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HISTIA: NAVAL HISTORY AND TEXTILE ARCHAEOLOGY. INVESTIGATING THE SAILS OF THE ANCIENT RHODIAN NAVY

Abstract: The paper discusses the methodology, some preliminary results and scientific problems of the HISTIA research project studying the production, maintenance, and administration of a neglected area of research, namely the sails, rope and any textile equipment needed for the military ships of Rhodes, mainly based on similar studies carried out for the Athenian navy, as well as research on the naval power of Rhodes. By focusing on this previously unstudied field of naval studies, this project, not only aims at breaching a significant research gap, but also establishes a new field of textile archaeology that studies textiles intended for the ships.

Keywords: *Rhodian navy, sails, textile archaeology, naval history.*

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The paper in the context of the HISTIA research project attempts to discuss issues of methodology and scientific problems, presenting some preliminary results on the production, maintenance, and administration of the sails, rope and any textile equipment needed for the military ships of Rhodes.¹ The research is based on studies carried out for the Athenian navy, as well as research on the naval power of Rhodes. The basic type of ship being the trireme, a significant source of information for the establishment of the requirements in textiles and rope were the naval catalogues of Piraeus listing the triremes and their equipment. The HISTIA project also studies the materials required for this production, the possibility of local cultivation, as well as the trade of raw materials and finished products; similarly, the production process, information about workshops, workforce, as well as different trades necessary to meet the constant requirements of the navy in textiles and rope. Moreover, as was also the case in Athens, in Rhodes too this material required constant and specific maintenance in storehouses with special conditions in order to be safely stored and be useful for a long period of time. Finally, the issue of the administration of the navy regarding this equipment is of special interest to the project and is studied in relation to the corresponding administration of the equipment in sails and rope in the Athenian navy.²

The Mediterranean Sea has always played an integral part to the

¹ The research was conducted in the context of the act «ΙΣΤΙΑ: Τα ιστία του ναυτικού της αρχαίας Ρόδου», στον Άξονα Προτεραιότητας «ΒΕΛΤΙΩΣΗ ΤΗΣ ΠΟΙΟΤΗΤΑΣ ΚΑΙ ΑΠΟΤΕΛΕΣΜΑΤΙΚΟΤΗΤΑΣ ΤΟΥ ΕΚΠΑΙΔΕΥΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ» του Ε.Π. «Ανάπτυξη Ανθρώπινου Δυναμικού, Εκπαίδευση και Διά Βίου Μάθηση». ΕΔΒΜ-103: ΥΠΟΣΤΗΡΙΞΗ ΕΡΕΥΝΗΤΩΝ ΜΕ ΕΜΦΑΣΗ ΣΤΟΥΣ ΝΕΟΥΣ ΕΡΕΥΝΗΤΕΣ-ΚΥΚΛΟΣ Β', Κωδ. ΟΠΣ: 5048420.

² For a fuller discussion of the issues see SPANTIDAKI/STEFANAKIS/MPARDANIS 2020.

Greek culture and history, as, since ancient times, people of the prehistoric Aegean and the Greeks from the early 1st millennium BCE travelled throughout the Mediterranean Sea and even beyond.³ Athens became a supreme naval power in the Classical period, and was matched, in the 3rd and 2nd century BCE by Rhodes, who was running a well-organized navy, maritime as well as commercial, controlling the sea routes of the East Mediterranean basin.⁴

The city of Rhodes was exploiting five harbours,⁵ which were serving the naval activities of the Rhodians and accommodated the fleet, estimated to consist of less than 100 ships of various types, *kataphracts* such as *trireme*, *tettreres*, *peneires* and *aphracts* such as *hemiolia*, *trihemiolia*, and smaller vessels known as “*phylakides nhes*” too.⁶ The harbours also had an infrastructure including various installations by the dockyards. A few shipsheds (*neōsoikoi*) have been excavated in Rhodes, with the main volume located by the small/military (mod. Mandraki) harbour. A rough estimate speaks of a max. of 100 shipsheds allocated on the east and south shoreline of the harbour.⁷

Large storage buildings have also come to light, but their use could not be defined.⁸ In any case, hulls and oars were stored in the shipsheds, while the hanging equipment was kept in separate storehouses. Indeed, the sails and rigging material needed to be stored away from direct sunlight and humidity, and at the same time ensure good ventilation. The largest known to-date example is the so-called *skeuothēkē* of Philon, in the port of Zea, whose plans are known from a detailed description in IG II² 1668.⁹ Such buildings are likely to have been located by the West, Akantia, and the South harbours of Rhodes, while more are expected to exist in the area of Mandraki too.

