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CONSIDERATIONS REGARDING THE GREEK GOLD COINS STRUCK DURING THE 4TH TO THE 1ST CENTURIES BC IN THE LIGHT OF THE XRF ANALYSIS

Aurel Vilcu *, Emanuel Petac**, Bogdan Constantinescu***,
Cătălina Chiojdeanu, Daniela Stan, Gheorghe Niculescu****

Abstract: *There were published the results of the XRF analysis from the ROMARCHAEOMET program on the 134 Hellenistic Gold coins struck between the 4th and the 1st century BC with a significant presence in the discoveries from Dacia. The first group is composed by staters from Philip II, Alexander the Great and Philip III struck during the 4th and the 3rd centuries BC in the Macedonian kingdom and different cities from the Hellenistic world. The second one contains Lysimachus type staters struck in the Greek cities from the Black Sea region during the 3rd to the 1st centuries BC. There were also discussed several aspects concerning the attribution and the chronology of the staters, regarding especially the staters from Istros, Tomis and Kallatis.*

Rezumat: *Sunt publicate rezultatele analizelor efectuate în cadrul programului ROMARCHAEOMET asupra a 134 de monede din aur elenistice bătute în sec. IV-I a.Chr. a căror prezență în Dacia a fost semnalată prin mai multe descoperiri. Un prim grup de piese este alcătuit din stateri din aur de tip Filip II, Alexandru cel Mare și Filip III emiși în sec. IV-III a.Chr. în regatul macedonean și apoi în diferite orașe din lumea elenistică. Cel de-al doilea grup de emisiuni este alcătuit din stateri de tip Lysimach puși în circulație de orașele grecești din zona Mării Negre în sec. III-I a.Chr. Pe baza rezultatelor analizelor sunt discutate o serie de aspecte privind atribuirea și cronologia staterilor, cu specială privire asupra emisiunilor orașelor grecești Istros, Tomis și Kallatis.*

Key words: *XRF analysis, gold coins, stater, Philip, Alexander, Lysimachus.*

Cuvinte cheie: *analize XRF, monede de aur, stater, Filip, Alexandru, Lysimach.*

Introduction

The earliest precious metal coins attested in the Geto-Dacian territories were the electrum staters from Cyzicos, struck in the 6th century BC. From the first discoveries there were several coins of 1/6 stater (hekté) found at Istros during archaeological excavations and also the great hoards from Orlovka (on the Danube, Odessa region, in western part of Ukraine) and Cuzgun (Ion Corvin), Constanța County¹. ROMARCHAEOMET program XRF analysis on a hekté from Cyzicos discovered in 1955 at Istros reflects the following electrum composition: Au 57.1%, Ag 39.0%, Cu 2.7%. The transition from the electrum coins to the gold ones was made during the reign of Cresus, king of Lydia (561-546 B.C), which was one of the richest regions from Minor Asia in gold ore. The Persian expansion during the reign of Darius I

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¹ Vilcu, Isvoranu, Nicolae 2006, 12.

(522-486 BC) was followed by the introduction of the darics, well refined gold coins having a title between 96.3% and 98.7%². Their presence in the West Pontic region was recently proved by a hoard discovered in Dobroudja³. After they thhad an important impact in the regions of Minor Asia, Balcan Peninsula, and the entire area of Greek influence from the border of the Black Sea during the 5th to the 4th century BC, the Cyzicos electrum issues and the Persian darics were finally replaced with the Macedonian staters of a high title (99%) struck by Philip II, Alexander the Great and Philip III. There were several factors contributing to the rise of the Macedonian stater in Dacia from the end of the 4th century BC and the beginning of the next one: the recruitment of mercenaries, commercial exchanges, and political subsidies from the West Pontic Greek cities to the local kingdoms. The penetration in Dacia of the Philip II, Alexander the Great and later Lysimachus type staters is well attested by important discoveries (coin hoards from Anadol, Mărășești, Gâldău and Dăeni). Alexander the Great type staters become the prototype of the gold coins for a long time after king's death in the entire Hellenistic world of the 3rd century BC. As a direct consequence of the Empire' division between the main generals of Alexander the Great, the central power lose the control over the gold coins mintage, so that the posthumous issues were struck not only by the Hellenistic kingdoms but also by a great number of Greek cities becoming again independent. The lifetime Lysimachus type staters, in the name of the new king of Thrace, had a great impact in the entire area, becoming prototypes for many gold coins struck from the 3rd to the 1st century BC in a great number of Greek cities from Minor Asia and Balkan Peninsula. This is the reason why the chronology and the mint identity of several gold issues of Alexander the Great and Lysimachus type are still difficult to specify. So, investigating the compositional analysis together with the study of the numismatic material we can make significant progress. During ROMARCHAEOMET program there were analysed 134 staters (Philip II, Alexander the Great, Philip III and Lysimachus type) from Macedonian kingdom, West Pontic Greek cities, Asia Minor, Middle East and Egypt from the collections of the „Vasile Pârvan” Institute of Archaeology of the Romanian Academy and Cabinet des Médailles from the Library of the Romanian Academy (Bucharest) – with a special interest for the gold coins from Istros, Tomis and Kallatis⁴.

