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THE SACK (CAKKOC) IS THE ARTABA WRIT LARGE

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## THE SACK (CAKKOC) IS THE ARTABA WRIT LARGE

In the past several decades there has been a number of detailed studies reexamining the earlier metrological assumptions of Segrè, Hultsch, and others regarding the Egyptian artab and its relationship to the Roman modius. Leading with a micro analysis of the artab measure was the work of Duncan-Jones, followed in the main by Shelton and Rathbone.<sup>1</sup> Duncan-Jones, summarizing his conclusions (*Econ. Rom. Emp.* [n. 1], 372), states that the grain-measure artab was "a term used to describe many different units (partly disputed by Shelton.1977 and 1981, but these attempts to deny all quantitative significance to the choenix, a sub-unit of the artaba, remain unconvincing). The artaba that is best attested over a long period, extending in fact from the Pharaohs to the Byzantine period, was the equivalent to 4 1/2 Italic modii... This artaba seems to have been commonly used for taxation."

Rathbone (*ZPE* 53 [n. 1], 270), basing his conclusions on an analysis of two metrological documents (*P. Oxy.* 3455 and *P. Lond.* 1718) and Pliny (*n. h.* 18.66), sees "an underlying metrological source", his "wheat text", "which gave the weight of 1 artaba = 5 modii Italici of wheat as 100 mnai = 104 1/6 librae, which is exactly the same as the figure of the elder Pliny and *P. Oxy.* 3455." He concludes (271) that "there were always in Roman Egypt a number of contemporary artabai and choinikes of different dimensions... If the thesis that the choenix was a set and stable unit is abandoned, the number of demonstrably different artabai attested in the documents is considerably reduced. And there must have been some fairly standard and stable artaba in common use: if not how can we explain the consistency of the quantities given time and again for sowing, for yields, for rents and for taxation? ... The real problem was not to identify the notional values of proffered artaba of wheat, but to check its real volume—did the actual quantify match its description? And here the method which required least equipment, least mathematics, least time was to weight it."

The approach suggested by Rathbone appears reasonable, but the documents speak of wheat or barley in artabs, not in λίτραί. The artab like the modius is a measure of capacity, not of weight, and whatever it measures may vary in weight from one year to the next. An artab of grain grown under ideal conditions of moisture, temperature and cultivation would weigh more than one eked out during a poor year. In addition, the Egyptian artab was traditionally a measure of varying capacities, in no way a uniform standard of the kind that Polybius (2.37.10) claimed for the Achaean League. There was a bewildering number of named measures, generally introduced by the word μέτρον, that were used to define an artab of grain. To name a few, there was the granary measure, the four or six choenix, the village, the Athenian, the eighth, the public, the public level, the public modius, and the half-artab public measure. How does one rationalize the capacity of a measure such as "the tenth of Apion", "the measure of Phib son of Mosch", "by our measure", "by my measure", or "by the landowner's measure"? To complicate the matter further, most documents use the word artab without mentioning the measure involved.<sup>2</sup> Note the care with which the lessor in *P. Oxy.* 101.39 insists upon the precise kind of measure for the pay-

<sup>1</sup> R. P. Duncan-Jones, *ZPE* 21 (1976) 43-52; *The Economy of the Roman Empire* (Cambridge<sup>2</sup> 1982). J. Shelton, *ZPE* 24 (1977) 55-67 and 42 (1981) 99-106, esp. 102-106. D. W. Rathbone, *ZPE* 53 (1983) 265-75.

<sup>2</sup> The English bushel, before being standardized in 1826, shared some of the idiosyncracies of the Egyptian artab. According to the *Oxf. Eng. Dict.*, the bushel had "a great variety of other values, now abolished by law, though often, in local use, varying not only from place to place, but in the same place according to the kind or the quality of the commodity in question." The bushel, like artab, is a traditional measure of capacity which ultimately becomes a measure of weight. In the modern market place, wheat and corn are measured in terms of bushels. For example, a futures contract for the purchase of grain is cited in thousands of bushels, but delivery is made in tons. A concrete example of this phenomenon is recorded in the first shipment of wheat from western Canada in 1876. A farmer needed 5,000 bushels of seed wheat, but all that could be assembled from 12 farms was 857 bushels which weighed as high as 64 pounds to the bushel. "This was weighed and sacked (my emphasis) and on its way by October..."

ment of rent due her: "[wheat] similar to that which is delivered at the public granary, measured by the bronze-rimmed measure containing four choinices used for the payments to the lessor or her agents."

