

The Chronology of Second Century Ptolemaic Bronze Coins And a Graphic Interpretation of Weight/Size Data

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Abstract: A recent heuristic study of weights and sizes of second century Ptolemaic bronze coins has presented a new and greatly different chronology for the coins from c.204 to 116 BC. It further concluded that obverse types indicated denomination and that the same denomination was produced in a piecemeal fashion with considerably reduced weights. In contrast, the use of valid metrological plotting (i.e., algorithmic scatter graphing) with the same weight data leads to a chronology that is consistent with all the previously established and up-to-date attributions of these coins. The two methods (and their very different results) are compared and, contrary to the heuristic approach, denominational marking did not occur. In accordance with established mint policy in the third century, the values of Ptolemaic bronze coins in the second century were indicated by weight and related size.

A recent review of second century Ptolemaic bronze coins gives weight and size data for coinage from the later time of Ptolemy IV (c.205 BC) extending into the time of Ptolemy VIII (c.145-116 BC).² From these weights/sizes a pattern of average weights versus hypothetical periods of time was produced and it was concluded that this extensive coinage was characterized by eight obverse types (with subdivisions: Zeus Ammon 1 and 2, Isis 1 and 2, Heracles 1 and 2, Alexandria, and Athena) in seven chronological Series; 6a, 6b, 6c, 6d, 6e, 7a, and 7b. The eight obverses were taken to be consistent markers of eight denominations where weight reductions occurred with various denominations at different times during the reigns of different kings (see F&L Table 3 below).³

The hypothetical basis of the new chronology obtained from weights/sizes is that there is a general pattern of declining weights for the larger denominations (as represented in hoards) and that the heaviest weights may therefore be used as a heuristic for placing other denominations within a table of weights versus chronology.⁴ A hypothesis of denominational marking by obverse types was considered critical because the ‘successive emission put a great many coins into circulation [and] the [obverse] types must have been critical for recognizing the various denominations’.⁵ Based on this heuristic expectation, a listing of average weights and nominal relative periods of time was developed that ultimately led to the results shown in F&L Table 3.⁶

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² T. Faucher and C. Lorber, ‘Bronze coinage of Ptolemaic Egypt in the second century BC’, *AJN* 22 (2010), pp. 35-80.

³ Faucher and Lorber, ‘Bronze coinage’, pp. 35, 42 (Table 3).

⁴ C. Lorber, private communication, October 11, 2012.

⁵ Faucher and Lorber, ‘Bronze coinage’, pp. 39-40.

⁶ Faucher and Lorber, ‘Bronze coinage’, Table 3, p. 42.

Table 3. Proposed classification for Series 6.

	Obverse Type	Series 6a III Unmarked	Series 6b	Series 6c	Series 6d K, OΔ	Series 6e	Series 7a	Series 7b
8	Zeus-Ammon ¹	Large-horn Ammon* ⁵ 35mm 39.8g	Sv. 1423* ⁵ 35mm 38.4g	Sv. 1424A* ⁵ 32mm 30.1g	Sv. 1375 ⁵ Milano 310 ⁵ 30mm 22.6g	Herakleion 1-4† 28-30mm 22-24g †	Sv. 1380 30mm 23g	Sv. 1383 30mm 22.9g
7	Isis 1	Sv. 1491 ⁵ 34mm 30.3g	Sv. 1233 33mm 30.3g			Sv. 1234† 27mm 17.1g		Sv. 1384 27mm 15.1g
6	Heracles 1	Sv. 1497, 1492 ⁵ 30mm 18-20.4g		Sv. 1494 ⁵ 24mm 11.3g	Sv. 1376 24mm 11.2g			Sv. 1385 24mm 9.4g
5	Alexandria	Sv. 1493* ⁵ 27mm 15g		Sv. 1495 22mm, 8.2g		Sv. 1236 22mm 9.1g	Sv. 1381, 21-22mm, 7.2g	Sv. 1386 21-22mm, 7.5g
4	Zeus-Ammon 2		Sv. 1173 ⁵ 21mm 6.2g	Necropolis hoard F 131-134 ⁵ 22mm 6.0g	Sv. 1377 21mm 6.2g			
3	Isis 2- Nilus- Isis 2	Isis Sv. 1154 ⁵ 22mm 7.2g			Nilus? Sv. 1378 19.5mm 4.7g	Isis Sv. 1238† 18mm 4.2g	Isis Sv. 1382 17mm 3.7g	Isis Sv. 1387 17mm 4.5g
2	Heracles 2, helmeted bust or head	Heracles Sv. 1496 18mm 3.7g	Helmeted bu Sv. 1155 19mm 4.2g		Helmeted bu Sv. 1379 16mm 3.3g	Helmeted hd Sv. 1156 14-15mm 2.4g		
1	Athena			Sv. 1195 13mm 2.3g				

The following review asks the questions; (1) how was F&L Table 3 produced from weight/size data, (2) what is the evidence that the weights of several denominations were reduced in a piecemeal fashion⁷ and (3) did diverse obverse types serve as consistent denomination markers?⁸ However, before reviewing the process of creating F&L Table 3 and before answering these questions, several aspects of the results given in this table should be pointed out.

With Ptolemaic bronze coinage there are many situations where coins with the same obverse circulated together and had significantly different average weights. These coins are conventionally treated as different denominations, i.e., different values. Since few obverse types were used (basically only four different types, Zeus-Ammon, Isis, Heracles, Alexandria), hypothetical introduction of denominational marking (in c.205 BC) by obverse types would result in many coins of different weights becoming the same denomination. Shown in general throughout F&L Table 3, there are many coins of lesser weights that would be the same value as heavier coins and the established fiduciary principle of Ptolemaic coinage, where relative modular weight/size = relative denomination = relative value,⁹ is then seriously damaged.

⁷ Faucher and Lorber, 'Bronze coinage', pp. 35, 40, 43, 53.

⁸ Faucher and Lorber, 'Bronze coinage', pp. 35, 39-40, 58.

⁹ This principle is well established in the literature of Ptolemaic coinage; for examples and discussion see R. Pincock, 'Are there Denominational Indicators on Ptolemaic Bronze Coins?', *NC* 172 (2012), pp. 35-46.

