick was not used as a cryptograph in this context, but for easy transport of a dispatch instead, while Lattimore aptly points out that it is unclear how the *scytale* as message stick would have worked or how a stick (as opposed to a bag, say) would have made transporting a written message easy (Lattimore 1998, 63; Rhodes 2014, 161; 271. See also: Jeffery 1961, 57). Yet, in a commentary on Thucydides, Andrewes argues that in the letters and situations that Thucydides describes, it must be assumed that secret communication (in this case *scytale* messages) was commonly used (Andrewes 1981, 120, in: Gomme, Andrewes & Dover 1981).

[16] While the original Greek text provides us with the word '*ἐπιστολέως/ ἐπιστολή*', Bearzot incorrectly mentions the word '*γράμματα*' when discussing the passage (Bearzot 2014, 100).

> they take the parchment off, and send it, [...] to the commander. (Plutarch, *Life of Lysander*, 19.5-6).

Aulus Gellius' later 2nd-century CE description is remarkably like Plutarch's:

> [When the] ancient Lacedaemonians [...] wanted to conceal and disguise [...] public dispatches sent to their generals [they] used to send letters written in the following manner. There were two thin, cylindrical wands of the same thickness and length, [...]. One of these was given to the general when he went to war, the other the magistrates kept at home [...]. [Then] [...] they bound about the staff a thong [and] [...] they wrote the dispatch on that thong [...] When the letter had been written [...], the thong was unrolled from the wand and sent to the general, [...]. This kind of letter the Lacedaemonians called *σκυτάλη* [*scytale*] (Aulus Gellius, *Attic Nights*, 17.9.6-16).

What Plutarch and Aulus Gellius describe here is a simple yet ingenious device for sending secret messages, whereby only 2 *scytalae* (literally 'sticks') of the same size, and a strip of parchment or papyrus were needed. When a Spartan commander was going to war, the *ephors* would take two *scytalae*. They gave one to the commander to take with him and kept the other one in Sparta. When one party had to communicate with the other one, they would wrap the strip of papyrus or parchment around the *scytale* and write a message on it. The strip was then unwrapped from the *scytale* and only the strip was sent to the other party. The unwrapping would make the letters partial and broken. The recipient could understand the message only be wrapping the strip around his own *scytale* again.[17]

If *scytalae* were ever used for secret communication in the way Plutarch and Gellius describe it, the most likely period for its use by the Spartans are the 5th and 4th centuries BCE, especially in the period between the outbreak of the Peloponnesian War (431 BCE) and the Battle of Leuctra (371 BCE). In this period Spartan commanders were away from home and would therefore have needed such devices to enable long distance communications during their operations in the field.[18] However, a crucial point must be made here: Plutarch and Aulus Gellius were active in the 2nd century CE – about 700 years after the Spartans supposedly used their *scytalae*. Plutarch's and Gellius' descriptions of the *scytale* are likely to have been based on a work of the 4th century BCE Greek historian and rhetorician Theopompus of Chios.[19] Only fragments of Theopompus' work have survived, none of which refer directly to the *scytale*.[20] However, we know that Theopompus was born around 378/377 BCE, and that both he and his father Damasistratus were allegedly exiled from their home in Chios for *lakōnismos*, that is: 'sympathising with Sparta' (Photius, *Lexicon*, 176 = T 2). There is good reason to believe, therefore, that the Greek Theopompus (and his father) would have had closer dealings with Sparta than many other Greeks of the time and would have had particular (perhaps even unique) opportunities to witness or to hear first-hand about the Spartan *scytale* and its use. We also know, by comparing Plutarch's reworking of passages from Theopompus that have been preserved, that Plutarch accurately and reliably preserved the details of the original in his paraphrase, although not repeating his source word for

[17] On the theoretical use of the Spartan *scytale* in Greek warfare see Diepenbroek 2020; 2021a; 2021b.

[18] Kelly 1985, 143; 1998.

[19] Luft 1952; Russell 1966; 1999; Flower 1988; Candau Morón 2000; Verdegem 2010; and Schettino 2013.

[20] Storey 2011-II: *Fragments of Old Comedy* 3.

word.[21] Like Plutarch, Aulus Gellius identifies a great number of earlier sources for his work from both well-known and less well-known authors, including Plutarch himself (*Attic Nights*, 1.1.1; 1.3.5; 1.4.31; 1.26.4-8; 2.8-9; 3.5-6; 4.11; 11.16; 15.10.1; 17.11; 20.8.7) and Theopompus (16.15).[22] Although Aulus Gellius does not identify his sources for his passage on the *scytale* (17.9.6-16), he will certainly have drawn upon earlier sources for his description here too. These sources include both Plutarch's description of the *scytale* – given the close similarity of Plutarch' and Aulus Gellius' accounts – and possibly Plutarch's own original source(s) on the topic, including directly or indirectly Theopompus.[23]

If, as seems likely, Plutarch and Aulus Gellius used Theopompus as their source on the Spartan *scytale*, it would make their descriptions of the *scytale* from the 2nd century CE more reliable sources. However, this still does not proof the Spartan use of the *scytale* in the 5th and 4th centuries BCE.