In view of the variety of Egyptian measures and the lack of a uniform standard, we are left with the task of finding out what an artab of wheat means in real terms, that is, in bulk and/or approximate weight. The weight for Alexandrian wheat that Pliny (*n. h.* 18.66) provides is one such term, even though it is not based on a fixed figure. He states that the weight for Alexandrian wheat, "if one weighs the grain itself", is one-third more than that of Gaul and the Chersonese which does not exceed 20 pounds. Pliny's figure for Alexandrian wheat, estimated to be 20 5/6 Roman pounds per Italic modius, is the equivalent of 6.73 kg at the rate of 323 g per Roman pound<sup>3</sup> (about 15 English pounds). Using this figure, it is possible to gain a rough idea of the weight of one artab of wheat by taking the number of Italic modii (3, 3.3, 4.5, 5) cited by various authorities as the equivalent of an artab.<sup>4</sup>

3 mod. = 20 kg (44 lb)

4.5 m. = 30 kg (66 lb)

3.3 m. = 22 kg (48 lb)

5 mod. = 33.65 kg (74 lb)

If these figures are representative, one artab of wheat would weigh between 20 kg (44 lb) and 33.65 kg (74 lb), or an average of about 26 kg (57 lb), close to a U.S. bushel. No small weight even for the lowest figure. Multiplied by artabs reckoned in the hundreds and thousands, the results would be metric tons and thousands of bushels. To handle only one artab of wheat weighing c. 26 kg or 57 lb required a container other than the usual clay jar. Artabs of wheat, as is well documented, were delivered to or left the granary in sacks (σάκκοι) as X number of sacks or as X number of sacks containing X number of artabs and fractions of an artab.

The use of sacks as a container for grain produced a terminology associated with the various activities and charges concerned with their handling: ακκοφόρος, the man who carried them; ακκοφόριον, the charge for portage; τιτομετροακκοφόρος, the man who carried the sacks for the grain measurer; ακκηγία, the transport of sacks; ακκηγός, the transporter of sacks; and similar related terms.

Sacks of wheat were carried mostly by donkeys or by camels and wagons. Large deliveries over a short period of time were conducted by convoys (φοραί) to granaries and then to river boats for further transport to Alexandria. For the period up to end of the 4th cent. H. Youtie (*TAPA* [1950] 100 [*Scriptiunculae*, I 214 with addendum on p. 232]) provides a summary of the activity and the literature connected with it. "Taxes and rents payable in grain were collected at the threshing floors of the villages and carried in sacks to the local granaries. There the grain was stored...until it could be forwarded on donkeys and canal boats to convenient Nile ports for transshipment to Alexandria... Donkey caravans were kept moving all year long between the village granaries and river ports...several hundred transportations receipts, most of them written in the late third or early fourth century, have been found at Karanis: *Ostr. Mich.* 1.360-562; 2.857-931 (cf. *TAPA* 71 [1940] 650; *CP* 39 [1944] 32, 37; *Berytus* 8, fasc. 2 [1944] 88-90)."<sup>5</sup> Later, at the end of the first quarter of the 4th cent., the system changed, as R.S. Bagnall has argued (*P. Columbia* VII p. 94-102): the farmers delivered the grain at harvest time to the ships or the storehouses at the harbors. But still long caravans had to transport the grain to the river.<sup>6</sup>

At this point a distinction has to be made between the distribution of artabs of wheat stored in granaries to satisfy the tax assessments imposed by Rome and those used to meet business, local transac-

<sup>3</sup> Using the figures of Duncan-Jones, *Econ. Rom. Emp.* (n. 1), 370.

<sup>4</sup> For 4.5 and 5 modii, see Duncan-Jones and Rathbone above (n. 1). For 3 and 3.3 see p. 193 with note 19, below.

<sup>5</sup> See also G. Rickman, *The Corn Supply of Ancient Rome* (Oxford 1980) 121. Youtie's article in *TAPA* 71 is reprinted in *Scriptiunculae* I, 63-104, see esp. 90.

