



NETWORKED SPACES

THE SPATIALITY OF NETWORKS IN THE RED SEA AND WESTERN INDIAN OCEAN

*edited by Caroline Durand, Julie Marchand, Bérangère Redon
and Pierre Schneider*

NETWORKED SPACES: THE SPATIALITY OF NETWORKS IN THE RED SEA AND WESTERN INDIAN OCEAN

ARCHÉOLOGIE(S) // 8

The 34 articles published in this volume form the proceedings of the 9th Red Sea conference held at Lyon in July 2019, whose core topic was the “spatiality of networks in the Red Sea”, including the western Indian Ocean. In the networked space that the *Erythra Thalassa* never ceased to be, stable factors such as landscape, climate, and wind patterns have been constantly entangled with more dynamic elements, such as human activity. The contributors to this volume explored how the former were integrated into the countless networks formed by humans in the region, and how these were impacted by spatial constraints over the long course of history.

This volume offers a wide range of stimulating contributions. The first articles are devoted to medieval and modern European sources on the Red Sea and its exploration, and to the networks of knowledge dissemination about the region. They are followed by papers relating to the main nodes, the ports and islands of the Red Sea. Several articles are then focusing on the agency of hinterland populations in the networks, and the relationships between the regions bordering the Red Sea and central powers that governed them, often from distant lands. Production and consumption networks are the subject of the next articles, to assess the extent and nature of exchanges and to shed light on the archaeology of circulations. The logistics of exploration, exploitation and trade in the regions bordering the Red Sea are then examined. The last series of papers focuses on regions where archaeological work started only recently: Somaliland, Tigray, and the Horn of Africa. Thanks to all the participants, whether they have exploited new data or re-examined long-known material, the 9th edition of the “Red Sea Project” gave rise to vibrant debates, showing that the *Erythra Thalassa* remains an endless source of knowledge.

Les 34 articles publiés dans ce volume forment les actes de la 9^e édition de la « Red Sea conference » qui s'est tenue à Lyon en juillet 2019. Son thème central était la « spatialité des réseaux en mer Rouge », mais aussi dans l'océan Indien occidental. Dans l'espace connecté que l'Erythra Thalassa n'a jamais cessé d'être, des éléments stables, tels que le paysage, le climat ou le régime des vents, ont été constamment enchevêtrés avec des éléments plus dynamiques, comme l'activité humaine. Les contributeurs de ce volume ont exploré la manière dont les premiers ont été intégrés au sein des innombrables réseaux formés par les hommes dans la région, et dont ceux-ci ont été affectés par les contraintes spatiales au cours de l'histoire.

Ce volume offre un riche éventail de contributions. Les premières sont consacrées aux sources européennes médiévales et modernes relatives à la mer Rouge et à son exploration, ainsi qu'aux phénomènes de diffusion des connaissances sur la région. Elles sont suivies d'études sur les nœuds principaux que sont les ports et les îles de la mer Rouge. Plusieurs contributions sont ensuite dédiées à l'agency des populations de l'arrière-pays dans les réseaux, de même qu'aux relations entre les régions bordant la mer Rouge et les pouvoirs centraux qui les ont régis, souvent depuis des contrées éloignées. Les réseaux de production et de consommation font l'objet des textes suivants. Ils évaluent l'ampleur et la nature des échanges et mettent en lumière l'archéologie des circulations. La logistique de l'exploration, de l'exploitation et du commerce dans les zones bordant la mer Rouge est ensuite examinée. La dernière série d'articles porte sur des régions où les travaux archéologiques ont commencé très récemment : Somaliland, Tigré et Corne de l'Afrique. Grâce à tous les participants, qu'ils aient exploité de nouvelles données ou réexaminé des documents connus de longue date, la 9^e édition du « Red Sea Project » a donné lieu à des débats animés, témoignant que l'Erythra Thalassa demeure une source d'information inépuisable.



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The Roman state and Red Sea trade revenue

Matthew Adam Cobb

University of Wales Trinity Saint David

Troy Wilkinson

University of Wales Trinity Saint David

Several estimates have been made of the revenue derived by the Roman state from taxing the goods flowing through its Red Sea ports as part of wider Indian Ocean networks of exchange. The present paper assesses these models and gives greater emphasis to the limitations of the evidence, particularly the typicality of the Hermapollon's cargo and the wider issue of fluctuations in trading activity (year to year and in the *longue durée*). It is suggested that previous revenue estimates of 200-270 million sesterterii are probably too high.

Plusieurs estimations ont été faites sur les revenus tirés par l'État romain de la taxation des marchandises qui transitaient par ses ports de la mer Rouge dans le cadre plus large des réseaux d'échange de l'océan Indien. Le présent article vise à évaluer ces modèles et à mettre davantage l'accent sur les limites des sources, en pointant en particulier le caractère typique de la cargaison de l'Hermapollon et la question plus large des fluctuations de l'activité commerciale (d'une année à l'autre et sur la longue durée). Il y est suggéré que les précédentes estimations de recettes de 200 à 270 millions de sesterces sont probablement trop élevées.

Introduction

By the early to mid-first millennium AD, a whole range of networks connected various nodes on the littorals of the wider Indian Ocean world. This increasingly complex web of connections allowed for the flow of goods, ideas and peoples between various societies linked via the South China Sea, Bay of Bengal and Arabian Sea (inclusive of the Red Sea, Gulf of Aden and Persian Gulf). The ruling elites of the polities in which these nodes were situated were able to take advantage of these flows of goods by acquiring a range of “exotic” (non-local) items (for prestige display, redistributive acts, etc.) and raising revenue through taxation. It is the raising of revenue from these networks of exchange which forms the focus of this paper. Specifically, the question of how much revenue the Roman state generated from taxing the goods coming into its Red Sea ports.