The absence of the *scytale* from Aeneas Tacticus' work

Let us take a look at another source: Aeneas Tacitus' *How to Survive Under Siege* – an important source on sending secret messages in 4th-century BCE Greece. Interestingly, Aeneas Tacticus never discusses the *scytale* in any of his surviving works, while he was clearly an expert of sending secret messages. The absence of the *scytale* from Aeneas' work is straightforwardly explained by Kelly, Sheldon, West and Whitehead on the grounds that it was not a cryptographic device known to Aeneas Tacticus, and therefore, not a cryptographic device at all.[24] Even though these scholars are correct in stating that there is no evidence from the 5th and 4th century BCE that *scytalae* were used by the Spartans in the way Plutarch and Aulus Gellius describe it 700 years later, it goes too far to state that *scytalae* were never used for

[21] See, for example, Plutarch *Moralia* 210d and Theopompus F22 = Athenaeus of Naucratis, *The Learned Banqueters*, 14.657b-c.

[22] By far the most influential historical source for Aulus Gellius is Plutarch himself, who is quoted in at least 11 passages including in chapter 17 in which we find Aulus Gellius' description of the Spartan *scytale* (1.1.1; 1.3.5; 1.4.31; 1.26.4-8; 2.8-9; 3.5-6; 4.11; 11.16; 15.10.1; 17.11; 20.8.7). However, Aulus Gellius does not always tell us which sources he consulted, and even when he does, we can never be sure whether he has consulted a source at first or second hand (Holford-Strevens 2003, 78). Similarly, even when he is clearly quoting from an older source text, Aulus Gellius does not always record that source. For example, Thucydides is an obvious source for a sizeable portion of the Greek history incorporated in *Attic Nights*. Yet, as Holford-Strevens points out: 'Thucydides (1.11.1) [is mentioned by Aulus Gellius] only once, for the Spartans' marching to the aulos (Holford-Strevens 2003, 247). See Holford-Strevens 2003, 246 on Aulus Gellius' considerable indebtedness to the Greek historians (including Herodotus and Thucydides). Intriguingly, Holford-Strevens speculates here that the reason Aulus Gellius offers such a confused misreading of Herodotus on Spartan history (in *Attic Nights,* 17 in particular) – including the steganographic stratagems practised by Histiaeus of Miletus and by Demaratus – may be because Aulus Gellius was simultaneously referring to another set of technical treatises (*stratagemata)* which focused on descriptions of the devices and stratagems (rather than the characters and stories, which were Herodotus' main concern). So, Holford-Strevens suggests (2003, 246): 'Gellius would have relied on a collection of *stratagemata* that concentrated on the stratagems themselves.' This raises the possibility that Aulus Gellius (and Plutarch before him) both had access to a now lost technical treatise on ancient steganographic and cryptographic stratagems when writing their descriptions of the Spartan *scytale*. See further on Aulus Gellius' sources Oikonomopoulou 2019; Howley: 2018; Grafton, Most & Settis 2013; Cavazza 2004; Holford-Strevens 2003; 2019-I; 2019-II (especially page 590); Holford-Strevens & Vardi 2004; Rolfe 1927, xvii.

[23] Cavazza 2004; Holford-Strevens 2003; 2019-I; 2019-II; Holford-Strevens & Vardi 2004; Rolfe 1927, xvii.

[24] Kelly 1985, 141-169; 1998; Sheldon 1987, 45; 1988, 195-197; West 1988, 42; Whitehead 1990, 184.

secret communications – only because Aeneas never discussed the device. There are several other reasons that might explain the absence of the *scytale* from his works.

First, it is possible (though perhaps not probable) that Aeneas did not know of the *scytale*'s potential or actual use by the Spartans as a cryptographic device at the time of writing *How to Survive Under Siege* as cryptographers suggest.[25] Aeneas Tacticus wrote his work in the mid-4th century BCE. The mid-5th to mid-4th century BCE is the most likely period in which the Spartans used *scytalae* for secret communication if they indeed ever used the devices.[26] In this period the Spartans obviously did not want the enemy to understand their messages. And, therefore, it is plausible that the device was not yet known to other Greeks in the 4th-century BCE when Aeneas wrote his work.[27] What is more, Aeneas Tacticus – living and writing in the middle of the 4th century BCE (that is, after the Peloponnesian War), may well have seen Spartan devices like the *scytale* as unworthy of inclusion in his treatise accordingly. He might, therefore, have excluded such a device from his list of techniques for surviving sieges even if he had been familiar with such stratagems.

Secondly, it seems that Aeneas Tacticus did not have much knowledge of Sparta. From the textual evidence supplied by *How to Survive Under Siege* it appears that Aeneas Tacticus' military experience is confined to the geographical limits of parts of the Peloponnese and the western coast of Asia Minor (10; 11). Aeneas Tacticus never mentions Sparta or a Spartan in his work.[28]

Thirdly, Aeneas may have discussed the *scytale* as a cryptographic device in a now lost work. Only his work *How to Survive Under Siege* has been preserved completely. Yet, there are indications that Aeneas has written other works too. From Polybius, for example, we know that Aeneas discussed a method for fire signalling in another work (Polybius, *Histories*, 10.44). He may have discussed this method and/or the Spartan *scytale* in one of at least four other works on military strategy that are now lost. Three of the works are referred to in *How to Survive Under Siege*: a work on military preparations (7.4; 8.5; 21.1; 40.8); a work on procurement (14.2); and a work on encampment (21.2). Scholars presume that Aeneas also wrote a work on conducting siege operations (Aelian, *The Tactics*, 1.2; 3.4; Julius Africanus, *Kestoi*, 37).[29]

Fourthly, if *scytalae* were used in the way Plutarch and Aulus Gellius describe, they would have been used for long distance communication and field warfare, while Aeneas Tacticus instead focused on surviving a siege in the closed quarters of a besieged town. In his work he shows the inhabitants of a *polis* whose city and homeland were endangered – especially leaders who oversaw maintaining the *polis*' security – that there was the constant danger of treachery from *within* the city itself during sieges. The focus in *How to Survive Under Siege* is,

[25] Kelly 1985, 141-169; Sheldon 1987, 45; West 1988, 42; Whitehead 1990, 184.