A network of Rhodian naval bases around the island itself, on other islands of the Dodecanese, as well as across the Asia Minor coast (Rhodian Peraia) were safeguarding and facilitating the routes and the trade, for which very few things are known.¹⁰

The large number of vessels and their extensive use during the Classical and Hellenistic period point out to constant needs for huge amounts of specific resources to build the ships, no less to equip them. Despite the fact that manoeuvring and sailing a trireme, for example, was primarily based on rowing and less on sailing, sails and different types of rope were an indispensable part of the ships

equipment.¹¹ Thus, when discussing Hellenistic Rhodes, one has to imagine a thriving naval industry combining several domains of production, a variety of materials and different trades working together to produce, among the other gear, the textile products used on the Rhodian fleet. In this great industry, there had to be large infrastructure accommodating the dockyards for the ship manufacture including different kinds of workshops: carpentry workshops, bronze workshops, textile, rope and leather workshops, as well as dye or paint workshops.

THE QUEST FOR SAILS AND ROPES

As the majority of modern archaeologists have studied the production and function of the trireme, but mostly focusing on hull and oar construction, there is a scientific gap in our knowledge of sails production and function concerning both ship and textile archaeology. The gap becomes vast when one comes to the hanging equipment industry of Hellenistic Rhodes as an important section of the Rhodian textile production. The hanging equipment included the sails (and most probably spare sails as well), textile screens, many different types of rope for different purposes, also leather screens for protection, leather covers protecting the lower oar ports from the water, and probably felt screens.

In order to draw information on ancient sails and ropes, one has to turn to three distinct categories of evidence: namely the written sources, the iconography and the direct archaeological evidence, while experimental archaeology offers also an important insight.

Scattered references in literary texts of the Classical period provide information on the materials required, the imports of resources and occasional insights on colours, crafts, the sailing terminology and practical information on sailing.¹² Most of the information about sails, however, comes from the naval records of Piraeus, administrative documents dated from 378/7 to 325/4 BCE that list the ships in the ship sheds and at sea¹³ along with their detailed equipment. This equipment is divided into “wooden” and “hanging” gear according to inscriptions.¹⁴ Sails and rigging are included in the “hanging” equipment. The records offer crucial information on the textile equipment of the ships, as well as the institutional framework, the administration and maintenance of sails and rigging, prices for construction, repair and specific equipment. Shortages of sails and officers that owe naval equipment and/or money to the *polis* are also mentioned.¹⁵

The naval inscriptions also mention two qualities of sails, standard and fine¹⁶ but they do not mention the

³ See for example STAMPOLIDES 2003, *passim*.

⁴ On Hellenistic Rhodes in general see BERTHOLD 1984; GABRIELSEN 1997; WIEMER 2002; FILIMONOS-TSOPOTOU 2004.

⁵ On the Rhodian harbors see indicatively, BLACKMAN *et alii* 2013 (BAIKA), 200-202; BLACKMAN/KNOBLAUCH/YANNIKOURI 1996, 377-378; RICE 1996, 199-202; BLACKMAN 1999a, 41-44; FILIMONOS-TSOPOTOU 2004, 46-69.

⁶ CASSON 1991, 123-35; MORRISON 1995, 66-77; BLACKMAN/KNOBLAUCH/YANNIKOURI 1996, 403-405; RICE 1996, 202-203. For the types of ships and their characteristics, see BLACKMAN *et alii* 2013, 76-85.

⁷ BLACKMAN/KNOBLAUCH/YANNIKOURI 1996, 379-402; GABRIELSEN 1997, 38; FILIMONOS-TSOPOTOU 2004, 52-53; BLACKMAN *et alii* 2013 (GERDING), 509-517.

⁸ See SPANTIDAKI/STEFANAKIS/MPARDANIS 2020.

⁹ SPANTIDAKI 2018, 79.