Consider, for example, three types of coins with Ammon obverses that circulated together in the Necropolis hoard (see denomination 8, at the top-left of F&L Table 3): these are c.39g/35mm coins (in Series 6a and 6b, both Sv1423); 30.1g/32mm coins (Sv1424-A in Series 6c); and 22.6g/30mm coins (Sv1375 in Series 6d) that are all treated as the same denomination. If this had actually been the case at the beginning of piecemeal reduction in weights of the same denomination, these coins would no doubt have repeatedly confounded the marketplace by causing many arguments and great confusion about their values. When a 23g/30mm coin is claimed to be the same value as both a 30g/32mm coin and a 39g/38mm coin, the previously used and by then well established principle that different modular weights indicate different denominations (i.e., different values) is definitely broken. Nevertheless, the conclusions gained throughout F&L Table 3 are that there is ‘a pattern of weight reduction that affected different denominations at different times’ and that denominational marking by obverse types ‘must have been critical for recognizing the various denominations’.¹⁰

Another aspect of F&L Table 3 is that the chronological pattern places many types of coins to times much later than generally and currently accepted and/or established by hoards. For example, some coins of the so-called Isis series, previously attributed to the time of Ptolemy V (before 180 BC) are said to possibly be as late as that of Ptolemy VIII (after 145 BC).¹¹ Furthermore, coins with a Zeus-Ammon obverse and a two-eagle reverse that make up denomination 8 (along the top of F&L Table 3, Series 6a to 7b) are said to represent coinage from c.205-115 BC; however, these coins are conventionally attributed to Ptolemy VI/Cleopatra I and Cleopatra II during a time span of only ten years (180-c.170 BC).¹²

¹⁰ Faucher and Lorber, ‘Bronze coinage’, ‘Abstract’, p. 35, pp. 39-40, and ‘Conclusion’, p. 58.

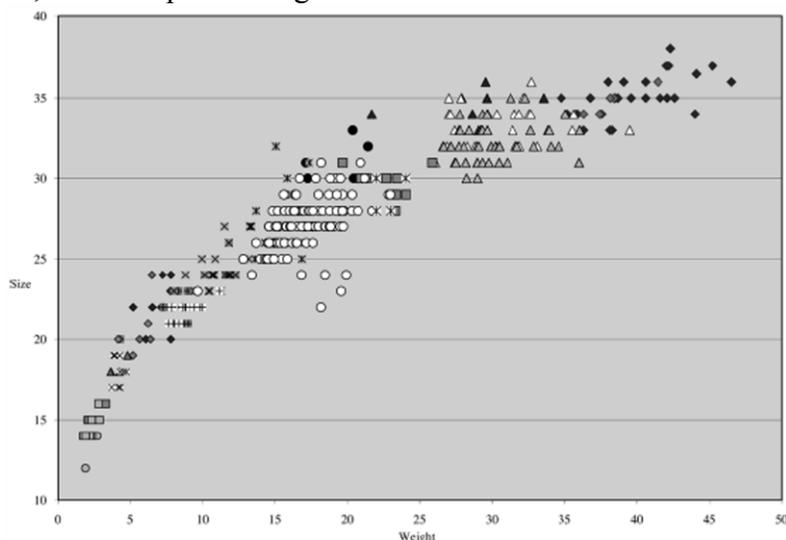
¹¹ In F&L Table 3 there are a number of individual coin types that appear in different F&L Series (i.e., different times) that are contrary to previous assignments by Svoronos, Mørkholm, Price, Noeske, Le Rider, Hazzard and many others (including earlier assignments of Lorber). The Isis series of coins (Sv1233-40) that is universally attributed to Ptolemy V by the above individuals is scattered in F&L Table 3 from an early series (Series 6b, Sv1233, c.201 BC of PtV) to a later series (Series 6e, Sv1234, 6, 8 of PtVI) and to the latest series (Series 7c, Sv1239-40, left out of F&L Table 3, but may be as late as after 146 BC, i.e., in the time of PtVIII); see Faucher and Lorber, ‘Bronze coinage’, pp. 42, 48, 59. There is no evidence presented that Sv1233-40 were produced in various periods later than that of the heaviest coin of the series, i.e., Sv1233 (PtV 204-180 BC). Lorber had previously agreed with the universal attribution of all the Isis-series to PtV, see C.C. Lorber, ‘Development of Ptolemaic Bronze Coinage in Egypt’, in *L’exception égyptienne? Production et échanges monétaires en Egypte hellénistique et romaine, Études alexandrines*, edited by F. Duyrat and O. Picard, 10 (2005), p. 143.

¹² Various attributions of coins Sv1423 and Sv1424 (denomination 8 in F&L Table 3, both with a Zeus-Ammon obverse and a two-eagle reverse) have ranged from before 205 BC (the time of Ptolemy IV) to the time of Ptolemy VIII (after 146 BC). The recent

F&L Table 3 was certainly taken to show definite examples of coin placements that fit the postulated hypotheses of piecemeal weight reduction and necessary denominational marking.¹³ The table presents an exceedingly complex pattern with multiple examples of production of the same denomination with decreasing weights during widely different periods. How was F&L Table 3 obtained from the weights and sizes of second century BC bronze coins?

Heuristic development of F&L Table 3 from weights/sizes and hoard data

The heuristic method of analysis begins with what is an algorithmic graph, i.e., F&L Graph 1 ‘Weights of the coins in Series 6’.



Graph 1. Weights of the coins in Series 6.

Faucher and Lorber state, ‘When the metrological data [i.e., the weight and size data in F&L Appendix 1] are placed on a graph [i.e., size vs weight in F&L Graph 1] it is possible to discern groups’. These groups are ten distinct denominations identified by Faucher and Lorber.¹⁴ The groups are then presented in F&L Table 1 (not reproduced here)¹⁵ where it is also stated that ‘Metrological analysis of the Series 6 identifies ten distinct modules, all but two of them used for more than one variety.’ However, F&L Table 1 also shows that four of the ten modules (i.e., denominations with weights;

abrogation by C. Lorber of the previous necessity that these coins were produced before 180 BC has allowed their reassignment to the time of Ptolemy VI (i.e., 180-c.170 BC). This is in accordance with M. Price’s assignments from the Necropolis hoard; see RP-Appendix 1, p. 13 below, i.e., ‘Re-attributions of the two-eagle coins of Ptolemy VI and the closing date of the Coinex and Necropolis hoards (c.170 BC)’.

¹³ Faucher and Lorber, ‘Bronze coinage’, pp. 40, 43, 47-9, 52-4.

¹⁴ Faucher and Lorber, ‘Bronze coinage’, p. 38 and Appendix 2, p. 63.

¹⁵ The denominations identified in F&L Graph 1 are listed in Faucher and Lorber, ‘Bronze coinage’, Table 1, ‘Approximate weights and diameters of Series 6’, p. 38; see also F&L Graph 1, Appendix 2, p. 63.