Experimental methods

The characteristic X-ray based elemental analysis method used was X-Ray Fluorescence (XRF), which require no sample preparation (the samples are measured practically in any shape delivered), based on two dedicated spectrometers – a portable one and a stationary one. For the portable spectrometer, the exciting X-ray beam is generated by a 40 kV tube with Rh-anode. The detection system is a PIN silicon diode detector with Peltier cooling. The resolution of the detector is 270 eV for the K_α line of Mn (5.89 keV). The measurement spot size is about 30 mm². The X-MET XRF analyzer has a Hewlett-Packard (HP) iPAQ personal data assistant (PDA) for software management and data storage. The stationary spectrometer has a 50 kV Mo-anode tube and a Peltier cooled Si drift chamber detector, with 170 eV resolution for the

² For analysis on darics, see Gondonneau, Guerra 2000, 30.

³ Petac, Talmațchi, Ioniță 2009, 25, no. 49.

⁴ For the identification and illustration of the coins used for this analysis, see Preda, Petac 2006 and also Vilcu, Isvoranu, Nicolae 2006, following the inventory numbers and types from the table.

K α line of Mn (5.89 keV). The typical diameter of the measurement spot is 0.7 mm, but it can be optimized for different tasks to 0.2 mm, 0.6 mm, 1 mm or 2 mm with four integrated – software controlled – collimators. A double video system with different magnifications is used to determine the exact measurement position in the large sample chamber.

The analyses on the coins marked in table with “CNBAR” were made with a X-ray portable spectrometer InnovX Systems Alpha Series type, anticathode W, SIPIN detector with Peltier cooling system; parameters : 35 kV, 40 microA, acquisition time 30 s.

Analysis of the coins

From the oldest Macedonian issues there were analyzed 19 gold coins of Philip II type: eight staters, eight samples of ¼ stater and a single one of 1/12 stater struck at Amphipolis and Pella and another two staters from Abydos. We have a very high title – the highest until this time, higher than any other earlier coin – for the fifth staters of Philip II lifetime (340-336 BC) from Pella (4) and Amphipolis (1), Macedonian kingdom, or between 336-328 BC, during the reign of Alexander the Great: 99.2%-99.5%. We can suppose that for the coins struck during Philip II lifetime were minted using gold from Macedonian mines⁵. Another three coins of Philip II type struck after Alexander the Great death at Amphipolis (2; 323/322-315 BC) and Pella (1; 323/322-310 BC) reflects also a very high title (99.4-99.5%). In a similar situation there are the two Philip II type staters struck at Abydos between 325-318 BC: 99.3%-99.7%. Similar values, between 99.3%-99.9%, were obtained by AAP and LA-ICP-MS investigations made on four lifetime Philip II staters struck at Pella and Amphipolis⁶. Significant title fluctuations (between 98.2% și 99.9%) were noticed for the posthumous Philip II type staters struck during the reigns of Alexander the Great and Philip III⁷. We must be enough cautious, because our collections contains also a number of modern forgeries after Philip II gold coins type and not all of them are easy to identify. So, from the eight analyzed coins of ¼ stater, only five have a normal, high title (over 99.1%), while for other three samples of the same denomination we noticed unusual low values for gold (95.7%, 96.7% and 96.9%) and unnatural high values for silver (between 1.7% and 2.8%). All the three samples have a common element: there are not in the acceptable limits of the metrological standard weighting too much or too less reported to the standard weight (2.15 g) of a ¼ stater. Iconographical and metrological study of the eight coins suggests another modern forgery (CNBAR AV. A 25⁸), despite his high title of gold (more than 99%). We noticed also that the coin was struck using the same pair of dies with the coin CNBAR AV. A 24⁹, a modern fake with a title of only 96.7%. Although they were struck with the same pair of dies, different alloys of gold were used for the two coins, one of them having a high percentage of silver and another one a much lower one. We have a similar coin, struck with the same pair of dies, from the old collections of the National Museum of Antiquities (before 1916) from the „Vasile Pârvan” Institute of Archaeology of the Romanian

⁵ Gondonneau, Guerra 2000a, 100.

⁶ Gondonneau, Guerra 2000, 31 and Gondonneau, Guerra 2000a, 100.

