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Ptolemaic Bronze Coins?

by

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Abstract: This review of the bronze coins of Ptolemies II, III, IV, V and VI argues that the Ptolemaic mint did not have a deliberate policy of denominational marking, and that the recent conclusion that Ptolemy II's monetary reform of 266-261 BC involved denominational marking and produced six rather than eight denominations is invalid. The general absence of denominational markings leads to suggestions about how the value of the smallest Ptolemaic bronze coins was determined in ancient transactions.

IN HIS review in 1991 of early Hellenistic coinage Otto Mørkholm includes a presentation of Ptolemy II's bronze coinage produced by the major monetary reform of 266-261 BC. He identified eight denominations on the basis of weights and diameters.[2] However, in 1998 Picard proposed division into six denominations, each determined by differences in reverses, and in 2006 Le Rider and de Callataÿ developed this idea, arguing that Mørkholm had been unduly influenced by weight distributions and small variations in diameter.[3] They divided the series on the basis of differences on the obverse and the reverses, including (on the obverse) Zeus Ammon, Zeus laureate, or Alexander head, and (on the reverse) eagle head right or left, wings open or closed, and one eagle or two eagles; see Table 1 below. They argued that, since the mint took the trouble to distinguish each of the heavier/larger denominations A, B, C and D by the use of different types, it was difficult to believe that the lighter/smaller denominations E, F, G and H would not be distinguished. Denominations A, B, C, and D each have different obverse/reverse combinations and thus, since E and F have the same obverse/reverse combinations, they are the same denomination; similarly for G and H. The result is a total of six denominations rather than eight (see Table 1, columns 5 and 6). They added (p. 57) that this concern to make each denomination more easily identifiable by dint of a modification of the obverse type or a variation of the reverse was maintained during the following reigns. As the following five tables will show, the above arguments do not fit the factual data.

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[2] Mørkholm, *EHC*, p. 105.

[3] O. Picard, 'Remarques sur la monnaie de bronze dans l'Égypte lagide', *BCH* Supplément 33 (1998), table on p. 413; G. Le Rider and F. de Callataÿ, *Les Séleucides et les Ptolémées* (Monaco, 2006), pp. 56-8.

Table 1: Denominations of Ptolemy II's Bronze Coins						
(Types, sizes, weights, modular weights, and two different denominational assignments)						
Coin Characteristics					Assignment In 1991	Assignment in 2006
Coin Types obverse / reverse	Diameter mm.	Weight Range, g.	Modular Weight, g.		Module See Mørkholm, n.2	Module See Le Rider, de Callataÿ, n.3
ZeusA / e-ow, hr	*c.* 48	76-105	*c.* 92		A	A
ZeusA / 2e-cw	*c.* 42	62-78	*c.* 68		B	B
ZeusA / e-ow	*c.* 36	41-50	*c.* 46		C	C
ZeusL / e-cw	*c.* 30	17-25	*c.* 22		D	D
Alex / e-ow	*c.* 24	9-15	*c.* 11		E	E + F
Alex / e-ow	*c.* 20	5-8	*c.* 6.8		F	
ZeusA / e-ow	*c.* 18	4-6	*c.* 5.2		G	G + H
ZeusA / e-ow	*c.* 16	2-4	*c.* 3.4		H	
ZeusA=Zeus Ammon head; ZeusL=Zeus laureated head; Alex=Alexander head; e-ow=eagle with open wings; e-cw=closed wings; hr=head reverted; 2e=two eagles					Examples of the above coins of Ptolemy II may be viewed at ptolemaic.net/pt2	

The data presented under 'Coin Characteristics' are taken from Mørkholm and apply to the major bronze coinage of the Alexandrian mint.

The fact that different combinations of obverse and reverse types can be observed for each of the four largest denominations of Ptolemy II does not necessarily show that they were intended to denote denomination. Moreover, if there was an effort by the mint to use denominational marking, the result was not a complete success. The denomination indicated by G + H in Table 1 (col. 6) has the same obverse/reverse combination (i.e., Ammon/eagle with open wings) as denomination C.[4] If the mint had a policy of denominational marking, they could easily have made the types on C differ from those on G + H.[5] Hence the idea that the Ptolemaic mint systematically put features on bronze coins to aid identification of denominations remains unproven.

There is universal agreement that weight and size are the fundamental characteristics that determined the relative value of Ptolemaic bronze coins. This is the basis of virtually all studies of Ptolemaic denominations.[6] We turn to the bronze coinages of later Ptolemies to see whether they provide any evidence for an additional policy of denominational differences in obverse or reverse designs.

[4] Picard, 'Remarques', p. 414, indicated that for Ptolemy II, 'la valeur de la pièce dépendait du type de reverse'. However, denominations C, E + F, G + H all have the same reverse type.