Several models have been created by scholars to try and estimate this revenue, primarily focusing on the early centuries AD. The figures produced vary widely, from as low as 10 to as high as 270 million sesterterii.¹ These calculations are primarily made in reference to the *tetarte*, a 25% tax charged on Indian Ocean imports prior to the Severan period.² Strabo specifically mentions that double duties (τέλη

1. Young 2001, p. 210; Speidel 2016, pp. 104-105, n. 81-82; Wilson 2015, p. 23; McLaughlin 2014, p. 14; McLaughlin 2019, p. 120. For a critique of this type of modelling, see De Romanis 2020, p. 318.

2. On the *tetarte* see the Muziris Papyrus (*P.Vindob G 40822 recto*); also *PME*, § 19.

διπλάσια) were charged on imports, which F. De Romanis has suggested refers to an initial *tetarte* on Indian Ocean goods when they entered Egypt (via the Red Sea ports), and then a subsequent *tetarte* for those goods shipped from Alexandria to other provinces of the Empire.³ It seems no charges were levied on exports leaving the Empire.⁴ R. McLaughlin has argued that some one billion sestertii worth of goods were imported each year.⁵ To put this in context, estimates for the total Gross Domestic Product (henceforth GDP) of the Roman Empire range from 9-20 billion sestertii per annum.⁶ Of course, it is a truism to state that quantitative economic data for the Roman world is severely lacking. More pertinently, the evidential basis for these models have several limitations which are explored here.

This paper does not outright dismiss such attempts at estimating state revenues generated from taxing this trade. While only plausible guesswork based on the evidence available, these models are useful for obtaining a sense of the scale and significance of the Roman Red Sea branch of the Indian Ocean trade. It also feeds into wider debates about the significance of long-distance trade to the economy. Instead, the purpose of this paper is to assess the basis on which these models are constructed, to highlight the limitations of the source material, and to frame these figures in a wider context. A further issue addressed is the limited attention given to fluctuations in trading activity (and ultimately revenue accrued) as a result of various factors from shipwrecks, piracy and banditry to political and ecological instability. This paper argues that the 270 million sestertii figure is far too high and that the actual Roman state revenue was probably closer to the 75-120 million sestertii mark for the first to mid-second century.

Methodology: deconstructing the revenue figures

In the last two decades a range of estimates have been proposed for the revenue generated from taxing the goods flowing through the Red Sea ports. This includes an estimated figure of 10-50 million sestertii (Young), 200 million sestertii (Speidel), 230 million sestertii (Wilson), and 250-270 million sestertii (McLaughlin). All of these estimates are based either on comments made in Pliny's *Natural history* or on a multiplication of the duties levied on the Hermapollon (recorded in the Muziris Papyrus) by the number of ships (120 according to Strabo) that departed from the Red Sea ports each year.

Pliny's figures on the cost of the "eastern trade"

To start with the lowest of the revenue estimates, G. Young based his calculation on two key passages in Pliny's *Natural history* relating to the value of the trade with Arabia, India and the Seres. The first passage states that India absorbs 50 million sestertii of wealth each year, sending back goods to be sold (in the Empire) at a hundredfold profit (6, 26, 101), while the latter states that Arabia, India and the Seres take 100 million sestertii each year from the Empire, followed by a bemoaning statement about *luxuria* (12, 41, 84). In the case of the latter passage, this can easily be understood within the

3. Strabo, 17, 1, 13; De Romanis 2020, pp. 132-133, 180-181, 277-297, 312. De Romanis argues that Pliny's *maris Rubri vectigal* (HN, 6, 24, 84) was one and the same as Strabo's double duties. He also notes that some goods were likely sold in Koptos for the Egyptian market. He further suggests (p. 240, 283-297, 322-232) that the quarter-taxes (import and export duties) and surcharges of the *arabarchoi* amounted to the ostensible equivalent of 43.75% taken on the goods carried in the Hermapollon.

4. For the basis of this view, see De Romanis 2020, pp. 134-135.

5. McLaughlin 2010, p. 161.

6. Scheidel, Friesen 2009. For a discussion of methods of GDP estimation, see Temin 2013, pp. 243-261.

framework of a frequently expressed topos bewailing decadence and the supposed decline from the *mos maiorum*.⁷ This need not mean his comments are disingenuous, but one should remain cognizant of the concerns expressed about social conduct, moral degradation and the financial stability of the elite. With regards to the former figure, G. Parker is right to note that Pliny's statement is neutral in tone and serves to add emphasis to his description of the routes taken by merchants travelling from Alexandria to Muziris and back.⁸

Young tentatively muses that Pliny's figures could be based on imperial customs receipts (although it is more likely he derived them from merchants' accounts, see below), supposing that the government took 25 million sestertii in tax.⁹ He further speculates that Pliny could have been referring not to the total value of the trade, but possibly the retail value of these goods at Rome or, alternatively, just the bullion spent (leaving out barter transactions), meaning that the actual figure could be higher. As a result, Young suggests the figure for revenue was anywhere between 10-50 million sestertii for the Flavian era, but only if Pliny's figures are accurate.

