

The Earliest Application of Brass and “Pure” Copper in the Hellenistic Coinages of Asia Minor and the Northern Black Sea Coast

Tat’jana N. Smekalova

Ancient coins were strictly standardized objects in which the newest innovations and achievements in the field of mining, metallurgy, technology, and metrology were concentrated. There were always special requirements for the issue of ancient coins: the best carvers were invited to make the manufacturing dies, and the composition of alloys and the weights and sizes of coins were strictly controlled. The ancient concept of a coin consists of three necessary attributes: good-quality metal, a certain design, and an established weight. The quality of the metal served to guarantee the authenticity of the coins and their ability to measure costs, serve as means of exchange and for accumulating wealth. In spite of the fact that the interest in studying alloys of ancient coins already has a long tradition in numismatic science, it is only now, with the introduction of modern, non-destructive, high-speed analytical methods, that researchers have the opportunity to carry out mass analyses of coin alloys, which are important for providing statistically corrected results. Now it is possible for data from the monetary alloys to be considered in numismatic studies alongside traditional metrological, typological, and die analyses.

Investigations of ancient coin alloys are of considerable importance for the history of metallurgy because unlike other ancient metal wares, coins represent independently dated material that make it possible to determine where and when a particular metal or alloy was used for the first time. Brass (Gr. *oreichalkos*), which is an alloy of copper and zinc, began being used in coins comparatively late, and the question about the beginning of its application is closely connected with the wider problem of the reasons for and time of the introduction of different copper-based alloys in coinage.

This study is based on analyses of coins from the collections of the State Hermitage Museum (St. Petersburg), the State Historical Museums (Moscow), and the Historical-Archaeological Museum (Kerch).¹ Analyses were carried out by means of two independent analytical methods: X-ray fluorescent spectroscopy and measurements of electrical conductivity of coins. The method of X-ray fluorescent spectroscopy has proven very useful in numismatic research² alongside neutron activation analysis.³ The method of electrical conductivity

has previously rarely been used for studying the alloys of ancient coins. Both methods of analysis are non-destructive, high-speed and complementary, and they make it possible to analyse not only the surface layer, but also, to some degree, the core of a coin. Several thousand coins from the main collection of the State Hermitage Museum, minted in the ancient Greek cities in the northern, western and southern Black Sea coastal areas, some areas of Asia Minor, Egypt, and North Africa have been investigated. One of the important research aims was to identify when, why and how new copper-based alloys (brass and "pure" copper) were introduced in the coinages.

Until the end of the 1960's, the common opinion was that the earliest application of brass was for the striking of coins of Augustus in 23 BC, when coins from two different alloys began being issued: asses from more or less "pure" copper and sesterces and dupondii from brass.⁴ However, already at the beginning of 20th century, analyses of the brass coins circulating prior to the age of Augustus were published. They were coins of the Roman proconsuls in Asia Minor in the years 45, 32, and 31 BC.⁵ Some coins of Julius Caesar can also be considered experimental issues from brass.⁶ Investigations carried out in the laboratory of the British Museum in 1970 showed however, that brass was used in coinage already in the 80's-70's BC, at least half a century earlier than previously thought.⁷ It was determined that the earliest coins from brass were minted during the reign of Mithridates VI in the Pontic Kingdom and in Phrygia and Bithynia. This conclusion was based on the analysis of 83 Hellenistic coins belonging to the coinages of Syria, Macedonia, Rome, Mysia, Phrygia, Pontos, Bithynia and Iberia of the 4th-1st century BC.

Ancient literary sources and results of modern research confirm that brass was a quite rare alloy in antiquity. P.T. Craddock has carried out thorough analyses of all available research results, and this shows that early regular use of brass in antiquity is recorded only for the area of Phrygia. Among the earliest objects are a handle in the geometric style dated to the 8th-7th century BC and Phrygian brass fibulae manufactured from an alloy of copper with 10 % zinc⁸ found in the excavation of the city of Gordion. The earliest application of brass in Etruscan objects probably dates to the 5th century BC.⁹

The earliest ancient Greek literary sources (7th century BC) refer to a copper-zinc alloy or *oreichalkos* (unlike *chalkos* – bronze or copper) as something special and expensive (Hes. *The Shield* 122; Hom. *Hymns* 6.9). Even in the 4th century BC, Plato in *Kritios* (*Criti.* 114e, 116b, 116d, 119c) describes *oreichalkos* as a very valuable material and relates that though gold was considered the most precious of all metals known to the inhabitants of Atlantis, *oreichalkos* followed right after it. Brass was apparently used rather seldom in Greece.¹⁰ In Bosphoros, brass became known in the 1st century BC. According to the investigations of M.J. Treister,¹¹ about 10 % of the analysed metal objects dated to this time were made from brass. In the 3rd century BC, only very few objects made from brass are known. Possibly, coins were the first mass-produced objects made from brass by the Greeks.