⁷ Gondonneau, Nicolet-Pierre, Guerra 2002, 371.

⁸ Preda, Petac 2006, 16, no.18.

⁹ Preda, Petac 2006, no. 17.

Academy¹⁰. This proves that the three forgeries were made by the same counterfeiter from the second half of the 19th century or beginning of the 20th.

Concerning Alexander the Great type lifetime staters and early posthumous ones (years 323-305 BC), there were made analysis on 18 pieces from Amphipolis (4), Abydos (2), Ake (2), Sardes (3), Sidon (2), Babylon (4) and Memphis (1). From the fourth analysed coins struck at Amphipolis, three belongs to the years 330-320 BC and they have a title between 99.3% and 99.7%. There are quite similar with the values obtained for the posthumous Philip II staters from the years 336-328 BC; in both cases gold are probably coming from the Macedonian mines. The last Alexander the Great type stater struck at Amphipolis¹¹ (IAB 546) shows a combination of symbols and letters (trident and Π• on the reverse, in the left field) unknown to the standard catalogue of M. J. Price¹². We have the same sign Π• on the Philip II¹³ staters assigned by G. Le Rider – with cautions – to the mint of Amphipolis, years 323/322-315 BC. The association of the same two marks was noticed also on the tetradrachms of the same mint, Amphipolis¹⁴. The similar Alexander the Great type staters (with trident or trident with a letter) were assigned also with cautions by M. J. Price to the same mint of Amphipolis, years 330-320 BC¹⁵. The XRF analysis of this coin reflect the following structure: Au 99.7%, Ag 0.1% și Cu 0.1% - normal values for the Alexander the Great staters struck at Amphipolis between 330-320 BC and also for the posthumous Philip II type staters from the same mint, years 323/322-315 BC. All this considerations suggest that the Alexander the Great type stater IAB 546 could be included in a series of gold coins struck at Amphipolis between 323-320 BC.

The analysis made on two Alexander the Great type staters – considered with cautions by M. J. Price as belonging to the mint of Abydos, years 323-317 BC – , seems to confirm the same M. Thompson¹⁶ localisation of the mint. We have a very high title for the both coins (99.5% and 99.6%), similar with that of the posthumous Philip II staters from the same mint, years 323-320 BC¹⁷ and also with that of the Philip III stater from the years 319-317 BC¹⁸. The XRF analysis on Alexander the Great type staters struck in Eastern mints reflects a significant decrease of the title, the usual explanation consisting in the use of the Persian gold¹⁹. The XRF analysis made on the three staters struck in Sardes between 334-323 BC revealed a gold title between 98.3% and 98.9%, sustaining the idea of the use of local gold and the melting of the Persian darics, reusing their gold for the mintage of the Alexander the Great staters in Sardes after the Macedonian conquest. Another argument is represented by the results of AAP and LA-ICP-MS analysis on several Persian darics struck in Sardes, having a gold title between 97.1% and 98.7%²⁰. The melting of the Persian darics and hoards was one of the gold sources for the Alexander the Great type staters struck in the Eastern mints. For example, the eight

¹⁰ Vilcu, Isvoranu, Nicolae 2006, 71, no. 97.

¹¹ Vilcu, Isvoranu, Nicolae 2006, 63, no. 49.

¹² Price 1991.

¹³ Le Rider 1977, 230, no. 267.

¹⁴ Le Rider 1977, 427.

¹⁵ Price 1991, 108-109.

¹⁶ Thompson 1991, 51, no. 165a.

¹⁷ Thompson 1991, 64-65.

¹⁸ Thompson 1991, 64-65.

¹⁹ Gondonneau, Nicolet-Pierre, Guerra 2002, 373-374.

²⁰ Gondonneau, Nicolet-Pierre, Guerra 2002, 372.

stater from Ake (2), Sidon (2) and Babylon (4) have a gold title between 97.5% and 98.9 %. One of the coins from Sidon (IAB 524), undated by M. J. Price, has a similar composition with the other one (IAB 525), struck in 324-323 BC. The results suggest that the coin IAB 524 could be dated to the end of the reign of Alexander the Great. For an Alexander the Great type stater struck at Memphis, in Egypt²¹, years 332-323 BC, variant to the standard catalogue of M. J. Price²² (Price 3966 A var.), the result of the XRF analysis (Au 98.1%, Ag 1.4% și Cu 0.2%) suggests also the use of the local gold. The analyses confirm also different sources of gold for three Philip III type staters struck between 323-317 BC at Abydos, Lampsakos and Babylon.