30, 17-20, 6-9 and 4-5g) each contain examples of the same denomination (weight/size) with different obverses. According to convention, this is, of course, contrary to denominational marking by obverse types.

The important result from F&L Table 1 is that, from valid metrological graphing of the weights vs sizes from a large number of second century coins,¹⁶ ten distinct modules are recognized (coins of weights/sizes ranging from 40g, 35mm to 2g, 13mm). These modules have been conventionally recognized as different denominations (i.e., in previous assignments of Svoronos, Mørkholm, Price, Noeske, Le Rider, Hazzard and many others including assignments of Lorber). F&L Graph 1 and F&L Table 1 validate the basic principle that the denominations of these second century Ptolemaic bronze coins are indicated by weight and size.

The data illustrated in F&L Graph 1 indicates ten denominations as determined by weight/size and Faucher and Lorber state¹⁷ that

‘Seemingly these ten modules represent ten bronze denominations, but this perception is somewhat misleading. A classification by module alone overlooks the significance of types and cannot account for the pattern of weight reduction in coins with the types Zeus-Ammon/double-eagle, a combination that appears to have served as a marker for the largest denomination of the system.¹⁸ To gain a better grasp of the denominational system, it is necessary to place the various emissions of Series 6 in their proper sequence’.¹⁷

This proper sequence is given (F&L’s Appendix 1, ‘Table of Hoards’),¹⁹ in a listing according to their hypotheses of weight reduction and obverse denomination marking. The listing involves new chronological assignments for coins with the Zeus-Ammon/double-eagle types as ‘denominational markers’. These seven coins are listed first (with progressive reduced weights) in each of the seven hypothetical sub-series named 6a, 6b, 6c, 6d, 6e, 7a, and 7b for relative times of emission. Other coins are placed in each

¹⁶ Algorithmic validity is shown, as in F&L Graph 1, when the same graphic result is obtained with weight/size data (i.e., the g versus mm of individual coins) listed for the computer in any of the very many possible sequential orders.

¹⁷ Faucher and Lorber, ‘Bronze coinage’, p. 38.

¹⁸ Here F&L refer to ‘Price, 1981: 160’ (i.e., Price’s Necropolis hoard) as apparently showing weight reductions of the same denomination indicated by the various coins with a Zeus-Ammon obverse and two-eagle reverse. However, Price only suggested that, if the two-eagle reverse type on coins Sv1423-4 of Ptolemy VI are an indication of the same denomination, the cornucopia in the left-field of coins Sv1424 could explain the cornucopia symbol applied by countermarking to coins Sv1375 (with one-eagle reverse and originally no cornucopia). Then, because of the cornucopias, coins Sv1375 and Sv1424 (both with the same weight/size) could well be the same denomination as heavier Sv1423 coins. He did not call for general obverse marking either by the obverse type Zeus-Ammon and/or by the double-eagle reverse; see M.J. Price, Appendix J, ‘Coins’, in G.T. Martin (ed.), *The Sacred Animal Necropolis at N. Saqqâra* (London 1981), p. 160. See also <http://ptolemaic.net/two-eagles/1c-newdata.htm>.

¹⁹ Faucher and Lorber, ‘Bronze coinage’, Appendix 1, p. 61-2.

of these sub-series in the order of decreased weights. The positions in the listing are said to be consistent with what is known from fourteen second century hoards that ‘establish the relative chronology of the series [Series 6]’,²⁰

As the next step in production of F&L Table 3, the listing of diameter (D) and weights (W) and series names (6a to 7b given in F&L Appendix 1) is presented graphically to give F&L Table 2, see below.

Table 2. Proposed subdivisions of Series 6.

D	W	Series 6a III Unmarked	Series 6b	Series 6c	Series 6d K, οΔ	Series 6e	Series 7a	Series 7b
35	38-40	Large-horn Ammon*§	Ammon Sv. 1423*§					
31-33	30	Isis Sv. 1491§	Isis Sv. 1233	Ammon Sv. 1424A*§				
29-30	22-24				Ammon Sv. 1375§ Milano 310§	Ammon Herakleion 1-4†*	Ammon Sv. 1380	Ammon Sv. 1383
28-30	17-20	Heracles Sv. 1497, 1492§				Isis Sv. 1234†		
27	15	Alexandria Sv. 1493*§						Isis Sv. 1384
24	11			Heracles Sv. 1494§	Heracles Sv. 1376			Heracles Sv. 1385
22-23	8-9			Alexandria Sv. 1495		Alexandria Sv. 1236†		
21-22	6-7	Isis Sv. 1154§	Ammon Sv. 1173§	Ammon Necropolis hoard F, 131-134§	Ammon Sv. 1377		Alexandria Sv. 1381	Alexandria Sv. 1386
18-19	4-5	Heracles Sv. 1496	Helmeted bu Sv. 1155		Nilus? Sv. 1378	Isis Sv. 1238†	Isis Sv. 1382	Isis Sv. 1387
15-16	2.4-3.3				Helmeted bu Sv. 1379	Helmeted hd Sv. 1156		
13	2			Athena Sv. 1195				

Unlike the valid scatter graph F&L Graph 1, F&L Table 2 is not a completely valid metrological graph²¹ since the horizontal positions are not actual data but only a nominal chronological sequence taken from a hypothetical list.²² In F&L Table 2 only the vertical positions (weights/sizes), not the horizontal positions (6a to 7b), are graphically valid data.

It is stated that F&L’s Table 2 ‘takes account of obverse types only, which were certainly easier to recognize at a glance than permutations of the

²⁰ In the F&L Appendix 1 listing, 38 coin types were placed in an order according to the notational Series 6a, 6b, 6c, 6d, 6e, 7a, and 7b. However, in this ‘Table of Hoards’ there are only 26 types of coins actually represented in the data; 12 types of coins in the listing were not represented in any of the hoards. In addition, the presence of a coin in a hoard with a late closing date does not necessarily mean that the coin was produced during a late Series. There is no information presented on how the positional listings of the coins in F&L Appendix 1 were obtained from their presence in (or absence from) the various hoards.

²¹ Although F&L Table 2 is named a ‘Table’, it is described as a ‘metrological ... graph’, see Faucher and Lorber, ‘Bronze coinage’, pp. 39-40, 41 and especially p. 63.

²² Unlike F&L Graph 1 where the data could be supplied in any order (see n. 16 above), the horizontal positions in F&L Table 2 are invalid because any different order in the listing in F&L Appendix 1 would result in a different horizontal order in the table.