Fig. 1. Pontic anonymous obol "head in leather cap, l./eight-rayed star, bow, monogram". State Hermitage Museum Collection, no. 12447. "Pure" copper. 20.51 g.

As mentioned above, the question of the use of brass in ancient coinage is closely connected to the wider question of the use of different copper-based alloys – brass, copper and bronze – for striking coins of different face values. The results of numerous studies testify that before the turn of the 2nd and 1st century BC, the only alloy used for striking coins of the smallest denominations was bronze.¹² At this time the new alloys "pure" copper and brass began being used in the coinage. The study of the coins from State Hermitage Museum Collection revealed that perhaps the earliest coins struck from "pure" copper were the so-called Pontic anonymous obols of the type "head in leather cap/eight-rayed star" (Fig. 1). These have variously been considered to be coins of the satraps of Mithridates VI in Bosporos or in Kolchis¹³ or the coins of Mithridates VI himself¹⁴ or of his predecessors¹⁵ in Pontos. It has also been suggested that they were issues of the temple state of Komana Pontike during the early years of the reign of Mithridates VI.¹⁶

It is highly probable that the Pontic anonymous obols were issued in Pontos as additional means to cover the military expenses of Mithridates VI. The image of the head in the leather cap or *kyrbasia* usually depicted Persian satraps,¹⁷ and this tradition has deep roots going back to the 5th century BC.¹⁸ It may be possible to date these coins more accurately since they have similarities with coins of the Pontic cities of the type "head of young man/sword" (RGAM, 54, no. 30, pl. VII, no. 23). Recently, François de Callataj proposed uniting the coins of this type with the types "head of Perseus/Pegasos" (Fig. 2a) (RGAM, 55, no. 32, pl. VIII, no. 25-26) and "head of Dionysos/cista" (Fig. 2b) (RGAM, 53, no. 24, pl. VII, nos. 14-16) in the same issue.¹⁹ As will be shown below, the two last types of coin were made of "pure" copper and brass. One could thus suppose that the Pontic anonymous obols were struck at a time not too distant from the time these coins of the Pontic cities were issued, and that this was the first time the alloys, "pure" copper and brass were introduced in the coinage.

Pontic anonymous obols were probably overvalued coins. They were issued partly as a substitute for silver coins. Therefore, it was necessary to strike them from "pure" copper, rather than bronze, to distinguish these coins from the other regular issues and thereby decrease the risk of fakes. Perhaps they were issued in Pontos to be used in Bosporos, since four out of six coins with a known provenience have been found in Bosporos.²⁰



Fig. 2. a) Amisos, "head of Perseus, r./Pegasus, monograms". State Hermitage Museum Collection, no. 12056. "Pure" copper. 12.19 g. b) Amisos, "head of Dionysos, r./cista, monogram". State Hermitage Museum Collection, no. 33318. Brass. 8.40 g.

Thanks to the investigations of the British Museum Research Laboratory, it was discovered that several mints in Pontos and Paphlagonia (Amisos, Dia and Chabakta) simultaneously issued coins of the type "head of Perseus/Pegasus" (ca. 12.17 g) struck of "pure" copper and coins of the type "head of Dionysos/cista" (ca. 4.00 g) struck in brass (Figs. 2a-b). There also exist one further, rather rare type of coin, "head in wolf exuvie/Nike" (RGAM, 56, no. 38, pl. VII, no. 30), which was struck in brass. The investigation of the Pontic coins in the collection of the State Hermitage Museum confirms this result, and it certifies that in Pontos around 90-70 BC, coins of different face values struck in two different alloys were simultaneously issued. All other coin types in Pontos and Paphlagonia issued during the reign of Mithridates VI were struck in bronze with a small amount of lead added.

The coins of the type "head of Dionysos/cista" were possibly the earliest but not the only example of brass being used for coins during the reign of Mithridates VI. Starting in the 80's BC, some of the coins of Mysia and Phrygia were made from brass as well, and this appears to be connected to the expansionist policies of Mithridates VI.

In 89/88 BC, large parts of Asia Minor were conquered by Mithridates VI. He appointed regional and urban satraps to rule the newly acquired territories (App. *Mith.* 21). The coins issued in many mints of this period bear signs of Mithridatic influence not only in the choice of types, face values, and imagery, but also, as will be shown, in the choice of alloys.