The accuracy of Pliny's figures and where he derived them from is the crux of the matter. Exactly what they represent has long been debated. E.H. Warmington thought they represented the Red Sea trade and that the 100 million sestertii figure was only a reference to a supposed deficit.¹⁰ More recently, McLaughlin speculated that Pliny's 50 million figure referred to bullion exports from Egypt to India.¹¹ However, Pliny refers to values (50 and 100 million) in terms of sestertii, so it cannot be taken for granted that he has either bullion (be it in the form of coins or otherwise) in mind or the total value of exported goods more generally. Even if he did, it cannot be assumed that such an export of bullion remained at consistent levels.¹² Similarly, debate surrounds the issue of Pliny's reliability as a source. Some adopt the view that he was a credible witness (because he was a procurator and part of the Flavian court);¹³ though, M. Raschke thought his figures statistically meaningless and cast doubt on Pliny's familiarity with eastern financial matters.¹⁴ How much credence one grants Pliny is ultimately subjective.¹⁵ But in terms of the source of his figures, it is plausible that they derived from merchants' reports. This is because in the passage setting out the schedule for the Alexandria-Muziris-Alexandria circuit (in which the 50 million figure is mentioned), Pliny reports that new information had become more widely available.¹⁶ In particular, his recording of dual dates for departure (based on the Julian and Alexandrian calendars) means that the information likely came from Red Sea merchants around the period AD 49-52.¹⁷ It then becomes a matter of conjecture as to whether the information acquired from these merchants represented something exact (the rounded nature of the figure makes this doubtful) or a rough estimate from those involved in this trade (this seems more plausible). Either way this information does not seem to relate to customs receipts for imports.

7. For comparative examples, see Seneca, *Natural questions*, 1, 17, 8-9; Juvenal, *Satires*, 6, 464-466, 509; Tacitus, *Annals*, 3, 53.

8. Parker 2008, pp. 183-186. Also Fitzpatrick 2011, p. 31.

9. Young 2001, pp. 210-211. See also Tchernia 1995, pp. 1001-1002. On Roman record keeping and revenue collection see Appendix.

10. Warmington 1928, pp. 275-276; also Frank 1940, p. 283.

11. McLaughlin 2019, p. 125. See also De Romanis 2020, pp. 265, 267 on the 100 million sestertii figure.

12. Tchernia 1995, pp. 1008-1009.

13. Frank 1940, p. 282; Miller 1969, pp. 223-224; McLaughlin 2010, pp. 13, 160.

14. Raschke 1978, pp. 632-665, 677, 767, n. 530.

15. For an overview of these debates, see Cobb 2015a; Cobb 2018, pp. 272-286.

16. Pliny, *HN*, 6, 26, 96-106. See Marcotte 2012, pp. 13-15; Tchernia 1995, pp. 991-1001.

17. De Romanis 2020, pp. 145-146.

The Hermapollon and Rome's Red Sea revenue

The second major approach adopted for estimating Roman state revenue that derived from taxing the Red Sea shipping is based on the Muziris Papyrus and Strabo's statement about the number of vessels operating. This method, with some minor variations, has been employed by several scholars. McLaughlin, who provides the highest estimate, takes the amount of tax that was on the Hermapollon's cargo (for the initial *tetarte*) – equivalent to 2,303,951 sesterii – and multiplies this by 120 ships (per Strabo's comment), to come up with the approximate figure of 270 million sesterii.¹⁸ A. Wilson, following essentially the same method, but adopting a figure of 100 ships operating from the Red Sea ports, comes up with a hypothetical revenue of 230 million sesterii.¹⁹ M. Speidel keeps the 120 ships figure, but estimates that the Roman state took about 1,700,000 from taxing the Hermapollon, and therefore puts the revenue figure at 200 million sesterii.²⁰ It seems likely that Speidel misconstrued the value of the Hermapollon's cargo after collection of the (initial) *tetarte* with the total value of the cargo itself (ca 6,900,000 divided by four). In all these models, it is assumed that the *tetarte* is levied once (additional surcharges taken by the *arabarchoi* and tolls imposed on people and pack animals – among other things – crossing the Eastern Desert are left aside).²¹ However, as De Romanis has argued, if some of these goods were then subsequently exported from Alexandria to other parts of the Empire, an additional *tetarte* may have been levied (see above for the τέλη διπλάσια). Thus, these models overlook further potential sources of revenue.

In order to fully evaluate this method, we must first outline the nature of the evidence on which it is based. In the case of the Muziris Papyrus, we have a mid-second century document which contains information on its recto and verso. Both sides relate to Indian Ocean trading activity.²² The recto reveals details about a loan taken out in Alexandria, relating to a trading venture to Muziris. It laid out requirements with regards to the transport of the goods and repayment of the loan.²³ The verso of the papyrus contains an account of the Hermapollon's cargo, which was worth 1,151 Egyptian talents and 5,852 drachmae after payment of (an initial) *tetarte*, equivalent to just under 6,911,852 sesterii.²⁴ This indicates that value of the (initial) *tetarte* levied on this ship was equivalent to 2,303,951 sesterii, giving an overall cargo value of 9,215,803 sesterii.²⁵

With regards to Strabo's comments, he reports that while at Syene (ca mid 20s BC) he heard that 120 merchant vessels sailed from Myos Hormos to India annually, whereas under the Ptolemies only a few vessels risked sailing as far as India.²⁶ The comment should be understood in the context

18. McLaughlin 2010, p. 161 (250 million); McLaughlin 2014, p. 94. Also, McLaughlin 2019, p. 120 (270 million). He asserts that an additional 90 million came from Palmyrene trade (Levantine-Mesopotamian-Persian Gulf networks of trade). The latter estimate is based on a Palmyrene funerary tower (no. 70, Umm Belqis); McLaughlin 2016, p. xix.

19. Wilson 2015, p. 23.

20. Speidel 2016, pp. 104-105, n. 81, 82.

21. For the surcharges, see the Muziris Papyrus – *P.Vindob G 40822 verso*; for the *apostolion* see the Koptos Tariff – *I.Portes 67 = OGIS 674*. For discussion, see De Romanis 2012, pp. 80, 85, 93-95; De Romanis 2017, pp. 91-92; De Romanis 2020, pp. 132-134. Also *tab. 3* below for calculations made in relation to the *apostolion*.