[26] Kelly 1985, 143; 1998.

[27] This period also matches with the timeframe in which Plutarch later maintains that key Spartan figures, including Lysander and Agesilaus received coded messages by *scytale* (Plutarch, *Life of Lysander*, 20.1-6; *Life of Agesilaus*, 10.5; 15.4-6) See also David 1986 (I), 343; Spence 2010, 26; Whitehead 1990, 9-12.

[28] In 31.14 of *How to Survive Under Siege* Aeneas discusses Herodotus' story of Demaratus warning the Spartans about Xerxes' invasion of Greece (480 BCE) by sending a message under the wax of a wax tablet (Herodotus, *Histories*, 7.239). Aeneas Tacticus tells the story without mentioning any names or places. He simply states that someone had once written under the wax of a wax tablet.

[29] Bliese 1994, 108; Chaniotis 2013, 446; Hanson 2007, 3; Hunter & Handford 1927, xii-xiii; Jenkins 1999, 35; Moore 2013, 462; Oldfather 1923, 4; 8-9; Vela Tejada 1991; 2004, 141-143; Rawling 2007, 139; Whitehead 1990, 14-15; Vela Tejada 1991; 2004, 141-142.

therefore, upon hiding messages to smuggle them in and out of the besieged *polis*, and not upon encoding them to prevent them from being read and understood by hostile agents (either within or without the city walls). Indeed, this is a recurring theme throughout Aeneas Tacticus' whole work, in which he made clear that establishing secure and mutually comprehensible means of secret communication were of vital importance. The *polis*' inhabitants had to secure all forms of communication that went in and out of the city.[30] Given the significant risk of citizens within the *polis* conspiring and communicating with the enemy, it was vital for the commanding forces to be able to communicate between themselves secretly and securely in Aeneas Tacticus' view. All methods for secret communication that Aeneas Tacticus discussed in chapter 31 of the work are related to this theme of internal treachery, and to his idea of an enemy who is always nearby. Yet, the *scytalae* would typically have been used for long distance communication rather than for the sort of local communications that concerned Aeneas Tacticus. Aeneas Tacticus, therefore, might well have known the use of the *scytale* for long distance communication, but he would not have seen it as a fit subject for his own work, with its particular focus on local communication in a time of siege. This is in fact the most plausible reason.

The fifth and final reason for excluding the Spartan *scytale* from the treatise may be that Aeneas Tacticus was far more interested in steganographic practices (to hide secret messages) than cryptographic practices (to encipher secret messages). Out of twenty-one methods for secret communication we can only see two examples of cryptography (31.30-31; 31.31). This fits in perfectly with the aim of Aeneas Tacticus' chapter 31 which is to teach inhabitants of a *polis* how to hide messages from enemies that were always nearby. Coded yet unhidden messages would obviously have attracted too much attention in such situations making steganographic methods of communication preferable over those that were purely cryptographic.[31]

[30] Aeneas Tacticus, *How to Survive Under Siege*, 4.1-4; 5.1; 9.2; 10.6; 10.11; 10.18-19; 10.25-26; 11.3-6; 12; 18.3-6; 18.8-11 (see also Polyaenus, *Stratagems of War*, 2.36); 18.13-21; 20; 22.5; 22.7; 23.7-11; 29.3-10; Burliga 2008; Pretzler 2018; Liddel 2018, 123; Rawling 2007, 139; Spence 2010, 26; Shipley 2018; Whitehead 1990, 4; 20-24; Williams 1904, 390.

[31] Fire signalling was commonly used in the Near East, Greece, and Rome for sending secret and non-secret messages over long distances (Aeneas Tacticus, *How to Survive Under Siege*, 4.1; 4.5-6; 6.1-6-7; 7.1-7.4; 10.25-26; Apollodorus, *Epitome*, 5.19; Aristotle, *On the Universe*, 398a; Aeschylus, *Agamemnon*, 7-9; 20-29; 278-350; Appian of Alexandria, *The Civil Wars*, 1.6.51; 12.66; *The Spanish Wars*, 6.15.90-92; Caesar, *The Gallic War*, 2.33; 3.65-67; 7.3; *The Civil War*, 3.65; Cicero, *The Verrine Orations*, 2.5.35; Diodorus Siculus, *Library of History*, 18.57.5; 19.17.7; Flavius Josephus, *Books of the History of the Jewish War against the Romans*, 4.10.5; Herodotus, *Histories*, 6.115; 7.183; 9.3; Homer, *Iliad*, 4.275-276; 5.770-771; 18.203-214; Julius Africanus, *Kestoi*, 77; Livy, *History of Rome*, 22.19.6; Maurice, *Strategikon*, 7.2.10; Onasander, *The General*, 25.3; Pausanias, *Description of Greece*, 2.25.2; Pliny, *Natural History*, 35.48 (14); Polybius, *The Histories*, 1.19; 8.28-29; 10.42-47; Polyaenus, *Stratagems of War*, 4.19.2; 6.16.2; Simonides, *Elegies*, 130; Suetonius, *Life of the Caesars* 3. Tiberius, 65; Thucydides, *History of the Peloponnesian War*, 1.63; 2.94; 3.22; 3.80; 4.42. 4.111; 8.95; 8.102; and Vegetius, *The Military Institutions of the Romans*, 3.5.25l Virgil, *Aeneid* 10.454; 11.526; *The Eclogues*, 8; 59; Xenophon, *Hellenica*, 1.1.1-4; 2.1.27; 5.1.27; 6.2.33-34). Interestingly, Aeneas' method for fire signalling (discussed by Polybius) is in fact an example of long-distance communication instead of short distance communication used in and around besieged cities. So, maybe Aeneas Tacticus had an interest in sending secret messages over long distances on the battlefield too. Yet, this does not fit in with the theme of *How to Survive Under Siege*. See: Aschoff 1984; D'Agapeyeff 1939, 16-17; Diepenbroek 2019; 2021a; 2021b; Dvornik 1974, 31-43; Hunter & Handford 1927, 120; 122-123; Hyde 1915; Kahn, 1996, 76-77; 82-83; Liddel 2018, 127-128; Mollin 2005, 9-10; Mollin 2006, 89; Oldfather 1928, 46-47; Rihll 2018, 281-287; Sheldon 1987, 135; Sheldon 2005, 127; Smith 1955, 16; Woolliscroft 2001, 159-171.