Starting in 89/88 BC, a new style of royal tetradrachm began being issued in Pergamon. They are dated according to a new Pergamenean era, and specimens of the years from 1 to 4 are known. Together with the tetradrachms, coins from copper-based alloys were issued. The biggest denomination had on the obverse the head of Athens with the legend "Mithridates" below, and on the reverse a standing Asklepios with the name of the city below (Fig. 3a) (*BMC Mysia*, 127, nos. 129-134, pl. XXVI, no. 7). The results of the investigations in the laboratory of the British Museum and in the State Hermitage Museum has shown that the coins were struck in brass with a zinc content of less than 15 %. The coins of the other denominations, which are quite frequent,



Fig. 3. a) Pergamon, "head of Athena, below "ΜΙΘΡΑΔΑΤΟΥ"/Asklepios standing". State Hermitage Museum Collection, no. 14395. Brass. 2.78 gr. b) Pergamon, "head of Asklepios, r./eagle on thunderbolt". State Hermitage Museum Collection, no. 14380. Brass, 7.81 g. c) Pergamon, "head of Athena, below inscription/owl on a palm branch". State Hermitage Museum Collection, no. 14415. Brass. 2.78 g.

were struck in copper-based alloys and bear the names of city magistrates. The images on these coins are connected with the cults of Athena and Asklepios (*BMC Mysia*, 135-138, 144-149, 151-157, 158-162, 163, 172-175, 183-184, 187-188, 195-204), and they date to 85/84 BC and later. Coins of some types (*BMC Mysia* 144-149, 187-188, 195-204) were produced from brass with a small amount of zinc (several percent), (Figs. 3b-c); the other coins were struck in tin-lead bronze. One may suppose that the tradition of striking coins in brass in Pergamon started during the reign of Mithridates VI. Perhaps this issue was connected to the victories of Mithridates at the beginning of the first war with Rome. Other regions of Mysia struck bronze coins with a large amount of lead (up to 27 %) as well.

There is a very interesting monetary series issued by Apameia from approximately 89/88 BC until the middle of the 1st century BC, which consists of coins of four different face values (*BMC Phrygia*, 74-75). This issue is probably connected to the military campaign of Mithridates VI in the year 89/88 BC. The coins of the highest denomination of this series are struck in brass and show "head of Athena/eagle on thunderbolt, meander, pilei" (Fig. 4) (*BMC Phrygia*, 77, no. 45, pl. X, nos. 4-5). The coins of the smaller denominations of the same issue are made of bronze.



Fig. 4. Apameia, "head of Athena/eagle on thunderbolt, meander, pilei". State Hermitage Museum Collection, no. 17060. Brass. 5.76 g.



Fig. 5. a) Akmoneia, "head of Athena/eagle on thunderbolt, name of magistrate "ΘΕΟΔΩΤΟ"". State Hermitage Museum Collection, no. 16962. Brass. 7.58 g. b) Dionysopolis, "head of Dionysos/Dionysos standing, name of magistrate "MENE[KA]"". State Hermitage Museum Collection, no. 17166. Brass. 9.47 g. c) Eumeneia, "head of Dionysos/tripod, name of magistrate "MENEK", below "ΑΣΚ"". State Hermitage Museum Collection, no. 17203. Brass. 7.33 g. d) Philomelion, "head of Nike, behind palm branch, stamp with eagle in round depression/two cornucopiae, eight-rayed star and crescent, below "ΣΚΥ"". State Hermitage Museum Collection, no. 17350. Brass. 9.39 g.

There are also coins made of brass in other cities in Phrygia: Akmoneia (Fig. 5a) (*BMC Phrygia*, 4, nos. 1-2, pl. II, no. 6), Dionysopolis (Fig. 5b) (*BMC Phrygia*, 182, nos. 3-5, pl. XXIII, no. 3), Eumeneia (Fig. 5c) (*BMC Phrygia*, 211, nos. 3-6, pl. XXVII, no. 3), and Philomelion (Fig. 5d) (*BMC Phrygia*, 353, no. 3, pl. XLI, no. 12). As a rule, they are the coins of the highest denominations and they bear types with Mithridatic symbols (eight-ray stars, eagle on thunderbolt, head of Dionysos, and standing Dionysos with panther by his legs, as on the coins of Pantikapaion). Moreover, they bear the names of the magistrates with patronymics as on the coins of Apameia. It is thus possible to date the all these issues to the time of Mithridates VI.

In Appianos' description of the First Mithridatic War (*App. Mith.* 20), there is evidence to suggest that the first use of the new alloys was in fact related to the activities of Mithridates. Appianos testifies that in 89/88 BC, Mithridates captured Pergamon and moved his capital there (*App. Mith.* 52). And the issue of coins of the type "head of Athena/Asklepios standing" made of brass began to be struck here. We also know from Appianos that Apameia, one of the centres of the Roman province of Asia in Phrygia, had willingly gone over to the side of Mithridates, and it was probably for this reason that Mithridates donated 100 talents to the town to repair the damage done by an earthquake. Scholars have seen a connection between this and the beginning of the issuing of cistophori with the abbreviation ΑΠΙΑ.²¹ Besides silver coins, Apameia also issued the copper-based coins in four denominations mentioned above.

