Ancient Methone

2003–2013

Excavations by Matthaios Bessios, Athena Athanassiadou, and Konstantinos Noulas

Volume 1

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FRONTISPIECE
Sketch of Methone, September 12, 2012, by Anne Hooton,
looking east across the archaeological site, with the Thermaic Gulf beyond,
including the delta of the Haliakmon River and Mt. Chortiatis in the distance

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METALLURGICAL CERAMICS FROM THE HYPOGEION

Samuel Verdan

INTRODUCTION

Among a variety of other finds, the Hypogeion at Methone has yielded the remains of a range of metallurgical activities, in various forms: metal waste products, slag, and, especially, fragments of refractory ceramics. This material, the study of which is only in its early stages, is both abundant and of high quality. To the best of our knowledge, it is virtually unparalleled in Greece for the period in question (end of the 8th/beginning of the 7th century B.C.). It is of interest for two reasons: it provides us with information about the different types of craftsmanship (and industries) that complemented the trading activities well attested at the site, and it sheds new light on metalworking technologies at the beginning of the Archaic period, about some of which—most notably, goldworking—little is known. For these reasons the remains, which may seem modest in comparison with other types of material found at Methone, are worth discussing here and will be the subject of more extensive research in the future.

The present discussion is of a provisional nature, for a number of reasons. First of all, the material was surveyed in a very brief and summary manner.[1] As a result, attention was focused on one category of remains in particular, metallurgical ceramics. Other categories (metal waste products and slag) have not yet been examined. It has not been possible to engage in any systematic reassembly of this highly fragmentary material, which makes identification of the items difficult, with the result that only a few observations can be made about the specific technical features of the implements. More to the point, for the moment only a visual assessment has been undertaken, and at this preliminary stage of the study there has been no laboratory analysis. I am well aware that such analysis is indispensable when studying this kind of material, as there is no other way of achieving a detailed understanding of the metallurgical processes that were carried out.[2] With the knowledge we currently have, then, it is possible to list the main types of remains that have been discovered and to describe some of their characteristics. At best, it is also possible to link them with a particular metallurgical activity but, as regards their exact function, the most that can be done is to put forward hypotheses that will need to be tested at a later stage.

The Material under Examination: State of Preservation and Identification

As noted above, the remains associated with metalworking did not receive an exhaustive examination. For the most part observations were confined to the metallurgical ceramics, of which the different categories (crucibles, furnaces, tuyères, melting plates) will be discussed below. The material considered here is what was previously sorted by the excavators. It consists of about a thousand artifacts in a highly variable state of preservation, from small fragments (of a few cm^2) to objects that are almost completely intact, although there are not many examples of the latter. On average, the material has gone through a significant degree of fragmentation, which explains the number of remnants. Indeed, technical ceramics such as crucibles, tuyères, and molds do not benefit from even firing at a high temperature and are therefore more fragile than common pottery. If they are not deliberately smashed after being used,[3] they are particularly liable to being discarded, and thus at the mercy of various post-depositional processes.

The state of preservation of the material makes it difficult to identify individual items. Generally, the presence of metal (in the form of spills, prills, or globules) or signs of exposure to high temperatures (vitrification) make it possible to distinguish metallurgical ceramics from common pottery, but this is not always the case.[4] Often, the absence of distinctive morphological features means that it is impossible to determine whether an item was once part of a particular kind of implement.[5] Lengthy reassembly work and analysis will be required before a more precise identification can be achieved.

General Overview: Which Metals, in Which Proportions?

Among the material under examination, it is possible to distinguish remains associated with the working of at least three "metals": iron, bronze,[6] and gold, in very uneven proportions. At this stage of the study, it is not possible to provide precise quantitative data, as no systematic reassembly work has been undertaken and no rigorous quantification method has been employed.[7] From a cursory estimate, however, a few figures can be extracted: although they remain very approximate, they are still meaningful. Of the almost 130 pieces that can be associated with a metal with relative certainty, only 6% relate to iron, 37% to bronze (and/or copper) and 57% to gold.[8] A second estimate completes the picture: of the just over 200 fragments (or groups of fragments) that have been documented, nine are pieces of slag of predominantly ferrous composition, ten are from tuyères (which cannot always be associated with a particular metal), 44 are from crucibles or furnace walls which relate mainly, but not exclusively, to bronze smelting, and 71 are fragments of melting plates for gold. So, among this material, the evidence for working of gold is most prevalent, directly followed by bronze. In terms of quantity, iron comes some way behind. Nevertheless, it would be advisable to refrain from drawing a definite conclusion about the relative predominance of these metals in the metallurgical activities carried out at Methone. The material examined so far largely consists of ceramics, and not all metalworking processes require recourse to clay materials to the same extent. Moreover, various factors, such as the location of work sites and deliberate sorting of waste products, could have determined what material was deposited (or not) in the Hypogeion. This material cannot be deemed a representative sample of all the metallurgical activities pursued at the site.

Although the great majority of the pieces that have been studied fall into the "technical ceramic" category, and it is not always possible to associate them with a particular metal, I have chosen to structure the discussion with reference to the metals that are known to have been worked at Methone. It will begin, therefore, with the material that relates to iron, then continue with bronze, and conclude with the material with links to goldworking.

IRON

Within the material under study, signs of ironworking are few and far between. They can be summed up as less than a dozen fragments of slag, most of which are small in size. For now, these pieces of slag cannot be assigned to a particular stage (smelting, primary smithing, or secondary smithing) of the iron production process.[9] To say more would require pieces to be much better preserved, coupled with further analysis. The very scarcity of the remains may be a form of evidence in itself. Since ore processing generally produces more waste products (slag and furnace walls) than the other stages of the ironworking process, it is fair to assume that it was not carried out at the site and that our pieces of slag were the byproducts of either primary or secondary smithing. Indeed, one fragment is plano-convex in shape and has a "spongy" look, features that are typical of smithing hearth-bottom slag.[10] Furthermore, it should be noted that smithing does not necessarily demand the use of technical ceramics, with the exception of bellow nozzles, and is a process for which there is a comparatively small chance of evidence being present in the material under examination. The best way of detecting it would be to find hearth sites along with high concentrations of hammerscales in the field.[11] At this point, it is worth recalling the inevitable limitations of a study of metallurgical activities that is based solely on material found in a context of secondary deposition, as is the case here. By way of a hypothesis, I suggest that ironworking at Methone was limited to smithing, for manufacturing and maintaining implements, possibly linked to other metallurgical activities.