¹⁰ SPANTIDAKI/STEFANAKIS/MPARDANIS 2020. See also BLACKMAN 1999b, 72; GABRIELSEN 1997, 41-43; GABRIELSEN 2001, 229. See also FUNKE 1999, 66-67.

¹¹ SPANTIDAKI 2018, 77.

¹² SPANTIDAKI 2018, 80-81.

¹³ SPANTIDAKI 2018, 82.

¹⁴ SPANTIDAKI 2018, 77.

¹⁵ SPANTIDAKI 2018, 78.

¹⁶ SPANTIDAKI 2018, 80; Fine sails: IG II² 1479.42; IG II² 1480.18; IG II² 1623.45, 272, 317, 333; IG II² 1628.34, 105, 116, 126, 244, 250; IG II² 1629.10, 371, 375, 490, 581, 711, 718; IG II² 1631.415-416, 447-448, 451-452, 456, 461, 465, 469, 472-473, 477-478, 482, 486, 523, 541, 547-548, 553-554, 559-560, 572, 661; IG II² 1632.130, 148-149, 154, 159, 164, 168-169, 177, 194, 221, 226, 232, 241-242, 246, 251-252, 266, 272-273, 289-290, 300, 305-306, 314, 324-325, 335-336. Standard sails: IG II² 360.36, 39; IG II² 1609.55, 85, 88, 101, 118, 119; IG II² 1611.298, 335, 379, 386, 401,

sizes of sails.¹⁷ They also mention types of rope of different thickness used for rigging.¹⁸ Written sources, also provide us with several information as to the technical characteristics of sails and ropes. We know that the sails were produced by sailmakers,¹⁹ and were so large that they were created by stitching together many different webs.²⁰ Classical sources mention flax as the material used for sails, but other plant fibres, such as hemp have to be considered as well. The existence of black, red and even purple sails in Classical Greece is also mentioned.²¹

The rigging was composed from a large variety of different kinds of ropes, each serving specific purposes. The naval inscriptions mention 6 and 8-finger ropes.²² From the fact that finger (*daktylos*) was an ancient Greek unit of length measuring 19,3 cm, we can estimate different sizes of cords and rope.²³

Furthermore, the two known ancient Greek terms for rope makers most probably refer to the two main rope making techniques: plying and plaiting. The first one, *kalōstrophos*,²⁴ refers to twisted rope, while the second one, *styppeiplokos*,²⁵ may refer to braided rope. The first consists of plying several thinner threads together (depending on the desired thickness of the rope) and involves the twisting of the thinner elements and the second consists of plaiting several thinner elements together to form a thicker rope.²⁶

Iconography, mainly depiction on black and red-figured vases, provides information on the shape and size of the sails, as well as on colours and the existence of extensive rigging.²⁷ A number of scholars have dealt with this issue in the past,²⁸ yet, we always ought to be cautious when studying iconographical material, since there is the problem of accurate depictions and chronological or regional variations/development.

Direct archaeological evidence on sails and rope, although extremely rare in Greece, does exist in a later period find from Amorgos and other finds from Egypt, thus providing complementary evidence and *comparanda* for the Greek sails:

1) Many carbonised fragments of fabric and rope have been discovered in Amorgos,²⁹ dating in the 8th century CE.

411; IG II² 1612.62, 267, 276, 307, 316, 338, 349, 356; IG II² 1613.196, 221, 234, 247, 259; IG II² 1614.149; IG II² 1615.167; IG II² 1620.5-6, 26; IG II² 1621.9, 30, 102; IG II² 1622.6, 19, 31, 177, 206, 220, 241, 252, 287, 304, 424, 459; IG II² 1624.112; IG II² 1625.22; IG II² 1626.17, 36; IG II² 1627.59, 63, 66, 142, 159, 178, 442 465; IG II² 1628.242, 246, 248, 252, 327, 582, 602; IG II² 1629.116, 369, 373, 377, 450, 470, 1057, 1079; IG II² 1631.262, 274; IG II² 1632.64, 65; IG II² 1648.13-14; IG II² 1668.85; SEG 45, 147 37; SEG 45, 148 40 (reconstructed).

¹⁷ SPANTIDAKI 2018, 80.

¹⁸ SPANTIDAKI 2018, 81.

¹⁹ *Ar. Thesm.* 935.

