

# The Weight of Trireme Rams and the Price of Bronze in Fourth-Century Athens

*William M. Murray*

THE UNEXPECTED discovery of an intact warship ram in 1980 off the coast of Israel near the small town of Athlit has raised some intriguing questions that have, in turn, forced reevaluation of some facts once considered certain.<sup>1</sup> For example, it had been thought for almost a century that the weight of a trireme ram was approximately 77 kg. (170 lbs.).<sup>2</sup> Thus, when the example recently discovered near Athlit was found to weigh 465 kg., the natural conclusion was that this ram came from a ship class of much greater size than the trireme.<sup>3</sup> Closer examination of the evidence for the weight of a trireme ram shows, however, that our only information is derived from the record of a single sale of damaged, probably fragmentary, rams being sold as scrap in 325/4 B.C. The evidence is thus of limited, if not dubious, value; consequently, there is nothing to exclude the possibility that the Athlit ram belongs to a ship of the trireme class.<sup>4</sup> On the positive side, an analysis of this sale does yield a reasonable figure for the price of bronze scrap in 325/4.

Before discussing the evidence for the rams and their weight, it will be helpful to describe briefly the nature of the accounts in which the

<sup>1</sup> For the initial discovery and first reports of the ram, see E. Linder and Y. Ramon, "A Bronze Ram from the Sea of Athlit, Israel," *Archaeology* 34.6 (1981) 62–64; A. Raban, "Summary of Research in Israel," *IJNA* 10 (1981) 292; L. Basch, "The Athlit Ram: A Preliminary Introduction and Report," *Mariner's Mirror* 68 (1982) 3–7; H. Frost, "The Athlit Ram," *IJNA* 11 (1982) 59f; and J. R. Steffy, "The Athlit Ram. A Preliminary Investigation of its Structure," *Mariner's Mirror* 69 (1983) 229–47. For a map identifying the findspot see A. Raban, *Harbour Archaeology* (BritArchRep, International Series 257 [1985]) 33 Fig. 14.

<sup>2</sup> Cf. C. Torr, *Ancient Ships* (reprint of 1894 edition, Chicago 1964) 63f with n.144. Although Torr's calculations were correct on the basis of information then available, subsequent writers failed to notice them, or if they did, misrepresented the figures. Cf. L. Casson, *Ships and Seamanship in the Ancient World* (Princeton 1971) 85 n.42; P. Pomey, "Remarques à propos de l'épiron d'Athlit," *Mariner's Mirror* 69 (1983) 248. Casson calculates the weight of a single ram by dividing the total weight by four, not five (see *infra*); Pomey simply misquotes Torr and says that a single ram weighed 125 kg. (275 lbs.).

<sup>3</sup> Cf. Pomey (*supra* n.2) 248.

<sup>4</sup> The evidence for the ship-type of the warship that once carried the Athlit ram will be treated elsewhere.

sale is recorded. Each year a board of ten men, one from each tribe, was selected to supervise the administration of the Athenian shipyards. In the fourth century, these Curators of the Shipyards (ἐπιμεληταὶ τῶν νεωρίων) were responsible for the yearly distribution and recovery of ships and gear (lines, oars, sails, anchors, etc.), and for recording trierarchs who did not return their gear at the end of the year. They also listed other debts owed to the yards, such as for ships lost or damaged by trierarchs, for example, who were then held responsible for their replacement. Ships damaged beyond repair were dismantled, their rams removed and recovered by the yards for reassignment to new vessels. The names of all those who did not comply with this procedure were recorded by the curators. Their other duties included maintaining records of moneys received from the sale of decommissioned gear, and also of payments from trierarchs to settle outstanding debts they owed to the yards.<sup>5</sup> The accounts of this board seem to have been inscribed on stone each year, with the intent of providing a public record of those responsible for the gear assigned to them, and to indicate exactly what equipment was available for use under the care of the curators. D. R. Laing has shown that the texts form a group of inscriptions that were probably opisthographic.<sup>6</sup>