Ptolemaic eagle on thunderbolt'.²³ F&L Table 2 is arranged in accordance with F&L's hypothesis in that the heaviest coin in each sub-series is a Zeus-Ammon/double-eagle coin (the exception is Sv1375 in 6d with a one-eagle reverse).

However, the results in F&L Table 2 are not consistent with marking by obverse types; they are consistent with conventional denominational recognition by weights/sizes. Firstly, this is shown among the top-three horizontal sets of the heaviest coins; these sets all contain coins with at least one Ammon obverse. They are three sets containing coins with different weight/sizes placed in different vertical positions (i.e., weight positions) indicating three different denominations (i.e., weights 38-40g, 30g, and 22-24g in the W column above). The Ammon obverses are associated with three different denominations; they are not the same denomination as would be the case if the Ammon obverses were denominational markers.

Secondly, F&L Table 2 also shows six horizontal sets of coins, each set with the same weight/size (same denomination), that contain coins with two different obverses. These are the six denominations with weights 38-40, 30, 17-20, 15, 6-7, 4-5g where each denomination appears with two (or more) different obverse types.

Even though it is said that F&L Table 2 'takes account of obverse types only', and is taken as consistent with hoard data, the results from graphing of the data from F&L Appendix 1 do not support the hypotheses of denominational marking by obverses with piecemeal reduced weights of the same denomination. The actual result presented in each of F&L Graph 1, F&L Table 1, and F&L Table 2, is that denominations are indicated by weight and corresponding size, not by obverse or other markings.

The next step in production of F&L Table 3 involves a 'reorganized version of Table 2, using obverse types as the main criterion'.²³ An upward movement of twenty-three of the thirty-four types from F&L Table 2 is carried out in order to produce F&L Table 3 (p. 2, above). The pattern in this table is then taken²⁴ to show both denominational marking by obverses and also corresponding piecemeal weight reduction of the same denomination. However, in the process of reorganization by rearrangement of F&L Table 2, F&L Table 3 has lost the metrological validity that is in the weight positions of F&L Table 2.

F&L Table 3 is invalid because the reorganization of F&L Table 2 to create F&L Table 3 involves unintentionally invalid data manipulations. Data manipulation is a heuristic method used to possibly uncover new,

²³ Faucher and Lorber, 'Bronze coinage', p. 40.

²⁴ Faucher and Lorber, 'Bronze coinage', pp. 47-9, 52-4. The view that F&L Table 3 necessarily gives a valid chronology is very strong; it is stated that 'denomination markers [by obverse types] persist across Series 6 and 7, despite a pattern of weight reduction that affected different denominations at different times'; Faucher and Lorber, 'Bronze coinage', 'Conclusion' p. 58.

different, or alternative information from data of various types. However, data manipulation is valid only when various arrangements of data are made without changing any established facts. Weights and sizes are distinctly factual and, with the data manipulations of the weight positions from F&L Table 2 to give Table 3, all claims to a valid metrological result are lost. Even with a heuristic approach, the graphic weight positions established by physical measurements of weights and sizes should not be ignored when they are considered to be metrologically valid in the preceding F&L Table 2. The preceding F&L's Graph 1, Table 1 and Table 2 cannot be considered as metrological evidence for F&L Table 3 because, as shown above, they do not support the hypotheses.

With more information, perhaps specific data from hoards, the positions in F&L's Table 3 might possibly be heuristically argued. In other words, if F&L Table 3 were presented merely as a heuristic possibility without the contrary evidence given in the graph and tables above, hoard evidence for the pattern in a final table might be presented. However, the pattern of F&L Table 3 was taken without question as strong support for the original hypotheses.²⁵

The conclusion is that there is no metrological basis for either the piecemeal production of the same denomination in distinctly different weights/sizes or for denominational marking by obverse types. The same obverses on Zeus-Ammon/double-eagle coins with decreasing weights/sizes (as shown in the top row of F&L Table 3) do not indicate the same denomination; these coins are simply different denominations with the same obverse.²⁶ Consistent with the fiduciary principle of Ptolemaic coinage, the different weights/sizes of coins are part of a metrological monetary system where different denominations may, or may not, have the same obverse. In the second century, as in the third century, denominations were indicated by weight/size, not by coin types.²⁷

Nevertheless, the successful identification from F&L Graph 1 of ten denominations obtained from the algorithmic treatment of weight/size data suggests that a further development of algorithmic graphing might be

²⁵ Faucher and Lorber, 'Bronze coinage', pp. 43-9, 58.

²⁶ A table that reviews the bronze coinage of 180-145 BC (including all the Zeus-Ammon/double-eagle types of that period) is contained in RP Appendix-2 below, see p. 16.

²⁷ The absence of denominational marking of Ptolemaic bronze coinage is most simply exemplified in the third century by the series Sv705-711 (seven different denominations of Ptolemy II's coins all showing Ammon obverses and weight from c.73g to c.3g); also by the series Sv964-8 of Ptolemy III with five different denominations with Ammon obverses and weights/sizes c.74g to c.5g. In addition, there are the obverse Isis head coins of Ptolemy V in six denominations (Sv1233-5, 1237-8, 1240, 31g to 1.8g). In the second century there is Ptolemy VI's series of two-eagle coins in seven different denominations (Ammon coins, Sv1423-Sv1428, c.40g to 2.8g) and Ptolemy VIII's eight different denominations with Ammon obverses and weights c.85g to 1.5g (Sv1640-7); see Pincock, 'Denominational indicators', pp. 35-44.

interesting and useful. As shown below, the same weight/size data can be combined with a valid indication of relative chronology to give a graphic illustration of currently accepted attributions of second century Ptolemaic bronze coinage.

Algorithmic scatter graphing of average weights, sizes, and relative times

Svoronos' catalogue numbers are widely used to indicate a specific type of coin listed in his monumental compilation of Ptolemaic coins.²⁸ His cataloguing placed related coins into series with later series having greater Svoronos numbers. Therefore, a Svoronos number not only indicates a specific coin type but may also give a distinct numeric indication of relative chronology that can be used in algorithmic scatter graphing. However, adjustments must first be made to those few Svoronos numbers where attributions have been changed (mainly because of new hoard data) since production of his catalogue in 1904.²⁹ Then, for each type of coin in the data tables,³⁰ Svoronos numbers are used with scatter graphing to give a meaningful presentation of average weights³¹ (g) versus chronology (Sv numbers); the results are shown in RP Graph 1 below.³²

²⁸ J. N. Svoronos, *Τὰ νομίσματα του κράτους των Πτολεμαίων* (Athens, 1904); German translation in vol. IV, *Die Münzen der Ptolemäer* (Athens, 1908).