[5] The greatly differing weights and diameters of G and H (*c.*4.6g, *c.*17mm) and C (*c.*46g, *c.*36mm) of course show clearly that they are different denominations, but the idea of denominational marking is undermined when the designs of A, B, C, D, and E+F are each different but G+H has the same markings as C. It is worth noting that Le Rider and de Callataÿ do not take into account the statistical evidence for the existence of distinguishable denominations among light-weight/small-diameter coins. A study of the weights of Ptolemies III's and IV's smaller bronzes shows that several different light denominations exist, e.g., with modes of 4.2g, 2.4g, and even 1.4g: see V. van Driessche, 'À propos du monnayage des Ptolémées au IIIe siècle avant J.-C.', *Revue des archéologues et des historiens d'art de Louvain* 1988, p. 69 n. 40, and histograms p. 73. (Mørkholm did not reproduce the detailed frequency tables that support his eight denominations for Ptolemy II's coins.)

[6] An exception to the different-modular weight = different-denomination principle has been published; however, it has recently been repudiated by the author, see p.41 below.

Bronze Denominations of Ptolemy III

Table 2 gives the module-letter designation, types, diameters, weight ranges and modular weights for Ptolemy III's ten denominations; modular weights varied from *c*.68g to 1.4g. Note that, because Ptolemy III may not have produced coins of the largest module of Ptolemy II (denomination A, *c*.92g),[7] the letter designations for Ptolemy III's coins (first column) are, for identical denominations, not the same as those for Ptolemy II (last column).[8]

Table 2: Denominations of Ptolemy III's Bronze Coins					
Coin Characteristics					
Module	Coin Types Obverse / Reverse	Diameter mm.	Weight Range, g.	Modular Weight, g.	Corresponding Ptolemy II Module
A	ZeusA / e-cw	43-5	59-78	*c*. 68	B (*c*. 68g)
B_i	ZeusA/e-cw, hr, cs	40	39-53	*c*. 46	C (*c*. 46g)
B_{ii}	ZeusA / e-ow, hr	40	38-53	*c*. 46	
C	ZeusA / e-cw	35	28-38	*c*. 35	
D	ZeusA / e-cw	30	19-25	*c*. 22	D (*c*. 22g)
E	ZeusL / e-ow	27	10-16	*c*. 15	
F_i	ZeusA / e-cw	25	9-13	*c*. 11	E (*c*. 11g)
F_{ii}	Alex / e-cw, hr, cs	25	8-12	*c*. 10-11	
G	ZeusA / e-cw, cs	20	4.5-6	*c*. 5.5	F (*c*. 6.8g)
H	Alex / e-cw	17	3-5	*c*. 4.2	G (*c*. 5.2g)
I	ZeusA / e-cw	16	2-3	*c*. 2.7	H (*c*. 3.4g)
J	Alex / e-cw	13	1-2	*c*. 1.4	
ZeusA=Zeus Ammon head; ZeusL=Zeus head laureate; Alex=Alexander head; e-ow=eagle with open wings; e-cw=closed wings; hr=head reverted; cs=cornucopia at eagle's shoulder					See coins of Ptolemy III at ptolemaic.net/pt3

Of the ten denominations of Ptolemy III, five (A, C, D, F_i, I) show no difference at all in their obverse/reverse combination (i.e., ZeusA/e-cw). There is no denominational marking to distinguish any one of the five. Two others of the ten denominations each consist of two varieties, i.e., weight *c*.46g (B_i and B_{ii}) and weight *c*.11g (F_i and F_{ii}). All four have individual markings that could be denominational. However, there would then be two different, unnecessary, and confusing markings for each of the two denominations.[9] Two more of the ten denominations, H (weight *c*.4.2g) and J (*c*.1.4g), show the same obverse/reverse (Alex/e-cw).[10] This leaves denomination G

[7] See Appendix: 'Did Ptolemy III produce any coins of denomination A (*c*.92g)?'

[8] The format and data shown in the 'Coin Characteristics' part of Table 2 are as presented by Mørkholm, *EHC*, p. 107. The last column gives his data for the corresponding modules of Ptolemy II as in Table 1.

[9] Mørkholm, *EHC*, p. 107: 'the existence of two variants of denominations B and F is best explained as a chronological sequence of the respective issues, indicating that they covered a fairly extensive period of time'.

[10] These two small denominations (H and J) with the same types (Alex/e-cw) cannot be combined into one (as was done to produce fewer denominations for Ptolemy II: see above) because the weight range would then include denomination I with its obverse (ZeusA/e-cw) differing from that of H and J (with Alex/e-cw).

(with ZeusA/e-cw, cs) as the only denomination of Ptolemy III with an individual design that could possibly indicate its denomination.