*IG II<sup>2</sup> 1629* presents the records kept by the Curators of the Shipyards for 325/4. During this year, the curators were empowered by the Council to sell some decommissioned equipment, including a number of rams. Originally “four” were indicated, although the word τέτταρες was subsequently erased. The total weight of the rams is recorded as something over 3τ (the numeral is not fully preserved), and the sale price is listed as a little over 524 dr. (lines 1144–47):

ἔ[μβολοι]  
 1145 [[τέτταρες]], σταθμ[όν: .]  
 ΤΤΤ : μναῖ Δ[Δ]ΔΠ,  
 τιμή : Π<sup>Ϟ</sup>ΔΔϞ Ϟ Ϟ Ϟ [III].

This same entry also appears on the curators' list for 323/2 (1631.332–34); apart from one minor grammatical difference, it is identical with the record for 325/4, except in the number of rams reported sold: here the number is clearly five, not four:

<sup>5</sup> For a discussion of the board's duties and responsibilities, see A. Böckh, *Urkunden über das Seewesen des attischen Staates* (Berlin 1840) 48–64; B. Jordan, *The Athenian Navy in the Classical Period* (Berkeley 1975) 30–35. For the stockpiling of rams for new vessels, see n.15 *infra*.

<sup>6</sup> D. R. Laing, “A Reconstruction of *IG II<sup>2</sup> 1628*,” *Hesperia* 37 (1968) 244–54.

332 [ ἐμ]-  
 βόλους : Π : σταθμόν : [.ΤΤΤ μναῖ]  
 ΔΔΔΠ : τιμή : [Γ<sup>Α</sup>ΔΔΕ Ε Ε Ε ΙΙΙ ]

That “5” is the correct number of rams sold is confirmed by the curators’ records for these two years: two rams were received from the curators of 326/5, one from the trierarch Demostratus, one from the trierarch Diaetus, and another from the trierarch Conon.<sup>7</sup>

Before turning to an examination of the conditions surrounding the sale of these rams, their true average weight should be established. Unfortunately, their combined weight is fully preserved on neither list, but a good case can be made for restoring this figure as 8.58τ arguing from their combined sale price, given as 524.5 dr. (1629.1147). Since it is clear from the circumstances about to be described that these rams were sold as scrap, their total weight could be calculated if we knew the price of raw bronze in 325 B.C. Of this, unfortunately, we have no record. We do, however, have the cost for the alloy’s ingredients (copper and tin) preserved in the accounts of the cult statues for the Hephaestum (*IG* I<sup>3</sup> 472 = I<sup>2</sup> 371.III 2–8, covering expenditures from 421/0 to 416/5):

χαλκὸς ἐονέθε [ἐς τὸ ἄνθεμον, τάλαντα – – –]  
 140 καίδεκα καὶ μναῖ δέκα, τιμὲ [τῷ τάλαντῳ τρι]-  
 ἄκοντα πέντε δραχμαί.  
 καττίτερος ἐονέθε ἐς τὸ ἄνθεμον, [τάλαντον]  
 καὶ ημιτάλαντον καὶ μναῖ εἴκοσι τ[ρὲς καὶ]  
 ημιμναῖον, τὸ τάλαντον διακοσίον τρι[ιάκ]-  
 145 οντα δραχμῶν, τιμέ vacat

Copper was purchased [for the *antheion*, talents – – –] and ten, and ten minae. Cost per talent = 35 drachmae. Tin was purchased for the *antheion*, a talent and a half and twenty-three and one-half minae. Per talent, two hundred thirty drachmae. Cost.

Torr’s calculation of the weight of our rams was based on lines 139–41. Taking the word *χαλκός* to mean bronze, and using the cost per talent of alloy given in lines 140f (*i.e.*, 35 dr.), he derived a total of approximately 15τ.<sup>8</sup> He concluded, accordingly, that a single ram must have weighed approximately 3τ, or 170 lbs. (77 kg.). Since Torr made these calculations, however, eleven fragments of the accounts for the statue of Athena Promachus have been found, on which the copper and tin required for the bronze are listed sep-

<sup>7</sup> Cf. 1629.813–16 and 1631.194–99. For a discussion of these entries, see *infra*.