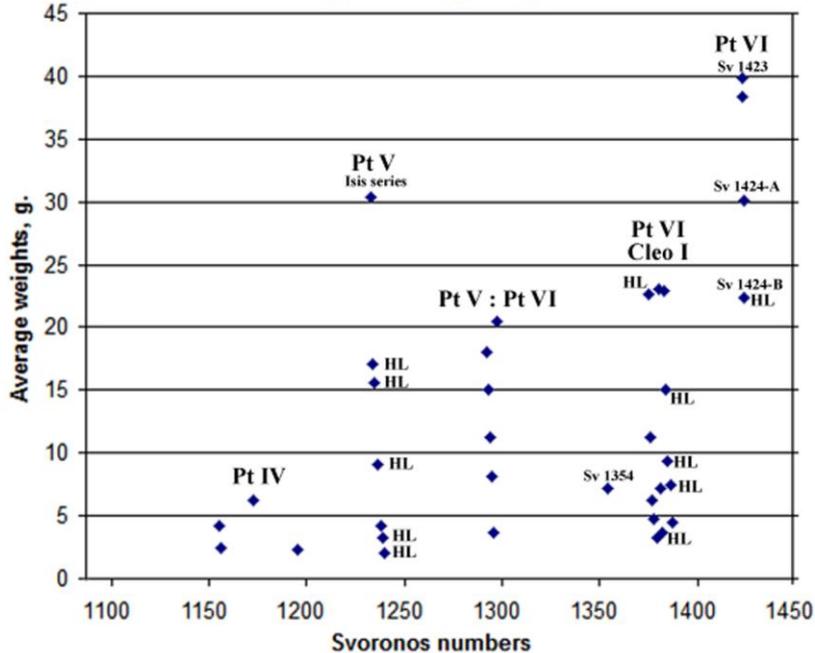
²⁹ The changes in Svoronos numbers are these: From the Necropolis hoard, Price reattributed Sv1154 from Ptolemy IV to Ptolemy VI; therefore Sv1154 is moved to a later position near coins of Pt VI by using the number 1354. Also, Sv1491 is identical to Sv1233; therefore Sv1491 is assigned number 1233.1 differing only by a decimal notation (see Price, 'Necropolis', p. 158-9). For details on these re-attributions see R. Pincock, 'A possibly unique Isis head bronze coin of Cleopatra I (180-176 BC)', *NC* 170 (2010), p. 58, ref. 20. Also, since Price closed the Necropolis hoard before 170 BC and indicated the likelihood that coins Sv1491-2 in Necropolis hoard B are coins of Ptolemy V (deceased 180 BC), the six coin types Sv1492-7 are treated as coins of PtV by assigning them earlier positional numbers Sv1292-7 rather than Sv1492-7. Additional changes are; the non-numeric Sv1424-A and Sv1424-B must be made numeric, i.e., 1424-A=1424.1 and 1424-B=1424.2. Also the 'Nilus?' coin (Sv1378), according to SNG Copenhagen (n. 273), is an Ammon coin; and the coin 'Large horn Ammon' is a variety of Sv1423.

³⁰ Average weight and size data are from Faucher and Lorber, 'Bronze coinage', Appendix 1, pp. 61-2, Appendix 2, pp. 65-6, 68.

³¹ While size is more prominent than weight in recognition of ancient denominations, in modern times weight is more easily and accurately determined. J. G. Milne seems to be first to comment on this. He made the interesting statements that 'It seems probable that in common use the copper coins were distinguished by their size' and '...while the practical distinction of the denominations in Egypt may have been secured by size, it will be most convenient to discuss them on the basis of weight'. J. G. Milne, 'The copper coinage of the Ptolemies', *Annals of Archaeology and Anthropology*, I, (1908), pp. 33-34.

³² The graphing system used was MS Excel in XY-scatter mode. In order to spread the width of the graph, only the last three digits of the Sv numbers were used (together with any decimal numbers). The first digit of the numbers (i.e., 1) was then put back into the completed listing of Sv numbers as in RP Graph 1.

RP Graph 1: Relative Chronology of Average Weights versus Svoronos Numbers



The letters **HL** indicate that examples are known that have a high lead content. Lead content data for coins of Pt IV and for some of the coins of Pt V and Pt VI are not yet available.

The well-organized pattern with cohesive columns of data-points in RP Graph 1 successfully shows the various series of related coins produced during periods involving four consecutive regencies. They are, from left to right the ‘helmeted head’ series with the Athena head coin of Ptolemy IV (c.205 BC); the so-called Isis series of Ptolemy V (204-180 BC); the Necropolis hoard coins of Ptolemy V and of Ptolemy VI;³³ the coins of Ptolemy VI (180-170 BC) with co-regent Cleopatra I (180-176 BC); and, finally on the right, three examples of coins with the two-eagle reverse type produced by Ptolemy VI (180-c.170)³⁴ and continuing with co-regent Ptolemy VIII (before 164 BC).

³³ In RP Graph 1 the positions for the Necropolis hoard coins (assigned as Sv1491=1233.1 in the Isis-series, and Sv1492-7=1292-1297 in PtV:PtVI) are consistent with Price’s assignments of Sv1491,2,4,5, present in Necropolis hoards B, C, E, and F, that all closed before 170 BC. Price assigned Sv1491-2 to Ptolemy V and Sv1494-5 to Ptolemy VI; coins Sv1493, 6, 7, not in the Necropolis hoard, are also placed in column PtV:PtVI. The previous attributions of coins Sv1491-7 to Ptolemy VIII, as assigned by Svoronos and accepted by Mørkholm (see *SNG Copenhagen*, 332-346), as after 169 BC and after 146 BC respectively, surely places these coins too late.

³⁴ Note that in the algorithmic RP Graph 1 above, the two-eagle coins Sv1423, Sv1424-A and Sv1424-B, all found in the Necropolis hoard, are placed (consistent with Price’s view) together in the time of Pt VI (180-170 BC); also see RP-Appendix 2, p. 16 below.

RP Graph 1 shows average coin weights according to the relative chronology (from c.205 to c.164 BC) implicit in Svoronos numbers.³⁵ RP Graph 1 does not ‘prove’ Svoronos’ assignments. It illustrates a chronological pattern where all the weight/size data are consistent with updated attributions (see n. 29) and, in contrast to F&L Table 3, are also in agreement with all previously accepted attributions (see n. 11).