The only prominent difference in the obverses of Ptolemy III's coinage is that between the Zeus head and the Alexander head. The same Zeus-head obverse is on eight of the ten denominations listed in Table 2; while three of the others (F_{ii}, H, J) have the same Alexander obverse. With little variation in the obverses, denominational marking would have to depend on the individually rather minor, complex, and easily confused differences on the reverses (i.e., ow or cw, hr or not, cs or not) and these markings result in a unique combination for only one denomination, G. Thus, it appears that under Ptolemy III the mint did not have a policy of denominational marking, and this makes it more likely that the mint under Ptolemy II did not have any such policy either.[11]

A further way to investigate a possible policy of denominational marking is to compare the obverses/reverses of individual coins that circulated together but were produced by different kings and have the same modular weight (i.e., same denomination). For example, Ptolemy II's and Ptolemy III's denominations of c.68g differ only on the reverse where the first has two eagles and the second one. Double eagles have been taken as a marking to indicate a diobol,[12] or other doubling of the coin value.[13] However, since the two-eagle coin of Ptolemy II and the one-eagle coin of Ptolemy III are the same module (i. e., same weight/size = same denomination = same value) and circulated at the same time,[14] the double eagles cannot indicate a double value of the single-eagle coin.[15] Therefore the two eagles do not have any denominational significance and Ptolemy II must have introduced the two-eagle reverse type for a different reason.[16]

[11] It has been assumed that Ptolemy II used variations of types to distinguish coins of different value and that Ptolemy III later dropped the system when a single design was introduced; see S. von Reden, *Money in Ptolemaic Egypt* (Cambridge, 2007), pp. 63-4, where the author states that she adopted Mørkholm's scheme for the weights and diameters of Ptolemy's reform coinage, adding 'The largest piece now measured c. 42 mm (c.72g)'. However, there is agreement among many leading numismatists (Svoronos, Newell, Mørkholm, Price, Noeske, Lorber, Weiser, and Hazzard) that the largest coin produced by Ptolemy II was denomination A (c.48mm, c.92g). Again her table 3 on p. 64, entitled 'Ptolemaic bronze coins from 266/5', gives only five of Mørkholm's eight denominations; missing are A, F and G.

[12] M.J. Price, Ch. 11, 'The Coins', in D.G. Jeffreys and H.S. Smith, *The Anubieion at Saqqâra I: the Settlement and the Temple Precinct* (London, 1988), p. 68; I. Carradice and M. Price, *Coinage in the Greek World* (London, 1988), p. 132. See also ptolemaic.net/two-eagles/diobol.

[13] M.J. Price, Appendix J, 'Coins', in G.T. Martin (ed.), *The Sacred Animal Necropolis at N. Saqqâra* (London, 1981), p. 160; S.M. Huston and C.C. Lorber, 'A hoard of Ptolemaic bronze coins in commerce, October 1992 (*CH* 8, 413)', *NC* 2001, p. 36; Le Rider and de Callataÿ, 'Ptolémées', p. 58.

[14] Coins of Ptolemy II′s c.68g module B with two eagles and coins of Ptolemy III of the same denomination with one eagle (c.68g module A) occurred in the Newell hoard: see E.T. Newell, 'Five Greek bronze coin hoards' (ANS NNM 68, 1935), pp. 54-5; also P. Visonà, 'A hoard of Ptolemaic bronze coins in the J. Paul Getty Museum', *J. Paul Getty Museum Journal* 6-7 (1978/1979), pp. 154-5.

[15] Moreover, it is unlikely that Ptolemy II's double eagle coin (c.68g) was a diobol, or the doubling of any denomination. Any single-valued coin, such as an obol, would have half the weight (c.34g) of the diobol. Such a module c.34g coin of Ptolemy II has never been found. See also ptolemaic.net/two-eagles/diobol.

[16] There is a good correlation of the occurrence of two-eagle coins with the times of various co-regencies; see ptolemaic.net/two-eagles.

If the weight modules of Ptolemy II had denominational markings, it would be expected that the corresponding weight modules of the following king (Ptolemy III) would have the same markings.[17] A comparison of *all* seven denominations of Ptolemy III that correspond in modular weight to coins of Ptolemy II is presented in Table 3. Each horizontal line extending from the module designation of Ptolemy III's denominations (first column) to the module designation of Ptolemy II (last column) represents one of the seven denominations produced by both kings. (Note that Ptolemy III produced two varieties of denominations B and of F, equivalent to modules C and E of Ptolemy II, respectively.)