BRONZE (AND COPPER?)

For bronzeworking we have the most reliable evidence possible in the form of indications of the final main stage of production (if cold working is excluded): clay and stone molds. These are well preserved and offer information of a specific kind about the items that were produced at the site: pendants and jewelry (see below). This is very fortunate, as these sorts of finds are rare. Stone molds were valuable implements which artisans sought to use for as long as possible. They are not found with other metallurgical waste products, except by accident. Lost-wax molds, in contrast, were smashed and thrown away after use, but the clay of which they were made was often imperfectly fired and can be very badly preserved, according to the conditions of deposition.[12] Consequently, the number of molds that have been recovered from the Hypogeion, and their quality, are worthy of note. It is tempting to base an argument on this material and link the other remains (crucibles, tuyères, and so on) to bronze casting, but it should not be forgotten that other stages of production (especially smelting) could have been undertaken at the site. In developing an interpretation of this material (which will remain in any case provisional until further analysis has been carried out), it is best to bear in mind all possibilities. In order to follow, to a certain extent, the order of the *chaîne opératoire*, I shall begin by discussing the crucibles and fragments of furnaces(?), then the tuyères, and finally the molds.

Crucibles and Furnaces

The fragments of refractory ceramic used in bronze melting (and smelting?) are well represented in the documented material (comprising 44 entries).[13] They may come from either crucibles or furnaces. Initially I am allotting them to one single group, because the preserved fragments are often too small to allow identification with certainty. I will then show that different types of implements can be distinguished, with reference to their morphology and, especially, their size. By contrast, the fragmentary character of the material makes it impossible to reconstruct complete shapes.

The remains of crucibles and furnaces are relatively easy to recognize, as their fabric is coherent. They are made of quite fine clay, which is micaceous (silver mica) and most probably of local origin.[14] No systematic addition of mineral tempers is discernible, contrary to what seems to be the case with local coarse ware.[15] Limestone inclusions, of varying number and size, were probably naturally present in the clay and not added by metalworkers. Conversely, an organic, vegetal temper, which burned with the first use, left numerous clearly visible hollows or voids.[16] This is not at all unusual; several studies have previously shown that organic tempers are useful for this kind of technical ceramic. First, they make the item more resistant before firing; subsequently, their disappearance during firing makes the crucible and furnace walls porous, which improves the refractory properties of the ceramic.[17] The crucibles were probably not fired, at least not at a high temperature as vases were, before their first use, and the furnaces definitely were not. For this reason, they can display highly variable firing characteristics, according to the temperatures and atmospheres (oxidation or reduction) that they experienced. If metal melting or smelting was carried out with a constant supply of oxygen, most items would be of a reddish orange color, tending toward beige on the outside. Nevertheless, it is common to find small areas of a gray to black color. In both the crucibles and the furnaces, the main heat source was inside (see below). As a result, only the inner surface bears the marks of exposure to high temperatures, in the characteristic form of a vitrified layer, a mixture of melted clay, slag, and prills (Fig. 14.1). The thickness of this layer varies, but is generally no more than a few millimeters. Given that the refractory properties of the fabric limit the transfer of heat through the vessel wall, the external surface experiences a markedly lower temperature than the internal surface and retains its original look; often polishing marks can still be seen.

One crucible is sufficiently well preserved for its general morphology to be clear (Fig. 14.1).[18] It is hemispherical in shape and has a diameter of between 18 and 20 cm and a maximum depth of 6.5 cm (the total height of the bowl is 9 cm). Near the rim, its wall is about 1.5 cm thick; at the bottom, it is almost 3 cm thick. Lacking a foot or a base, it has a simple rounded underside. Its most important distinguishing feature is a ledge-handle that is more than 10 cm wide,[19] which projects at a slight angle at the point where the belly lengthens, and which protrudes over the top of the basin, above the level of the rim, by about 4 cm. It was clearly a device for gripping that made it possible to grasp the crucible with tongs during the casting process.[20] There must have been a pouring spout, placed either perpendicular to the handle or on the opposite side, but certainty is impossible as the item is only partly preserved.[21]

By referring to the profile, diameter, and thickness of the walls, it is possible to assign several fragments to crucibles similar to the one described above. In particular, there are two more rims with ledge-handles for gripping. If it is possible to make a judgment on the basis of this limited sample size, this kind of crucible does not seem to have been uncommon at Methone. It should also be noted that its morphology is such that it fits perfectly within the lengthy series of bronze melting crucibles used in the Mediterranean area during the Bronze Age and at the beginning of the Iron Age. It is one of the larger examples: limited as they were by technical constraints (which included handling difficulties, resistance to the weight of the metal, and the need for rapid casting), these crucibles generally have a diameter of less than 20 cm (and of 25 cm at most).[22] It can be estimated that our better-preserved crucible could contain about 0.5 liters, that is, almost 4.5 kg of metal. From this quantity, a significant number of items could have been manufactured in a single casting.

Some of the fragments are too thick or too large in diameter to belong to crucibles of the kind described above. They most probably come from one or several furnaces, the existence of which is indirectly attested by the presence of tuyères with a large diameter. Indeed, the latter were inserted through walls of an installation to blow air on the combustion zone (see below). This kind of cylindrical furnace, with a diameter of 30 cm or more, and which was several dozen cm in height, is well known.[23] It remains to be seen for which stage of production these were used at Methone. If the crucibles are compared with the other evidence for bronze casting, it can be assumed that there was a melting furnace at this site, which made it possible to work much more metal at one time than in a crucible. This sort of apparatus, which was stationary, would have been equipped with a metal-flow

FIGURE 14.1. Large crucible used for bronze melting and casting, ΜΕΘ 5344 (ΜΕ 1928). Photo I. Coyle

system that was stoppered by a plug during the heating phase and released when casting began. This kind of furnace, however, tended to be used for copper smelting, which could also have been carried out on a small scale at the site at Methone.[24] Both solutions are plausible and further analysis is needed to obtain more information.

Tuyères (Bellows Nozzles)

Almost all the production stages in which ore or metal was worked at high temperatures (i.e., smelting, melting, and smithing) required an artificial air supply and therefore the use of tuyères: they were used not only in copper and bronze production but also in the working of iron and gold. Discussion of such tuyères is included in the section on bronze because the best-preserved examples seem to be linked to bronzeworking (or copperworking), but tuyères will also be mentioned in the discussion of goldworking.