Alexander the Great type staters from the West Pontic Greek cities received a special attention between the ROMARCHAEOMET program. A significant series of Alexander the Great type staters struck at Kallatis between 250-225 BC (Price chronology)²³ presents a special interest. The entire lot was analyzed from the point of view of the letters or monograms from their reverse, following the order of the standard catalogue of M. J. Price²⁴. There were investigated 34 staters illustrating most of the numbers from the catalogue. The Alexander the Great type stater Price 890, without monogram, was attributed to Kallatis on the single reason of its presence in the Mărășești hoard. It has a very high title (99.7%). Investigating eight staters of Price 894 and 896 types, we noticed some obverse die-links between them, so the two types were struck almost in the same time despite their different monograms from the reverse. The XRF analyses show that the coins Price 896 have a better title (99.6% and 99.9%), so there are probably struck the first. For the second type (Price 894) the title has fluctuations between 99.6% and 97.8%. We have also a consistent group of staters of Price 910 type (10 samples) and there were struck with four different obverse dies. Fluctuations of the gold title are more important, from 99.8% to 96.4%; there are not so extensive for Price 914 (99.6% to 98.8%). The similar style of the two issues suggests that there were struck in the same time or one after another over a short period. The coins Price 915 show a stylistic connection with Price 914, so it is quite probable that there were struck in the same period. It has a better gold title (99.7%). The style changes for Price 916 despite their apparently similar monograms with Price 915. We analyzed a single coin, having a very low title (95.4%). Both considerations suggest that the staters Price 916 are one of the last Alexander the Great gold coins struck at Kallatis. All our analyses show that we have for each Price' series coins with a very high title (99.8%) and also low title samples (95.4%). The stylistic observations and the distribution of the analyses results for each pair of dies suggest the mintage of the above mentioned series of Alexander the Great staters from Kallatis in a very short period. All data (metal title, style, discoveries) sustain the mintage of the most series of the Alexander the Great staters from Kallatis at the middle of the third century BC, almost in the same time, in the context of the war with Byzantion.

We have also some data on a very rare coin, an Alexander the Great type stater from Istros (Price 964), struck before the first Lysimachus type gold coins of the same city²⁵. XRF analysis reflects a very high title (99.8%), similar to the values of the same type gold coins from Kallatis that we have just considered as from the middle of the 3rd century BC.. The stylistic features, the title and also the structure of the monetary discoveries (the hoards from

²¹ Vilcu, Isvoranu, Nicolae 2006, 63, no. 48.

²² Price 1991, 497, no. 3966 A var.

²³ Price 1991, 176.

²⁴ Price 1991, 176-179.

²⁵ Petac 2009, 18.

Anadol and Dăeni) sustain the attribution of this Istros coin to the middle of the 3rd century BC. This data and the exceptional character of the mintage of the Alexander the Great type staters from Istros suggest that the most probable reason was again some payments in the context of the war against Byzantion as an ally of Kallatis.

The ascension of Lysimachos as king of Thrace in 306-305 BC was followed by the appearance of a large number of coins bearing on the reverse his name. In a great number of cities from the Asia Minor or the Balkan Peninsula their mintage continue also after the death of the king. One of the most difficult problems of the posthumous Lysimachus type staters struck during the 3rd century is to identify where and when some series of coins with different monograms and styles were struck. We analyzed a number of 50 Lysimachus type staters, lifetime and posthumous issues, struck during the 3rd-1st centuries BC. The most of them are West Pontic issues, the coins minted at Istros, Tomis and Kallatis presenting a special interest. Several coins struck in the 3rd-2nd century BC in Byzantion and Chalcedon were used to compare the results. The oldest analyzed Lysimachus type staters were struck in Lysimacheia in 297 BC, having a quite high title (99.6%), similar to the lifetime Philip II and Alexander the Great staters. Other coins struck in Asia Minor before or soon after 281 BC (as it is a stater from Alexandria Troas) seem to maintain a similar high title. A significant volume of Lysimachus type staters were struck in Byzantion and Chalcedon at the middle and the second half of the 3rd century BC. Despite the still existing major difficulties concerning their chronology and even their localization, the XRF analysis reflect the existence of at least two series of coins; one of them (staters with spiral, struck at Byzantion) have a superior title of gold: 98.4% and 98.6% (CNBAR AV. B 70 and CNBAR AV.A 143), while the second one (also staters with spiral and Δ in the left field) have a significant lower title: 96.4% (CNBAR AV. B 66). There is also a stater with spiral on throne but also having a simple trident in the exergue struck in the second half of the 3rd century BC with a superior title (98.9%). We have a similar situation for the first Byzantion issues having spiral on throne and decorated type trident in the exergue. For the staters struck at the end of the 3rd - beginning of the 2nd century BC with letters BY on throne and decorated trident in the exergue we notice significant fluctuations for the gold title (from 99.5% to 97.8%). The title continues to decrease for the Byzantion staters struck around 150 BC (94.5%). We have significant results for two Chalcedon issues, one of them having a bull in the exergue and another one having in the exergue $Z\Omega\PY$. There are contemporary and seems to have the same source for the precious metal.