Table 3: Type Comparisons for Denominations of Pt III and Pt II						
Ptolemy III				Ptolemy II		
Module	Obverse	Reverse		Obverse	Reverse	Module
A	ZeusA	eagle / cw		ZeusA	two eagles, cw	B
Bi	ZeusA	eagle / cw, hr, cs		ZeusA	eagle, ow	C
Bii	ZeusA	eagle / ow, hr				
D	ZeusA	eagle / cw		ZeusL	eagle, cw	D
Fi	ZeusA	eagle / ow		Alexander	eagle, ow	E
Fii	Alexander	eagle / cw				
G	ZeusA	eagle / cw, cs		Alexander	eagle, ow	F
H	Alexander	eagle / cw		ZeusA	eagle, ow	G
I	ZeusA	eagle / cw		ZeusA	eagle, ow	H
ow = open wings; cw = closed wings; hr = head reverted; cs = cornucopia at shoulder						

Table 3 shows that *none* of the seven denominations has the same combination of reverse and obverse types for both Ptolemy II and Ptolemy III, i.e., there is no correlation (for any denomination) between any possible denominational marks on coins of Ptolemy II with possible marks on the same denomination of Ptolemy III. Hence, either the denominational indicators used by each king were very complex (with completely different combinations of denominational markings used by Ptolemy III compared with those used by Ptolemy II) or, much more likely, none of the various differences in obverses or reverses of these two kings indicate denominations.[18] A look at some of the coinage of other mints and other kings gives further evidence that denominational marking did not occur.

Other examples showing the absence of denominational marking

As in the above tables for Ptolemies II and III, there are many other cases where the same markings occur on different denominations and also where different markings

[17] Ptolemies III and IV essentially kept the same basic system of denominations initiated by Ptolemy II. Minor changes involved the creation of a few new denominations and slight weight adjustments to some previous denominations of Ptolemy II; see A. Davesne, 'Réflexions sur la valeur des bronzes des premiers Ptolémées', *RN* 1998, p. 59, who comments 'Le système institué par Philadelphie en 265 était toujours en vigueur, … avec les monnaies frappées entre 265 [by Ptolemy II] et 204 [death of Ptolemy IV] - qui circulaient concurremment'; see also Price, 'Anubieion', p. 68.

[18] The fact that *all* of the obverse/reverse combinations used by Ptolemy II are different from those of Ptolemy III is certainly not consistent with a general policy of denominational marking. These differences would be consistent with a policy that the change(s) in obverse/reverse were made to indicate production at a different time or by a different administration; see also n. 9.

occur on the same denomination. See, for example, Table 4 summarizing four other series of denominations, those of the Tyre mint, the Aphrodite reverse type from a mint on Cyprus, the Isis series of Ptolemy V, and the two-eagle coins of Ptolemies VI and VIII.[19]

Table 4: Some Examples of Same Types on Different Denominations								
King →		Ptolemy II		Ptolemy III		Ptolemy V		Ptolemy VI/VIII
Series →		Tyre mint		Aphrodite		Isis		Two eagles
→ Weight modules given by letters; **A** = heaviest	→ obv/rev types **S**ame or **D**iffer	**B**	S_T	**A**	S_A	**A**	S_{IS}	**A**	D_{NC}
		C	S_T	**B**	S_A	**B**	S_{IS}	**B**	S_{TE}
		D	S_T	**C**	S_A	**C**	S_{IS}	**C**	S_{TE}
		E	S_T	**D**	S_A	**D**	D_i	**D**	S_{TE}
		F	S_T	**E**	S_A	**E**	S_{IS}	**E**	S_{TE}
		G	S_T			**F**	D_{ii}	**F**	S_{TE}
		H	S_T			**G**	D_i		
						H	D_{ii}		
Weight range →		*c.* 73-2.7 g		*c.* 17-1.6 g		*c.* 32-1.8 g		*c.* 46-2.8 g
Svoronos numbers→		Sv 705-11		Sv 1005-9		Sv 1233-40		Sv 1423-8

The prevalence of the letter **S** (= same) in Table 4 indicates that most members of a denominational series have the same obverse and reverse types over a wide range of weights and sizes;[20] the letters D_i and D_{ii} indicate the same markings on different denominations of Ptolemy V's coins. These show two cases of the same obverse/reverse on different denominations, Di (Alex/e-ow) on denominations D and G, Dii (Isis/e-cw, hr, cs) on F and H. Two eagles appear on all the reverses of Ptolemies VI/VIII's most common coinage, thus establishing that they do not indicate a unique denomination (or a doubling such as a diobol).[21] Table 4 thus gives a wide range of evidence that other kings (and other mints) did not use denominational marking. The only established case of Ptolemaic denominational marking occurred late, under Cleopatra VII, on whose major bronze coins the letter Π indicates 80 drachmas while the half denomination is marked with M for 40 drachmas.[22]

As summarized in Tables 1-4, and described above, there is thus good evidence that, although various occurrences of type differences occasionally resulted in a

[19] A referee has drawn my attention to T. Faucher and C. Lorber, 'Bronze coinage of Ptolemaic Egypt in the second century BC', *AJN* 22 (2010), pp. 35-80 especially p. 42 Table 3, where the Isis series and the two-eagles series (and all other bronze coins produced after c.205 until 115 BC) have been treated as if the denominations are identified by obverse types with the denominational weights reduced piecemeal at various times. Such denominational marking conflicts with the principle of same weight/size=same denomination=same value that is the basis of all Ptolemaic denominations. Other considerations also negate the idea of denominational marking by obverse types; e.g., if such denominational marking was in effect, eight types of Ptolemy VIII's coins (with weights varying from c.85 to 1.5g, all with Ammon obverses and Ptolemy VIII's name on the reverses) would necessarily all be the same denomination; see Svoronos, *Ptolemies* 1640-7 and *SNG* Copenhagen 651-9.