²⁰ SPANTIDAKI 2018, 80.

²¹ SPANTIDAKI 2018, 80; Apollod. *Bibl.* 1,7a.9: «melan histion», black sail; Simon. *Fr.* 45(a)1: «phoinikeon histion hygrōi pephymenon anthei prinou erithaleos» red sail dyed with kermes (*prinos*); Duris *Fr.* 64,13-14 FHG 2: «histiōi halourgōi», purple sail.

²² SPANTIDAKI 2018, 81; IG II² 1627.123-5, 129-30, 132, 447-8, 471-2.

²³ BÖCKH 1840; SPANTIDAKI 2018, 81.

²⁴ Plut. *Per.* 12,6,8.

²⁵ SPANTIDAKI 2018, 81; IG II² 1673.15, 1673.41.

²⁶ SPANTIDAKI 2018, 81.

²⁷ SPANTIDAKI 2018, 81.

²⁸ See indicatively, KIRK 1949; WILLIAMS 1949; WILLIAMS 1957; CASSON 1958.

²⁹ ALEXIOU/MARGARITI/LOUKOPOULOU 2017; SPANTIDAKI 2018, 81.

Although late in dating, these are the only fragments of sailcloth discovered so far in Greece. The fabric is quite dense and made in basket weave, which is a tabby where both the warp and weft threads are working in pairs. This adds strength to the cloth, which is crucial for a sail.

2) More comparative material comes from Egypt.³⁰ Forty-six fragments of a linen sail have been discovered torn up and used as mummy packing in a grave in Thebes, dated between 150 BCE-50 CE. The sailcloth had vertical and horizontal reinforcements with linen bands, as well as several patches. Moreover, blue and/or red warp stripes have been identified on the bands suggesting that they were initially of a different colour than the sailcloth.³¹

Moreover, in Berenike, fragments of medium-weight and coarse linen and cotton tabbies have been found, dated to the 1st century CE. Narrow strips of fabric had been sewn on the textiles, which, in all probability, corresponded to reinforcements.³²

3) Finally, excavations at the Roman port of Myos Hormos on the Red Sea coast revealed a large corpus of rigging as sail material, dated between the 1st century BCE to the 3rd century CE.³³ Indian cotton has been used as the material for sailcloth, like in the port of Berenike.³⁴

Experimental archaeology is yet another source for the understanding of sails. The reconstruction of the Olympias, a full-scale replica of a trireme, 36,8 m length, did not focus on sails but on the hull and oars, while the trireme was equipped with two sails, one large 96m², one small 25m², sewn of woven lengths in a rectangular shape, wider than high,³⁵ an important but problematic contribution. Also, the majority of reconstructed models of triremes in Greek museums use modern textiles and ropes for sails and rigging.³⁶ In a similar way, textile archaeologists who have investigated the textile industry of Classical Athens have not taken into account the textiles for the fleet.³⁷

TECHNICAL INFORMATION ON THE PRODUCTION OF SAILS

Technical information on the production of sails is missing from the ancient sources: Since there was a constant need for huge amounts of sailcloth, the most time-efficient weaving technique would be desirable.

On Rhodes, the production either took place in local workshops or elsewhere and the finished sails were brought to the island. Unfortunately, almost no loom-weights have been discovered near Rhodian harbours – we only have a small number from the town of Rhodes, but their characteristics

³⁰ ROUGÉ 1987, 91-96; SCHOEFFER/COTTA/BEENTJES 1987, 77-80; WILD 2004, 63; SPANTIDAKI 2018, 81.

³¹ WILD 2004, 63.

³² WILD 2004.

³³ WHITEWRIGHT 2007.

³⁴ WHITEWRIGHT 2007, 289; WILD/WILD 2007, 226-227; WILD/WILD 2008.

³⁵ MORRISON/COATES 1986, 223; SPANTIDAKI 2018, 82.

³⁶ SPANTIDAKI 2018, 77; See, for instance, the reconstructed models in the exhibition "Voyage. Greek Shipbuilding and Seafaring from Antiquity to Modern Times" at the Museum Herakleidon, in Athens (1/10/2016-28/5/2017).