Mithridates himself led the advance into Phrygia, Mysia, and the Roman province of Asia (App. *Mith.* 24), and at the same time the towns of Akmonia, Dionysopolis, Eumeneia, Philomelion struck large coins in brass with Mithridatic images and symbols. Laodikeia on the Lykos, on the other hand, was probably the first town to oppose Mithridates and undergo a siege (App. *Mith.* 24; Strab. 12.8.16). It seems that Laodikeia did not receive any aid from Mithridates afterwards – in any case, there were no brass coins or coins with Mithridatic symbols. It seems reasonable therefore to attribute the introduction of brass coinage to the help of Mithridates to friendly cities, and hence to date their beginning closely to 89/88 BC.

From the very beginning, different alloys were used for coins of certain denominations, while different alloys were never used for coins of the same denominations. This made it possible to distinguish the coins of higher face values from the ones of copper-based alloys, which were used for smaller denominations. The brass coins could probably replace silver money, at least for inner-market payments.

The introduction of new alloys in the coinage was apparently dictated by the necessity of finding additional monetary resources to prepare for the large-scale military operations. It is most probable that these pioneer issues were introduced in the period of preparation for and the peak of the first war with Rome, which put pressure on all the resources available for Mithridates VI. The greatest quantity of tetradrachms of Mithridates VI was also issued during the years prior to the beginning of military campaigns. According to the study of Callataj,²² based on coins from the largest European numismatic collections, 55 tetradrachms are known from the period from 96 to 91 BC, while 145 coins are known from the shorter period from 90 to 87 BC. The issue of tetradrachms the following year was apparently determined by the continuation of the war with Rome. So, in 86 and 85 BC, a significant amount of tetradrachms (50 coins) was struck. Subsequently, the mints issuing silver coins slowed down for a number of years. In the period 84-77 BC, only 12 tetradrachms are known. A last peak of production coincides with the period of preparation for the third war with Rome in 76-74 BC, when 101 tetradrachms are known. Finally, the striking of royal tetradrachms came to a halt in 73-66 BC, a period from which only 11 coins have been found.

One of the main reasons Mithridates carried out military operations in Asia Minor was to gain control of the gold, silver and other metal mines situated in different parts of the area. It seems that the preparation for the war with Rome demanded such an enormous amount of resources from the Pontic king that he had to experiment with new monetary alloys to solve the problem of finding additional monetary sources.

Strabon (12.3.19) described Pharnakeia as a region known for its mines: iron mines in his times and previously also silver mines. Ancient mines of gold and silver are known near the modern villages of Giresun and Ordu in Pharnakeia. Copper mines are situated in Pontos and Bithynia, Paphlagonia,



Fig. 6. Bosphoran anonymous obol, "head of Dionysos, r./bowcase, monogram". State Hermitage Museum Collection, no. 27534. "Pure" copper. 20.95 g.

Pharnakeia and Lesser Armenia.²³ Mixed copper-lead-zinc ores are known in only two places in Asia Minor. The first area, according to Strabon (12.3.19) and also to modern investigations, is situated in Chaldis south of Pharnakeia. The second is situated in Phrygia.²⁴ Strabon mentions that *oreichalkos* was manufactured from the ores found in the mines close to Andeira (Strab. 13.56). It is possible that the mines near Andeira can be identified with the mines at Balya Maden near Balikesir in north-western Anatolia.²⁵ Balya Maden is known for its silver mines, but poly-metallic ores, such as silver-ferrous galena and sphalerit were also mined there. The ores also have a rather high content of arsenic.

The experiments with new alloys also took place on the territory of Bosphoros, on which the power of the Pontic king Mithridates VI was expanded towards the end of the second century BC. During the study of the Hellenistic coinages of the northern Black Sea another type of coin was discovered, which was struck in "pure" copper, namely the Bosphoran anonymous obols with "head of Dionysos/bowcase" (Fig. 6). The fact that the Bosphoran anonymous obols were made of "pure" copper was verified through the analysis of a large number of coins. In total 1163 Bosphoran anonymous obols were analysed. Only seven of these (0.6%), all showing signs of overstriking, were made of bronze, the other 1158 coins were made of pure copper.