[20] Table 4, Tyre mint, shows that there are no differences at all in Ptolemy II's coin types for his denominations at Tyre (the weight range for Ptolemy II's seven denominations at Tyre is similar to that at Alexandria; note that no example of module A, *c*.92g, from Tyre has been found). The Aphrodite denominational series from Cyprus of Ptolemy III also shows the same obverses and reverses.

[21] See n. 15 above. For the heaviest coin of the two-eagle series the letters D_{NC} denote that only denomination A lacks a cornucopia in the field left of the two eagles.

[22] K. Regling, *ZfN* 23 (1901-2), pp. 115-16.

unique design for an individual denomination, the Ptolemaic mints did not make a systematic effort to place features on coins in order to act as denominational indicators. With the absence of denomination marks on Ptolemy II's coinage the premise that led Le Rider and de Callataÿ in 2006 to combine his lighter/smaller coins (so that eight denominations became six) is rendered invalid, and there is no evidence that Mørkholm's tables summarizing the coinages of Ptolemies II and III are incorrect.[23]

An exception to the different-module = different-denomination principle?

In a recent review of Ptolemaic bronze coinage Lorber created an exception to the principle that different modular weights indicate different denominations.[24] Coins of modules A and B of Ptolemy II were initially classified as octobols and drachms respectively, but Lorber argued that under Ptolemy III the larger denomination was reclassified as a drachm and that both were made equal in value to the considerably lighter module B of Ptolemy III which is also a drachm. Thus, during the different periods of Ptolemy II and Ptolemy III, coins of module A had different values (octobol and drachm, respectively).[25]

Lorber herself a few years later repudiated the notion of denominational change for module A: 'In earlier publications Lorber (2000: 79-80; 2005: 138-140) [here nn. 25 and 24] posited an increase in the weight standard for Series 4 and a return to the previous standard for Series 5. This reconstruction [involving changes in name and value of denomination A] is implausible from a practical point of view. Since hoards indicate that Series 3 [containing coins A and B of Ptolemy II], 4 [containing coins of Ptolemy III showing a cornucopia], and 5 [containing coins of Ptolemy III and of Ptolemy IV] circulated together, existing denominations would have had to be revalued not only once, but twice, with each change in weight standard. Such changes to the currency system would have caused unnecessary confusion.'[26]

It does indeed seem difficult to believe that the mint, in the time of Ptolemy III, could accomplish a change in nomenclature and value (octobol to drachm) of all the circulating octobols produced by Ptolemy II and, perhaps,[27] by Ptolemy III. The effect in the market when coins of module A of Ptolemy II were somehow changed from octobol to drachm would have been their devaluation by 25%. Participants in

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[23] The bronze denominations of Ptolemy II and of Ptolemy III are reviewed at ptolemaic.net/two-eagles/pt2denom.htm and ptolemaic.net/two-eagles/pt3denom.htm.

[24] C.C. Lorber, 'Development of Ptolemaic bronze coinage in Egypt', in F. Duyrat and O. Picard (eds) *L'exception égyptienne? Production et échanges monétaires en Egypte hellénistique et romaine.* Études Alexandrines 10 (2005), pp. 138-40 ; 153, n.7 ; 154, n.12.

[25] C.C. Lorber, 'Large Ptolemaic bronzes in third-century Egyptian hoards', *AJN* 12 (2000), pp. 73-4, 77-80. Newell believed that Ptolemy III produced some coins of module A and Lorber took these as drachms after Ptolemy III's supposed change in standards. Catalogues by Mørkholm, Noeske, Weiser, and Hazzard do not assign any module A coins to Ptolemy III.

[26] Faucher and Lorber, 'Bronze coinage of Ptolemaic Egypt' (n. 19 above), p. 36, n. 4. I thank the referee for pointing out this repudiation.

[27] In 1935, Newell, 'Hoards', pp. 58-9, assigned some of the largest coins of Ptolemy II (i.e., denomination A, *c.*92g) to the time of Ptolemy III. However, coins found in the 1993 Elephantine hoard indicate that Newell's attributions to Ptolemy III are very probably incorrect; see Appendix.

the market would have been confused, even angered, when coins of greater weight, *c*.92g (i.e., coins of module A of Ptolemy II and, perhaps, of Ptolemy III) were suddenly treated as equal to the lower value of coins B of the different modular weight *c*.68g. Such hypothetical changes, even if possible, would be neither fiscally nor politically beneficial. In addition, the equating of a type A octobol to a type B drachm would damage the fiduciary aspect of bronze coinage (i.e., destroy trust in denominational values). The conclusion is that no change in denomination of module A occurred and that modules A and B are different denominations indicated by their differing weights and sizes.