³⁷ SPANTIDAKI 2018, 77; Also, see SPANTIDAKI 2016.

do not support a sailcloth production. The question here is the type of loom used for the production of sailcloth. Since the demand was so high, we may consider the possibility of the use of a different type of loom that doesn't require loom-weights and allows for fast weaving.

In the context of HISTIA project, a find of 61 loom-weights from the residential district of the ancient city of Rhodes, dating to the late Hellenistic period, was examined, in order to determine whether they are suitable for the manufacture of fabric that matches the quality of sails. An innovative method developed at the Center for Textile Research at the University of Copenhagen was applied, which allows the function of the loom-weights to be examined and the qualities of the fabric they were able to fabricate to be calculated.³⁸ According to this method, the two main parameters of loom-weights that provide information about the types of fabrics they could produce are weight and thickness.

Two qualities of sails are mentioned in the nautical catalogues of Piraeus, the standard and the fine.³⁹ To make a fabric relatively thick and dense in order to have the required durability of the standard quality of a sail, one would have to choose relatively heavy and narrow loom-weights, so that they could be used with threads of medium thickness and placed close to each other so that the fabric would be dense. In order to achieve the fine quality, the weight of the loom-weights would have to be changed so that they could be used with finer threads. The ideal shape for making sail fabric seems to be the discoidal that can be both quite heavy and very thin.

The research showed that the studied loom-weights were not heavy enough to produce the standard quality sailcloth and most were not even narrow enough to achieve a dense weave. Nevertheless, a small number of these loom-weights may have been used to make fine quality sails.⁴⁰ The problem remains, of course, that the production of the large quantity of sailcloth required by the Rhodian fleet would require a huge number of loom-weights. Of course, one must take under consideration that sails may have been woven in a different type of loom, without the use of loom-weights, namely the two-beam loom that leaves no traces in the archaeological record.

Given the existence of an extensive Rhodian fleet measuring less than 100 ships at its peak in the 2nd century BCE, the requirements in cloth for sails and raw materials for rope would have been immense, requiring if not direct cultivation, import and process of raw materials, such as flax or hemp.⁴¹

The complete lack of archaeological evidence for the cultivation of these plants on Rhodes however, leaves little space for speculations. Information from the ethnological record does though testify on the cultivation of flax on the

island and the neighboring isles of the Dodecanese during the later years (19th century), an indication that the climate and the soil of the area could support the cultivation of flax also in antiquity.⁴² Regarding the possibility of imports, documented for Athens,⁴³ there are no relevant references concerning Rhodes. The only exception is the testimony of Polybius, mentioning that after the destructive earthquake of the late 220s BCE,⁴⁴ Rhodians received a lot of donations and presents for various kingdoms and cities, that is money, wheat and materials for the restoration of the Rhodian navy.⁴⁵ Among the other things it is worth mentioning here the donation of 3000 pieces of linen for sails by Ptolemy III Euergetes,⁴⁶ as well as the donation of 1000 talents in animal fibers, by Seleucus II Calinicus,⁴⁷ materials obviously intended for the production of sails and rope.⁴⁸

Finally, in all the major urban centers with a strong fleet, such as Athens and Rhodes, we would expect to discover workshop facilities related to the construction of the necessary fabrics and ropes for the needs of ships. These could be located in the port, in the surrounding area or in neighboring places, while either they could be gathered together in one place, a large central workshop, or divided into several, i.e. many smaller ones. Unfortunately for Rhodes, despite the knowledge for the extensive dockyards, no such find has come to light yet.

CONCLUSIONS AND SCIENTIFIC QUESTIONS

It has to be underlined that despite the great importance of the maritime textile industry for the good function of the ancient Greek navies, evidence of it is extremely scarce. Textiles are anyway a very sensitive organic material that requires specific environmental conditions in order to be preserved, and although textiles and rope for rigging were an indispensable part of the ships' standard equipment, not only the actual textile fragments, but also details of their manufacture and trade are almost invisible in both the archaeological record and the ancient sources making this research quite challenging.

The naval records contain significant but not always clear information that has to be thoroughly studied. It is crucial to analyse and interpret how the practical requirements, the problems of misappropriation of sails and rope, and the institutional frameworks led to different

³⁸ SPANTIDAKI/STEFANAKIS/MPARDANIS 2021-2021.