It seems reasonable to connect the issue of the Bosphoran anonymous obols with the beginning of the reign of the son of Mithridates in Bosphoros. Plutarch says that: "For he [Mithridates] himself had wrested Asia from the Romans, and Bithynia and Cappadocia from their kings, and was now set in Pergamum, dispensing riches, principalities, and sovereignties to his friends; and of his sons, one was in Pontus and Bosphorus, holding without any opposition the ancient realm as far as the deserts beyond Lake Maeotis" (Plut. *Sull.* 11.2). Thus, during the period of the greatest success of Mithridates VI in the wars with Rome, i.e., 89/88 BC, one of his oldest sons, Mithridates the Younger, was satrap in Bosphoros and Pontos. Probably the Bosphoran anonymous obols were first issued in 89/88 BC. The many different monograms on them and the stylistic changes suggest a rather extended period of issuing of these coins. N.A. Frolova has counted 50 different monograms, many of which are similar to the monograms on the Pontic municipal coins.²⁶ It should, however, be noted that many of the monograms published by N.A. Frolova represent different spellings of similar names. This phenomenon is well-known from



Fig. 7. Monograms on the Bosporan anonymous obols.

the mints of many Greek cities during the Hellenistic period.²⁷ Grouping the monograms there are about 16 different groups left, which could correspond to approximately the same number of annual magistrates (Fig. 7). If magistrates changed annually, we can suppose that the Bosporan anonymous obols were issued for at least 16 years (in reality, we could probably increase this number to 20-25 years). If we accept 65 BC as the final year these coins were issued (the end of the rule of the son of Mithridates in Bosporos), then production must have started in the beginning of the 80's BC, possibly in 89/88.

Some of the monograms on the Bosporan anonymous obols corresponds to the monograms on the royal tetradrahms of the years 89/88, 87/86, 86/85, 79/78, 76/75, 75/74, and 73/72. Thus, it is possible to conclude that Bosporan anonymous obols were struck from about 89/88 BC to the end of the reign of Mithridates. Thus the introduction of the Bosporan anonymous obols corresponded to the above-mentioned series of Pontic coins, struck in brass and "pure" copper, and consequently, to the issuing of Pontic anonymous obols. The question of where the Bosporan anonymous obols were struck is still open. They may have been produced in Pontos and brought from there along with Pontic tetrachalkoi to be circulated on Bosporos. According to the observations of Ju.S. Kruškol and N.A. Frolova, many of the monograms on the Bosporan anonymous obols are similar to those on the Pontic and Bithynian municipal coins.²⁸ This could perhaps indicate that the same magistrates were responsible for the issuance of the Bosporan anonymous obols and the coins of the



Fig. 8. Bosporan coins of the first Mithridatic period. a) Pantikapaion, "head of Dionysos/deer running, thyrsos". State Hermitage Museum Collection, no. 27164. Silver. b) Phanagoreia, "head of Artemis/flower". State Hermitage Museum Collection, no. 27362. Silver. c) Pantikapaion, "head of Poseidon/prow". State Hermitage Museum Collection, no. 27137. Bronze. d) Pantikapaion, "head of Artemis/stag lying". State Hermitage Museum Collection, no. 27138. Bronze. e) Phanagoreia, "head of Artemis/stag lying". Bronze.

cities of the Pontic Kingdom. It seems that during the reign of Mithridates, Bosporan towns received the right to strike coins, but I agree with Callataj that the presence of the names of the towns does not automatically mean that they were autonomous.²⁹ Perhaps the Bosporan towns had the same degree of quasi-autonomy as the Pontic cities.

The first Mithridatic issue in Bosporos was silver coins of the type "head of Dionysos/stag running" (Pantikapaion, Gorgippia) (Fig. 8a). Some of these coins were overstruck on Amisean silver coins of the type "Athena/owl" (Fig. 9).³⁰ The silver of these coins was of the same good quality as that of the Amisean coins. Phanagoreia was striking silver coins with "head of Artemis/rose" (Fig. 8b). The early bronze coins of the types "head of Poseidon/prow" (Fig. 8c) (Pantikapaion) and "head of Artemis/stag lying" (Figs. 8d-e) (Pantikapaion, Phanagoreia) were struck in bronze with a small amount of lead, which is characteristic also for the Pontic coins. Therefore, it may be assumed that during the early period silver and bronze for Bosporan coinage was delivered from Pontos.

Since some of the Bosporan silver coins have been overstruck on Amisean drachms, this period should be dated until 96/95 BC, when municipal silver coinage apparently was stopped in Pontos and royal tetradrachms began being struck there.³¹ The start of the first Bosporan period corresponds to the

Fig. 9. Amisos, "head of the nymph Amisa with turreted crown/owl". State Hermitage Museum Collection, no. 11944. Silver drachm.



first use of Dionysian symbols on the coinage, which can be dated to around 102/101 BC. This is when the name of Mithridates appeared with the epithet "Dionysos" for the first time on the monument in honour of Mithridates in the sanctuary of the Samothracian Kabeiroi on Delos.³²