The results are surprising for two Lysimachus type staters considered from Tyras²⁶. One of them (Au 98.2%, Ag 1.7% și Cu 0.1%), with trident in the exergue, could be considered rather from the beginning of the 2nd century BC; the second one, without trident, has a significant lower title (Au 97%, Ag 2.8%, Cu 0.1%); despite this situation, the style suggests years c. 280- c. 240 BC.

From Orghidan collection we have analyzed a very rare coin, a Lysimachus type stater from Istros, without spiral on throne, and the structure is at follows: Au 98.9%, Ag 1.0% și Cu 0.1%. These results and the stylistic features suggest that it belongs to a series from the second half of 3rd century BC.

²⁶ Preda, Petac 2006, 5-6.

For the Lysimachus type staters struck at Tomis and Kallatis in the first decades of the 1st century BC, during the Mithridatic wars, we notice the significant fluctuations of the title (90% to 97%). Unfortunately, we are not in the situation to determine the sources of gold of the West Pontic Greek cities at the beginning of the 1st century BC. It is quite clear that the mintage of the late Lysimachus type staters from Istros, Tomis and Kallatis it is related with the payments of the soldiers of Mithridates VI Eupator from these cities²⁷. In this context the most plausible is that the source of gold must be searched in the Pontic Empire of Mithridates VI (Macedonian mines but also those from Bosporan kingdom or Minor Asia).

Conclusions

XRF analysis on Philip II staters show that they have a title superior to all others gold issues struck until then (over 99.6%), the most plausible sources being the Macedonian mines. This high level of the title it is maintained also for the posthumous Philip II staters, struck in the first years of Alexander the Great reign. For the Alexander lifetime staters and also for those struck between 323-305 BC we notice decrease of the title, especially of those from the Oriental mints (Ake, Sydon, Babylon but also Memphis from Egypt), suggesting the Persian and Egyptian gold as a possible source of gold. We saw a different situation in Amphipolis and Abydos, their staters continue to have a very high title, the most plausible source of gold being represented by the ore from the Macedonian mines. The analysis seems to suggest also different sources of gold for the staters in the name of Philip III struck between 323-317 at Abydos, Lampsakos and Babylon. We concentrate our posthumous Alexander the Great staters analysis from the 3rd century BC on Kallatis issues. The results suggest the mintage of a series of Alexander the great type stater sat Kallatis at the middle of the 3rd century BC, in the context of the war against Byzantion. It seems that a very rare stater of Alexander the Great type from Istros belongs to the same period. The analysis on a consistent lot of Lysimachus type staters show that the lifetime Lysimachus gold coins have a high title. The title decrease significantly for the posthumous Lysimachus type staters struck at Byzantion, Chalcedon and other West Pontic Greek cities during the second half of the 3rd century BC. We have a significant fluctuation (90% to 97%) of the title for the late posthumous Lysimachus type staters struck at Istros, Tomis and Kallatis in the first decades of the 1st century BC, during the Mithridatic wars. The most plausible source of this gold must be searched in the Pontic Empire of Mithridates VI Eupator.

²⁷ Poenaru Bordea 1999, 155-164.

Table 1. Greek gold coins. XRF concentrations
(expressed in weight percents)