RP Graph 1 also shows results related to the metallic composition of the coins. Superimposed near many of the data points are indications (see **HL**) of coin composition where examples of these coins have been found with high percentages of lead.³⁶ (Note that either no data is yet available for the other coins in RP Graph 1 or examples are known that contain only a small percentage of lead).

Five of the seven examples of coins in the Pt V Isis-series column have high lead concentrations (15.6% to 33.3%). It has previously been accepted that the earliest examples of Ptolemaic bronze coins known to contain high percentages of lead were those attributed to Ptolemy VI (i.e., after 180 BC).³⁷ As shown by **HL** in RP Graph 1, it now has become clear that, rather than after 146 BC as suggested by F&L,³⁸ it was at least in the time of Ptolemy V (204-180 BC) that adulteration of bronze coinage with relatively inexpensive lead was initiated, apparently to reduce the cost of production and to increase the money supply during this especially difficult period in Ptolemaic history.³⁹

³⁵ RP Graph 1 is metrologically valid because the same graphic positions are algorithmically obtained with any of the many different sequences in the weights with corresponding Svoronos numbers supplied to the computer; see n. 16, n. 22.

³⁶ Data from Faucher and Lorber, ‘Bronze coinage’, Appendix 3, pp. 71-2. Weight/size data for high lead coins are in Series 7c, p. 44; Series 7c is not shown in F&L Tables 2 and 3.

³⁷ E. R. Caley, *The Composition of Ancient Greek Bronze Coins*, Memoirs of the American Philosophical Society, 11, (Philadelphia 1939), p. 95-8. See also, B. Bouyon, G. Depuyrot, J.-L. Desnier, ‘Systèmes et technologie des monnaies de bronze’, *Collection Moneta*, 19 (2000), p. 44-6, 49-50.

³⁸ Because they contain high percentages of lead and are unmarked, Isis coins (Sv1235, 1239, 1240) are placed (by F&L) into Series 7c to join with other high lead coins in Series 7a and 7b; see Faucher and Lorber, ‘Bronze coinage’, pp. 44-5, 48. They state that Series 7c possibly ‘did not commence until [after 146 BC]’, i.e., in the time of Ptolemy VIII. However, with their high lead content the three Isis coins should not have been displaced from their universal assignment of Ptolemy V (204-180 BC); they belong together with other unmarked Isis coins of Ptolemy V (Sv1234, Sv1236) with the identical obverse/reverse as well as high percentages of lead.

³⁹ G. Hölbl, *A History of the Ptolemaic Empire* (London and New York, 2001), pp. 153-9.

Summary: With the heuristic method presented above there is no actual metrological evidence given for the pattern of coinage shown in F&L Table 3; furthermore, there is no evidential support for the claimed chronological production of coins with piecemeal declining weights nor for denominational marking by obverse (and/or reverse) types. The overall result is that this heuristic treatment of weight/size data (1) breaks the fundamental fiduciary principle that relative weight/size = relative value = relative denomination, (2) presents an impractical monetary system that is contrary to many conventional and current views, (3) gives metrologically unsupported assignments of graphical weight positions and chronology, and (4) leads to an incorrect dating of high-lead coins.

On the other hand, the algorithmic method given above is metrologically valid because it directly connects coin weights/sizes to a cogent measure of relative chronology. The newly available weight data is used to place coin types in cohesive chronological positions that are consistent with both earlier and recent attributions. The conventional and hitherto generally accepted means of identifying coins and assigning chronology, involving characteristics such as closely related obverse and/or reverse types, control marks, styles, and evidence from hoards, is preserved. Also, the algorithmic method follows the fiduciary principle operating within Ptolemaic bronze coinage that the relative weight/size of coins should have a trustworthy relationship to relative coin value. Unlike the heuristic method (in F&L Table 3), the algorithmic method produces a useful graphic illustration (in RP Graph 1) of weights/sizes and the relative chronology of second century Ptolemaic bronze coins.

RP-Appendix 1:
Re-attributions of the two-eagle coins of Ptolemy VI and the closing date of the Coinex and Necropolis hoards (c.170 BC)

RP Graph 1 shows Sv1423, Sv1424-A and Sv1424-B as coins of Ptolemy VI (180-c.170 BC) while earlier studies have placed Sv1423 with Ptolemy IV, Sv1424-A with Ptolemy V, and Sv1424-B perhaps with Ptolemy VIII. After reviewing these previous attributions, the assignments to Ptolemy VI are corroborated by recent information as given below.

Coins Sv1423, Sv1424A-B are two types of early second century Ammon coins, each with two-eagle reverses which differ only in that Sv1423 does not show a cornucopia at the left of the two eagles. Two-eagle coin types appear in the closely related Coinex and Necropolis hoards and the closing dates for these hoards have been placed to the time of Pt V (before 180 BC),⁴⁰ or Pt VI (c.170 BC),⁴¹ or possibly in the time of Pt VIII (after 146 BC).⁴²

However, consistent with the attributions of Price (and as shown in RP Graph 1), it has recently been possible to reasonably settle these coins into the early time (180-c.170 BC) of Ptolemy VI. Following a review (below) of earlier attributions, there is new information that supports the closing date of c.170 BC for both the Coinex and the Necropolis hoards.

Various attributions of Sv1423 and Sv1424

In his 1981 study of the Necropolis hoard, Price attributed coins Sv1423 and Sv1424 to the early time of Ptolemy VI (180-170 BC). This was based on the presence of two Sv1424 coins in the Corinth hoard⁴³ together with a coin (Sv1380) that showed the name Cleopatra I (180-176 BC); also present were examples of Sv1384 that are universally dated within 180-170 BC. Price also associated the burial of the hoard with the threat of Syrian king Antiochus IV's expedition to Egypt in 169 BC, and he gave a closing date of c.170 BC for the Necropolis hoard.⁴⁴

Huston and Lorber, in 2001, with coins Sv1423 and Sv1424 in the Coinex hoard, recognized that the Sv1424 coins in this hoard were of distinctly higher weight than generally found. They determined that the Sv1424 type in general is comprised of two populations differing only in weight/size; these were called, respectively, Sv1424-A (c.29g/32-35mm) and Sv1424-B (c.23g/28-30mm).⁴⁵

⁴⁰ S. M. Huston and C. C. Lorber, 'A hoard of Ptolemaic bronze coins in commerce, October 1992 (CH 8, 413)', *NC* (2001), pp. 15-18, 28-9.

⁴¹ Lorber, 'Development', p. 145.

⁴² Faucher and Lorber, 'Bronze coinage', p. 48.

⁴³ M. Thompson, 'A Ptolemaic bronze hoard from Corinth', *Hesperia* 20 (1951), p. 355.