The second period in the Bosphoran coinage starting around 96/95 BC, is characterised by types relating to Dionysos. Pantikapaion, Phanagoreia and Gorgippia issued didrachms of the type "Dionysos/wreath and bunch of grapes", drachms "Artemis/stag feeding", and hemidrachms "Dionysos/thyrsos", which were all made of poor quality silver. These cities also issued obols of the type "Men/standing Dionysos" and tetrachalkoi "Dionysos/tripod" (Fig. 10d-e). Almost all the coins have common monograms, and only three different monograms are found. Therefore the second period was probably rather short. The monograms on the Bosphoran coins are similar to the monograms on the Pontic coins of the types "Aigis/Nike", "Athena/Perseus", "Ares/sword", "Dionysos/cista", and "Dionysos/thyrsos". The silver alloy of the Bosphoran coins during this period is of a very bad quality. The alloy contains more than 50 % copper. Many of bronze coins of this period were overstruck on the Pontic obols "Athena/Perseus" and "Zeus/eagle", and tetrachalkoi "Aigis/Nike". We can date this period from about 96/95 BC, when the Amisean drachms stopped being issued to about 89/88 BC.

The beginning of the third Mithridatic period in the Bosphoran coinage (approx. 89/88 BC) is connected to the establishment of the son of Mithridates as ruler of Bosphoros during the peak of the first war against Rome. Around 80 BC there was an anti-Mithridatic movement in Bosphoros, which was stopped by Mithridates VI, who appointed another son, Machares, as the new ruler of Bosphoros (App. *Mith.* 67). During this entire period from 89/88 BC until about 65 BC, no coins were issued with names of cities in Bosphoros. Only anonymous coins were issued (Fig. 6), and these were circulated along with the Pontic coins, mostly Sinopean tetrachalkoi of the later type "Zeus/eagle". Thus, the numismatic data and historical evidence indicate that during this period Bosphoros was a satrapy under the Pontic Kingdom. Bosphoran anonymous obols were overvalued coins and served to replace silver coins, which were not struck in Bosphoros at this time.

The fourth period was very short, lasting only from 65 to 63 BC. All the Bosphoran anonymous obols were overstruck on coins of Pantikapaion of the type "head of Apollon/eagle". This is very easy to determine because the material of all of these coins is pure copper. Almost all the Pantikapaian tetrachalkoi of this period of the type "head of Apollon/tripod" were overstruck



Fig. 10. Bosphoran coins of the second Mithridatic period. a) Phanagoreia, "head of Dionysos/wreath and bunch of grapes". State Hermitage Museum Collection, no. 27355. Silver drachm. b) Pantikapaion, "head of Artemis/stag feeding, monogram". State Hermitage Museum Collection, no. 27158. Silver drachm. c) Phanagoreia, "head of Dionysos/thyrsos, monogram". State Hermitage Museum Collection, no. 27404. Silver drachm. d) Pantikapaion, "head of Men/Dionysos standing, monogram". State Hermitage Museum Collection, no. 27184. Bronze obol. e) Gorgippia, "head of Dionysos/tripod, monogram". State Hermitage Museum Collection, no. 27519. Bronze tetrachalk.

on Pontic coins of the type "Zeus/eagle on thunderbolt". No silver coins were struck in Bosphoros during this period.

After the death of Mithridates no more coins were struck in brass and pure copper for a period of time. Only during the time of the proconsuls C. Clovius and Q. Oppius in 45-44 BC, were brass coins issued again. They had a weight of 15 and 12 g., which corresponded to the weight of asses, but they were dupondii, so they had twice the value of an ass.

A quarter of a century later, Augustus started to issue brass sesterces and dupondii, as well as pure copper asses and quadrances. The transition to striking coins from brass and copper involved a transition to coins of conventional value. Brass and "pure" copper were chosen for this purpose because they were practically novel alloys for minting. Additionally, the complexity of the metallurgical process needed to produce brass and the scarcity of zinc ores, made it rather easy to establish a state monopoly on the use of brass exclusively in the coinage.³³ It was therefore possible to give the coins made from brass an artificially high value, and consequently they brought considerable income to the state.³⁴ Copper was chosen alongside brass because it had rarely been used before for striking coins, so it was a convenient material for overvalued coins.

This system worked so well that it existed for more than two and a half centuries throughout the vast territory of the Roman Empire. But it should be remembered that Mithridates VI, the greatest enemy of Rome, was the first to introduce a bimetallic system in copper-based coinage.