The small coin problem

One problem raised implicitly by Le Rider and de Callataÿ remains. With the greater weight/size of heavier/larger Ptolemaic coins, it would be relatively easy to distinguish individual denominations without any help from markings. On lighter/smaller coins the differences become much less obvious and may not be readily detected, especially in the case of the smallest coins (perhaps below *c*.15mm/*c*.3g). See Table 5.

Table 5: Examples of Different Types of Ptolemy IV's Small Coins					
Sv 1160, 14/10 mm.		Sv 1161, 12/10 mm.		Sv 1162, 10 mm.	
Obv. Bust: Rev. Double Cornucopia		Obv. Head: Rev. Single Cornucopia		Obv. Head: Rev. Eagle	
2.60g	1.96 g	1.60 g	1.47 g	1.50 g	1.00 g

There are cases where some small coins *are* distinguished by differences that might indicate a policy of denominational marking. In the time of Ptolemy IV a series of small coins was produced with on obverse a female image (probably of Arsinoe III, his sister/wife) on three types of coins, each with variations which give unique combinations of reverse and obverse; Table 5 shows two examples for each of the three different types recognized by Svoronos.[28] The differences in the reverses are a double cornucopia, a single cornucopia, or an eagle; while the obverses show either a female bust or just a head. Such differences, except for the eagle reverse, are minor and easily missed, and they would be difficult to distinguish rapidly as denominational markings. Thus neither the variations in types nor the weight/size

[28] Kromann and Mørkholm's attributions of other examples confirms the separation of Sv1160 and Sv1161 according to their differences in obverses/reverses: see *SNG* Copenhagen 648 (1.45g) = Sv1160 and 649-50 (2.79g, 1.78g) = Sv1161. The wide range of weights among all these examples overlaps the different types.

seem readily to distinguish denominations in these cases. The fact that the mint did not bother to keep the weight of any bronze denomination within a narrow range adds to the difficulty. It may simply be that these different types of coins were produced at different times with slightly different designs and that they are the same denomination.

In modern times, it is easy to rapidly and accurately measure the weight and size of ancient coins and also to take the time to see minor differences in types. This can lead us to make false distinctions among denominations; the three different types of small coins in Table 5 may be three different denominations but this seems unlikely.

From their weights and sizes Svoronos identified thirteen cases among the coinage of Ptolemy II where the two smallest/lightest modules in a distinct series of denominations[29] showed no differences at all in obverse/reverse types where denominational markings would seem to be most needed. Obviously such small and unmarked coins were produced to be useful, otherwise they would not have been created in such quantities. How might the value of such coins, and others, be determined in ancient commercial transactions?

A neglected aspect of denominational value recognition in ancient commerce

In the fifth century BC a few of the smallest Greek silver coins had letters indicating denominations (e.g., *H* for hemiobol, *TPIH* for trihemiobol). However, denominational names or markings on later Greek coins are rare.[30] The difficulty of producing and the inconvenience of manipulating such very small, light-weight coins with their low silver value led to the invention of bronze coins. Unlike silver coins, bronze coins were fiduciary and, since copper was much less expensive than silver, could be produced at a greater profit to the mint and also in more convenient larger modules without the need to take great care over consistency of weights. [31]

The earliest bronze coins were produced in Sicily around the third quarter of the 5th century BC and were marked with pellets to indicate relative values with respect to silver coins. The production of bronze coinage spread rapidly and widely, but the use of marks of value declined within decades. Throughout the later centuries,

including the period of the Greek imperials, denominational marking was rare.[32]

Thus the number of coin types in silver or bronze with any denominational marking is very small compared to the vast number of unmarked coins. It is clear that denominational marking was not needed; unmarked bronze coins of many types, weights and sizes must have facilitated, probably without any significant problems, the activity of an important part of ancient commerce involving less expensive items.

[29] The various series of related coins shared one or more of the same control mark (A Sv426-7, Δ Sv441-2, E Sv452-3, Θ Sv469-70, I Sv473-4, Λ Sv484-5, P Sv500-1, or none Sv417-8), same monogram (for 'Berytos' Sv839-40, 'Ioppa' Sv819-20), or same image in the field (club Sv710-1, flower Sv842-3, silphium Sv868-9).

[30] Kraay, *ACGC*, pp. 7-8; 'Inclusion of the denomination on a Greek coin is unfortunately rare, for the practice could have solved a number of problems' (p. 7).