Sending messages during sieges

Let us take a closer look at chapter 31 of *How to Survive Under Siege*. In the chapter Aeneas Tacticus discusses twenty-one[32] different methods for secret communication that can be divided into fifteen examples of steganography[33], two examples of cryptography[34], and a further four examples that are a combination of cryptography and steganography.[35] The method of fire signalling – known from Polybius (*Histories*, 10.44) – also falls into the category of steganography bringing the total to twenty-two methods. Of the examples Aeneas Tacticus offers of cryptographic devices and of crypto-steganographic combinations there are three examples of transposition ciphers, and three examples of substitution ciphers.[36] As Whitehead points out, this makes the collection the fullest accumulation of cryptographic and steganographic devices known from antiquity.[37] Other scholars argue that there was no clear categorisation in the methods for secret communication discussed in Aeneas Tacticus' work: the author simply discussed a sample range of methods covering,[38] as Liddel argues:

> a variety of (a) means of physical transference of written objects, (b) means of concealment and (c) of the materials used for writing.[39]

However, as my own classification above makes clear, Aeneas Tacticus is clearly far more knowledgeable about, and interested in steganographic devices for hidden secret communication than in encrypted messaging (i.e., cryptography) – a point that previous scholars have not picked up upon before.[40] To understand Aeneas Tacticus' interest in

[32] Hunter and Handford discuss eighteen different methods, but they do not discuss the two variations of the *astragali* method (also known as 'knucklebones method') separately. Instead, they see only one variation (Hunter & Handford 1927, 211). Yet, I believe this distinction to be crucial since the two variations are clearly different methods (see below).

[33] Aeneas Tacticus, *How to Survive Under Siege*, 31.4-5 (3x); 31.6; 31.7; 31.8; 31.9-9b; 31.10-13; 31.14; 31.15; 31.15-16; 31.23; 31.25-27; 31.28-29; 31.31-32.

[34] Aeneas Tacticus, *How to Survive Under Siege*, 31.30-31; 31.31.

[35] Aeneas Tacticus, *How to Survive Under Siege*, 31.1-3; 31.16-22. In another now lost work Aeneas Tacticus also discussed a method for fire signalling used in secret communication (Aeneas Tacticus, *How to survive under Siege*, 7.1-4; Polybius, *Histories*, 10.44-46). On this method, Polybius' improvements, and its application in the German ADFGX and ADFGVX ciphers used by the German military intelligence services in the First World War see Diepenbroek 2019, 63-76.

[36] In a transposition cipher the normal sequence of letters of a plaintext is rearranged. Hereby, alphabetic letters are not typically substituted by any other letters, numbers, or symbols. In substitution ciphers, however, the letters of a plaintext message are substituted with other letters, characters, or symbols that are not necessarily found in the original text and the sequence of ciphertext letters that is used for such encryption and decryption is known as a ciphertext alphabet (Bauer 2007, 382; Reinke 1962, 113; Singh 1999, 5). For examples of transposition ciphers in *How to Survive Under Siege*, see 31.16-19; 31.20; 31.21-22. For examples of substitution ciphers in the work, see 31.10-13; 31.30; 31.31.

[37] Whitehead 1990, 183; 187.

[38] Debidour 2006; Liddel 2018, 135; Rance 2018, 313.

[39] Liddel 2018, 135.

[40] Various methods of secret communication discussed in the work seem to have been Aeneas Tacticus' own inventions, especially the use of *astragali* (knucklebones) and its variations (31.16-22), while other methods have clearly been based on reports and descriptions found in historical sources. These sources include Herodotus' *Histories,* and Thucydides' *History of the Peloponnesian War*, well as other unspecified oral and/or written sources (Aeneas Tacticus, *How to Survive Under Siege*, 31.14 = Herodotus, *Histories*, 7.239; 31.25-27 = *Histories*, 8.128; 31.28-29 = *Histories*, 5.35; 37.6 = *Histories*, 4.200; 2.3-6 = Thucydides, *History of the Peloponnesian War*, 2.2-6 (esp. 4); 27.11 = Xenophon, *Anabasis*, 2.2.20. Throughout chapter 31 Aeneas Tacticus also discusses many

steganography over cryptography, it is useful to look in detail at those devices and stratagems which he does discuss.