22. Harrauer, Sijpesteijn 1985; Casson 1986; Casson 1990; Thür 1987; Rathbone 2000; Morelli 2011; De Romanis 1996; De Romanis 2012; De Romanis 2015; De Romanis 2017; De Romanis 2020.

23. De Romanis 2017, p. 96; De Romanis 2020, pp. 168-172, 188-208. De Romanis argues that the loan related specifically to the transport of goods in Egypt.

24. On surcharges taken by the *arabarchoi*, see De Romanis 2020, pp. 225-230.

25. *P.Vindob G 40822 verso*, col. II, l. 27-29; Casson 1990, p. 195. Also Rathbone 2000, p. 49; Wilson 2015, p. 23; De Romanis 2020, pp. 211-212.

26. He also comments that Ptolemy XII, who supposedly ruled Egypt incompetently, was still able to raise an annual tribute of 12,500 talents, despite only 20 vessels annually daring to traverse the Red Sea – Strabo, 2, 5, 12; 17, 1, 13.

of his desire to denigrate earlier Ptolemaic management of Egypt in contrast to Augustus' supposed good management of the province. Strabo does not elaborate upon the nature or size of the vessels ("Roman" and non-Roman) operating from Myos Hormos nor does he say anything about ships that might be operating from other Roman Red Sea ports.²⁷

It is an obvious point to make, but one that is worth emphasising, both these sources are quite far apart in date (Strabo's comments, ca 20s BC; the Muziris Papyrus, mid-second century AD). Patterns of Red Sea trade did not remain static from the Augustan period to the second century AD. Networks developed and shifted and nodes like Berenike became more significant (its lower latitude made it more suitable for larger ships); additionally, the number of ships operating will have fluctuated (it is worth noting that fewer, but much larger ships could potentially transport more cargo from southern India, with smaller ships primarily trading with ports along the Red Sea, Gulf of Aden and northwestern India).²⁸ More broadly, it is possible to identify fluctuations in the importance of certain nodes, due to a series of natural events, localised factors and wider geopolitical incidents.²⁹ Almost certainly there will also have been year-to-year fluctuations in the amount of goods reaching Egypt (due to shipwrecks and predatory attacks), although we lack the data to be able to say anything more concrete.³⁰ Consequently, how reliable a source of income this was varied much more than previous static estimates suggest.

A second fundamental issue that requires discussion is that we do not know the size of the *Hermapollon*, the ship mentioned in the Muziris Papyrus. This matters because the aforementioned models all (implicitly) assume that it represents an "average" vessel (see below, for more detail on vessel sizes). However, it seems likely that the *Hermapollon* was in fact a very large ship. Unfortunately, the Muziris Papyrus is in a fragmentary state. While the total value of the cargo after deduction of (an initial) *tetarte* (and additional surcharges) is clear enough, the total content of that cargo and its weight remains uncertain. The items that are clearly readable include Gangetic nard (60 containers, weight not specified), ivory (78 talents, 54.75 minae weight), and *schidai* (13 talents, 9.75 minae weight) which cumulatively amount to around 5 metric tons (henceforth mt).³¹ The remaining cargo of the *Hermapollon* has been variously interpreted on the basis of faint lettering and spacing in the document. Among the purported additional cargo are black pepper, malabathrum and tortoiseshell.³² Alternative reconstructions have also been offered for the remaining weight of the cargo. De Romanis argues that the *Hermapollon* had about 625 mt worth of capacity (most recently, over 635 mt), with black pepper accounting for some 544 mt of space. By contrast, F. Morelli suggests the ship's total cargo capacity was somewhere around 180 mt, about 130-140 mt of which was taken up by black pepper.³³

The discrepancy between the higher estimate of De Romanis and lower estimate of Morelli comes down to the reconstruction of the value of black pepper, which De Romanis argues is about 6 Egyptian drachmae (equivalent to 6 sesterii) per mina (511 g), while Morelli puts it at 24 drachmae per mina.

27. De Romanis 2020, p. 254, argues these were likely smaller than the vessels which would subsequently operate from Berenike.

28. For an overview, see De Romanis 2020, pp. 46-54, 137-139, 317-318.

29. See, among others, Cobb 2015b; Tomber 2017.

30. On bandit attacks in the Eastern Desert, see Cuvigny 2005; Cuvigny 2011; Cuvigny 2012; on piracy and shipwrecks, Schneider 2014; on burnt down "cinnamon" groves in East Africa effecting prices, Pliny, *HN*, 12, 32, 93-94; on the problems of sailing into Berenike harbour late in the season, *P.CiYBR*, inv. 624.

31. *Schidai* has been variously interpreted as cloth or fragments/cuttings of ivory. Harrauer, Sijpesteijn 1985, pp. 148-149; Casson 1990, p. 201 (cloth); Rathbone 2000, pp. 44-45 (tusk fragments); De Romanis 2014, pp. 1-34; De Romanis 2020, pp. 220-222 (cuttings).

32. Morelli 2011; De Romanis 2012; De Romanis 2014; De Romanis 2015; De Romanis 2020.

33. McLaughlin 2019, p. 121, speculates that the *Hermapollon*'s capacity was at least 220 mt. Alternatively, Casson and Rathbone, while discussing the ivory cargo, assume that the ship had a capacity of around 300-340 mt, see Casson 1990, p. 205, n. 29; Rathbone 2000, p. 46.

De Romanis reconstruction seems preferable because a value of 6 Egyptian drachmae/6 sestertii per mina would represent a more reasonable fiscal value in Alexandria.³⁴ Pliny gives a price for the Early Flavian period of black pepper sold for 4 denarii (16 sestertii) a libra or Roman pound (ca 323 g). This is most probably the retail price in Rome at this time (ca AD 70s), which of course may not have been the same in mid-second century Rome. But assuming it is reasonably close this would represent a mark-up of slightly more than fourfold for the retail price in Rome compared to the initial fiscal value (assessed for the purposes of taxation and, in most cases, likely lower than the market value) in Alexandria, whereas, by comparison, Morelli's figure gives only 3% mark-up. This seems far too low.

