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## The Tonnage of the *Syracusia*: a metrological reconsideration

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The tonnage of the *Syracusia*, the biggest ship built in the ancient Mediterranean, has been much discussed by scholars. Indeed, the various merchandise the ship carried are detailed by Athenaeus, who relies on a text previously written by Moschion. However, the value of the units of measurements used in Athenaeus' account are not well known. So far, scholars have suggested only either Athenian or Roman units of measurement. The present report aims at exploring the possibility of local metrological systems, such as Ptolemaic or Sicilian ones, as Moschion and Athenaeus respectively lived in Sicily and in Alexandria.

### **Key words**

*Metrology, tonnage, cargo, wheat, giant ship, Sicily*

The *Syracusia* is known as the biggest ship built in ancient times (5, 206a-209e). The ship was built by Archias of Corinth, to fulfill an order from king Hiero II (269–215 BCE). The construction was supervised by Archimedes (Salviat, 1987; Zevi, 2001; Pomey & Tchernia, 2006; Castagnino Berlinghieri, 2010; Nantet, 2016:12–131). Big the ship certainly was, but how big exactly? Many scholars have focused on that giant ship in order to assess the maximum tonnage allowed by the construction techniques in Hellenistic times (Rougé, 1984; Casson, 1971; Pomey & Tchernia, 1978). Of course, the contents of the cargo are precisely described (Athenaeus, *Deipnosophistae*, 209a):

*Σίτου δὲ ἐνεβάλλοντο εἰς τὴν ναῦν μυριάδας ἕξ, ταρίχων δὲ Σικελικῶν κεράμια  
μύρια, ἐρίων τάλαντα δισμύρια, καὶ ἕτερα δὲ φορτία δισμύρια.*

*The vessel was loaded with 60,000 measures of grain, 10,000 jars of pickled Sicilian fish, 20,000 talents of wool, and 20,000 talents of miscellaneous cargo. (Trans. Lionel Casson, Princeton, University Press, 1995 [1<sup>st</sup> ed. 1971]).*

Tzetzes, a poet of the 12<sup>th</sup> century CE, tells that the cargo included 50,000 *medimni* of corn (Tzetzes, Chiliades, 2, 35, 106–111):

*Ὁ Ἀρχιμήδης ὁ σοφός, μηχανητῆς ἐκεῖνος,  
Τῷ γένει Συρακούσιος ἦν, γερων γεωμέτρης,  
Χρόνους τε ἑβδομήκοντα καὶ πέντε παρελαύνων,  
Ὅστις εἰργάσατο πολλὰς μηχανικὰς δυνάμεις,  
Καὶ τῇ τρισπᾶστω μηχανῇ χειρὶ λαίᾳ καὶ μόνη  
Πεντεμυριομέδιμνον καθείλκυσεν ὀλκάδα.  
Wise Archimedes, that machinist,  
Was a Syracusan by race, an old geometrician  
And driving past seventy-five seasons,  
A man who built many mechanical capacities,  
Even with the three-pulley machine, with the left and only hand  
He drew to the sea a trading vessel burdened with fifty thousand medimni.  
Trans. Gary Berkowitz (modified)*

According to Elena Flavia Castagnino Berlinghieri, this ship was constructed in the Syracusan shipyard as both a floating palace and a warship (Castagnino Berlinghieri, 2010:185–186). The vessel may then have been layed up and converted to a commercial ship just before being given to the Ptolemies. Indeed, the contents of the cargo is detailed just a few lines before the description of the vessel being given to Ptolemy (Athenaeus, Deipnosophistae, 209b), maybe Ptolemy II (Castagnino Berlinghieri, 2010:note 14). However, as Fausto Zevi emphasizes (Zevi, 2001), the *Syracusia* was designed first as a grain carrier (Athenaeus, Deipnosophistae, 206e). It should also be underlined that the numerous estimations conducted so far by most of the scholars rely on the contents of the cargo. Therefore, the aim is to provide the weight of the cargo carried by *Syracusia* for the journey related in Athenaeus' account. The latter has to be considered as the deadweight tonnage, i.e. the load capacity of the ship that is dedicated to the cargo, notwithstanding that the ship could be intentionally under- or overloaded. This approach should not be mistaken with the calculations intended to estimate displacement, which relies not only on the weight of the cargo, but also the weight of the ship itself, including the hull, the rigging, the crew, etc (Turfa-Steinmayer, 1999). Of course, these kinds of calculations rely on many unknown parameters and should be considered with caution. Thus, the only reliable approach consists in estimating the weight of the cargo, whose contents are detailed by Athenaeus.