<sup>6</sup> In the Ptolemaic period the transportation was a liturgy imposed by the government (N. Lewis, *The Compulsory Public Services of Roman Egypt*, Pap. Flor. XI [Florence 1992] 134; cf. p. 40 on ὀνηλασία, ὀνηλάτης, Ptol. - A.D. 318), although also organized professional beast-of-burden drivers were contracted (C. Preaux, *L'économie royale des Lagides* [Brussels 1939] 143-147). P. Mich. Inv. 6981, an unpublished papyrus, is a royal edict of the second cent. B.C. requesting the owners of draft animals, mules, horses (?), and camels to register with the assigned officials within five days and to be present for the transportation of prescribed loads of grain from the granaries to the harbors for a period of 140 days (L. Koenen brought this to my attention).

tions, and personal obligations, such as the payment of rent, payment in kind for labor, request for seed, or a sale to a merchant. With regard to the latter, the measure used, even though ideocentric as some of those cited above, was accepted in the knowledge that the receiver was aware of the quantity contained in that particular artab measure, and, perhaps, had the opportunity to check the quality of the wheat and to see, in the popular phrase, that it was "new, clean, unadulterated, sifted, with no barley in it."

Wheat destined for local granaries and transshipment to granaries at Alexandria required a more orderly method of handling. Since thousands of artabs of wheat required the loading of sacks onto donkeys for transportation to local granaries and similarly from granaries to boats, some standard of weight, though expressed in artabs, must have been observed with regard to the *κακκοφόρος*, the donkey, and even the boat. Each one of these three had limitations. The *κακκοφόρος* could only lift a sack of wheat of so many pounds; the donkey could only carry a total of so many pounds, and the boat could only carry so many pounds lest it founder. According to the documents, the common denominator is a sack containing 3 artabs of wheat, and when donkeys or wagons are cited as carriers, the ratio was generally one 3-artab sack per donkey or 5 per wagon.<sup>7</sup>

If there is substance to this argument, we must opt for the artab cited by Jerome (*Comm. in Dan.* 11.5), in the *Carmen de Ponderibus* (IV A.D.), and by a certain Africanus:<sup>8</sup> this artab is the equivalent to 3 or 3 1/3 Italic modii; i.e., one that weighs about 44 or 48 lb,<sup>9</sup> or c. 130 to 140 lb for a 3-artab sack.<sup>10</sup> Although this weight might appear excessive for a *κακκοφόρος* to heft a 3-artab sack of wheat onto the back of a donkey, Epiphanius (c. A.D. 315 -403) reports that a young man can lift up 15 modii (over 220 lb) of barley or wheat and place it on a donkey.<sup>11</sup> At the other end of the spectrum, the 4.5 and 5 Italic modii equivalent cited by Duncan-Jones and Rathbone would range between 200 and 220 lb for a 3-artab sack, capable for a camel,<sup>12</sup> but doubtful for a donkey and very doubtful for a *κακκοφόρος*.

As for the boats that transported sacks of wheat from granary to granary, the documents record their maximum displacement in terms of artabs. Introduced by the word *ἀγωγή* a boat's displacement is given in X hundreds and thousands of artabs. However the word *ἀγωγή* is translated, whether as "burden," or "carrying," or "capacity", its meaning is displacement in terms of artabs.<sup>13</sup> For the captain of a grain carrier his concept of maximum displacement was not in tons (i.e., in weight) but in the number sacks containing a known (uniform?) measure being loaded aboard his ship.

Two documents from the Oxyrhynchus archive, *P. Oxy.* 2670 and 1259, illustrate how the sack enabled the efficient management of large quantities of state grain to and from public granaries. *P. Oxy.* 2670, a shipper's receipt for convoys of grain, records that the master of an unknown number of boats delivered to the *sitologos* of the Thmoisepho toparchy over 10,000 artabs of wheat in some 3,500 sacks

<sup>7</sup> See esp. *P. NYU* 17, *P. Oxy.* 2670, *SB* 8251. *P. Harr.* 93, an account of a delivery of wheat from the granary to a merchant, shows a ratio of two 2-artab sacks per donkey, probably one on each side of the animal. *P. Phil.* 17, an account of a single delivery of 13 sacks totalling 52 artabs of wheat to a granary, most likely by donkey or camel, points to a 4-artab sack. Note however that although the wagons cited in *Mich. Coptic (etmoulon) Texts*, pp. 259, 285-293, were capable of carrying 15 artabs, wheat was packed in 3-artab sacks. In four-fifths of the 77 ostraca the proportion is one wagon, five sacks, 15 artabs.

<sup>8</sup> *Anth. Lat.* I 145. 15. 25; Hultsch, *MSR* II. 92. 89. For Jerome see *Corp. Christ. Lat.* 75a, see n. 19.

<sup>9</sup> A.C. Johnson, *ESAR*, IV.466 gives a round figure of 50 English pounds for an artab.