⁴⁴ Price, 'Necropolis', p. 161.

⁴⁵ Huston and Lorber, 'Coinex', pp. 24-6.

Contrary to Price's assignment of Sv1423 and Sv1424 (in the Necropolis hoard) to Ptolemy VI, with the Coinex hoard Huston and Lorber assigned coins Sv1423 to Ptolemy IV (or early issues of Ptolemy V) and Sv1424-A to Ptolemy V. These assignments were based on an argument-from-absence, i.e., 'Because Sv1380 and Sv1384 are relatively common and extremely common, respectively, their absence [from the Coinex and Necropolis hoards] is significant and points to closure of before 180 BC ... in the reign of Ptolemy V'.⁴⁶

In a 2005 review of Ptolemaic bronze coins,⁴⁷ some examples of Sv1423 were 'perhaps issued under Ptolemy IV, but the majority were surely coins of [Ptolemy V]'. The heavyweight coins, Sv1424-A, were still assigned to Ptolemy V while the lightweight coins Sv1424-B were moved to Ptolemy VI. This change for Sv1424-B was based on association with Sv1380 (showing Cleopatra's name), and with Sv1383 (both of the latter are unquestionably established as coins of 180-170 BC). All three types (Sv1424-B, Sv1380, Sv1383) have essentially the same weight/size module (c.23-24g/28-32mm) and also show the double-eagle reverse with a cornucopia in left field. In addition, association with Sv1380 in the Corinth hoard supported the assignment of Sv1424-B to Ptolemy VI.⁴⁸ Although unaware of the weight difference of Sv1424-A and Sv1424-B, Price would no doubt have agreed with the 2005 argument that Sv1424-B belongs to Ptolemy VI (but he would not have agreed with the 2005 assignments of Sv1423 to Ptolemy IV and Sv1424-A to Ptolemy V).⁴⁴

In 2010 (i.e., see F&L Table 3) coins Sv1423 are in the earliest Series 6a and 6b (c.204 BC), while Sv1424-A followed closely in Series 6c. Yet Sv1424-B is in the latest series, i.e., Series 7c that 'may not commence until after [146 BC]'.⁴⁹

The rather complex difficulties, as described above, in obtaining a single reliable assignment for coins Sv1423, Sv1424-A and Sv1424-B, disappear now that new information is available. The above various attributions of years 2001, 2005, and 2010 may now be replaced by Price's attributions of year 1981.

New information related to Sv1423, Sv1424 and Sv1380, Sv1384

It has been pointed out (in 2010)⁵⁰ that 'The chronology [presented in 2001 and 2005] is problematic because it leaves very little official coinage

⁴⁶ Huston and Lorber argued that Price incorrectly took Sv1380 and Sv1384 as coins of Cyprus. However, while later accepting that Sv1380 and Sv1384 are coins of Alexandria, it is apparent (from the argument presented in Huston and Lorber, 'Coinex', p. 28-9), that Price did not change his mind about coins Sv1380, Sv1384 and Sv1424, all being coins of Ptolemy VI. Nor is it reported that there was any change of mind regarding his closing date (c.170 BC) for the Necropolis hoard.

⁴⁷ Lorber, 'Development', pp. 141, 145.

⁴⁸ Lorber, 'Development', p. 145.

⁴⁹ Faucher and Lorber, 'Bronze coinage', p. 48.

⁵⁰ Faucher and Lorber, 'Bronze coinage', pp. 47-8.

for the last century of Lagid Egypt’ and ‘The hoards cited by Lorber do not really support a high chronology [i.e., the early chronology for Sv1423 with Ptolemy IV, and Sv1424-A with Ptolemy V] and in fact suggest that at least some of her dates should be lowered [i.e., given a later date].’ In addition, there are the statements that ‘Although we cannot agree with the numismatic arguments Price offered to date the Necropolis hoards,^[51] his explanation for their loss [burial] is not implausible’, and ‘We differ only in that we would no longer maintain that the absence of Sv1380 and 1384 from the Necropolis hoards dates their burial before 180.’⁵² Since the basis of the 2001 argument-from-absence (that gave the assignments of coins Sv1423, Sv1424-A and Sv1424-B) has been abrogated, and since it is agreed by F&L that these coins can reasonably be dated later, Price’s assignments (in 1981) to Ptolemy VI (during 180-c.170 BC) have now been corroborated.

Coins Sv1423, Sv1424-A and Sv1424-B are all found in the Necropolis hoards⁵³ and, in 2005, Lorber placed Sv1424-A with Ptolemy VI. Also, Price’s historical explanation for the burial of the Necropolis hoards was accepted as ‘not implausible’.⁵⁴ Therefore it can no longer be maintained that the Necropolis and Coinex coins must have been buried before 180 BC; coins Sv1424-A and Sv1424-B should logically, until contrary evidence arises, be placed together (as in RP Graph 1) with Sv1423 as coins of

⁵¹ Faucher and Lorber, ‘Bronze coinage’, pp. 39, 48. F&L do not agree with Price’s closing dating for the Necropolis hoard due to his use of insignificant wear estimates (with examples of Sv1424, Sv1494, and of a smaller denomination, Price’s nos. 131-134). However, Price’s closing date for the Necropolis hoard (c.170 BC) depended, not on coin wear, but on the close chronological relationship of coins Sv1424, Sv1380 and Sv1384 (all found in the Corinth hoard) with coins Sv1424 in the Necropolis hoard; see Price, ‘Necropolis’, p. 161.

⁵² Faucher and Lorber, ‘Bronze coinage’, p. 48, and see p. 48, n. 39.

⁵³ In 2005, C. Lorber assigned all of the Necropolis cornucopia-double eagle coins as Sv1424-A. However, Necropolis hoard F contained fifteen examples of Sv1424 A+B (not distinguished by M. Price). The range of weights for coins Sv1424 A+B is 16.0 to 28.8g with a median of 22.5g; there are seven coins (ave. 26.6g, Sv1424-A) above the median and seven coins (ave. 19.7g, Sv1424-B) below the median. These averages are both within the range of weights for Sv1424-B coins and they are below the mode of 29g for A and 23g for B as given by Huston and Lorber ‘Bronze coinage’, p.25-6. In addition, associated with the Necropolis hoard F were two other groups of coins that contained examples of both Sv1423 and Sv1424; i.e., Necropolis groups C and D contained one example each of the ‘Large Horn’ variety of Sv1423 (as very clearly shown in Plate 44, n. 43 and n. 48, no weight/size data available). In the Necropolis hoard F itself there were two examples of Sv1423 (Price n. 65, 36.30g, 35mm in Plate 45 apparently without the large horn, and n. 66, 30.91g, 31mm, not pictured). The above is good evidence that both Sv1424-A and Sv1424-B were present in the hoards together with examples of the Sv1423 varieties as shown in RP Graph 1. Based on size alone, all of the Sv1424 coins in the hoard were assigned by Lorber to Sv1424-A, see Lorber, ‘Development’, p. 142. That the weights are lower than expected for Sv1424-A coins was because ‘The low weights are typical for [worn] excavation coins’; see Huston and Lorber, ‘Hoard in commerce’, pp. 25, 28. However, Price indicated that Sv1424 coins in the hoard were ‘fresh’, i.e., not worn; see Price, ‘Necropolis’, p. 159. In the related Coinex hoard, the presence of only the heavier weight Sv1424-A coins may be due to selection of these coins as a greater denomination than Sv1424-B.