### **The estimation of the cargo with *medimni***

The estimation of the weight of the cargo is rendered unmeasurable by metrological factors. Indeed, what metrological system was used in the account given by Athenaeus? He does not point out any specific unit of measurement for the cargo of grain. At first, many scholars (Torr, 1894: 27; Graser, 1864: 48; Frank, 1933: 105; Duncan-Jones, 1977: 332; Rougé 1984: 226–230) considered it should be the Attic *medimnos* (52 l). Indeed, Tzetzes, a Byzantine poet, mentions the *medimnos*, which could support this idea. However, this evidence is very late. The use of the *medimnos* looks even stranger since this unit of measurement has not

been used for more than a millennium. Therefore, the choice of the *medimnos* allows a huge tonnage (4000 tonnes approx.), far beyond the several hundred tonnes carried by the *myriophoroi* — the biggest ships mentioned in the written evidence (Nantet, 2012, 2016: 115–116). Jean Rougé, who doubted such a gigantic ship could have existed, considers that the *Syracusia* was nothing but a ‘sea monster’, surely more a legend than a historical fact.

<b>Merchandise (in ancient units of measurement)</b>	<b>Unit weight of the merchandise (in kg)</b>	<b>Weight of each cargo (in tonnes)</b>
60,000 ‘measures’ of wheat	40 ( <i>medimnos</i> of 52 l)?	2400
10,000 <i>keramia</i> Sicilian salt-fish	50 (amphora)	500
20,000 talents of wool	26 (talent)	520
20,000 talents of other merchandise	26 (talent)	520
		Total approx. 4000

Table 1: Estimation of the cargo with *medimni*

### **The estimation of the cargo with *modii***

However, Lionel Casson emphasizes that Athenaeus lived in the Roman period, i.e. five centuries after the event he relates (Casson, 1956–1957, 1995: 184–186). He notes that the *medimnos* is no longer in use in the Roman period, which is accurate. He suggests that Athenaeus may have decided to adapt his text to his audience. Therefore, the Roman writer would have substituted the *modius* (8.733 l) for the *medimnos* and therefore converted the amount of corn.

Thus, the choice of the *modius* led to an enormous decrease of the grain cargo — and of the tonnage, reducing them respectively to a mere 400 and 1940 tonnes. At first, Lionel Casson even chose a weight of 25kg for the *keramion* (Casson, 1956–1957 :232–233), which provided a weight of 1650 tonnes only for the whole cargo. Fifteen years later, he changed for a more relevant weight of 50kg, which produced a higher weight of 1940 tonnes for the cargo.

<b>Merchandise (in ancient units of measurement)</b>	<b>Unit weight of the merchandise (in kg)</b>	<b>Overall weight of the cargo (in tonnes)</b>
60,000 'measures' of wheat	66 (Roman <i>modius</i> of 8733 l)?	400
10,000 <i>keramia</i> Sicilian salt-fish	50 (amphora)	500
20,000 talents of wool	26 (talent)	520
20,000 talents of other merchandise	26 (talent)	520
		= 1940

Table 2: Estimation of the cargo with *modii*

Nevertheless, he was not followed by R.P. Duncan-Jones (Duncan-Jones, 1977), nor Jean Rougé (Rougé, 1984), who both objected that this choice would not be in accordance with the fame of the ship, renowned as a huge grain carrier. Moreover, it should be noted that the *modius* was not used in Egypt, when Athenaeus was alive (Mayerson, 2006).

It should be also noted that the talent of 26 kg used by all these scholars, including Rougé and Casson, is surely not relevant. Indeed, this talent was used in the Attic metrological system during the Classical period. It was no longer used in the Hellenistic and Roman periods, and therefore should be rejected in the estimation of *Syracusia's* tonnage.

In spite of these reservations, Casson was followed by Jean MacIntosh Turfa and Alwin G. Niemeyer, who based their numerous calculations on his estimation (Turfa-Steinmayer, 1999: note 9).

#### **The estimation of the cargo with Ptolemaic units of measurement (*artabae*).**

It has not previously been considered that the unit of measurement mentioned by Athenaeus, who lived in Naucratis, may have been the *artaba*, which was the usual unit of measurement of tonnage used in Egypt between the Persian and the Byzantine periods. Could it be that Athenaeus did not mention a specific unit of measurement because it was obvious to his readers? Whoever read his account would not be mistaken; this unit was clearly the *artaba*.