Considering the fact that tuyères were frequently used implements, their limited number in the material at the Hypogeion is surprising, especially if this is compared with the total number of documented metallurgical remains. It is true, however, that these consist almost exclusively of those parts of metalworking ceramics which were placed in the hearth and which bear the marks of their exposure to high temperatures. It is probable that the backs of such objects, which were exposed to fire to a limited extent, or not at all, were not preserved, or that they were not identified in the first round of sorting because they lacked distinctive features.

In terms of their fabric, the tuyères can be compared with the crucibles: their clay predominantly contains vegetal tempers. The three best-preserved items are the extruding parts of three tuyères of a similar type (Fig. 14.2). Their cross sections are circular but slightly flattened on four sides (squared), and they have the same dimensions (an external diameter of 5.5 cm and an aperture diameter of 2 cm). In two of the items, it can be seen how they were inserted in the wall of a furnace, directed downward at an angle of about 45°. Only their extruding parts are vitrified: the remainder was protected from the heat by the furnace wall. In one, prills of bronze or copper were caught in the vitrified layer, which gives an initial indication of the type of work for

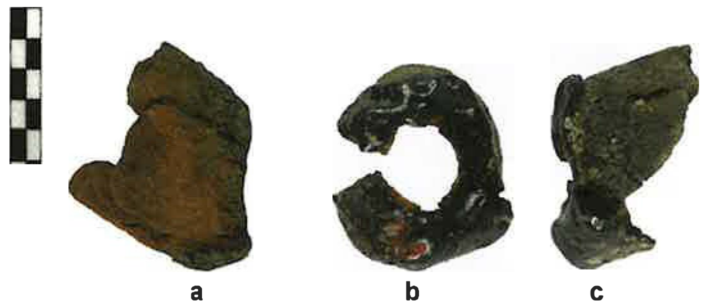

FIGURE 14.2. Tuyère ends: a) MEΘ 5329 (ME 1080); b–c) MEΘ 5330 (ME 2958). Photos I. Coyle

which these tuyères were used. It is worth noting in passing that tuyères with an aperture of this diameter must have been used at the end of a bellow rather than a blowpipe.[25]

Lost-wax Molds

The lost-wax molds, just like the stone molds,[26] are among the most important items of metallurgical material, not only because they offer evidence about the technologies used, but also because they provide detailed information about the objects produced at Methone. Indeed, many of them are sufficiently well preserved for it to be possible to discern the outline of the items they were used to make.

The fabric of these molds is notably homogeneous and can be clearly distinguished from that of other technical ceramics and common pottery: a special paste was mixed for this use. The clay, well fired prior to casting, is quite hard, which explains the good state of the preservation of these molds. In addition to the mica and some limestone inclusions, the paste contained fine mineral tempers that gave the material a rough texture easily recognizable to the touch. The clay was applied around the wax matrix in several successive layers (at least two, and sometimes perhaps four).[27] It seems that the outer layer contained some fine organic (vegetal) tempers. The colors change from the core to the surface. In the middle, the clay that came into contact with the molten metal took on a gray tinge. All around this a purplish area formed. Finally, the color of the outer layer varies between orange and beige.

The majority of the fragments come from molds that were used for casting a kind of pendant well known in northern Greece and generally described as a "jug stopper" or "bottle stopper." It consists of a seated figure, with its elbows resting on its knees and its hands close to its face, on top of a rod with vertical rows of knobs (Fig. 14.3).[28] The mold from Methone is illustrated (Fig. 14.3a), together with two pendants, one in the Ashmolean Museum, Oxford (Fig. 14.3b), the other in the Ny Carlsberg Glypothek, Copenhagen (Fig. 14.3c), that were produced in similar molds. The molds from the Hypogeion provide evidence for the production of a "naturalistic" type, as several scholars have defined it: the body appears to have a certain solidity, as does the head, which is rounded (rather than triangular, as with the more stylized versions). The figure is seated on a circular "platform" and the knobs are clearly distinct from each other.[29] It is generally thought that the more naturalistic types were succeeded by the more stylized types, but for the moment there are no fixed points of dating to which this hypothesis can be linked.[30]

This type of object was for a long time thought to be a jug stopper, a term that is still conventionally used, but it is actually a pendant, which has been found in a number of tombs, associated with other items of jewelry.[31] The geographical regions where these are most common are Macedonia and Chalkidike, as well as Thessaly (for example, the sanctuary of Artemis Enodia at Pherai).[32] On

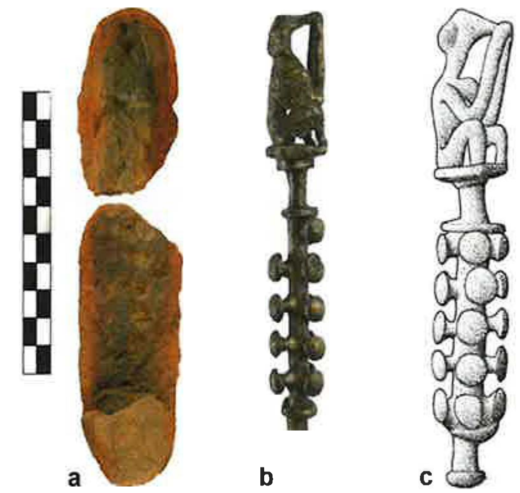

FIGURE 14.3. a) Lost-wax mold of a bronze pendant (so-called "jug stopper"), two non-joining fragments from Methone, upper fragment MEΘ 5337, lower fragment MEΘ 5335. Photo I. Coyle; b) bronze pendant ("jug-stopper") of unknown provenance, H. 10.5 cm, Ashmolean Museum, Oxford, inv. AN1938.365, photo courtesy Ashmolean Museum, University of Oxford; c) bronze pendant of unknown provenance, H. 11.3 cm, Ny Carlsberg Glyptotek, Copenhagen, after Kilian-Dirlmeier 1979, pl. 62, no. 1175

stylistic grounds, Imma Kilian-Dirlmeier has argued that production sites existed in each of these regions.[33] A detailed reconsideration of this issue would be worthwhile (cf. Chapter 26). In any case, Methone is, to my knowledge, the first site for which definite evidence exists for local production of these pendants, and this information is important for understanding how these items were distributed in northern Greece. Furthermore, it provides a new fixed point for the dating of these pendants. On account of the fact that only a small number of such objects have known, securely dated contexts, contradictory opinions have been put forward on the matter of chronology: some scholars have argued that they were produced principally in the 8th century, while others have reckoned that their production began only in the course of the 7th century.[34] Fragments of molds found in the deepest layers of the Hypogeion[35] make it possible to assert at least that the older type (if the notion of a stylistic evolution from a naturalistic to a stylized type is accepted, as was noted above) was already in existence between the end of the 8th century and the beginning of the 7th century.