<sup>10</sup> Rickman (*Corn Supply* [n. 5]) 20, describing the onerous task of unloading grain ships at Rome's river ports, estimates that "if the 40 million modii of grain is divided into sack loads able to be carried by one man we have to think in terms of at least 6 million sacks..." This would translate into 6.7 modii for each sack or about 100 lb, a low figure.

<sup>11</sup> J.E. Dean, ed., *Epiphanius' Treatise on Weights and Measures—The Syriac Version*, *Studies in Ancient Oriental Civilization* 11 (Chicago 1935) 40, 136. If this figure represents a single sack of 15 modii, it should be taken as hyperbole. Segrä, *Metrologia*, 30 claims that the net load of a donkey was 200 Alexandrian pounds, but Pearl, *TAPA* 71 (1940) 379-81 challenges the basis on which this figure is arrived at.

<sup>12</sup> Epiphanius, p. 136: "30 modii heaped together makes a camel load." Note that Epiphanius not only treats common weights and measures but also the load capacity of donkeys and camels in a ratio of 2 donkeys to 1 camel.

<sup>13</sup> L. Casson, *Ships and SeamanSHIP* (Princeton 1971) 164, n. 48), citing *P. Teb.* 845, lists a number of grain carriers with "burdens" of 9,000 to 18,000 artabs, which he converts to tonnages of 225 to 450 tons based on a 50 lb artab.

that had been conveyed to him by more than 185 donkey (?) convoys over a period of 9 days. The receipt certifies that the contents of the sacks contained "pure, unadulterated wheat, without earth, without barley, sieved and winnowed, (measured) by the public half-artaba measure according to the prescribed measurement."

*P. Oxy.* 1259 is also a shipper's receipt from the master of 8 boats with a displacement (ἀγωγῆς) of 40,000 artabs declaring that "I have received and had measured out to me (παρέλαβον καὶ παραμεμέτρημαι)" X-thousand 840 artabs of unadulterated...wheat from two sitologoi for transportation to Alexandria." Unlike the situation in *P. Oxy.* 2670, no mention is made of sacks of wheat, only of artabs. This raises the question of how did the captain of 8 grain boats have thousands of artabs measured out for him by the sitologoi. If the wheat had arrived at the local granary in convoys of sacks, it is likely that they were transferred to the captain in the selfsame sacks after the sitologoi had certified that they contained the requisite number of artabs of pure and unadulterated wheat by a declared measure. If, on the other hand, wheat from local threshing floors were unloaded onto the granary floor,<sup>14</sup> then the sitologoi and his staff (σιτομετροακκοφόροι ?) had the onerous task of measuring out the grain, certifying its quality, and sacking (or resacking) it for further disposition. The process of measuring out large numbers of 3-artab sacks could not have been handled with any degree of efficiency with less than the public one-half artab measure prominently cited in the documents. Even then, how was it done and what was used to hold a half-artab? The likelihood is that the "public half-artab measure" was a reed or palm-leaf basket (α θαλλίον ?; Wadi Sarga, ed. W.E. Crum and H.I. Bell, pp. 20f.), somewhat like a bushel, which held the prescribed legal measure that could be leveled before being dumped into an empty sack. Weighing about 25 lb, the half-artab measure could be handled without difficulty by one of the granary workers.

There remained the task for the sitologoi to verify the quality of the wheat delivered in sacks. In keeping with the Egyptian system of checks and balances, sealed samples (δείγμα) of the contents of a shipment were required, among other considerations,<sup>15</sup> to prove that the wheat was clean and free of foreign substances. The samples, zealously guarded by supercargos or sample carriers (ἐπίπλοοι or δειγμακαταγωγοί), accompanied shipments of tribute to Alexandria and then on to Rome or Constantinople.

The meticulous inspection given to these samples is reflected in *P. Oxy.* 708, a letter to a strategus of a nome, complaining that a cargo of 2000 artabs contained evidence of adulteration "at the weighing of the samples (ἐν τῇ τῶν δειγμάτων ἄρσει)". After analyzing a half-artab of the cargo, "it proved to be under measure by 2 per cent. of barley and likewise 1/2 per cent. of earth." Of interest, apart from use of samples to inspect a shipment of wheat, is the editor's translation of ἄρσις as "the weighing" of the samples. This would appear to support the view of Rathbone (n. 1, 271) that weighing might be the method of determining the real volume of an artab. Wilcken (*Chrest.* 432), staying close to the literal meaning of ἄρσις, suggests that the text refers to the lifting of samples "bei dem man einzelne Proben aufhebt und durch die Hand laufen läßt." If that were the case, how could such exact figures of 2 percent and 1/2 percent be obtained without weighing unless the examiner just estimated the adulterating substances?