⁵⁴ Faucher and Lorber, ‘Bronze coinage’, p. 48.

Ptolemy VI, 180-c.170 (with a closing date for both the Coinex and Necropolis coins of c.170 BC).⁵⁵

RP-Appendix 2:
**Comparisons of sizes and obverses for Ptolemaic bronze coins
produced in 180-145 BC**

There is a general pattern in Ptolemaic bronze coinage in that coins with Zeus-Ammon obverse are almost always the heavier/larger in a given series; Heracles coins and Alexandria coins are lighter/smaller in that order, Isis coins have various weights, and the more specialized coinage is generally the lightest/smallest (e.g., Helmeted head). This pattern is shown with the three series Sv1375-1379 (K marked coins), Sv1380-2 (with Cleopatra's name), and Sv1383-7 (Α marked coins). The result is that coins in each of these series may appear to have denominational markings by obverse types in the order Ammon, Isis, Herakles, and Alexandria (see 30, 27/28, 25, 22 mm) on the left side of the table shown below.

Size and Obverse Comparisons of Bronze Coins produced 180-145 BC					
Series: Sv1375-9, 1380-2, 1383-7			Series: Sv1423, Sv1424-A and -B, Sv1425-8		
Diameter, mm.	Svoronos Number	Obverse	Diameter, mm.	Svoronos Number	Obverse
			36/40mm	Sv1423	Ammon
30mm	Sv1375, Sv1380, Sv1383	Ammon	32mm	Sv1424-A	Ammon
27/28mm	Sv1384	Isis	29mm	Sv1424-B	Ammon
25mm	Sv1376, Sv1385	Herakles	23/25mm	Sv1425	Ammon
22mm	Sv1377	Ammon	19/22mm	Sv1426	Ammon
	Sv1381, Sv1386	Alexandria			
18mm	Sv1378	Zeus or Nilus	16/18mm	Sv1427	Ammon
17mm	Sv1382, Sv1387	Isis	15mm	Sv1428	Ammon
16mm	Sv1379	Helmeted Head			

However, a more general view, involving all of Sv1375-87 circulating together with Sv1424-8 (as in the table), shows that the various different obverse types of coins Sv1375-87 (as well as the Ammon obverse type on each of Sv1424-8) can be, and apparently were, ignored as denominational indicators in Ptolemaic times. Since it is generally accepted (see below) that coins Sv1375-87 circulated together with coins Sv1424-8, it is apparent (as explained below) that there was no systematic policy of denominational recognition by obverse types.

⁵⁵ See also <http://ptolemaic.net/two-eagles/1c-denomptvi.htm>

Based largely on the appearance of Cleopatra I's name on coins Sv1380-2, there is wide agreement that related coins in the series Sv1375-87 (left side in the table) were produced during 180 to c. 170 BC, i.e., in the reign of Cleopatra I and Ptolemy VI (Sv1375-82, 180-176 BC) and then by Ptolemy VI (Sv1383-87, 176-c.170 BC) shortly thereafter. The coins Sv1375-87 do not give examples of denominational markings by obverses; they make up denominations according to weights/sizes (indicated in the table above by sizes) as: Sv1375 = Sv1380 = Sv1383 all 30mm; Sv1384 28mm; Sv1376 = Sv1385 both 25mm; Sv1377 = Sv1381 = Sv1386 all 22mm; Sv1378 18mm; Sv1382=Sv1387 both 17mm; and Sv1379 16mm.⁵⁶

Coins Sv1423-8 (right side in the table) make up a set of seven denominations (including Sv1424-A and Sv1424-B) all with Ammon obverses and distinguished only by their weights/sizes (from c. 40g to c. 3g). According to Price (Necropolis hoard) the two-eagle coins (Sv1423-8), that predominated during the second century, began production before c. 170 BC. With contemporary or at least consecutive timing established for production of Sv1375-87 and Sv1423-8 there can be little or no doubt that coins Sv1375-87 (180-c.170 BC) would have been in circulation with coins Sv1423-8 (before c.170-145 BC).⁵⁷

As shown in the table above, and contrary to the hypothesis of obverse denominational marking, five of the seven denominations (same weight/size) of Sv1375-87 and Sv1423-8 circulated together before and after 170 BC, each with two, or more, different obverse types. The smallest coins (15-18mm) would have been particularly confusing in the market place if five different small obverses had to be remembered in addition to the large size coins Ammon, Isis, Heracles, and Alexandria. In a bartering society, transactions could be much better settled without the need for complicated obverse identification.⁵⁸

Even if, in our modern times, coins Sv1375-87 may be taken as being denominationally marked by Ammon, Isis, Heracles and Alexandria, in the second century, they would have been used with the familiar weight/ size recognition as was the whole series of Ammon coins Sv1424-8 during that time. The table above shows good evidence that there was no systematic policy of denominational recognition by obverse types from 180 BC to 145 BC. The denominations of these coins, like those of the previous century, were identified by weight/size.

⁵⁶ All the diameters given in the table are from Svoronos' catalogue except those for Sv1424-A and Sv1424-B. Svoronos did not separate Sv1424-A and Sv1424-B; he gave Sv1424 as 29 to 32mm. Huston and Lorber recognized that Sv1424 was composed of two different denominations; Faucher and Lorber give Sv1424-A as 32mm and Sv1424-B as 29mm.

⁵⁷ The Corinth hoard contained examples of Sv1380, Sv1384 and Sv1424; Thompson, 'Corinth', p. 355. Other pertinent hoard data seems to be unavailable for lesser weight coins; heavier weight coins were essentially always preferred for hoarding.

⁵⁸ See 'The small coin problem' in Pincock, 'Denominational indicators', pp. 42-44.