Type	Au (wt %)	Ag (wt %)	Cu (wt %)	References
Pella, stater, Phillip II (Le Rider 117)	99.4	0.3	<0.1	CNBAR AV. A 11
Amphipolis, stater, Phillip II (Le Rider 154)	99.5	0.3	<0.1	CNBAR AV. A 17
Amphipolis, stater, Phillip II (Le Rider 177)	99.5	0.4	<0.1	CNBAR AV. A 18
Amphipolis, stater, Phillip II (Le Rider 209)	99.4	0.5	<0.1	CNBAR AV. A 19
Pella, stater, Phillip II (Le Rider 209 A)	99.2	<0.1	0.4	CNBAR AV. A 13
Pella, stater, Phillip II (Le Rider 349)	99.4	0.4	<0.1	CNBAR AV. A 12
Pella, stater, Phillip II (Le Rider 373)	99.5	0.3	0.2	IAB 494
Pella, stater, Phillip II (Le Rider 462)	99.5	0.3	<0.1	CNBAR AV. A 15
Pella, ¼ stater, Phillip II (Le Rider 71)	99.4	0.4	<0.1	CNBAR AV. A 20
Pella, ¼ stater, Phillip II (Le Rider 128j)	99.6	0.3	<0.1	CNBAR AV. A 21
Pella, ¼ stater, Phillip II (Le Rider 128)	95.7	2.5	1.7	CNBAR AV. A 22
Pella, ¼ stater, Phillip II (Le Rider 80 a)	99.8	<0.1	<0.1	CNBAR AV. A 23
Pella, ¼ stater, Phillip II (Le Rider 83)	96.7	2.8	<0.1	CNBAR AV. A 24
Pella, ¼ stater, Phillip II (Le Rider 83)	99.1	<0.1	0.8	CNBAR AV. A 25
Pella, ¼ stater, Phillip II (Le Rider 85)	96.9	1.7	1.4	CNBAR AV. A 26
Pella, 1/12 stater, Phillip II (Le Rider 16)	99.7	<0.1	<0.1	CNBAR AV. A 27
Pella, ¼ stater, Phillip II (Le Rider 58b)	99.8	0.1	0.1	IAB 499
Abydos, stater, Phillip II (Thompson 1991, 75)	99.3	0.3	<0.1	CNBAR AV. A 14
Abydos, stater, Phillip II (Thompson 1991, 72)	99.7	0.2	<0.1	CNBAR AV. A 16
Amphipolis, stater, Alexander (Price 172c)	99.7	<0.1	0.1	IAB 509
Amphipolis, stater, Alexander (Price 175b)	99.5	<0.1	0.1	IAB 508
Amphipolis, stater, Alexander (Price 175a)	99.3	0.4	0.3	IAB 488
Amphipolis, stater, Alexander (Price -, Vilcu, Isvoranu, Nicolae 49)	99.7	0.1	0.1	IAB 546
Abydos, stater, Alexander (Price 1524)	99.5	<0.1	0.1	IAB 522
Abydos, stater, Alexander (Price 1524)	99.6	<0.1	0.1	IAB 512
Ake, stater, Alexander (Price 3264)	97.5	1.7	0.5	IAB 515
Ake, stater, Alexander (Price 3276)	98.4	0.8	0.3	IAB 521
Sardes, stater, Alexander (Price 2532)	98.3	0.8	0.3	IAB 528
Sardes, stater, Alexander (Price 2532)	98.5	0.8	0.6	IAB 531
Sardes, stater, Alexander (Price 2539)	98.9	0.7	0.1	IAB 513
Sidon, stater, Alexander (Price 3471)	98.7	0.8	0.1	IAB 524
Sidon, stater, Alexander (Price 3490)	98.4	0.9	0.5	IAB 525
Babylon, stater, Alexander (Price 3748)	98.9	0.5	0.5	IAB 527
Babylon, stater, Alexander (Price 3721)	97.9	1.2	0.4	IAB 519
Babylon, stater, Alexander (Price 3715)	97.9	1.4	0.3	IAB 514
Babylon, stater, Alexander (Price 3715)	97.8	1.4	0.4	IAB 1182
Memphis, stater, Alexander (Price 3966A var., Vilcu, Isvoranu, Nicolae 48)	98.1	1.4	0.2	IAB 516
Lampsakos, stater, Philip III (Price P11)	99.3	0.5	0.1	IAB 555
Abydos, stater, Philip III (Price P36)	99.2	0.5	0.1	IAB 557
Babylon, stater, Philip III (Price P178a)	98.8	0.5	0.4	IAB 556
Athens, stater (SNGDelepieire, 1485)	99.2	0.4	0.1	IAB 593