<sup>8</sup> Torr (*supra* n.2).

arately.<sup>9</sup> In light of this document, the word *χαλκός* in line 139 should therefore be understood as copper, not bronze.<sup>10</sup> This drastically affects the price of bronze originally calculated from the Hephaesteum inscription. If we assume a normal copper to tin ratio of 10:1, then the price of bronze (excluding the labor required to produce the alloy) would equal about 54.5 dr. per talent of metal.<sup>11</sup>

The cost per talent of manufacturing the alloy can be calculated (at least for the mid-fourth century) from an inscription found at Eleusis detailing building specifications for the Portico of Philon (*IG II<sup>2</sup> 1675*). The contractor's bid accepted as reasonable for the production of bronze *poloi* and *empolia* stipulates 5.75 obols as the cost of manufacture per mina of alloy.<sup>12</sup> This rate yields a cost of 5 dr. 4.5 obols per talent.

If this production cost is added to the price of bronze calculated above, the total cost of 1τ of bronze would equal approximately 60 dr. 1.5 obols (54 dr. 3 obols + 5 dr. 4.5 obols). Admittedly, this figure is derived using prices separated by at least half a century; the cost of copper and tin might have been quite different in the mid-fourth century, and even more so by 325 when the rams were sold. It will be seen, however, that this figure corresponds well to a simple restoration of the combined weight of the rams in the list for 325/4. Let us now return to this list and use the price of manufactured bronze derived above.

If five rams cost 524.5 dr., then at 60.25 dr. per talent of metal, the weight of these rams would have equalled approximately 8.7τ. The restoration of Π in line 1145 of the list for 325/4 and in line 333 of

<sup>9</sup> Cf. *IG I<sup>3</sup> 435.10–13* (restored), 42–45 (restored), 69–72 (restored), and 101–04.

<sup>10</sup> Cf. E. B. Harrison, "Alkamenes' Sculptures for the Hephaisteion: Part I, The Cult Statues," *AJA* 81 (1977) 144.

<sup>11</sup> Harrison (*supra* n.10) 144 with n.34 gives the normal range as 10–12% tin for the production of bronze "most desirable for strength and workability." We cannot be certain of the exact composition of the bronze utilized in Athenian trireme rams, although the ratio used in the Athlit ram is roughly 10:1 (cf. Steffy [*supra* n.1] 234). We are fully justified, therefore, in using a 10:1 ratio here *exempli gratia*: tin = 23 dr. per 1/10 talent (*i.e.*, 230 dr. per talent), copper = 31.5 dr. per 9/10 talent (*i.e.*, 35 dr. per talent), total = 54.5 dr. per talent of alloy.

<sup>12</sup> Cf. line 31. Here, the ratio of copper to tin is 11.1:1 (9%). Tin was expensive, and the low percentage of this metal relative to the copper was probably an attempt to economize. Cf. G. J. Varoufakis, "Materials Testing in Classical Greece, Technical Specifications of the 4th Century B.C.," *Journal of the Historical Metallurgy Society* 9.2 (1975) 57–63, for an analysis of this inscription. Varoufakis argues (61) that the composition of the alloy was specified to prevent the contractor from casting a "poorer . . . and for him more profitable copper tin." It may also be that the regulations were drawn up expressly to allow for the production of a lower quality bronze in an attempt to save money where a higher quality was unnecessary. Regardless of the above, the production costs would be roughly the same for bronze of different copper–tin ratios.

the list for 323/2 seems justified: ΠΤΤΤ, 8 talents.<sup>13</sup> If this is correct, the combined weight of all five rams was 8Τ 35 minae (8.58Τ), the price per talent of bronze in 325/4 was 61 dr. (524.5 ÷ 8.58), and a single ram weighed a little over 1.7Τ, or roughly 44.5 kg. (=98 lbs.).