The salient point is that if the ship was closer to the size and capacity Morelli suggests, it would be a fairly decent-sized ship, but within the norm if compared to the "average" Mediterranean merchantman (70-180 mt).³⁵ Whereas, if De Romanis' estimate is correct (which seems likely), the Hermapollon was a very large vessel, one of the half-dozen to dozen "very big ships" that sailed, in particular, to South India (on this point, see the reference to μέγιστα πλοῖα in the *Periplus Maris Erythraei*), with other smaller vessels voyaging to various ports in the Red Sea and wider Indian Ocean.³⁶ Indeed, recent pictorial, archaeological and literary analysis indicates Roman vessels operating from the Red Sea ports utilised the same construction methods as seen in the Mediterranean (mortise-and-tenon joints, shell of plank hull with lead-lining, square rigs), but had the potential to be very large (multiple-masted) vessels.³⁷ The De Romanis reconstruction allows for substantial volumes of goods to be imported, since one such vessel could potentially carry the cargo equivalent of several much smaller vessels, but it means that we should not imagine 120 Hermapollon-class ships operating, as McLaughlin's, Wilson's and Speidel's models suppose. In fact, the number of camels required to transport such a volume of cargo (ca 75,000 mt = 375,000 camel loads) would be implausibly high.³⁸ Kerala could also not produce nearly enough black pepper for 120 Hermapollon-class vessels (even under Morelli's 180 mt reconstruction).³⁹ The key point is that simply calculating total state revenue by taking the value of the Hermapollon's cargo and multiplying it by 120 odd ships is not as straightforward a method as has been asserted.

Hypothetical calculations for Rome's Red Sea revenue

Despite the caveats noted above, the models produced by Wilson, McLaughlin and Speidel have the merit of providing a sense of the importance of Red Sea revenues for the Roman state; although, as noted, this type of approach has some key limitations. It does not fully grapple with the likely fluctuations in the volume and value of trade, both year to year and in the longue durée. Instead, it fixes on the 120-ship figure (though note Wilson's variant) and assumes that the total value of the Hermapollon's cargo was typical. It also does not seem to factor in the potential for further revenue generated by double duties (τέλη διπλάσια).

The assumptions made in these models are understandable, especially given that the Muziris Papyrus is the only real document of its type that we have for the Imperial Period. But, as noted, the Hermapollon may represent one of the limited number of very large "pepper carriers". The use

34. De Romanis 2020, pp. 236-245.

35. On the size of Mediterranean vessels see Heilporn 2000; Sidebotham 2011, pp. 195-196. Wilson 2009, p. 229, notes that small ships may be over-represented in shipwreck finds. However, on the extremely large vessels sailing between Alexandria and central Italy, see De Romanis 2020, pp. 252-253.

36. *PME*, § 56. See De Romanis 1996, pp. 178-180, n. 40; De Romanis 2012, pp. 75-77; De Romanis 2017, p. 90. De Romanis 2020, p. 202, suggests from early modern evidence that there would unlikely be more than eight or nine (for the first century AD), and by the late second to third century perhaps only two.

37. See Pomey 2012, pp. 114-119.

38. See below *tab. 3*.

39. On Kerala's pepper production, see De Romanis 2020, pp. 98-101, 252-260.

of Strabo's 120-ship figure is also understandable, since no other source for the Imperial Period mentions the number of ships operating from the Red Sea ports. However, as has been noted, even if a smaller number of vessels were operating within a particular network, if they were very large in size this could compensate in terms of capacity of goods moved. Essentially, there is no suitable evidence with which to try and model fluctuations in the volume of goods moved (which may or may not necessarily correlate to the number of ships operating). One can grasp at the *Martyrium sancti Arethae* or *Acta S. Arethae (MSA)* as a possible means of comparison. This late antique text records details about Byzantine aid for the Axumite campaign against Himyar.⁴⁰ Among the help provided was a number of requisitioned vessels (most likely merchant ships) sent by the Emperor Justin from several key Red Sea ports/stations. We are told that 20 were sent from Clysma (Suez), 7 from Iotabê (Gulf of Aqaba?), 7 from Farasan (islands in southern Red Sea), 5 from Aila (Gulf of Aqaba), 2 from Berenike (Egyptian Red Sea coast) and 9 from "India" (Axumite territory).⁴¹ This makes 50 vessels in total. Nevertheless, it must be noted that these ships were likely much smaller on average than the Hermapollon-class vessels, especially those operating from the Suez and Gulf of Aqaba ports (due to dangerous coral reefs and prevailing northerly winds).⁴² So making a meaningful comparison with the Imperial Period is extremely fraught, and there is no intention here to do so. Rather, the figure of 50 ships is merely used as a hypothetical means of taking account of fluctuations in the level of trading activity in Rome's Red Sea ports, particularly reflecting the lower level of early to mid-third century AD activity. This utilisation of a lower 50-ship figure is therefore not intended to provide a firm reconstruction (none of the models discussed do), but it is used here as a means of furthering our hypothetical exercise.

An additional issue which needs to be considered is that the *tetarte* or 25% tax on Indian Ocean goods was subsequently replaced with a lower rate of 12.5% or *octava*. This happened at some point between AD 174, when it is last mentioned, and AD 227 when the *octava* is recorded as being levied.⁴³ This lower rate may reflect a decline in private commercial traffic and a weakening of the state's ability to provide protection for travellers (although De Romanis suggests that the lower tax rate may have been partially off-set by higher fiscal values for imported goods).⁴⁴ Coupled with this, the lower tax rate may have been intended to entice merchants to participate in the Red Sea trade (the tax rate, fiscal values set for different commodities, the weight standards applied, and volume of goods imported (linked to the various sizes – cargo capacities – and numbers of vessels operating) all impacted on the revenue generated).