Kallatis, stater, Alexander (Price 890)	99.7	0.1	0.1	CNBAR AV. A 41
Kallatis, stater, Alexander (Price 894)	99.6	0.1	<0.1	CNBAR AV. A 42
Kallatis, stater, Alexander (Price 894)	98.3	1.1	0.4	CNBAR AV. A 45
Kallatis, stater, Alexander (Price 894)	98.2	1.6	0.1	CNBAR AV. A 46
Kallatis, stater, Alexander (Price 894)	98.7	0.8	0.4	IAB 523
Kallatis, stater, Alexander (Price 894)	97.8	1.7	0.4	IAB 510
Kallatis, stater, Alexander (Price 894)	98.8	0.7	0.4	IAB 1181
Kallatis, stater, Alexander (Price 896)	99.6	0.1	<0.1	CNBAR AV. A 43
Kallatis, stater, Alexander (Price 896)	99.9	0.1	<0.1	CNBAR AV. A 44
Kallatis, stater, Alexander (Price 897)	98.8	0.4	0.4	CNBAR AV. A 47
Kallatis, stater, Alexander (Price 897)	99.5	0.4	<0.1	CNBAR AV. A 48
Kallatis, stater, Alexander (Price 897)	98.3	1.6	<0.1	CNBAR AV. A 49
Kallatis, stater, Alexander (Price 903)	99.5	0.3	0.1	CNBAR AV. A 50
Kallatis, stater, Alexander (Price 906)	98.2	1.6	<0.1	CNBAR AV. A 51
Kallatis, stater, Alexander (Price 909)	98.9	0.3	0.5	CNBAR AV. A 58
Kallatis, stater, Alexander (Price 910)	99.3	0.4	<0.1	CNBAR AV. A 52
Kallatis, stater, Alexander (Price 910)	99.8	<0.1	<0.1	CNBAR AV. A 53
Kallatis, stater, Alexander (Price 910)	99.7	0.2	<0.1	CNBAR AV. A 54
Kallatis, stater, Alexander (Price 910)	99.4	0.3	<0.1	CNBAR AV. A 55
Kallatis, stater, Alexander (Price 910)	96.4	3.2	<0.1	CNBAR AV. A 56
Kallatis, stater, Alexander (Price 910)	99.8	<0.1	<0.1	CNBAR AV. A 57
Kallatis, stater, Alexander (Price 910)	99.8	<0.1	<0.1	CNBAR AV. A 59
Kallatis, stater, Alexander (Price 910)	98.2	1.5	<0.1	CNBAR AV. A 60
Kallatis, stater, Alexander (Price 910)	99.8	<0.1	<0.1	CNBAR AV. A 61
Kallatis, stater, Alexander (Price 910)	97.5	1.82	-	CNBAR AV. A 62
Kallatis, stater, Alexander (Price 910-911)	98.8	0.3	0.5	CNBAR AV. A 63
Kallatis, stater, Alexander (Price 914)	99.6	<0.1	<0.1	CNBAR AV. A 64
Kallatis, stater, Alexander (Price 914)	99.6	0.3	<0.1	CNBAR AV. A 65
Kallatis, stater, Alexander (Price 914)	98.9	0.4	0.5	CNBAR AV. A 66
Kallatis, stater, Alexander (Price 914)	99.2	0.4	<0.1	CNBAR AV. A 67
Kallatis, stater, Alexander (Price 914)	98.8	0.8	0.3	IAB 520
Kallatis, stater, Alexander (Price 915)	99.7	<0.1	<0.1	CNBAR AV. A 68
Kallatis, stater, Alexander (Price 916)	95.4	3.6	0.2	IAB 530
Kallatis, stater, Alexander (Price - ; Preda, Petac 100)	99.3	<0.1	0.4	CNBAR AV. A 69
Istros, stater, Alexander (Price 964)	99.8	0.1	0.1	CNBAR AV. A 70
Messambria, stater, Alexander (Price 974 ?; Preda, Petac 129)	99.2	0.4	<0.1	CNBAR AV. A 71
Odessos, stater, Alexander (Price 1134)	99.5	0.5	<0.1	CNBAR AV. A 72
Odessos, stater, Alexander (Price 1135)	99.7	0.3	<0.1	CNBAR AV. A 73
Odessos, stater, Alexander (Price 1135)	98.2	1.3	0.5	CNBAR AV. A 74
Odessos, stater, Alexander (Price 1135)	98.3	1.3	0.4	IAB 487
Odessos, stater, Alexander (Price 1135)	98.3	1.2	0.2	IAB 511
Tyras, stater, Lysimachus (Preda, Petac 260)	97.0	2.8	0.1	CNBAR AV. A 158
Tyras, stater, Lysimachus (Preda, Petac 149)	98.2	1.7	0.1	CNBAR AV. A 155
Istros, stater, Lysimachus (Müller 283)	98.9	1.0	0.1	CNBAR Orghidan 44
Kallatis, stater, Lysimachus (Müller 261)	96.7	2.9	0.1	CNBAR AV. A 138
Kallatis, stater, Lysimachus (Müller 265)	97.2	2.3	0.4	CNBAR AV. A 139
Kallatis, stater, Lysimachus (Müller 265)	94.0	5.4	0.6	CNBAR AV. A 140
Kallatis, stater, Lysimachus (Müller 265)	97.6	1.7	0.4	CNBAR AV. A 141