We are now faced with an obvious problem. Is it possible that Athenian trireme rams were 90% smaller than the example found recently off Israel? The answer is no, and the evidence is provided by the circumstances that resulted in the sale of these five rams—circumstances reflected in the rubrics under which the rams, their ships and their trierarchs are listed. As noted above, two of these rams were received from the curators of the previous year (who had received them, in turn, from the board for 327/6); their exact origin is not recorded.<sup>14</sup> Of the remaining three rams, however, one comes from the *Proplous* (trierarch Demostratus), another from the *Delphis* (trierarch Diaetus), and another from the *Demokratia* (trierarch Conon), all triremes.

This fact, however, is not readily apparent from the list for 325/4, as can be seen from the following entry (1629):

<sup>13</sup> The other alternatives are few. The restoration of a Δ for δέκα is not likely because it would yield a price per talent of bronze of 38.6 dr. Given the general inflation of prices during the fourth century (cf. H.-D. Zimmerman, "Freie Arbeit, Preise und Löhne," in E. C. Welskopf, ed., *Hellenische Poleis I* [Berlin 1974] 92–107), this restoration seems inferior to that adopted above, which reveals a stable price of bronze. The restoration of a T yields a total weight of 4.58Τ, an average weight per ram of less than one talent (which is surely too low) and a price per talent of bronze of 114.5 dr. (which seems rather high). I have not seen the stone, but perhaps there is room for the restoration of both a Π and a T, thus resulting in a total weight of 9.58Τ. This would yield a price per talent of 54.75 dr. and a weight per ram of approximately 1.9Τ, or almost 50 kg. I consider this restoration unlikely, however, because of a pattern revealed by the mason who cut the text of 1629. Out of nine preserved examples where a numeral occupies two lines, the mason prefers to divide the numeral where the symbols change. For example, ΗΗΔΔΔΠ (the numeral 235) would be hyphenated between the Η and the Δ, or between the Δ and the Π, but not within groups of the same symbols. A list of such divisions demonstrates the point: lines 283f ΗΗΤ/ΔΔΔΔΠ, 299f ΗΗ/ΔΔΔΔΠ, 316f ΗΗ/ΔΔΔΠΠ, 491f ΧΧΗΗ/ΤΔΔΔΠΠ F F F, 582f ΧΧ/ΗΗΤΔΔΔΠΠ F F F, 997f Δ[ΔΔΔ]/ΠΠ[Ι], 1041f ΗΗΤ[ΠΠ F F]/ΠΠ, 1084f [ΠΠ]/Ι (the restoration is likely if standard gear on a 'four' is the same as on a 'three'; cf. 1061–63), 1151f ΗΗΗΤ[ΔΔΔ]/F F ΠΠΤ (cf. 1631.337). On only one occasion does a hyphenation occur within a group of similar symbols (lines 1084f), but on this occasion only one symbol-group comprises the number. I therefore favor the restoration of the weight in talents as Π/ΤΤΤ rather than ΠΠ/ΤΤΤ, which would result in an uncharacteristic hyphenation.

<sup>14</sup> Cf. 1629.813f and 1628.498–500. Böckh (*supra* n.5) 224 believed that the rams came from the *Epideixis* and the *Tacheia*, two ships for which rams were not recorded as received in the surviving lists; but there are other possibilities. Almost forty years after Böckh made these comments, the list for 333/2 was discovered and increased the number of possible ships from which these rams could have come (e.g. the *Eukarpia* and the *Delias*; cf. 1623.109–34). If we had the lists for 332/1, 331/0, 330/29, 329/8, and 328/7, other possibilities would present themselves. It is best at this time to admit our ignorance of the origin of these rams. For the possibility that rams were passed from board to board, see *infra*.