In chapter 31.14 of *How to Survive Under Siege* Aeneas Tacticus discusses a relatively straightforward strategy of secret communication involving the concealment of writing under the wax of a wax-tablet. According to Aeneas, a non-encrypted secret message would be written on the base of a tablet and then wax was poured over it, and a second open message would be written on the top film of wax. When this tablet was delivered, the recipient who knew or anticipated that a message was written under the wax would scrape off the wax to read the message hidden underneath and send any reply in the same way (31.14). According to Sheldon:

> This device originally comes from Herodotus and was used to transmit one of the most important messages in all of Greek history.[41]

The method Aeneas' discusses is indeed based upon a story by Herodotus. This is the story of the Spartan king Demaratus sending a secret message to Sparta while he was exiled at Xerxes' court in Persia. In the message Demaratus warned the Spartans for Xerxes' invasion of Greece (480 BCE; *Histories* 7.239).[42] Yet, we cannot know with certainly how much (if any) of Herodotus' story is true. Therefore, it goes too far to argue that Demaratus' message was 'one of the most important messages in all of Greek history'. This is an example of how cryptographers seem to misinterpret original sources. What we can say is this: When using a source Aeneas Tacticus did not literally quote it. Instead, he paraphrased his sources in order to bring out his own points in the clearest way, thereby omitting unessential details and sometimes adding information to the original.[43] Aeneas Tacticus does not simply follow Herodotus' earlier account verbatim. After discussing how the nameless person in his example sent a secret message following the details of his Herodotean source closely, Aeneas Tacticus suggests that a message was sent back in the same way (31.14) – as if this were a useful practical way of secret communication that had taken place between two parties. He then adds two other possibilities, as if to show that he could improve on his sources by supplementing them with ideas of his own. First, we see the possibility to write a message on the base of a boxwood tablet, and then whitewash the tablet and perhaps paint a picture over it to render the writing invisible. To make the writing visible again a recipient had to place the tablet in water to dissolve the paint (31.14-15). Aeneas Tacticus' second alternative suggestion was to use a hero's plaque (an image of a hero usually left in a shrine) for the same

times that he knew or had heard that something had once happened without specifying his sources (*How to Survive Under Siege*, 31.1-2; 31.6; 31.8-9b; 31.10-14; 31.23; 31.24-29; 31.32-35)). When Aeneas Tacticus uses one of his secondary sources, he then nuanced the method for secret communication discussed in the source with his own ideas – presumably since he believed that his own alternatives (based on his own first-hand tried and tested experiences, perhaps, were improvements upon the original method). On Aeneas Tacticus' sources see Bettalli 1990; Brown 1981; Dain & Bon 1967; David 1986 (I); David 1986 (II); Hunter & Handford 1927; Luraghi 1988; Vela Tejada 1991, 37-43; Vela Tejada & Garcia 1991; Whitehead 1990. On examples of Aeneas Tacticus' personal experience discussed in *How to Survive Under Siege*, see Burliga 2008.

[41] Sheldon 1988, 190.

[42] See also Aulus Gellius, *Attic Nights*, 17.9.6; Julius Africanus, *Kestoi*, 53; Justin, *Epitome of the Philippic History of Pompeius Trogus,* 2.10.13; Polyaenus, *Stratagems of War*, 2.20. See for a parallel from Roman times: Herodian, *History of the Empire from the Death of Marcus*, 7.6.5.

[43] Brown 1981, 388; Burliga 2008; Pretzler 2018; Shipley 2018.

purpose (31.15-16).[44] Clearly, Aeneas considered that his alternatives would have worked more effectively as practical steganographic devices than the original method described by Herodotus. It is plausible that Aeneas Tacticus (quite sensibly) believed that a seemingly empty tablet in transit would have attracted too much suspicion if it fell into the wrong hands. In 31.28-29 we see another story based on Herodotus: Histiaeus sending message to Aristagoras tattooed on a slave's head (31.28-29 = Herodotus, *Histories*, 5.35). These examples from Herodotus fit in well with the broader theme of Aeneas Tacticus' work on sieges, since here we are dealing with hidden messages being smuggled out of a besieged city.[45] Indeed, this case is included as an example of the importance of the use of trustworthy messengers for secret communications during a siege, which is a recurring theme in Aeneas Tacticus' work.[46]

Aeneas Tacticus discusses seven further examples of steganographic messages that could be sent hidden in or under clothing, footwear, armour, jewellery, and even a dog collar.[47] Amongst his simple suggestions are to hide a message under a breastplate (31.8), to sew one into a bridle-rein (31.9-9b), or to hide it in between layers of clothing (31.23).[48] Aeneas Tacticus also discusses how a message was once sent bound to a wound on a man's leg (31.6), and how in Epirus and Thessaly it was the custom to take a dog away from his home, hide a secret message in its collar, and then sent it back home (31.31-32).[49] A slightly more complicated method compared to these is found in 31.7, where Aeneas suggests to write messages on pieces of lead that could be rolled up and worn as women's earrings.[50] Significantly, the lead could be rolled up, making it possible to send a closed and sealed message hidden in plain sight. Another slightly more complicated method can be found in 31.4-5. Here, Aeneas Tacticus discusses the sending of secret messages by using a messenger without the messenger knowing about this. Before sending out the messenger the sender had to insert a secret letter into the sole of one of the messenger's sandals.[51] He would then send the messenger to the recipient with a non-secret letter to provide a cover for his actual

[44] In this second example presumably another type of paint would be used since Aeneas Tacticus recommends that oil was needed to dissolve the painting instead of water (31.16).

[45] See also Aulus Gellius, *Attic Nights*, 17.9.18-27; Polyaenus, *Stratagems of War*, 1.24.