Kallatis, stater, Lysimachus (Price 938 var.; Preda, Petac 124)	93.1	6.8	0.1	CNBAR AV. A 163
Kallatis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 60)	95.4	3.7	0.6	IAB 570
Kallatis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 59)	94.5	4.5	0.1	IAB 574
Kallatis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 62)	96.8	2.6	0.5	IAB 576
Kallatis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 61)	95.2	4.1	0.6	IAB 575
Tomis, stater, Lysimachus (Pick 1910, 2485)	96.4	3.2	0.1	CNBAR AV. A 144
Tomis, stater, Lysimachus (Pick 1910, 2480)	95.6	3.9	<0.1	CNBAR AV. A 145
Tomis, stater, Lysimachus (Pick 1910, 2480)	94.1	3.7	0.1	CNBAR AV. A 146
Tomis, stater, Lysimachus (Pick 1910, 2482)	95.2	3.7	0.7	CNBAR AV. A 147
Tomis, stater, Lysimachus (Pick 1910, 2476)	95.7	4.1	0.1	CNBAR AV. A 148
Tomis, stater, Lysimachus (Pick 1910, 2481)	98.4	1.2	0.1	CNBAR AV. A 149
Tomis, stater, Lysimachus (Pick 1910, 2481)	97.9	2.0	0.1	CNBAR AV. A 150
Tomis, stater, Lysimachus (Pick 1910, 2481)	96.3	3.6	<0.1	CNBAR AV. A 151
Tomis, stater, Lysimachus (Pick 1910, 2478)	96.3	3.3	0.1	CNBAR AV. A 152
Tomis, stater, Lysimachus (Preda, Petac 141)	96.7	3.2	0.1	CNBAR AV. A 153
Tomis, stater, Lysimachus (Preda, Petac 131)	97.6	2.3	0.1	CNBAR AV. A 154
Tomis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 56)	96.3	2.9	0.4	IAB 579
Tomis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 58)	96.0	3.4	0.1	IAB 578
Tomis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 54)	97.7	1.8	0.3	IAB 561
Tomis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 55)	97.4	2.3	0.1	IAB 581
Tomis, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 57)	91.9	6.6	1.3	IAB 582
Odessos, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 63)	98.0	1.1	0.8	IAB 333
Byzantion, stater, Lysimachus (Müller 226 var.)	97.9	1.7	0.1	CNBAR AV. A 137
Byzantion, stater, Lysimachus (Müller 513; Preda, Petac 61)	96.3	2.4	0.7	CNBAR AV. B. 66 (4226)
Byzantion, stater, Lysimachus (Müller 223; Preda, Petac 80)	97.8	1.6	0.4	CNBAR AV. B. 67 (4227)
Byzantion, stater, Lysimachus (Müller 189 var.; Preda, Petac 73)	99.5	0.3	<0.1	CNBAR AV. B. 69 (4229)
Byzantion, stater, Lysimachus (Müller -; Preda, Petac 60)	98.6	0.3	0.7	CNBAR AV. B. 70 (4230)
Byzantion, stater, Lysimachus (Müller 150)	98.2	1.4	<0.1	CNBAR AV. B 71 (4231)
Byzantion, stater, Lysimachus (Müller -; Preda, Petac 71)	99.7	0.2	<0.1	CNBAR AV. B 72 (4232)
Byzantion, stater, Lysimachus (Müller -; Preda, Petac 75)	99.6	<0.1	<0.1	CNBAR AV. B 73 (4233)
Byzantion, stater, Lysimachus (Müller -; Preda, Petac 63)	98.9	0.4	0.5	CNBAR AV. B 74 (4234)

Byzantion, stater, Lysimachus (Müller -; Preda, Petac 84)	97.5	1.50	0.5	CNBAR AV. B 75 (4235)
Byzantion, stater, Lysimachus (Müller 453; Preda, Petac 58)	99.2	<0.1	0.6	CNBAR AV. B 77 (4236)
Byzantion, stater, Lysimachus (Müller 199; Preda, Petac 74)	94.5	2.7	2.4	CNBAR AV. B 79 (4238)
Byzantion, stater, Lysimachus (Müller 217; Preda, Petac 70)	98.2	1.6	<0.1	CNBAR AV. B 80 (4239)
Byzantion, stater, Lysimachus (Müller -; Preda, Petac 76)	98.6	1.2	<0.1	CNBAR AV. B 81 (4240)
Chalcedon, stater, Lysimachus (Müller 468)	97.8	1.8	<0.1	CNBAR AV. B. 68 (4228)
Chalcedon, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 66)	97.7	1.7	0.2	IAB 563
Chalcedon, stater, Lysimachus (Vilcu, Isvoranu, Nicolae 65)	97.5	1.3	0.2	IAB 562
Lysimachia, stater, Lysimachus (Thompson 1967, 8)	99.6	0.1	0.2	IAB 567
Alexandria Troas, stater, Lysimachus (Müller 99; Thompson 1967, 144)	99.9	<0.1	<0.1	CNBAR AV. B 78 (4237)
Uncertain, stater, Lysimachus (Müller 502 var.)	97.5	2.0	<0.1	CNBAR AV. A 142
Byzantion, stater, Lysimachus (Müller -; Preda, Petac 59)	98.4	1.2	0.1	CNBAR AV. A 143

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