- ἐμβόλους παρελάβομεν  
 παρὰ νεωρίων ἐπιμελη(τῶν) : II·  
 815 καὶ παρὰ Δημοστράτου Κυθηρ(ρίου) : I·  
 οὔτοι ἐπράθησαν ἐπ' Ἀντικλέους ἄρχον(τος)·  
 καὶ ἀπελάβομεν ἐμβό-  
 λους παρὰ Κόνωνος  
 Ἄναφλυ(στίου) : ἀπὸ τῆς Εὐχά-  
 820 ριδος, Ἀλεξιμάχο ἔργ(ον) : I·  
 παρὰ Θρασυκλέους Ἐλευ(σινίου)  
 ἀπὸ τῆς Δικαιοσύνης,  
 Χαιρίωνος ἔργον : I·  
 καὶ παρέδομεν ἐν νε-  
 825 ωρίω ἐμβόλους : II·

We took over 2 rams from the (previous year's) Curators of the Shipyards, and 1 from Demostratus Cytherrius. These were sold in the archonship of Anticles (325/4). And we took back rams: from Conon Anaphlystius, from the *Eucharis*, built by Aleximachus, 1; from Thrasycles Eleusinius, from the *Dikaiosyne*, built by Chairion, 1; and we handed over, in the shipyards, 2 rams.

Note that only three of these rams are listed as sold; the other two were retained in the shipyards presumably for re-use, which seems to have been the normal procedure followed when the rams were serviceable.<sup>15</sup> We learn about the two additional rams returned during this year by Diaetus and Conon from a six-line insertion in the list for 323/2 that interrupts a reinscription of the entry just discussed (in all, lines 813–58 of the list for 325/4 are reproduced in the list for 323/2).

The insertion (1631.194–99) is placed at the end of a list of trierarchs who owe rams from ships they agreed in the courts to replace with new vessels; it follows directly after the text originally seen as line 840 in the list for 325/4, and was presumably intended to correct

<sup>15</sup> Cf. 1623.6–13: ταύτην ὁμολόγησεν ἐπὶ τοῦ δικαστηρίου καινήν ἀποδώσειν τῇ πόλει Εὐξένιππος Ἐθελοκράτους Λαμπτρ(εύς), τὴν δὲ παλαιὰν διαλύσειν καὶ τὸν ἐμβολὸν ἀποδώσειν εἰς τὰ νεώρια: “Euxenippus Lamptreus, son of Ethelocrates, agreed in the lawcourt to return this (ship) to the city, new, and to break up the old one and hand over the ram to the yards.” The rubric makes its first recorded appearance in this list for 333/2, and recurs on subsequent lists in slightly altered forms; cf. 1628.609–19; 1629.475–612, 826–40; and 1631.184–94. Since the preserved lists record only one sale of rams (and this consisting of five rams only), as compared with the numerous rams ordered turned over to the yards, most rams were presumably re-assigned to new vessels. For an explanation of the phrase ταύτην ὁμολόγησεν ἐπὶ τοῦ δικαστηρίου καινήν ἀποδώσειν τῇ πόλει, cf. *infra* and U. Köhler, “Eine attische Marine-Urkunde,” *AthMitt* 4 (1879) 80–82 (=1623, p.234 *ad* line 9).

the entry immediately preceding it, listing Diaetus and Conon as still owing rams:

τούτων ἀ-

195 [πέδο]σαν Δίαυτος Φρεάρρι(ος) : Κόνω[ν] Ἄν-  
αφλύστ(ιος) : τοὺς ἐμβόλους, οὓς [ἀ]ποφαί-  
νει Ὀψίγονος ὁ δημόσιος [π]επραμέ-  
[ν]ου[ς] ὑπὸ τῆς βουλῆς τῆς [ἐπ' Ἄν]τικλ-  
έους ἄρχοντος·

Of these (trierarchs recorded above as owing rams), Diaetus Phrearrius (and) Conon Anaphlystius handed over the rams which the public slave Opsigonus testified were sold by the Council (*i.e.*, they authorized the sale by decree) in the archonship of Anticles (325/4).