[46] Aeneas Tacticus, *How to Survive Under Siege*, 9.2; 10.6; 10.11; 10.25-26; 22.5; 22.7; 31. Unlike his reworking of the Demaratus' story reported by Herodotus, however, here Aeneas Tacticus includes names (Histiaeus; Aristagoras) and places (Miletus) that Herodotus supplies in his version too, thereby lending credibility and authority to Aeneas' account.

[47] Four examples seem to be based on Aeneas Tacticus' sources (31.6; 31.23; 31.25-27; 31.31-32), while three examples were his own suggestions (31.4-5; 31.7; 31.9; 31.9).

[48] See also Julius Africanus, *Kestoi*, 53; Philo of Byzantium, *Compendium of Mechanics*, D.78 (102.37–39) in: Thévenot, Boivin, et al., 1693, *Veterum Mathematicorum Opera*, 102. See for a Roman parallel: Ammianus Marcellinus, *Roman History*, 18.6.17-19; Frontinus, *Stratagems*, 3.13.3-6; Florus, *Epitome of Roman History*, 1.40.15-16; Orosius, *Seven Books of History Against the Pagans,* 6.2.14.

[49] See for a parallel from Roman times: Frontinus, *Stratagems*, 3.13.5-8; Pliny, *Natural History*, 10.53 (37)). A link can be made to the use of animals as secret messengers in the 20th century. For the role of carrier pigeons in the Second World War, see e.g.: O'Connor 2018.

[50] See for a parallel from Roman times: Cassius Dio, *Roman History*, 46.36; Frontinus, *Stratagems*, 3.13.7.

[51] To make sure that the hidden message was not affected by water and mud, Aeneas Tacticus suggested that it be written on a piece of lead (31.4). Whitehead incorrectly presumes that Ovid suggested this same method in *Ars Amatoria,* 3.624 (Whitehead 1990, 184). However, Ovid simply mentioned that one could hide a letter between a foot and a sandal amongst a selection of simple methods to communicate in secret quickly and easily (*Art of Love,* 3.619-630).

mission. The recipient could reply in the same way if requested (31.4-5).[52] These seven examples show Aeneas Tacticus' interest in steganographic messages that were hidden in simple ways almost in plain sight, by using commonly known household objects.

In chapter 31.10-13 Aeneas Tacticus discusses a rather more laborious way of sending secret messages by using an oil-flask and a bladder. According to Aeneas Tacticus, one could inflate a bladder and write on it with ink mixed with glue. Once the writing was dry one had to deflate the bladder, press it into a flask, and inflate it again. Hereby, the glue would stick the bladder to the insides of the flask. Then one had to fill the flask (or technically the bladder lining it) with oil. In this way, the bladder would have become (nearly) invisible. Upon receiving the flask, the recipient had to pour out the oil, re-inflate the bladder and read the text.[53] He could then wipe off the text with a sponge and reply in the same way (31.10-13). This method of steganographic communication is not only laborious but demands access to a panoply of domestic supplies. Indeed, such a method for securing the secret communication of hidden (though not encoded) messages would have been highly impractical on a battlefield (the context in which a *scytale* was used if we follow Plutarch and Aulus Gellius) since both parties would have needed flask, bladders, ink, glue, and oil. Yet, however laborious, the method might have been useful as a means of securing a secret communication in a siege defence, and therefore offers us a salient reminder that this is the specific context of Aeneas Tacticus' work.

In fact, so confident is Aeneas in the security of his various steganographic devices, that he has comparatively little to say about the risks of these messages being intercepted and read by hostile agents. He gives only two suggestions for the use of cryptography (31.30-31) and two methods that are a combination of cryptography and steganography (31.1-3). In passage 31.30-31, Aeneas Tacticus suggests that, instead of marking a slave's head with easily recognisable words or letters, one could instead write by replacing vowels with dots (31.30-31), or any other letter or symbol (31.31).[54] The encoded messages created here by using this very basic form of encryption through partial substitution would help to add an additional layer of security should the messenger-slave be intercepted by hostile agents and his head shaved to reveal the message on his scalp.[55] Aeneas Tacticus' methodology here represents

[52] See also Julius Africanus, *Kestoi*, 51; Philo of Byzantium, *Compendium of Mechanics*, D. 81 (102. 45-50). In: Thévenot, Boivin, et al. 1693, *Veterum Mathematicorum Opera*, 102. This method could have been useful if one did not trust his messenger.

[53] This is not an example of the use of invisible ink since the recipient simply had to pour out the oil to be able to read the text again. He did not have to use e.g., charcoal to make the text visible again. For the use of invisible ink in antiquity see Ausonius, *Epistles*, 28.21-22; Ovid, *Ars Amatoria*, 3.627-630; Philo, *Compendium of Mechanics*, D. 77 (102.31-36); Pliny the Elder, *Natural History* (26.39 (62)).

[54] Bauer – based on Hunt 1929 – suggests that the ancient Greeks were familiar with the cryptographic principle of replacing letters by other letters (Bauer 2017, 96). See also Plutarch, *Dion*; Timonides, Fragment 1, in: Brill's New Jacoby (561); Timaeus, Fragment 114; in: Brill's New Jacoby (566). When discussing this passage, scholars – starting with Von Gutschmid in 1880 – have typically only focused upon attempting to link this example to a historical event: the war between Dionysius II of Syracuse, and his opponents Dion and Heracleides in 357 BCE. These scholars seem to have overlooked the fact that this short passage provides the only two suggestions of cryptographic methods out of the total sum of twenty-one methods for secret communication that Aeneas Tacticus discussed in chapter 31 of his work – again clearly showing that Aeneas Tacticus was far more interested in steganographic (hidden) messages than in cryptographic (coded) messages (Bengtson 1962, 460; Glotz & Cohen 1936, 410-411; Dain & Bon 1967, 75; Oldfather 1928, 5-7; Von Gutschmid 1880, 588-590; Whitehead 1990, 191).