It is proposed here to take Strabo's figure (120) as representing the higher end of the range, and to borrow the figure from the *MSA* (50) as the lower end of the range. Of course, the number of ships that could have been operating at different points, and their various sizes, may well have been greater or lesser. Additionally, it will be assumed that the Hermapollon represents the upper end of Roman vessels operating from the Red Sea (ca 625 mt), with many medium sized (ca 180 mt) and smaller sized (ca 70 mt) vessels operating as well. Thus, the tax levied on the Hermapollon will be scaled down in the case of the medium-sized and smaller vessels (of course, in reality, a smaller vessel might carry low volume, low weight items like pearls or precious gems – among other items –, taking up little space, but representing a high monetary value). Furthermore, a tax rate of 12.5% will be applied when considering the Severan period to mid-third century AD. Finally, a second set of

40. *MSA*, 27-29, the text of which can be found in *Anecdota Graeca*, ed. J.-F. Boissonade 1833, pp. 41-43; also *Fontes Historiae Nubiorum*, vol. III, no. 327.

41. The term "India" could also be used to refer to regions like East Africa. On this general confusion, see Schneider 2004.

42. De Romanis 2020, pp. 35-46, 68-70, 251.

43. *Codex Justinianus*, 4, 65, 7; Wilson 2015, pp. 27-28.

44. For possible reasons for this weakening of traffic see Cuvigny 2005; Cuvigny 2011; Cuvigny 2012; Cobb 2019; Wilson 2015, pp. 27-28; De Romanis 2020, pp. 290-294.

	“Extreme” highest estimate	“Plausible” upper estimate	Middle estimate	Lower estimate
Total number of ships for the first and second centuries AD (120)	120 ships of 625 mt capacity	12 ships of 625 mt capacity; 50 ships of 180 mt; 58 ships of 70 mt	6 ships of 625 mt capacity; 40 ships of 180 mt; 74 ships of 70 mt	2 ships of 625 mt capacity; 30 ships of 180 mt; 88 ships of 90 mt
Total revenue generated: pre-Severan period (<i>tetarte</i> – 25% tax)	HS 276 million	HS 76 million	HS 59 million	HS 47 million
Total number of ships for the Severan period to mid-third century (50)	50 ships of 625 mt capacity	6 ships of 625 mt capacity; 24 ships of 180 mt; 20 ships of 70 mt	3 ships of 625 mt capacity; 17 ships of 180 mt; 30 ships of 70 mt	1 ship of 625 mt capacity; 12 ships of 180 mt; 37 ships of 70 mt
Total revenue generated: Severan period to mid-third century (<i>octava</i> – 12.5% tax)	HS 58 million	HS 18 million	HS 13 million	HS 10 million

Tab. 1 – Estimates of revenue for the collection of the (initial) *tetarte* on Indian Ocean goods arriving into Egypt.

These figures have been rounded to the nearest million. HS = sestertii; mt = metric tons.

	“Extreme” highest estimate	“Plausible” upper estimate	Middle estimate	Lowest estimate
Remaining value of goods, with the initial <i>tetarte</i> (25%) having already been levied	HS 828 million	HS 228 million	HS 177 million	HS 141 million
Revenue generated from an additional <i>tetarte</i> levied on 80% of the total value	HS 166 million	HS 46 million	HS 35 million	HS 28 million
Remaining value of goods, with the initial <i>octava</i> (12.5%) having already been levied	HS 174 million	HS 54 million	HS 39 million	HS 30 million
Revenue generated from an additional <i>octava</i> levied on 80% of the total value	HS 35 million	HS 11 million	HS 8 million	HS 6 million

Tab. 2 – Estimates of further revenue generated by taxation of Indian Ocean goods exported to other provinces (the second *tetarte*).

It is assumed this represents about 80% of the imported goods; figures have been rounded to the nearest million. HS = sestertii; mt = metric tons.

	“Extreme” highest estimate	“Plausible” upper estimate	Middle estimate	Lowest estimate
Total number of ships (120) and tonnage of goods moved	120 ships of 625 mt capacity = 75,000 mt	12 ships of 625 mt capacity; 50 ships of 180 mt; 58 ships of 70 mt = 20,560 mt	6 ships of 625 mt capacity; 40 ships of 180 mt; 74 ships of 70 mt = 16,130 mt	2 ships of 625 mt capacity; 30 ships of 180 mt; 88 ships of 90 mt = 14,570 mt
Number of camel loads required (with a capacity of 200 kg or 600 libra per camel)	375,000 camel loads	102,800 camel loads	80,650 camel loads	72,850 camel loads
Total tolls collected for the camels (1 obol per camel) according to the Koptos Tariff	ca 10 talents (HS 62,500)	ca 3 talents (HS 17,133)	ca 2 talents (HS 13,442)	ca 2 talents (HS 12,142)

Tab. 3 – The number of camel loads required based on tonnage of goods imported for the first to second centuries AD.