Notes

- 1 I would like to express our sincere gratitude to the keepers of the collections, N.A. Frolova and A.L. Žoltikova, for giving me the opportunity to carry out measurements of the compositions of the alloys.
- 2 Stos-Gale 1986, 978-1021; Bui, Calliari, Milazzo, Martini & Vismara 1993, 229-235; Hawkens, Merrick & Metcalf 1966, 98-138.
- 3 Gordus 1967, 76-86; Beuchesne, Barrandon, Alves, Gil & Guerra 1988, 187-197.
- 4 Caley 1964, 45-68.
- 5 Bahrfeldt 1905, 42.
- 6 Crawford 1974, 11.
- 7 Craddock, Burnett & Preston 1980, 53-64.
- 8 Craddock 1978, 3-4.
- 9 Craddock 1978, 4.
- 10 Craddock, 1978, 4-5; Craddock 1977, 103-123.
- 11 Treister 1992, 91-92.
- 12 Treister 1992, 91-92.
- 13 Imhoof-Blumer 1890, 40; Imhoof-Blumer 1897, 254; Imhoof-Blumer 1912, 81; Giel 1886, 4; Minns 1913, 287; Zograf 1951, 186; Kleiner 1955, 6.
- 14 Baldwin 1913, 284.
- 15 Kolb 1926, 26; Golenko 1969, 141, 144.
- 16 Saprykin 1996, 106-121.
- 17 There were also images of kings wearing tiara – for example Mithridates I Kallinikos of Kommagene on the bronze coins from the 90's BC (*BMC Galatia*, 104, nos. 1-3, pl. XIV, no. 7) and Mithridates II (Guadan 1957, 28-29).
- 18 Zahle 1982, 101-112.
- 19 Callataj 2005, 124-125.
- 20 Golenko 1969, 135.
- 21 Kleiner 1979, 122.
- 22 Callataj 1987, 55-66.
- 23 Jesus 1980, 397.
- 24 Jesus 1980, 397; Caneva, Palmieri & Sertok 1988; Cowell, Craddock, Pike & Burnett 2000.
- 25 Craddock 1988, 294-295.
- 26 Frolova 1996, 165.
- 27 Rogalsky 1975, 3-9.
- 28 Kruškol 1952, 140-141; Frolova 1996, 166.
- 29 Callataj, 2005.
- 30 Golenko 1969, 29.
- 31 Golenko 1969, 34.
- 32 Maksimova 1956, 203 and Kreuz in this volume.
- 33 Grant 1946, 88; Craddock 1978, 1.

- 34 Burnett, Craddock & Preston 1982, 267-268. The cost of *oreichalkos* was probably twice that of bronze, as it is possible to judge from the fact that Republican asses with a weight of more than 25 g., were transformed by Augustus to dupondii weighing 13.65 g. The weight of a dupondius from brass was considerably lower than the weight of two post-reform asses of copper, see Zograf 1951, 53; Grant 1958, 287; Grant 1946, 90.

Bibliography

- Bahrfeldt, M. 1905. Die Münzen der Flottenpräfekten des Marcus Antonius, *NumZ* 37, 9-57.
- Baldwin Brett, A. 1913. Les monnaies de bronze dites incertaines du Pont ou du Royaume de Mithridate Eupator, *RevNum* 17, 285-313.
- Beauchesne, F., J.N. Barrandon, L. Alves, F.B. Gil & M.F. Guerra 1988. Ion beam analysis of copper and copper alloy coins, *Archaeometry* 30, 187-197.
- Bui, C., I. Calliari, M. Milazzo, R. Martini & N. Vismara 1993. Sigloi, monetazione licia: evidenze critiche della analisi X.R.F, in: *Actes du XIe Congrès de numismatique, Bruxelles 8-13 septembre 1991*. Louvain, 229-235.
- Burnett, A.M., P.T. Craddock & K. Preston 1982. New light on the origins of orichalcum, in: T. Hackens & R. Weiller (eds.), *Proceedings of the 9th International Congress of Numismatics, Berne, September 1979*. Louvain, 263-268.
- Caley, E.R. 1964. *Orichalcum and Related Ancient Alloys. Origin, Composition and Manufacture with Special Reference to the Coinage of the Roman Empire*. New York.
- Callataÿ, F. de 1987. La politique monétaire de Mithridate VI Eupator, roi du Pont, 120-63 av. J.C.), in: *Rythmes de la production monétaire, de l'antiquité à nos jours. Actes du colloque international organisé à Paris 10 au 12 janvier 1986*. Louvain, 55-61.
- Callataÿ, F. de 2005. Coins and archaeology: the (mis)use of Mithridatic coins for chronological purposes in the Bosporean area, in: V. Stolba & L. Hanestad (eds.), *Chronologies of the Black Sea Area in the Period c. 400-100 BC*. Aarhus, 119-136.
- Caneva, C., A.M. Palmieri & M.K. Sertok 1988. Mineral analysis in the Malatya area: some hypotheses, *Arkeometri Sonuçları Toplantısı* 4, 39-47.
- Cowell, M., P.T. Craddock, A.W.G. Pike & A.M. Burnett 2000. An analytical survey of Roman provincial copper-alloy coins and the continuity of brass manufacture in Asia Minor, in: B. Kluge & B. Weisser (eds.), *Akten XII. Internationaler Numismatischer Kongress, Berlin 1997*. Berlin, 670-677.
- Craddock, P.T. 1977. The composition of the copper alloys used by the Greek, Etruscan and Roman civilisations. Part 2. The Archaic, Classical and Hellenistic Greeks, *Journal of Archaeological Science* 4, 103-123.
- Craddock, P.T. 1978. The composition of the copper alloys used by the Greek, Etruscan and Roman civilisations. Part 3. The origins and early use of brass, *Journal of Archaeological Science* 5, 1-16.