Some of the fragments of molds are evidence for the manufacture of objects other than "jug stoppers" (pendants). In particular, the outline is discernible of a biconical bead, of a type widespread in northern Greece, which could easily have been found in a set of jewelry along with the pendants discussed above (Fig. 14.4).[36] There is also a conical molded item, which may be a pin head.

FIGURE 14.4. Lost-wax mold fragment for a biconical bead, MEΘ 513 (ME 554). Photo I. Coyle

GOLD

Goldworking leaves very few traces (with the exception of the finished product). Extracting the metal does not require a smelting phase that produces a large amount of slag, as in the case of copper and iron. Generally, craftsmen only handle small quantities at a time, and thus large-scale infrastructure is not required. Moreover, the value of the metal is such that even the smallest remains (such as casting prills, offcuts, and filings) are carefully retrieved so they can be melted down again. As a result, we are familiar with the two endpoints of the production process—on the one hand, the areas delivering up the primary (ore) and placer deposits, and, on the other, the manufactured objects—but the intermediary stages of moving and working the metal remain, for the most part, obscure. In this respect, the Greek world is not exceptional. All discoveries are therefore of significance, and the material unearthed at Methone is especially so, in terms of its quantity and quality, although it is particularly informative about a very specific aspect of gold processing. Indeed, for the moment it has been possible to identify with certainty only one type of ceramic associated with goldworking, the melting plate (see below). Nevertheless, future analysis may reveal other types.

Melting Plates

This material, for which only a few parallels have been published,[37] is clearly less familiar than the crucibles and tuyères. It is, therefore, important to describe it here in detail and to explain precisely how it was used.

The melting plates are fragments of vases (or, possibly, other terracotta implements) reused for goldworking. Consequently, they are of irregular and variable shape. Their fabric also varies, because the sherds may have come from any one of the several different categories of locally made ware present at the site. Metalworkers generally preferred fragments of large coarse ware vessels with a thick wall, in particular pithoi, as this ensured solidity, but use of finer handmade pottery, with less thick walls, is also attested. Conversely, reuse of fine wheelmade pottery is not attested, as this type does not have the features necessary to withstand the thermal stresses produced by gold melting. Given the fragmentary state of the material, it is difficult to say if the sherds were recut in order to be reused. Either way, the few whole (or almost whole) examples (Figs. 14.5–14.6) are not regular in shape (see, for instance, Fig. 14.6). These pieces also supply information about the small dimensions of the melting plates: they vary from between 10 and 16 cm in length, and 8.5 and 12 cm in width. Only one specimen, partially restored from a number of fragments, is larger (as its length is 20 cm). Although the shape of the sherds was not important, it seems that their curvature, by contrast, was a selection criterion. A shallow cavity was needed to collect the molten gold, but the metalworkers most often used fragments from the belly of a vase that were not especially concave, which gives an indication of the function of these plates (see below).

Figure 14.5. Gold melting plate, ΜΕΘ 5331 (ΜΕ 1483). Photo I. Coyle

Figure 14.6. Gold melting plate, ΜΕΘ 5332 (ΜΕ 1419). Photo I. Coyle

Since I am discussing reused ware here, I shall reserve for future study a detailed description of the fabrics for work that focuses on local/regional productions.[38] As noted earlier, most of the melting plates come from handmade coarse ware vessels, which contain a greater or lesser quantity of quartz. This feature deserves emphasis. A number of studies have shown that quartz makes ceramics better able to withstand mechanical stresses and thermal shocks.[39] These refractory properties, which were useful in the case of both large pithoi and cooking pots, might also have been put to good use in goldworking.[40] There is no doubt that the qualities of this ceramic, which contained a high level of quartz, were recognized by the craftsmen.

As on the crucibles, the upper side (i.e., the "inside") of the melting plates is partly covered by a vitrified and bubbly layer (Figs. 14.5–14.8). The vitrification is especially pronounced in the center of the objects and diminishes with distance from this area. At the edges, the clay has often kept its original look.[41] The vitrified layer principally consists of clay that melted when subjected to high temperatures. It is fine (rarely more than 1 mm thick), an indication that it was exposed to heat only for a short time.[42] Its color varies between gray and black, and parts of its surface sparkle. Within this layer the most important signs of goldworking can be seen: the globules and the location of the pellet produced by melting.

The globules of gold are found in highly variable quantities. On some plates, none can be seen with the naked eye, but others are studded with them (Fig. 14.7). The globules are spherical: the smallest visible ones have a diameter close to 100 microns (0.1 mm), but some are much bigger (up to 1 mm in diameter, if not more: Fig. 14.8). The globules are caught in the vitrified layer. They are tiny drops of liquid gold that were trapped in the layer, which during the melting process was of a viscous consistency, and which solidified in place. The globules are of obvious importance because they show which metal was melted on the plates. Moreover, it will be possible to analyze them in order to obtain valuable information about the composition, and consequently the provenance, of the gold (or types of gold) worked at Methone.[43]

Figure 14.7. Gold melting plate fragment, ΜΕΘ 5340. Photo I. Coyle

FIGURE 14.8. Gold melting plate with large gold globule (Diam. 2 mm) and ingot impression, MEΘ 5339 (ME 1924). Photo I. Coyle

In order to understand the stage of goldworking that involves the use of melting plates, another element is just as important as the globules, although it is less shiny and obvious: the "impressions" left by the molten metal in the vitrified layer (Figs. 14.5–14.8). So far, in the assemblages of material similar to ours (at Sardis and Eretria), it has not been possible to discern any marks of this kind.[44] At Methone, they are unmistakably visible on almost a dozen melting plates. On the best-preserved items, it can be seen that they are located approximately in the middle of the plate. They are more or less oval-shaped, and of variable size: the smallest measures 2 x 1.4 cm, the largest 5.5 x 5 cm (it appears to be atypical: Fig. 14.5). Their depth corresponds to the thickness of the vitrified layer (1–2 mm). It is easy to explain how these marks were formed. During melting, the molten gold formed a large drop in the lowest part of the plate (generally the center). The weight of this drop made it sink into the vitreous layer, which was then of a viscous consistency because of the high temperature. Once cooling had taken place, a pellet of metal remained caught in the vitrified layer; this had to be removed, and thus left the aforementioned outline.