HS = sestertii; mt = metric tons.

calculations has been created, based on the assumption that 80% of the goods imported into Egypt via the Red Sea ports, were then traded within the Roman Empire to other provinces, being subject to a further *tetarte*.⁴⁵ Potentially the Roman state readjusted this additional assessment by utilising a slightly different weight standard (in favour of the merchants), as De Romanis suggests from his interpretation of the Muziris Papyrus, meaning that the actual tax taken for the second *tetarte* will have been slightly lower than the hypothetical calculations offered here (for the sake of simplicity, 25% tax is assumed to be collected from 80% of the Hermapollon's post-initial *tetarte* value of 6,911,852 sesterii).⁴⁶ Similarly, since the *arabarchoi* received small surcharges and took a share of the base-quarter rate (unfortunately how large this share was remains unknown), the amount actually generated by the state would be lower.⁴⁷ In any case, a range of hypothetical calculations are provided here to reflect the limitations of the evidence and the reality of fluctuations in volume and value of the trade outlined above. The figures offered are not real (although they may possibly be within the realms of the plausible), but rather they are intended to highlight the problems inherent in the models produced by Wilson, McLaughlin and Speidel.

The hypothetical calculations provided in *tab. 1* (the collection of the initial *tetarte*) give the extreme “highest” estimate of 276 million sesterii for the first to mid-second century and a lowest estimate of 10 million for the Severan to early mid-third century. *Tab. 2* supposes an additional 166 million sesterii generated for the “extreme” upper estimate (first to mid-second century) and 6 million (Severan to early mid-third century) for the lower estimate on those goods sent out of Egypt to the rest of the Empire. The figures in these tables are entirely hypothetical, but it is suggested that the actual revenue generated likely fluctuated around the upper (plausible) and lower estimates. Adding these together (double duties), the lower to upper (plausible) estimates come to around 75-120 million sesterii for the first to second centuries and 16-29 million for the Severan period to early mid-third century (minus whatever share was kept by the *arabarchoi*). By contrast, if the value of the Hermapollon is multiplied by 120 and a further *tetarte* is applied to 80% of the remaining cargo, the implausibly high figure of 442 million sesterii is generated. As noted, some tolls were also collected for camels and people crossing the Eastern Desert, but this would raise a comparatively small amount of some several thousands of sesterii (*tab. 3*).

Red Sea revenue figures in a wider context

Having generated these hypothetical calculations, it is now possible to put into context the middle to upper estimates (75-120 million sesterii) for Roman revenue derived from the Red Sea ports in the early centuries AD. This would represent about 9-15% (800 million sesterii) or 8-12% (1 billion sesterii) of R. Duncan-Jones' estimate of the Imperial Era state budget.⁴⁸ This is not quite the “third” of the Roman state budget that McLaughlin argues for in his “Eastern Commercial Revenue Model”, but it is arguably a more realistic scenario.⁴⁹ It means that the Roman state would not have been quite as dependent upon this source of income as McLaughlin suggests, though it would still represent something quite significant. Fluctuations in the volume and value of the trade will necessarily have impacted on the resources that the state had to cover its expenses – such as military pay, administrative costs, infrastructure, various forms of largesse (*indulgentia*) or euergetism, and the *cura annonae*.

45. There is no evidence on which to base the level of consumption of Red Sea imports in Egypt, versus distribution elsewhere in the Empire. So an entirely arbitrary, but hopefully at least plausible, figure of 80% is utilised.

46. De Romanis 2020, pp. 288-297.

47. De Romanis 2020, pp. 299-308.

48. Duncan-Jones 1994, pp. 33-46.

49. McLaughlin 2019, pp. 117, 122.

However, any longer-term downturns or sudden shocks to this branch of the wider Indian Ocean networks of exchange would not be quite as devastating as it would be if one were to suppose that the Roman state really were dependent upon it for a third of its revenue.

It is generally thought that the period of the first to mid-second century represents a high point for direct “Roman” participation in the Indian Ocean trade, with a subsequent downturn, becoming quite marked during the so-called Third Century Crisis, and then a later revival (though not quite to the same scale as seen in the first century) from the mid-fourth into fifth century.⁵⁰ There are a number of wider geopolitical, natural and localised factors that may have caused a pronounced downturn for Roman Red Sea trading activity in the late second and (especially) third century.⁵¹ Among these are wider economic, social and political turmoil in the period, unrest in Koptos, a massacre in Alexandria under Caracalla, and invasions and rebellions in Egypt in the AD 270s and 290s.⁵² McLaughlin himself points to the Antonine Plague as a major reason for a downturn during the latter second century.⁵³

In light of this, it seems peculiar that Septimius Severus and then Caracalla were both in a position to raise the pay of the soldiers from 1,200 sesterii (legionary pay post-AD 84) to 2,400 (Septimius Severus) and then 3,600 sesterii (Caracalla) per annum.⁵⁴ This is at a time when there appears to be a downturn (though certainly not a cessation) of Red Sea trading activity and hence revenue generated from it. The lowering of the tax rate from 25% to 12.5% almost certainly reflecting these difficulties. The progressive debasement of the denarius from about 70% under Commodus to about 45% purity in the reign of Septimius Severus, and the subsequent introduction of the *antoninianus* under Caracalla, may have been one way that the state could try to mitigate a significant downturn in its revenue and still provide for an increase of its soldiers’ pay.⁵⁵ However, we should be mindful that the debasement and weight reduction process had been occurring in earlier generations and would continue down to the late third century.⁵⁶ We have no real evidence to tie these two developments together. It would be purely a matter of speculation to argue for causation. Thus, McLaughlin’s notion of a third of revenue deriving from the Red Sea trade seems unsustainably high.

Conclusion

The Roman state controlled a number of nodes (ports) on the northern Red Sea coastline which linked into wider Indian Ocean networks of exchange. Taxes levied on goods imported through these ports allowed the state to generate a significant amount of revenue. However, it has been demonstrated that the models produced by Wilson, Speidel and McLaughlin are static and more consideration needs to be given to factors such as variations in ship sizes and numbers, longer-term changes in the pattern of

50. See, for example, Sidebotham 2011; Cobb 2015b; Cobb 2019; Tomber 2017; Brun, Cuvigny, Reddé 2011, p. 162. Of course, not all mid-third century activity ceased. For example, a fragmentary inscription from the Great Temple at Berenike reveals activity around the time of the emperors Trebonianus Gallus and Volusianus (AD 253): Sidebotham et al. 2019, p. 15.