- Craddock P.T., A.M. Burnett & K. Preston 1980. Hellenistic copper-base coinage and the origins of brass, in: W.A. Oddy (ed.), *Scientific Studies in Numismatics* (British Museum Occasional Paper, 18). London, 53-64.
- Crawford, M.N. 1974. *Roman Republican Coinage*, Vol. II. London.
- Giel, C. 1886. *Kleine Beiträge zur antiken Numismatik Südrussland*. Moskva.
- Frolova, N.A. 1996. Towards a history of Bosporan coinage (1st century B.C.), *AncCivScytSib* 3, 151-168.
- Golenko, K.V. 1969. Pontijskaja anonimnaja med', *VDI* 1, 130-154.
- Gordus, A.A. 1967. Quantitative non-destructive neutron activation analysis of silver in coins, *Archaeometry* 10, 78-86.
- Grant, M. 1946. *From Imperium to Auctoritas*. Cambridge.
- Grant, M. 1958. Asses of orichalcum, in: H. Ingholt (ed.), *Centennial Publication of the American Numismatic Society*. New York, 285-302.
- Guadán, A.M. de 1957. Bronze de Mithridates II de Commagene, *Numisma* 7, 28-29.
- Hawkins, S.C., J.M. Merrick & D.M. Metcalf 1966. X-ray fluorescent analysis of some Dark Age coins and jewellery, *Archaeometry* 9, 98-138.
- Imhoof-Blumer, F. 1890. *Griechische Münzen*. München.
- Imhoof-Blumer, F. 1897. Zur Münzkunde des Pontus, von Paphlagonien, Tenedos, Aiolis und Lesbos, *Zeitschrift für Numismatik* 20, 254-288.
- Imhoof-Blumer, F. 1912. Die Kupferprägung des mithradatischen Reiches und andere Münzen des Pontus und Paphlagoniens, *NumZ* 45, 169-192.
- Jesus, P.S. de 1980. *The Development of Prehistoric Mining and Metallurgy in Anatolia* (BAR International Series, 74). Oxford.
- Kleiner, F.S. 1979. The late cistophori of Apameia, in: O. Mørkholm & N.M. Waggoner (eds.), *Greek Numismatics and Archaeology. Essays in Honour of Margaret Thompson*. Wetteren, 119-130.
- Kleiner, G. 1955. Pontische Reichsmünzen, *IstMitt* 6, 1-21.
- Kolb, P. 1926. Monnaies de bronze incertaines du Pont. Remarques sur l'article de M'lle Baldwin à propos de la découverte d'une monnaie nouvelle, *RevNum* 29, 23-28.
- Kruškol, Ju.S. 1952. Monety s monogrammami iz Patrejskogo klada 1950 g., *VDI* 3, 137-147.
- Maksimova, M.I. 1956. Antičnye goroda jugo-vostočnogo Pričernomor'ja. Moskva-Leningrad.
- Minns, E.H. 1913. *Scythians and Greeks*. Cambridge.
- Rogalski, A. 1975. Po vyprosa za monogramite na magistratite pri grytskite moneti, *Numismatika* 10.4, 3-9.
- Saprykin, S.Ju. 1996. *Pontijskoe carstvo*. Moskva.
- Stos-Gale, Z. 1986. X-ray fluorescence and lead isotope analysis, in: M. Price et al. (eds.), *A Survey of Numismatic Research 1978-1984*. London, 978-1003.
- Treister M.Ju. 1992. Bronzolitejnoe remeslo Bospora, *SoobMuzMoskva* 10, 66-110.

Zahle, J. 1982. Persian satraps and Lycian dynasts. The evidence of the diadems, in: *Proceedings of the 9th International Congress of Numismatics, Berne, September 1979*. Louvain, 101-112.

Zograf A.N. 1951. *Antičnye monety* (MatIsslA, 16). Moskva-Leningrad.

Abbreviations

BMC Mysia W. Wroth 1892. *British Museum. Catalogue of Greek Coins of Mysia*. London.

BMC Galatia W. Wroth 1899. *British Museum. Catalogue of Greek Coins of Galatia, Cappadocia and Syria*. London.

BMC Phrygia B.V. Head 1906. *British Museum. Catalogue of Greek Coins of Phrygia*. London.

RGAM W.H. Waddington, E. Babelon, & Th. Reinach 1904-1912. *Recueil général des monnaies grecques d'Asie Mineure*. Paris.