Apparently Diaetus and Conon had indeed returned their rams from the *Delphis* and the *Demokratia* in 325/4, but for one reason or another had not received appropriate credit. Since their rams had been sold with three others in 325/4 (*cf.* 1631.174–78), as the public slave affirmed two years later, the error went undetected until 323/2 when the curators updated their records and tried to exact whatever was still owed to the yards.

The circumstances that produced this accounting error can be reconstructed as follows. During the sailing season of 325/4, fourteen ships of the Athenian fleet were badly damaged. Some were caught in storms and others were run aground through the negligence of their trierarchs or crews. These ships are recorded under two separate rubrics in the list for 325/4. Seven trierarchs from ships caught in storms were able to prove they were not at fault by entering a plea to that effect in the courts (in official terms, they entered a ‘plea of damage by storm’, *σκήψις κατὰ χειμῶνα*).<sup>16</sup> They were, however, still required to return the rams from their ships to the yards for re-use.<sup>17</sup> The remaining seven trierarchs either failed to win their pleas, or decided not to contest their liability.<sup>18</sup> They are listed as follows (1629):

475 τὰδε εἰσεπράξαμεν  
καὶ ἀπ[ε]λ[ά]βομεν χρή-

<sup>16</sup> *Cf.* 1629.746–82; 1631.116–40; and Köhler (*supra* n.15) 82f.

<sup>17</sup> This is clearly seen from another rubric recording trierarchs who have won their pleas but still owe rams to the yards: *οἷδε ὀφείλουσι ἐμβόλου[ς] τῶν σκηψα[μ]ένων κατὰ χειμῶνα*, “the following (trierarchs) owe rams of those who (successfully) entered pleas of ‘damage by storm’” (1629.841–43). For this particular rubric, see Köhler (*supra* n.15) 83.

<sup>18</sup> *Cf. supra* n.15. Since storms are not mentioned in this rubric, it is possible that some of these ships were run aground purely through the negligence of the trierarch and his crew.

ματα παρὰ τῶν τριηράρχων·  
 παρὰ Καλλίου τοῦ Ἄβρωνος  
 Βατῆθεν τριήρους, ἧς ὁμο-  
 480 λόγησεν καινὴν ἀποδώ-  
 σειν, ἧ ὄνομα Στρατηγίς,  
 Ἀλεξιμάχου ἔργον,  
 ἀπελάβομεν : F.

The following sums we exacted and took over from the trierarchs: for the trireme of Callias Batethen, son of Habron, named the *Strategis*, built by Aleximachus, for which he agreed to return a new ship, we received 5,000 dr.

These trierarchs were charged with replacing their damaged ships, and as can be seen from the example of Callias, they paid a fee to the curators for this purpose. The trierarchs were also required to return the old rams to the yards.<sup>19</sup> Demonstratus, Diaetus, and Conon are listed under this rubric. They had returned damaged ships, had agreed to replace them, and had made the appropriate payments.<sup>20</sup> Demonstratus returned his ram to the curators and received the appropriate credit. The ram he returned was obviously not serviceable, because it was separated from two other rams turned over to the shipyards for re-use (*i.e.*, the rams of Conon from the *Eucharis*, a ship for which he had been excused from liability, and of Thrasycles from the *Dikaiosyne*), and kept with two other (damaged?) rams received from the previous year's board of curators. As we learn from the insertion in the list for 323/2 (lines 194–99), Diaetus turned in his ram as did Conon from another ship (he was assigned at least two ships in 325/4), presumably to the public slave Opsigonus who served as the curators' assistant, but he neglected to give them proper credit. Their rams were also unserviceable, were added to the other three, and all were eventually sold as scrap.

The physical state of these rams is probably reflected in the mistakes made in recording their receipt and subsequent sale. Of the five we know were received, only three were officially recorded, yet four were listed as sold.<sup>21</sup> It is difficult to explain this last error if whole rams were being counted, but easy to understand if the rams had been turned over to the curators in fragments. And this makes sense,

<sup>19</sup> Cf. 1629.826–30: οἶδε τῶν τριηράρχων ὀφείλουσιν τοὺς ἐμβόλου[s] τῶν τὰς καινὰς ὁμολογησάντων ἐν τῷ δικαστηρίῳ, “the following of the trierarchs owe rams from ships they agreed in the lawcourt to return new.” The same seven trierarchs (and associates) are mentioned, among whom are Demonstratus, Diaetus, and Conon.