[31] M.J. Price, 'Early Greek bronze coinage', in C.M. Kraay and G.K. Jenkins (eds), *Essays in Greek Coinage Presented to Stanley Robinson* (Oxford, 1968), pp. 93-5. See also Kraay, *ACGC*, pp. 230-1.

[32] *RPC* I, p. 30. Denominations and marks of value are reviewed by K. Butcher, *Roman Provincial Coins: an Introduction to the Greek Imperials* (London, 1988), pp. 31-5.

The approximate weight and size of a coin was apparent in every transaction, but there was something more, although strange to us, that was also commonplace in ancient commerce. While modern commerce has come to be facilitated by fixed prices, ancient commerce operated without them. Price discrimination (also called price differentiation or value-based pricing)[33] involves no fixed prices; bargaining sets flexible prices. Although, in the modern west, bargaining is generally thought to be a time-consuming hindrance, it is still commonplace in the east.[34]

Price differentiation gives a flexibility to commerce; the value of the item bought and the value of the item transferred (coins) can be determined (not advertised or stated in advance) as part of the transaction. For example, the value of such small coins as shown in Table 5 and the value of the item bought would both be determined according to supply and demand and the current local, individual, and mutually agreed view of the persons involved. From the roughly similar weight and size of such coins as illustrated, their acceptable value could quite promptly be determined without any study of details on obverses or reverses.[35]

Price discrimination may account for the use of the bewildering (to us) variety of denominations which were used and can appear together in hoards. The social and financial benefits of price discrimination are currently known to most eastern merchants but are often misunderstood by western tourists who want to know a fixed price and even one expressed in e.g., dollars or euros. Recognition of the flexible practice of value-based price discrimination may help us to envisage how the values of multi-various small (or large) bronze coins were determined in ancient times.[36]

[33] Price discrimination occurs in a great variety of types and conditions; the best definition may be that given by Wikipedia: 'Price discrimination exists when sales of identical goods or services are transacted at different prices from the same provider'.

[34] Ancient price discrimination seems not to be directly addressed (by name) by economists. However, a general review points out that with the 'development of monetary institutions … business in the marketplace of ancient *poleis* did not stop to be guided by values and norms which could result in rather unequal pricing according to social proximity or distance': A. Möller, 'Classical Greece: Distribution', chapter 10 in W. Scheidel, I. Morris and R. Saller (eds), *The Cambridge Economic History of the Greco-Roman World* (Cambridge, 2007), p. 370. Bargaining scenes found in ancient comedies, including 'haggling as a kind of public competition', are reviewed (pp. 372-3) and it is concluded that 'In their proper context, prices reveal their role by a complex of factors, including personal relationships and ideology'.

[35] Cf. *RPC* I, p. 30, 'It would be curious, indeed, if they [the people] had no idea of the value of the coins they were using.'

[36] An excellent review of barter as an important phenomenon is given in the introduction to C. Humphrey and S. Hugh-Jones, *Barter, Exchange and Value, an Anthropological Approach* (Cambridge, 1992), pp. 1-20.

APPENDIX:
Did Ptolemy III produce any coins of denomination A (c. 92g) ?

In 1935, Newell[37] assigned two types of denomination A (*c*.92g) to Ptolemy III (i.e., Sv446 and Sv478); these differ only in showing two different control marks (E and Λ, respectively) between the eagle's legs on the reverses. The Newell hoard contained thirteen examples of denomination A, which showed three different control marks or none: E (on Sv446), Λ (on Sv478), Θ (on Sv462), and none (Sv412). On the basis of style and of wear on the hoard coins, he assigned Sv462 and Sv412 to Ptolemy II and Sv478 to Ptolemy III. He also assigned coins of module A with the control letter E (Sv446) to Ptolemy III because they were 'clearly associated by the mint mark E with the gold issues of Ptolemy III bearing the portrait, name and type of Berenice (Sv972-3)'.

However, it is important to recognize that Ptolemy II, as part of his monetary reform, also used control marks E, Λ, Θ or none on denominations other than module A. In 1993, nearly 60 years after Newell wrote, came publication of the Elephantine hoard which contained mostly coins of the smaller denominations B, D, and E (*c*. 68g, 22g and 11g, respectively), with control marks E, Λ, Θ or none, and all of these are attributed to Ptolemy II.[38]

Moreover, other examples, not known from hoards, of denominations B, C, D, E, F, G and H use the same set of three control marks or none as used on coins of denomination A. All these lesser denominations, with modular weights *c*.68g (B) to 3.3g (H), are securely attributed to Ptolemy II.[39] These pieces of evidence from control marks seem much stronger than those from style or wear of hoard coins, or from the letter E on Ptolemy III's gold coins, or from the absence of denomination A

[37] Newell, 'Hoards', pp. 58-9.