THE MELTING OPERATION

Now that the melting plates have been described, it is appropriate to discuss in more general terms the process in which they played a role. Following this, the features of the goldworking carried out at Methone will be considered. The gold melting technique used here is clear. The metal, in a form that remains to be ascertained (see below) and in a quantity that varied (from a few grams to more than 100 g),[45] was placed on the plate and covered with charcoal: heat was supplied from above, as in the crucibles. On this subject, it should be mentioned that the charcoal needed to be fanned for the melting point of gold to be reached (1064° C). Considering the small scale and the speed of the process, as well as the care it demanded (especially if the gold was in the form of dust, and thus crucial not to scatter), it is not very likely that the necessary air was blown by bellows with large tuyères. More probably, the craftsmen made use of blowpipes with a small diameter, which allowed them to direct and control the airflow very precisely.[46] A fragment of fired clay may come from a nozzle that protected the end of these pipes. It contains vegetal tempers (like the crucibles and tuyères) and displays the marks of being exposed to the fire, and was molded on a perishable item with a diameter of 1.2 cm, which may have been a reed stem.[47]

FIGURE 14.9. Two pieces probably belonging to the same gold ingot, hammered and cut, ME 1345 and ME 1346. Photo I. Coyle

FIGURE 14.10. Lower surface of a large gold ingot (112 g, max. L. 6 cm) from the Geometric hoard found in Eretria, Eretria Museum inv. 14948. Photo courtesy École Suisse d'Archéologie en Grèce

Once the gold was liquid, it was very difficult to cast it in a mold with melting plates. These were too irregular in shape and had no fitting in the form of a channel or pouring spout that allowed this sort of operation to be carried out without wastage: with precious metal this is obviously essential. For this reason, the term "crucible" is not used when referring to these implements. The best solution was to let the gold cool on the melting plate and then to retrieve it, as I described above. Consequently, the "end product" of this operation was in the form of pellets of metal, of which two examples have been found at the site (Fig. 14.9);[48] the most striking examples, however, come from the gold hoard discovered at Eretria by Petros Themelis, which dates from the end of the Geometric period.[49] Indeed, this hoard contained many pieces of this kind, some of them whole, but most of them cut into small pieces. The spherical shape of the objects and the irregular look of their lower surface clearly show how they were produced (Fig. 14.10). In the following pages, these pellets will be termed "ingots," according to the common terminology. It should be noted, however, that this term could be misleading, if we have in mind the most common type of ingot nowadays, which is the result of metal casting in a mold. It has a set shape and weight, which allows for a certain level of standardization. Obviously, this does not apply to our ingots, which are of variable shape and size. But the principle, at least, is the same: in both instances the metal is in a form that facilitates its handling, transport, and use.

The melting plates were probably used several times, since it was possible to retrieve the gold without breaking them. Clearly, it was not difficult to obtain them, given that there was no lack of broken vessels, but the metalworkers were well advised to hold on to items with a proven ability to withstand thermal shocks. An indication of this repeated use has been discerned on the specimens from Sardis and Eretria: often the same plate held globules of different composition, a sign that different qualities of gold had been melted there.[50] In this way, one single plate could have served to transform a significant amount of metal.

WHAT SORT OF GOLDWORKING AT METHONE?

Having described the material and melting operation, it makes sense to continue the inquiry by considering for what purposes gold was worked at the site. At this stage of the study, and with the material available, it is not possible to give a definite answer to this question.

The presence of stone molds indicates that jewels were cast, but it has not been determined yet whether they were used for bronze or gold, or for both. For the time being, evidence for bronze casting is plentiful, and absent for gold casting, since the melting plates were not fitted for the casting operation, and real crucibles for gold have not been retrieved as yet. One small-sized example could fit, but its surface shows no traces of the effects of the temperature needed to melt gold (Fig. 14.11). It might have been used for working lead, instead.

Consequently, the general picture that emerges from the data is relatively clear. It does not seem that the manufacture of gold objects was a priority at Methone, as for the moment the only activity for which there is secure evidence is the production of ingots. It is not inconceivable that recovered metal—goldsmithing waste or fragments of jewelry, as found in the Eretria hoard[51]—was melted to produce them, but more probably most of the metal transformed at the site was placer gold. The advantages of the process would have been obvious: from gold dust, which is difficult to handle, ingots were obtained which were easy to transport, weigh, assay, and exchange, and could be used immediately by a goldsmith (in cutting, hammering, stretching, drawing wire, and so on). In order to verify this hypothesis, it will be necessary to analyze the gold.

The example of the gold refinery at Sardis, where melting plates similar to those at Methone have been found, may suggest that gold refining was also practiced at our site.[52] Only analysis will make it possible to say for certain, but this scenario is not very likely. First, the situation at Methone was different from that at Sardis. In the Lydian capital, goldworking was associated with the minting of coins. Refining was genuinely useful for practical reasons: it made it possible to regulate gold composition (by separating it from silver) and so gain a better control of the alloy for electrum coin issues.[53] At Methone, and in Greece more generally before the advent of coinage, this was perhaps not a consideration. The quality of gold obviously mattered and might have been checked when it was used in transactions—probably with a touchstone[54]—but the natural variations in its composition were apparently not of crucial importance, especially if the quantities of metal in question were small.[55] The second point concerns what has been observed about the remains discovered at Sardis and Methone. At first sight, the gold-melting sherds (plates) are the same at both sites, with their globules caught in a vitrified layer. It is surprising, however, that no

FIGURE 14.11. Small crucible perhaps used for lead melting, ΜΕΘ 515. Photo I. Coyle

outlines of ingots have been preserved on the Lydian specimens. This suggests that only very small quantities of gold were melted, as part of the refining process, in order to assay the metal with a touchstone.[56] At Methone, the size and weight of the ingots are much greater than what would have been necessary for an assay: their production was an end in itself. Finally, it should be noted that at Methone, remains of ceramics that could have been used for refining—specifically, parting vessels used for the cementation process[57]—have not been identified, for the time being.