<sup>20</sup> For Demonstratus, see 1629.544–68; for Diaetus, 585–99; for Conon, 600–12.

<sup>21</sup> 1629.813–16; 1631.194–99; 1629.1144–47.



moreover, for unserviceable rams coming from severely damaged triremes.<sup>22</sup>

In 323/2, Diaetus and Conon persuaded Opsigonus to affirm that the rams they were still officially listed as owing had in fact been returned and were among those sold off in 325/4. The mistake had been caught, but little more could be done to the list of 325/4 than to erase the most glaring error, the word *τέτταρες* (line 1145), from the total of rams sold. Belated credit was duly given these trierarchs in the list of 323/2 (1631.194–99), and the correction was made as well in a reinscription of the total number of rams sold off as scrap (1631.333).<sup>23</sup>

In conclusion, I suggest that the evidence from the extraordinary sale of rams in 325/4 is sufficiently ambiguous to be used in support of the contention that Athenian trireme rams weighed a great deal more than 44.5 kg. I find it noteworthy that two of these five rams were handed on through two boards of curators before being sold in 325/4. It seems that for some reason, these two decommissioned rams were being saved. Is it possible that they were being held until enough bronze was collected to warrant the casting of a new ram? Such an amount, roughly 8.5τ of metal (roughly 216 kg. or 476 pounds), was reached in 325/4; the collected fragments of the decommissioned rams were sold; the foundry added what metal was still necessary; the new ram was cast, and would have been purchased subsequently by the *trieropoioi* and recorded by their treasurer on their own separate set of records.<sup>24</sup>

<sup>22</sup> A problem still remains to be considered: how did a bronze ram suffer such damage so as to remain on the bow (and thus be available for salvage) yet lose a major portion of its weight? This is a question best answered by an expert in metallurgy. I can only presume that a faulty cast resulted in cracks or weak areas that allowed the solid center of the weapon to crack off from the rest of the ram, thereby leaving portions of the bottom plate and cowl still affixed to the bow (for the terms, see Steffy [*supra* n.1] 234).

<sup>23</sup> The sequence of events postulated here argues against Jordan's view that these lists were inscribed on stone every four years; cf. Jordan (*supra* n.5) 31, who follows J. Sundwall, "Eine neue Seeurkunde," *AthMitt* 35 (1910) 50–53. Jordan fails to note that Sundwall was aware (53) that the lists from the 330's and the 320's were inscribed yearly, and that he postulated a reform after the battle of Chaeronea to account for the change in the frequency of their publication. This whole theory has been effectively demolished by Laing's conclusion (*supra* n.6) that the records as a group were probably opisthographic and thus large sections of text are lost. In any event, given the obvious dates of the accounts contained on 1629 (325/4) and 1631 (323/2), and the equally obvious corrections made in 323/2 to records already inscribed on stone, Jordan's view is clearly not possible.

<sup>24</sup> For the duties of the *trieropoioi* and their treasurer, see Jordan (*supra* n.5) 46–50. The evidence for records associated with this standing commission comes from *IG* I<sup>3</sup> 153.4f (= *IG* I<sup>2</sup> 73).

If this supposition is correct, it gives us about 216 kg. (476 pounds) as the best lower limit we have for the weight of a trireme ram. Such a ram could of course weigh much more than this—perhaps as much as the 465 kg. of the Athlit ram. Whether or not this final observation is accepted as likely, our examination of the curators' records makes two things quite certain: (1) The evidence from the lone sale of rams in 325/4 cannot be used as it has in the past to determine the weight of an intact and serviceable trireme ram; and (2) the price of bronze in 325/4 was most probably 61 dr. per talent.<sup>25</sup>

THE UNIVERSITY OF SOUTH FLORIDA  
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