³⁹ Pseudo-Xenophon, in his *Athinaion Politeia*, mentions the great importance of flax among the imported raw materials for the needs of the Athenian fleet. In the only reference about hemp, Herodotus (4.74.1) describes the plant as foreign in Greece in this period and used by the Thracians and the Scythians.

⁴⁰ Polyb. 5.88.1-90.4; Diod. Sic. 26.8.1; Strabo, 14.2.5. For the dating of the earthquake around 225-4 BCE, see CATAUDELLA 1998, 197; around 220 BCE, PIRAZZOLI *et alii* 1989, 99; STIROS AND BLACKMAN 2014, 220.

⁴¹ GABRIELSEN 1997, 77. Concerning donations to the Rhodian city-state in general, see also BRINGMANN 2001.

⁴² «ἐπηγγέλματο δὲ καὶ Πτολεμαῖος αὐτοῖς ἀργυρίου τάλαντα τριακόσια καὶ σίτου μυριάδας ἄρταβῶν ἑκατόν, ξύλα δὲ ναυπηγήσιμα δέκα πεντήρων καὶ δέκα τριήρων, πευκίνων τετραγώνων πήχεις ἑμμέτρους τετρακισμυρίους, καὶ χαλκοῦ νομί σματος τάλαντα χίλια, στυππίου τρισχίλι, ὀθονίων ἰστούς τρισχίλιους». Polyb. 5.89, 1-2.

⁴³ «καὶ ῥήτινης καὶ τριχὸς μυριάδας πηχῶν καὶ ταλάντων χιλιάδας». Polyb. 5.89.9.

⁴⁴ See especially GABRIELSEN 1997, 75-77.

³⁸ MÅRTENSSON/NOSCH/ANDERSSON STRAND 2009.

³⁹ See above, n. 16.

⁴⁰ SPANTIDAKI/STEFANAKIS/MPARDANIS 2020, Appendix.

⁴¹ «Recently, archaeological installations dated in the 13th century BC in Halimos south of Athens, have been identified as retting installations that may have been used for both flax and hemp» SPANTIDAKI 2018, 79. See KAZA-PAPAGEORGIOU/KARDAMAKI 2011, 201-208; KAZA-PAPAGEORGIOU 2015.

strategies concerning the management of sails and rope for the fleet.

There remain several questions to be answered and several issues to be further investigated. One such issue is the use of sails on the trireme. It is known that the trireme had two sails, but there is no information about their use; were the two sails used simultaneously or not? What was the crew responsible for sails and rigging? Furthermore, the technical characteristics of the sails need to be studied in detail. For instance, the reinforcements were both horizontal and vertical bands? Was the sailing cloth composed from different quality textiles, in relation to the tension required in each place of the sail? Similarly, the cultivation of raw materials is another issue for further investigation. The consumption of fibre in terms of flax has to be calculated in order to be able to estimate how much land was needed to produce sufficient crops for sailcloth and rope.⁴⁹ According to the experiments in the Roskilde Viking Ship Museum⁵⁰ on linen sails for the Gislunge boat, for example, the sail is made of five lengths and a surface of 10 m².

In addition to all that, one must also be aware that the military ships were not the only ones in Rhodes to have used sails in this period. Commercial ships, called *holkades*, were sailing ships as well, as other cargo ships that followed the triremes in military expeditions. Finally, it is very probable that fishing ships may also have used sails. Thus, the actual quantity of sailcloth and rope required for the totality of the ships would be much higher than this intended only for the military fleet. Last but not least, the study of the organization of the institutional context of Rhodes in relation to the production, management, storage and maintenance of sails and rope will generate new knowledge, which will deepen our knowledge of the Rhodian fleet.

As far as Rhodes and the Dodecanese are concerned, to date there are no testimonies and remains of workshop facilities near the port, let alone for the cultivation and organization of the production of raw materials, while the ethnographic archive speaks only of the use of cotton and wool against them during the couple of the recent past centuries. It is hoped that this research will contribute to the generation of new knowledge on the neglected scientific area of the ancient Greek sails and bring closer together the disciplines of archaeology, ancient military and naval history and ancient textile studies.

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⁴⁹ SPANTIDAKI 2018, 79.

⁵⁰ ANDERSEN/NØRGARD 2009; SPANTIDAKI 2018, 81.

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