[38] H.-Chr. Noeske, 'Prämonetäre Wertmesser und Münzfunde aus Elephantine', *MDAI (Kairo)* 49 (1993), pp. 206-7. Coins present were (Svoronos number, control mark) for denomination B, *c*.68g (Sv447, E), (Sv479, Λ), (Sv463, Θ), (Sv413, none); for denomination D, *c*.22g (Sv449, E), (Sv481, Λ), (Sv465, Θ), (Sv415, none); for denomination E, *c*.11g (Sv450, E), (Sv482, Λ), (Sv 467, Θ).

[39] All four varieties with control marks E, Λ, Θ and none occur (as well as on denomination A) on the lesser denominations B, D, F, G and H, while the two other denominations, C and E, are known in three of the four variants. These attributions of lesser denominations to Ptolemy II were first made by Svoronos, *Ptolemies* Vol. IV: Sv446-53 for E, Sv462-3, 465, 467-70 for Θ, Sv478-85 for Λ and Sv412-18 for none. They are the same as those given by, among others, W. Weiser, *Katalog Ptolemäischer Bronzemünzen der Sammlung des Instituts für Altertumskunde der Universität zu Köln* (Papyrologica Coloniensia 23; Opladen, 1995), pp. 32-8; H.-Chr. Noeske, *Die Münzen der Ptolemäer* (Frankfurt, 2000), pp. 60-3; Price, 'Anubieion', p. 68; A. Kromann and O. Mørkholm, *SNG Copenhagen* (nos. 153 for E; 149, 161 for Λ; 145 for Θ; and 141, 152, 155, 159, 163 with no control mark); Le Rider and de Callataÿ, 'Ptolémées', pp. 56-7, pl. 44-5, 47-8; and Lorber, 'Hoards', Table 1, p. 70 (Sv447, 449-50 for E; Sv479, 481, 482 for Λ; Sv463, 465, 467 for Θ; and Sv413, 415 for none). However, for the largest denomination A, *c*.92g, Lorber followed Newell in assigning coins with the control mark Θ (Sv462) to Ptolemy II and control marks E (Sv446) and Λ (Sv478) to Ptolemy III, and, contra Newell, also assigned unmarked coins (Sv412) to Ptolemy III. Le Rider and de Callataÿ, 'Ptolémées', p. 56 and pl. 43, show denomination A with control E (Sv446) for Ptolemy II.

from the Elephantine hoard.[40] The obvious conclusion is that denomination A should be attributed to Ptolemy II.

However, the control letters E, E$_{variations}$ and Λ appear on major bronze series of Ptolemy III so that these letters are of doubtful value for deciding whether or not Ptolemy III produced examples of denomination A. The above argument for the attribution of all coins of denomination A to Ptolemy II is thereby certainly weakened. However, the letter Θ is of greater importance for it appears on coins attributed to Ptolemy II and on none of the coins of Ptolemy III; furthermore, if module A coins were produced by Ptolemy III, they would be the only denomination of that king that did not show a cornucopia. Also, in a recent publication reviewing denomination A, it is stated that 'la ressemblance stylistique de tous les exemplaires de ce poids [i.e., all coins of denomination A] plaide plutôt en faveur de la contemporanéité de toutes ces variétés dans une même série : la série 4, frappée selon C. Lorber entre ca 241 et ca 221' [i.e., under Ptolemy III].[41] However, this stylistic resemblance would just as well support the attribution of all coins of denomination A to Ptolemy II.

Ptolemy II initiated a set of denominations that was designed to impress by having greater denominational weights/sizes,[42] and it is likely that it was he (not Ptolemy III) who produced the most impressive *c*.92g denomination A as an important part of his monetary reform. Although it is not impossible that Ptolemy III also produced some coins of denomination A, the same four control marks on examples of all eight denominations from A to H show a unity and abundance in Ptolemy II's reform coinage that leaves no reason to attribute any examples of denomination A to other than him.

In summary, I find it difficult to believe that Ptolemy III produced any coins of denomination A. On the other hand, I find it easy to believe that, if Newell in 1935 had been aware of the Elephantine hoard of 1993, he would have placed all coins A with Ptolemy II and we would now all be in agreement with that conclusion.

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[40] The absence of any denomination A coins from the Elephantine hoard was suggested by Lorber as evidence that most coins of denomination A were produced by Ptolemy III: Lorber, 'Hoards', pp. 74, 79; Lorber, 'Development', p. 139, n. 31.

[41] M. Seif el Din, M. Shahin, and T. Faucher, 'Un trésor de monnaies ptolémaïques en bronze au Musée greco-romain d'Alexandrie: le trésor de Nag Hammadi 1937', in D. Gerin, A. Geissen, and M. Amandry (eds), *AEgyptiaca serta in Soheir Bakhoum memoriam* (Milan, 2008), pp. 81-2. I thank a referee for comments on denomination A and for drawing this reference to my attention.

[42] Mørkholm, *EHC*, p. 106; Carradice and Price, 'Coinage', p. 132.