The weighing of a sample is quite possible even though it may not have been applied to an entire artab. The δείγμα was only a fraction of an artab. *P. Phil.* 17, an account of a delivery of 52 artabs of wheat to the public granary which was reduced to 45 1/2 by the subtraction of payments for various people, services, and 1/8 of an artab for δείγματα). The 1/8 would amount to about 6 pounds, small enough to be sealed in the jar described by O. Guéraud (see n. 15; p. 117) and even smaller if several

<sup>14</sup> As described by G. Rickman, *Roman Granaries and Store Buildings* (Cambridge 1971) 298.

<sup>15</sup> See O. Guéraud, *JJP* 4 (1950) 107-115 for the full text inscribed on a jar that presumably held the sealed samples of a shipment of taxed wheat; also, G. Rickman, *The Corn Supply* (n. 5) 122.

samples were to be made of that amount.<sup>16</sup> The careful sifting of a sample for adulterating substances and weighing them would make it possible to assign penalties of the sort that were dealt out in *P. Oxy.* 708.

Although the δειγµατα may have been weighed when there was suspicion or evidence of adulteration, wheat and other grains were measured in terms of capacity, of artabs and modii, not of weight. This fact highlights the unusual, if not unique, step taken by Pliny (*n. h.* 18.66) to cite the net weight of wheat (*granum ipsum*) from several growing areas in terms of Roman pounds without taking into consideration whether it represented the yield of an average year, a good or poor one. Those considerations would affect the weight of a measure, but what was being bought or traded was a measure, just as milk is bought in quarts even though regular milk weighs more than skim.

To return to the sack, and in particular to the large number of 3-artab sacks of wheat that were shipped out as part of annual tribute assessed by Rome or Constantinople, why was the 3-artab sack commonly used for this transaction? Why not the 2-artab sack as in *P. Harr.* 93? or even one as heavy as 6 and more artabs of aracus seed cited in *P. Mil. Vogl.* 212.5-8? And lastly, why, prior to Rome's control of Egypt, were there no donkey loads of 3-artab sacks or convoys (φοραί)?<sup>17</sup>

The answer to these questions suggests that in Roman times there was a direct relationship between the statutory artab (i.e. the public or legal measure<sup>18</sup>) and the Italic modius which facilitated, not only the conversion of one measure into another at the Roman port of entry, but also the task of verifying that deliveries of artabs were in accord with the annual tax assessment in terms of modii. That relationship of capacity, expressed above in approximate weight, is one artab equals 3 1/3 or 3 Italic modii, or 1 : 3. Simply put, one artab of 48 lb or 22 kg would be the equivalent three 16 lb modii, and a 3-artab sack of c. 150 lb could be conveniently offloaded from grain ships by Roman *saccarii*. For the captain of a grain carrying ship, a load of 3-artab sacks would also facilitate the calculation of his ship's maximum capacity.

There is support in the literature both for the ratio of one artab equals 3 and for 3 1/3 modii. In a short metrological treatise attributed to a certain Africanus mentioned above (see n. 8), the statement is made that "... the Ptolemaic medimnus is one and a half times as large as the Attic and consisted of 2 "old" artabs. For the artab used to be 4 1/2 Italian modii, but now, through Roman practice, it is reckoned as 3 1/3 modii (νῦν δὲ διὰ τὴν Ῥωμαϊκὴν χρῆσιν ἡ ἀρτάβη χρηματίζει μοδίων γγ')." This is the reading of Hultsch (*MSR* I.258.19. However, another manuscript reads 3 modii as does Eusebius.<sup>19</sup> The other statement concerning the ratio of the artab to modii is found in Jerome's *Comm. in Dan.* 3.11 (see n. 8). Speaking of the wealth and power of Ptolemaeus Philadelphus and of number of artabs of wheat in his possession, he gives the ratio as one to 3 1/3, (i.e., in post-Ptolemaic Egypt): "*frumentum artaba, quae mensura tres modios et tertiam modii partem habet.*"<sup>20</sup>

What happens to sacks of artabs when they reached Ostia, one of Rome's river ports, is illustrated in a tomb painting of a grain barge, the Isis Geminiana.<sup>21</sup> Moving up the gangway of the barge are a number of *saccarii* each carrying a sack of grain which is opened and poured into a measure situated in

<sup>16</sup> For the use of leather pouches, see Rickman, *Corn Supply* (n. 5) 122.