[55] From around 600-500 years BCE Hebrew scholars were already using a substitution system known as the *Atbash* cipher and Aeneas Tacticus may have based his simple cipher on this model. See Strasser 2007, 278.

the first known substitution cipher recommended for use in warfare. Yet, it is important not to overlook the fact that it is presented by Aeneas Tacticus as a secondary device, an insurance policy of sorts, to support his primary stratagem recommending a steganographic approach as the foundation to successful secret communication. In passage 31.1-2, Aeneas Tacticus discusses how a message could be written by marking letters in a book or document with dots – and the book or document with the message then hidden in baggage. The recipient had to make a transcript of all the marked letters to understand the message (31.1-2). As an alternative, Aeneas Tacticus suggests that instead of using a book or document as the vehicle for the message, one could simply write a letter and then add the markings (31.3) – which obviously had to be as inconspicuous as possible by placing them far apart and making them as small as possible (31.1-3). Clearly marked letters in a text would have attracted suspicion especially for trained people who would have been trying to uncover their enemy's secrets, and especially if there were a pattern in the text with e.g., every third letter being marked. One, therefore, had to avoid clear marking and patterns when using this technique. The combination of cryptographic and steganographic encryption here, as in the previous case, makes the method more secure. However, Aeneas Tacticus is clearly less confident in the protection offered by encryption than he is in the protection offered by concealment. Although he recommends numerous steganographic techniques that work (so he suggests) on their own, here he once again recommends that the coded message or text is also hidden and concealed in a bag to secure its transmission.

A possible explanation for Aeneas Tacticus' comparative lack of confidence in cryptographic devices may be traced to his account in his treatise of the use of *astragali* (also known as knucklebones or *talus* bones) to send secret messages (31.16-22).[56] As becomes clear from Aeneas Tacticus' description, one could pierce 24 holes into an *astragalus* to represent the 24 letters of the Greek alphabet.[57] Whenever someone wanted to communicate a message by using an *astragalus*, this person had to draw a thread through its holes. In other words, he would 'sew' a message through an *astragalus,* and this transposing of letters would compose a simple transposition cipher (31.16-19).[58] The unthreading obviously took place in the reverse order, since the decoding necessarily started by unthreading at the end. Consequently, all the letters of the message appeared in the reverse order. Therefore, to understand the intended message properly, the recipient had to turn the letters back into their normal order. Because of its size, a message sent using an *astragalus* could not have been much longer than one or two words or a short sentence. The message '*Enemy Attacks At Dawn*' could, for example, have been abbreviated to *EAAD*. Yet, the use of such a small object must have made the use of *astragali* for this form of secret communication very time consuming and exceedingly difficult in practice. One would easily end up with a ball of thread whereby it was no longer possible to find the correct holes – making the use of *astragali* rather troublesome for the sender, and even more so for the receiver, as Whitehead, and Hunter and Handford point out.[59] Therefore, it is questionable whether the method may have functioned well. It seems plausible that Aeneas found out for himself that using the *astragali*

[56] Aeneas' use of *astragali* is discussed for the first time in modern cryptographic scholarship by Hunter and Handford in 1927 (Hunter & Handford 1927, 209).

[57] Only knucklebones of hooved animals – like sheep or goats – were useful for this purpose since these are almost square or rectangular and, therefore, have four more or less flat sides, on to which the 24-letter Greek alphabet naturally fell in to four neat groups of six letters (Olivetti 2015, 263).

[58] It is plausible that Aeneas Tacticus tried out the method before putting it into practice. In passage 31.18, namely, he discussed how to 'write' his own name by pulling a thread through the holes of the *astragalus*.

[59] Hunter and Handford 1927, lxxxii; Whitehead 1990, 187.

for secret communication was laborious, since he describes the method not only as the most secret, but also the most difficult (or 'troublesome' as Whitehead translates it; 31.16).[60] Since the method was rather complicated and very time consuming, Aeneas accordingly suggested two simpler variations. Instead of an *astragalus* one could either use a rectangular piece of wood (31.20), or a wooden disk (31.21-22) in which one would then pierce twenty-four holes as in the bone *astragalus.* When using the disk, one had to prick holes in the centre of the disk too. Whenever a letter occurred twice in a row, one had to pull the thread through one of the holes in the centre in between the two other letters (31.22). Two reconstructions show what this disk might have looked like. Figure 1 (left) shows Diels' suggestion in which the letters *alpha* to *omega* are written clockwise in their normal order at the edge of the disk. Diels incorrectly describes this as a reconstruction of an *astragalus* while it clearly represents Aeneas Tacticus' wooden disk.[61] Figure 1 (right) shows Welskopf's reconstruction in which the first four letters – *alpha, beta*, *gamma*, and *delta* – can be found at the top, bottom, and left and right side of the disk as on a compass where north, south, east and west are pointed out. The rest of the letters can be found right opposite each other on the disk starting at the top with a letter of the right side, then a letter on the left side and so on.[62] Yet, it is more plausible that the letters were 'written' in alphabetical order to avoid making this already complex method yet more complex again.