51. Possibly some Red Sea trading activity shifted during the course of the second century from ports like Myos Hormos and Berenike, to those like Clysma, especially with the development of Trajan’s Canal. See Cobb 2019, p. 104.

52. Young 2001, p. 85 (late second to third century instability); Adams 2001, p. 157 (Koptos an area of unrest); Sidebotham 2011, p. 163; Cobb 2019, pp. 93-105 ([nomadic] banditry). For a brief overview of the Palmyrene invasion of Egypt and a few revolts in the AD 290s, see Pollard 2013. On Caracalla’s massacre in Alexandria, see *Historia Augusta. Caracalla*, 6, 2.

53. McLaughlin 2010, pp. 59-60; McLaughlin 2014, pp. 210-217.

54. Speidel 1992, p. 88.

55. On the debasement of the denarius see Ponting 2009; Butcher, Ponting 2012.

56. Lo Cascio 2007, pp. 627-630; Duncan-Jones 1994, pp. 217-223; Ponting 2009, p. 275.

the Red Sea/Indian Ocean trade networks, and year-to-year fluctuations resulting from shipwrecks and piracy (among other issues). The calculations offered in this paper do not represent concrete reality, nor do the other models assessed. Rather, the intention of the hypothetical exercise undertaken here has been to demonstrate the evidential and methodological limitations of such models. While they provide interesting reflections on the potential significance of Red Sea revenues for the Roman state, any attempt to build more complex arguments upon such foundations seem misguided; McLaughlin's Eastern Commercial Revenue Model being a case in point.

Appendix: the collection of revenue and the keeping of records

The handling and calculation of the *tetarte* was under the responsibility of the *arabarchoi* (probably farmed out by the Prefect of Egypt) who assigned the *paralemptai* to collect the tax.⁵⁷ As De Romanis notes, unlike normal practice, in the case of this tax it was probably not paid up front as a lump sum, rather the *arabarchoi* would be given responsibility by the treasury to collect these taxes, keeping for themselves “a percentage of the base-quarter rates” of the duties, as well as the small added surcharges.⁵⁸ The Muziris Papyrus seems to indicate that it could be taken in kind rather than cash, as it is recorded that part of the cargo might be used to pay the *tetarte*.⁵⁹ However, De Romanis argues that this was only in extremis, such as failure by a borrower to repay a loan or if the market prices for the goods dipped below the fiscal values set by the state.⁶⁰

Almost certainly the *arabarchoi* would have kept records that were shared with state officials, like the supervisor of the Alexandrian *fiscus* and the Prefect of Egypt, and in Rome the *procurator fisci Alexandri* and *a rationibus*, although unfortunately none survive.⁶¹ More concretely, at a localised level, there are the so-called customs passes which listed the goods transported through the customs gate at Berenike; one presumes this information was collated in a central record.⁶² In a wider context it is known that the emperors kept dossiers of financial data; for example, Severus Alexander's ledger of military service records and pay.⁶³ At a provincial level, Pliny the Younger was able to utilize local records during his governorship of Bithynia, although such record keeping might not always be done consistently and competently (at least by the late antique period) to judge from some Justinianic Era sources.⁶⁴ In any case, almost certainly records of the collection of the *tetarte* would have been known to the *familia Caesaris*. How much of this information disseminated to the wider “public” is anyone's guess, but in the case of Pliny the Elder it has been noted that his figures about the “outflow of wealth” likely derived from reports of Red Sea merchants (and do not connect to imperial customs receipts).

57. Burkhalter 1999, pp. 44-54; Ast, Bagnall 2015, pp. 177, 178-183; Cuvigny 2005, pp. 59-62; De Romanis 2020, pp. 132, 298-320; *P.Vindob* G 40822; *OGIS* 674. On the *vectigal Maris Rubri*, see Pliny, *HN*, 6, 24, 84; De Romanis 2020, pp. 277-297.

58. De Romanis 2020, p. 299.

59. *P.Vindob* G 40822, recto, col. 1, l. 17-19; Rathbone 2000, pp. 43-45; Young 2001, p. 52.

60. De Romanis 2020, pp. 6, 174, 280-283.

61. Rathbone 2000, p. 39; Young 2001, p. 210; De Romanis 2020, pp. 317-320.

62. Nappo, Zerbini 2011, pp. 63-65.

63. *Historia Augusta. Severus Alexander*, 21, 6-8.

64. Pliny the Younger, *Epistles*, 10, 56; Justinian, *Novellae Constitutiones*, 15, Pr. 5, 2.

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Abbreviations

AnzWien: *Anzeiger der österreichischen Akademie der Wissenschaften. Philologisch-Historische Klasse* (Vienna).

AW&E: *Ancient West and East* (Leuven).

HN: Pliny the Elder, *Historia Naturalis*, ed. and transl. H. Rackham, London, Loeb, 1942-1945.

ISAW Papers: *Institute for the Study of the Ancient World. Papers* (New York).

JAIH: *Journal of Ancient Indian History* (Calcutta).

MSA: *Martyrium sancti Arethae. Anecdota Graeca*, vol. V, ed. J.-F. Boissonade, Paris, Excusum in Regio Typographeo, 1833.

NumChron: *The Numismatic Chronicle* (London).

OGIS: *Oriens Graeci Inscriptiones Selectae*, ed. W. Dittenberger, Leipzig, Hirzel, 1903-1905.

PME: *Periplus Maris Erythraei*, ed. and transl. L. Casson, Princeton, Princeton University Press, 1989.

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