To sum up, I am of the opinion that goldworking at Methone mainly consisted of the transformation of placer gold gathered in the region into a form that could be transported and traded easily. In geographical terms, the site was well placed for the collection of gold. There is no need here to emphasize the number of gold deposits in Macedonia and Thrace; I merely stress that Methone is not far from the mouths of three rivers that were most certainly exploited for their gold in antiquity—the Haliakmon, Axios, and Echedoros/Gallikos).[58] The site, linked as it was to maritime trade networks, was also a good base for the distribution of gold in Greece and the Aegean basin.

THE EUBOIAN *CHRUSIA*?

It is now possible to explore several lines of inquiry that are opening up as a result of the finds at Methone, although their study is only in its infancy. First of all, there is the question of gold circulation in the Greek world during the Early Iron Age and the early Archaic period, about which little is known.

I begin with the origin—or rather, the several possible origins—of the gold used in Greece in this period. Given that data to help advance our knowledge of this complex issue is very scarce, simple hypotheses have been favored: some, for example, think that Egypt was the principal source, while others assume that the supply came by way of the Phoenicians.[59] As this shows, closer sources, including those in northern Greece, are generally overlooked.[60] It is true that neither the geologically attested presence of gold nor the existence of texts that provide evidence for the ancient exploitation of this metal can prove that a region was productive during the Early Iron Age. Archaeological remains must be found, and datable ones at that. This is one of the reasons why the finds from Methone are so important. They strongly suggest that Macedonian gold was extensively exploited at the end of the 8th and in the 7th century, as it already was in the Bronze Age.[61] Of course, it is impossible to estimate how much was extracted in this region and what proportion it represented of the total quantity of gold in circulation in the Greek world. Once again, other areas in the eastern Mediterranean were much richer in gold than northern Greece. What was collected in the north Aegean, however, may have been enough to feed a significant "market" during the period in question.

An emerging body of evidence suggests that the Euboians played a not insignificant role in this precious-metal "market." A starting point is provided by archaeological data: it is hard to attribute to chance alone the finds made at Methone and Eretria, two sites whose history in the 8th century was linked.[62] It is not a question of gold alone, for it was shown earlier that there is a genuine correlation between the metallurgical material in the northern "colony" and the form of the metal in the hoard discovered in the Euboian *metropolis* ("mother-city"). For the time being, there is no proof that the Eretrian gold came from northern Greece. Nevertheless, although it may not make it possible to say for certain, analysis should at least provide information about the plausibility of this hypothesis. Two further arguments are relevant: Strabo's reference to Euboian *chrusia*, and the importance of the Euboian weight system in Greece. In a passage about the Euboian foundation of Pithekoussai, the author of the *Geography* mentions the *chrusia* that contributed to the prosperity of the Chalcidians and Eretrians.[63] The reading and the interpretation of this term have been disputed,[64] and the text does not make clear whether these *chrusia* relate to Pithekoussai in particular or to Euboian activities in general. Either way, in Strabo's account, the Euboians are unambiguously associated with goldworking. The second argument concerns the importance of the Euboian mass standard in Greece.[65] This standard was adopted by the Athenians and Corinthians for their coinage, and was also used to measure the gold tribute paid by each nation (*ethnos*) to the Persian king Darius, according to Herodotus.[66] This may seem implausible, but if the Greek historian was willing to transmit the information it must have had at least an element of truth. It should be emphasized that the passage makes a specific link between the Euboian weight system and gold. This surely means that at one time the Euboians played a special role in the circulation of this precious metal in Greece, and possibly beyond. Moreover, the form taken by the Eretrian gold hoard, comparable to that of many silver hoards discovered in the east, suggests that the metal could be used in "monetary" transactions.[67] This may provide another perspective on the finds at Methone, as they could indicate a starting point in a network in which gold in its raw state was used as a medium of exchange and hoarding, as well as a standard of value. In conclusion, I should stress that the term "Euboian" refers to practices common in the eastern Mediterranean (the system of weights and the "monetary" usage of metal)[68] and most probably the active participation of Levantine trading partners, who may even have been preeminent in taking the initiative. The fact remains that the archaeological evidence and literary sources are in agreement in suggesting that the Euboians were involved.[69]

CONCLUSION

The metallurgical remains from the Hypogeion at Methone are rich and varied, and give valuable information on two issues. First of all, they shed light on metalworking in Greece between the end of the Geometric period and the beginning of the Archaic period, a topic about which relatively little is known even today, and, secondly, they suggest the factors that drew people to the site of Methone at this point in history.

It is already certain that ironworking, bronzeworking, and goldworking were carried out here, but further analysis will be needed to determine precisely which stages of the sequence of operations are concerned, and to make better use of the information of a technological nature. It is worth recalling, too, that all the material was discovered in a context of secondary deposition. Ideally, we should relate these finds to remains on the ground, so as to have a more complete picture of the metallurgical activities carried out at the site and, crucially, of the scale on which this happened: was it a case of casual manufacturing work or, conversely, "industrial" production? Moreover, between these two extremes lies a whole range of possible intermediate solutions.

Fortunately, the material makes it possible to see that at least two categories of objects were produced at the site: bronze pendants and gold ingots. It is possible to trace the spread of the former through northern Greece (although not all the specimens that have been found were manufactured at Methone!), while the latter seem to have been circulated on a large scale, on routes taken by the Euboians and well beyond. These two scenarios show that the site occupied an advantageous position on both maritime and land-based trading networks, and was a point of contact between the Macedonian hinterland, Thrace, and the Aegean.

NOTES

1 I had occasion to study the material during a period of three days, in the archaeological storerooms at Makrygialos, in September 2013. I take this opportunity to thank Manthos Bessios, John Papadopoulos, and Sarah Morris for their invitation and their warm welcome, and the archaeologists from the Ephoreia, Athena Athanassiadou and Kostas Noulas, as well as the museum guards, for the exceptional working conditions at Makrygialos. I also pay tribute to the very substantial sorting work previously carried out, with great care, by the excavators, which made my task much easier. I also would like to thank Elon Heymans for his valuable comments, and Katie Low for the English translation.

2 The direction taken by archaeometallurgical research in the last three decades is a perfect demonstration of this, see esp. Rehren and Pernicka 2008.

3 This is especially the case with lost-wax molds, which need to be smashed so that the cast object can be retrieved. In the material under examination, fragments of molds make up about one-third of the remains.

4 Some items classified as metallurgical remains are probably just cooking ware, the results of unsuccessful firing in a potter's kiln, or other terracotta implements with no connection to metalworking. Conversely, it is likely that a large number of fragments of refractory ceramics remain classified as pottery, primarily as coarse wares, or as weights (for example, Chapter 16, ΜΕΘ 2794, Fig. 16.4, top row, far right, from Phase I of the Hypogeion).