<sup>17</sup> As indicated in a screening of the PHI Documentary Texts CD Rom disc #7. Note, for example, the variety in the number of artabs per donkey load in *P. Teb.* 848, dated to II B.C. This is confirmed by the unpublished Michigan papyrus mentioned in n. 6, where the totals of the artabai to be transported by various kinds of animals over a period of 140 days are also not calculated as a multiple of 3.

<sup>18</sup> Dictated by Rome through the Praefectus Annonae?

<sup>19</sup> P. de Laguard, *Symmikta* 1877, I.169.69 cited by Duncan-Jones, *ZPE* 21 (1976) 47, n. 20. For Eusebius, Hultsch, *MSR* I.277.21. See also O. Wiedebant, *Forschung zur Metrologie des Altertums* (1917) 136-137 and Shelton, *ZPE* 24 (1977) 55, n.3; 65 and n. 23.

<sup>20</sup> Here the manuscript tradition offers no alternative number. See *Corp. Christ. Lat.* 75a, p. 903 and 921. It is unlikely that Jerome was aware that a Ptolemaic artab was the equivalent of 4.5 modii.

<sup>21</sup> Meiggs, R., *Roman Ostia* (Oxford 1973) 295, fig. 25e.

the midships. Opposite the *saccarius* is a man (*ensor frumentarii?* or a member of his staff) checking the quantity of grain as it fills his measure. In the bow of the boat there is another figure sitting next to a measure on which is written *fecit*, showing that he finished checking the quantity of grain (i.e. that his measure has been filled). A third figure, a man in black, is said to be connected with their work (Meiggs, *op. cit.* [n. 21] p. 294).

If this painting were to refer to the 3-artab sacks arriving from Egypt, the measures which are depicted undoubtedly are of a specific number of modii. An artab equivalent to 3 modii would represent 9 modii for a 3-artab sack; one equivalent to  $3 \frac{1}{3}$  modii would be 10 modii. For converting artabs to modii and for facilitating accounting procedures, the latter, the decimal system, would be the most effective and simplest method of converting Egyptian artabs into Roman modii.

I save for last a passage in the *Carmen de Ponderibus* (see n. 8) in which the artab is equated with  $3 \frac{1}{3}$  modii, and that "a threefold artab is filled up with 10 modii" (*artaba, cui superest modii pars tertia post tres, namque decem modiis explebitur triplex*).<sup>22</sup> The *artaba triplex* is surely the 3-artab sack, equal to 10 modii, which made its way by donkey, wagon, and boat to Rome/Constantinople as part of the annual tribute levied upon Egypt.

To sum up, the attempt to establish the number of choinices in a "standard" artab, and on that basis to calculate its conversion into modii, has not achieved a scholarly consensus. This paper takes another approach, viewing the post Ptolemaic artab of wheat from the larger perspective of its approximate weight and its container, the sack. For many transactions that did not involve conversion into modii, there were artabs of different measures, but for those concerned with the collection of tribute, there was a general standard of a sack that held 3 artabs of wheat weighing about 150 lb. As for the positions taken by Duncan-Jones and Rathbone that  $4 \frac{1}{2}$  and 5 modii were the equivalent of one artab, that amount if put into a sack, would likely be too heavy to be handled by a single *κακκοφόρος* or a *saccarius*. The 3-artab sack on the other hand would facilitate the loading and offloading of donkeys and ships, help the captain of a grain carrier to calculate his ship's capacity, and enable the *ensores frumentarii* to measure and to certify that a shipment of wheat was in accord with its bill of lading. The combination of a sack containing 3-artabs as the equivalent of 10 modii, appears to have been a bit of Rome's ingenuity in providing its officials with the efficiency of the decimal system to get full measure of the tribute levied upon Egypt in terms of the Roman modius.

<sup>22</sup> Reproduced in Hultsch, *MSR* II.92.89 (*Anth. Lat.* I.2.33.89). A fragment of a table of Alexandrian measures (*MSR* II.145.15.25) holds that the artab was equated with 3 modii. A.C. Johnson, *ESAR* IV.466, citing Jerome's equation of  $3 \frac{1}{3}$  modii to the artab, states, with prescience, "Probably this was the standard used for the collection of tribute and foreign trade."