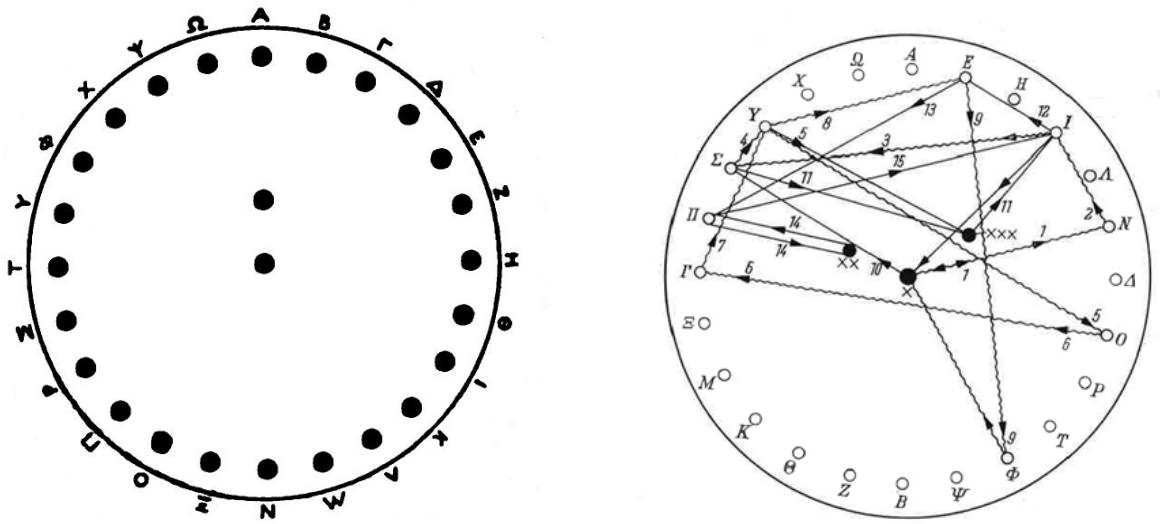

Figure 1: Two reconstructions of Aeneas Tacticus' wooden disk used instead of an astragalus. Left: reconstruction Diels; right: reconstruction Welskopf.[63]

Aeneas Tacticus mentions that the extra holes in the middle were added to prevent suspicion from being raised (31.21) – though what exactly he meant by this is unclear. Translations and commentaries seem to have overlooked this point. It might be that there is an omission in the text here, but another intriguing possibility is that one could have pulled a thread through the holes in the middle in order to wear the disk as a necklace – in the same

[60] Whitehead 1990, 87. If no actual writing in cryptographic messages, one speaks of a semagram (Chatton 2010, 43; Lunde 2012, 42).

[61] Diels 1914, 67.

[62] Welskopf 1974, 44.

[63] Diels 1914, 67; Welskopf 1974, 44.

way as the lead earrings described as a steganographic device in the treatise were designed to be worn as jewellery (31.7). Indeed, this interpretation again fits in well with Aeneas' wider approach to such devices and stratagems in *How to Survive Under Siege*, and his obvious interest in hiding secrets in plain sight (steganography) over encrypting secrets (cryptography).

Conclusion

Historians of cryptography presume that *scytalae* were never used for secret messaging in the way Plutarch and Aulus Gellius discuss, only because Aeneas Tacticus never discusses it in his works. Even though it is correct to state that we have no evidence for the use of the *scytale* as a cryptographic device by the Spartans in the 5th and 4th centuries BCE, it goes too far to state the device has never been used for the purpose – only because Aeneas did not discuss it. As I have shown in this article, there are various other reasons that may explain the fact that Aeneas Tacticus never discusses the *scytale* in chapter 31 of *How to Survive Under Siege*.

First, it is possible (though not very probable) that Aeneas did not know of the *scytale*'s potential or actual use by the Spartans as a cryptographic device at the time of writing *How to Survive Under Siege* – since he wrote in the mid-4th century BCE, the time in which the Spartans most likely used *scytalae*, something they obviously did not want to share with the enemy at the time. Secondly, it seems that Aeneas Tacticus did not have much knowledge of Sparta. Thirdly, Aeneas may have discussed the *scytale* as a cryptographic device in a now lost work. Fourthly, if *scytalae* were used in the way Plutarch and Aulus Gellius describe, they would have been used for long distance communication and field warfare, while Aeneas Tacticus instead focused on surviving a siege in the closed quarters of a besieged town. Finally, and most importantly, we have seen that Aeneas Tacticus was far more interested in steganographic practices to hide secret messages than cryptographic practices to encipher secret messages. We can reasonably conclude, then, that the absence of the Spartan *scytale* from Aeneas Tacticus' treatise does not in itself offer sufficient evidence to support the theory forwarded by Whitehead, West, and Sheldon that the *scytale* was unknown to Aeneas Tacticus, and therefore, that it was never used as a cryptographic device.[64] However, these historians of cryptography present Aeneas' methods and devices as something that has in fact been used. Yet, there is no evidence that any of Aeneas Tacticus' twenty-two methods for cryptography and steganography were ever used in warfare – they are merely suggestions, based upon stories. However, most methods are so simple and ingenious that is seems very plausible the methods could have been used during sieges. The same applies to the *scytale*, and therefore, we must give Plutarch some credit. The ingenious rearrangement of the letters that Plutarch (and later Aulus Gellius) describe as the key feature of *scytale* communication, make the *scytale* a candidate for the earliest known theoretical transposition cipher in history. And the principle of this cipher keeps reappearing throughout the ages until modern day.[65]

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[64] Sheldon 1987, 45; West 1988, 42; Whitehead 1990, 183-184.

[65] On the use of the principle of the *scytale*-system as the first theoretical transposition in history, in later cryptographic systems see: Bauer 2007; Bauer 2013; 2017; Diepenbroek 2021a; 2021b; Singh 1999.

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