5 For example, distinguishing between fragments of crucibles and furnaces is highly problematic.

6 The term "bronze" is used here for convenience. In the absence of any analysis, however, it would be more correct to use the more neutral expression "copper-base alloys." Moreover, if bronze casting is securely attested by the presence of crucibles and molds, it is also not inconceivable that the copper was worked at the site (at the stage of the smelting process). This possibility will be discussed in the section on bronze, pp. 547-549.

7 For material of this kind, selecting a quantification method (counting the total number of remains, weighing them, or estimating the minimum number of individual items) is in any case difficult.

8 It is important to make clear that the remains of molds are excluded from these figures, as their high rate of fragmentation means they are present in large numbers, and would skew the percentages.

9 On the sequence of operations involved in the iron production process, and the different forms of slag produced, see Tylecote 1987, pp. 151–178, 248–280, 310–321; Craddock 1995, pp. 241–254; Serneels 1993, pp. 43–48; Fluzin, Ploquin, and Serneels 2000; Fluzin et al. 2001, pp. 114–115; Bachmann 1982, pp. 30–33.

10 Tylecote 1987, pp. 318–319; Fluzin, Ploquin, and Serneels 2000, p. 109 (and fig. 42.2); Bachmann 1982, pp. 30–33. For a possible ironsmithing hearth uncovered on the West Hill at Methone in 2014, see Morris et al. 2020, p. 701, fig. 52.

11 For a Greek case contemporary to the finds at Methone, see the example from the excavations at Oropos (Doonan and Mazarakis Ainian 2007).

12 Zimmer 1990, p. 133 (on molds, see pp. 133–139).

13 It should be recalled, however, that no systematic mending has been carried out yet. Several fragments can belong to the same piece, and this is particularly true of furnaces, which could be of large size.

14 On local pottery production, see Kotsonas 2012, especially pp. 126–127.

15 Kotsonas 2012, p. 163; see also pp. 552-554 on melting plates for gold.

16 From the appearance of these marks, the temper must have been chopped straw.

17 This porosity increases the insulating effect of the clay and so limits possible heat loss through the walls (crucibles and furnaces were heated from the inside): see Hein, Kilikoglou, and Kassianidou 2007; Hein et al. 2013.

18 More than half of the piece has been reconstructed from a number of fragments (ΜΕΘ 5344 [ΜΕ 1928]).

19 On account of damage, it is not possible to ascertain its exact dimensions.

20 For a useful parallel on Crete, see Evely, Hein, and Nodarou 2012, p. 1824, fig. 3e.

21 For a pouring spout on the opposite side of the handle, see Evely, Hein, and Nodarou 2012, p. 1824; for a pouring spout placed perpendicular to the handle, see Tylecote 1987, fig. 6.7, 1.

22 Verdan 2007, pp. 354–355 (appendix by W. Fasnacht). Cretan examples from the Late Bronze Age include Evely, Hein, and Nodarou 2012, p. 1822. Hemispherical crucibles there have a diameter of between 10 and 20 cm (and most often between 16 and 18 cm); their internal height is slightly less than the radius, and their volume varies from 250 to 4000 cm^3 (the larger number seems very high, and it probably refers to the total volume of the crucible rather than the volume of metal melted inside).

23 Tylecote 1982, pp. 89–92; 1987, pp. 109–115, 124–125, 182–183; Hein, Kilikoglou, and Kassianidou 2007, p. 143 (Cyprus).

24 To support this scenario, it would be advisable to seek other forms of evidence, in particular pieces of slag. The existence of this production stage was also dependent on the proximity of a source of ore (for the location of copper-mineral deposits in northern Greece, see Pernicka 1987, p. 620, fig. 5).

25 Rehder 1994.

26 For some of the stone molds, see Chapter 1, Figs. 1.16, 1.36; for surface finds, see Chapter 27.

27 For comparison, see Zimmer 1990, pp. 134–135; Hemingway 1996, p. 237.

28 Jantzen 1953; Bouzek 1974b, pp. 76–86; Vickers 1977; Kilian-Dirlmeier 1979, pp. 194–208, pls. 61–73. For further discussion of this type, see Chapter 26.

29 Kilian-Dirlmeier 1979, pp. 194–197, pls. 61–64, nos. 1164–1197.

30 Kilian-Dirlmeier 1979, pp. 206–208.

31 Vickers 1977, pp. 18–19; Kilian-Dirlmeier 1979, pp. 205–206. For two "jug stoppers" associated with other pendants and bracelets in a 7th-century female(?) grave from Axioupolis (in the Axios valley), see Descamps-Lequime 2011, pp. 89–92. For recent discoveries (some in the Haliakmon valley, not far from Methone), see references in Misailidou-Despotidou 2011, p. 57, n. 328.

32 Kilian-Dirlmeier 1979, pl. 107.

33 Kilian-Dirlmeier 1979, p. 208.

34 Vickers 1977, pp. 30–31; Kilian-Dirlmeier 1979, pp. 206–207.

35 It is clear that many fragments belong to lots attributed to the first phase.

36 Bouzek 1974b, pp. 105–117 (figs. 32–33); Vickers 1977, fig. III; Bouzek 1987, pp. 91–100 (see distribution maps figs. 8–9).

37 See *Sardis* 11, pp. 90, 100, 102–117, 126–127, 160–161, 207 (Sardis); *Eretria* XXII, pp. 148–149, pl. 114; Meeks and Craddock 2013, pp. 271–273 (Eretria).

38 A pilot analytical program has been undertaken by the Fitch Laboratory (British School at Athens) on coarse wares found in Methone, aiming to define characteristics of local products. Preliminary results indicate the presence of a number of potentially local fabrics for pithoi, but also of imported pottery from neighboring areas (pers. comm. E. Kiriatzi and X. Charalambidou).

39 Kilikoglou, Vekinis, and Maniatis 1995; Kilikoglou et al.1998.

40 It should be noted that at Sardis, in the gold refinery complex from the Archaic period, the ceramic used to make gold-melting sherds also contains quartz (*Sardis* 11, pp. 158–159).

41 When this happens, it becomes very difficult, if not impossible, to discern with the naked eye fragments of melting plates among the coarse wares.