The reconsideration of the units of measurement mentioned by Athenaeus allows us to estimate a tonnage of 2580 tonnes (with an *artaba* of 29.107 l, see Mayerson, 2006). It provides a weight of 1362 tonnes for the cargo of corn, which is more or less the same as the capacity of the *Isis*, another huge and famous grain-carrier (Lucian, *Navigium*, 5; see Pomey and Tchernia, 1978). As the value of the *artaba* is still discussed, it should not be excluded that the weight of the cargo could have been 2904 tonnes, including 1 686 tonnes of corn (with an *artaba* of 38 l, i.e. 28.1 kg, see Duncan-Jones, 1976).

Merchandise (in ancient units of measurement)	Unit weight of the merchandise (in kg)	Overall weight of the cargo (in tonnes)
60,000 'measures' of wheat	22.7 ( <i>artaba</i> of 29.107 l)?	1362
10,000 <i>keramia</i> Sicilian salt-fish	40 (amphora)	400
20,000 talents of wool	20.46 (Ptolemaic talent)	409
20,000 talents of other merchandise	20.46 (Ptolemaic talent)	409
		= 2580

Table 3: Estimation of the cargo with *artabae*

As for the talent used for the wool and other merchandise, its value in the Ptolemaic metrological system was 20.46kg. And then what about the Sicilian *keramia* mentioned by Athenaeus? The inquiry conducted by Emmanuel Botte in Sicily led to the identification of a "tubular amphora" (Botte, 2009, 2012). It is called Type T-7.6.3.1, and is related to a Punic tradition. It was surely made for tuna. That specific type of amphora was produced in Sicily, and has been found all over the Mediterranean, especially in the Eastern part. Its height ranges 100–108cm and its maximum width from 16–20cm. Although its capacity is not known, its dimensions are close to Dressel 21–22 amphoras. Thus, its capacity may have been approximately 20 l that is a weight of 40kg when full. Certainly, this amphora is well known all through the 2<sup>nd</sup> and 1<sup>st</sup> centuries BCE. Therefore, it is slightly earlier than *Syracusia*. This is the closest parallel that can be found. The salt-fish *keramia* mentioned by Athenaeus was surely not very different from that amphora.

### The estimation of the cargo with Sicilian units of measurement

As the *Syracusia* was built in Sicily, the use of a Sicilian unit of measurement should be considered, too. Indeed, the account given by Athenaeus was written first by Moschion, a poet of the 3<sup>rd</sup> century BCE, maybe from Syracuse (Cambiano, 1996). Fortunately, the Sicilian metrological system is now better known. Indeed, several cylindrical vessels with grooves around the body were found in Morgantina and other south-eastern Sicilian cities. They have been interpreted by Walthall as grain measures. Their capacity was 32 l, i.e. a weight of 25 kg. They were surely used whilst Hiero II reigned over the island (Walthall, 2011: figs 3 & 4).

And what was the weight of the talent in his kingdom? The weight of the drachma was 3.36 g, which gives a talent of 20.16 kg (Caccamo Caltabiano, 1995; Cattamo Caltabiano *et al.*, 1997).

It is worth noting that many Sicilian units of measurement are close to Ptolemaic ones. In fact, this is not surprising, as Sicilian and Ptolemaic kings had close relationships (Manganaro, 1989; Santagati Ruggeri,

1996; Caccamo Caltabiano *et al.*, 2004). When Hiero offered the *Syracusia* to Ptolemy II, the gift showed how deeply this alliance was rooted between the two Hellenistic kingdoms.

Merchandise (in ancient units of measurement)	Unit weight of the merchandise (in kg)	Overall weight of the cargo (in tonnes)
60,000 'measures' of wheat	25 (Sicilian unit of 32 l)	1500
10,000 <i>keramia</i> Sicilian salt-fish	40 (amphora)	400
20,000 talents of wool	20.16 (Syracusan talent)	403
20,000 talents of other merchandise	20.16 (Syracusan talent)	403
		= 2706

Table 4: Estimation of the cargo with Sicilian units of measurement

### Conclusion

It is not easy to determine with absolute certainty the units of measurement used by Athenaeus, but it seems that a more accurate analysis shows that the author surely relied on another metrological system than the Athenian or Roman ones. More probably, he used the Ptolemaic or Sicilian units of measurement. Egyptian or Sicilian? This metrological issue makes the link with two locations, Sicily and Alexandria, which played a significant role in Honor Frost's research. However, the difference is not significant (2 580 and 2706 tonnes).

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