42 See *Sardis* 11, pp. 126–127, 160–161; Meeks and Craddock 2013, pp. 271–272.

43 For examples of globule analysis, see *Sardis* 11, pp. 102–117 (and table 5.1); Meeks and Craddock 2013, p. 273, table 1.

44 At Sardis (*Sardis* 11, pp. 127, 207), the quantities of molten gold may have been too small to leave visible marks on the plates. At Eretria (*Eretria* XXII, pl. 114, cat. nos. 526–529), the material is fragmentary and items consistently lack a central section.

45 The only pellet/ingot discovered so far at Methone (Fig. 14.9) weighs 10 g (cut into two "halves" weighing 3 and 7 g respectively). In the largest cupule preserved on a melting plate (5.5 x 5 cm) was an ingot at least as big as the largest item in the gold hoard discovered at Eretria, which weighs 112 g (Fig. 14.10).

46 Craddock 1995, p. 177. Blowpipes used in metallurgical activities are depicted on Egyptian tombs (Craddock 1995, p. 178, fig. 5.17; Scheel 1989; Davey and Edwards 2008, figs. 1, 3 [relief in the Old Kingdom Tomb of Mereruka at Saqqara]).

47 It is worth noting that this diameter is itself too great to make an effective blowpipe (see Rehder 1994, pp. 348–349).

48 Most probably two halves of the same piece; note that the flat surface is the result of hammering.

49 Themelis 1981, 1983.

50 *Sardis* 11, p. 109 (sherd 45670U), pp. 116–117 (sherd 45681Z.IV, sherd 45684T), p. 126; Meeks and Craddock 2013, p. 272. The question remains, however, were the different types of gold melted one after the other, or at the same time?

51 Themelis 1983, pp. 162–164.

52 This hypothesis was also advanced with reference to the finds from the sanctuary of Apollo at Eretria, but the results of analysis of the gold disproved it, see Verdan 2007, pp. 348–349; *Eretria* XXII, p. 149; Meeks and Craddock 2013, pp. 271–272.

53 *Sardis* 11, pp. 169–173, 212–213; Craddock, Cowell, and Guerra 2005. On early Lydian electrum coinage, see also Le Rider 2001, pp. 85–100; Keyser and Clark 2001, pp. 115–117.

54 *Sardis* 11, pp. 247–249; Le Rider 2001, pp. 89–90.

55 On the variations in the composition of gold in its natural state, see, for instance, Boyle 1979, pp. 197–207; Chapman, Leake, and Styles 2002. The Eretrian hoard is a perfect case to tackle the issue, since it contains pieces that seem to be of very different composition, according to their color (Themelis uses the term "electrum" for some pieces, see Themelis 1983, pp. 160–161). This point certainly deserves further investigation.

56 This is the interpretation favored by the authors, see *Sardis* 11, pp. 127, 207, 210. Another hypothesis is possible: that the melting plates were used to make blanks to be struck. This method would not have been very productive but would have made it possible to calibrate the weight of the coinage accurately, by preliminary weighing of the quantity of metal to be melted, which is not possible when carrying out casting in multi-cavity molds (for experiments and discussion on this matter, see Faucher et al. 2009, pp. 53–61).

57 *Sardis* 11, pp. 122–124, 127–128, 159–160, 166, 202–208.

58 Mack 1964; Pernicka 1987, pp. 676–677; Vavelidis 2004; Vavelidis and Andreou 2008 (with further references). Placer gold is found in the Haliakmon, Axios, and Gallikos. As yet, its exploitation in antiquity is only attested for the Gallikos, called *Echedôros*, "having gifts," by ancient Greeks (already in Herodotus 7.124 and 7.127; see also *Etymologicum Magnum*, s.v. Ἐχέδωρος). See now the Ada Tepe gold mine in Thrace, in use since the Bronze Age: Haag et al. 2017.

59 See, most recently, Le Rider and Verdan 2002, pp. 147–148; Descoeudres 2008, pp. 306–307.

60 See, for instance, Bakhuizen 1976, p. 85, where he states: "There is no reason to assume that gold was mined (sic) in any of the places occupied by the Euboeans." *Contra,* Tiverios 1998, pp. 249–250; Tiverios 2008, p. 21; Tiverios 2013a, p. 101.

61 Vavelidis and Andreou 2008.

62 Plutarch *Quaest. Graec.* 11, *Mor.* 293A (whether or not the etiological tale of the *aposphendonetoi* is to be believed: Chapter 2). See Hammond 1998, pp. 393–395; Tzifopoulos 2012, pp. 19–21; see also Chapter 28.

63 Strabo 5.4.9.

64 I retain here the reading *chrusia* (χρυσία "gold objects") rather than *chruseia* (χρυσεῖα "gold mines," which definitely did not exist at Pithekoussai), which follows the suggestion of Giorgio Buchner (1979, pp. 136–137) and David Ridgway (1992, pp. 34–35, with further references); more recently, see Lane Fox 2008, p. 135 (in which the author argues that the gold possessed by the Euboians came from northern Greece). In fact, the *chrusia* mentioned by Strabo could refer not to gold artifacts produced in Pithekoussai (as proposed by Buchner and Ridgway), but rather to traded metal (see, first, Bakhuizen 1976, p. 85); *contra*, Radt 2007, pp. 127–128, who dismisses both the translation of *chruseia* by "goldsmiths' workshops" (Mureddu 1972) and the *chrusia* reading. It is worth adding that all of the accepted manuscripts of Strabo 5.4.9 have χρυσία; the variant χρυσεῖα is only in MS Par. Gr. 1408, dating to the 15th century and usually considered an emendation.

65 Kroll 2001, pp. 81–82; 2008a (44, where it is noted "the most influential weight standard of Archaic and later Greece").

66 Herodotus 3.89. The tribute paid in silver, however, was measured in Babylonian talents.

67 Furtwängler 1986, p. 156; Kroll 2001; Le Rider and Verdan 2002; Vargyas 2002. See also Kroll 2008b, and more recently Verdan and Heymans 2020; Heymans 2021 (especially pp. 205–207). On what happened in the east, see especially Balmuth 2001; Le Rider 2001, pp. 1–39; Thompson 2003; Kletter 2003; Heymans 2018a, 2018b, 2021.

68 For the eastern origin of the Euboian weight system, see Kroll 2001, pp. 80–82; Kroll 2008a, pp. 44–46.

69 More on this issue in Verdan and Heymans 2020; Heymans 2021, pp. 203–212.