Bronze in Aegean of the Late Bronze Age: significance of metallurgy, delivering and consumption

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The article is devoted to significance of metallurgy of bronze, delivering of copper and tin into Aegean and consumption of bronze in Mycenaean centers of the Late Bronze Age. Metallurgy of bronze was vital for the formation and development of Mycenaean society. Excavations of shipwrecks in Uluburun and at Cape Gelidonya showed that Cyprus was the main source of copper supplies to Aegean. However, there were also sources of this metal in Lavrion in Greece, the Taurus Mountains of Anatolia, in Israel and in Sardinia. It was generally believed that Mycenaeans held a monopoly on maritime commerce in the Eastern Mediterranean but it was not correct. The discoveries in Uluburun and Cape Gelidonya shipwrecks led to conclusion that ships were Near Eastern in origin or perhaps Cypriot. The scale of supplies allows us to consider it as a real trade in metals. In the mainland Greece, bronze objects were produced in various palace workshops, which are well known from the excavations of Kadmeia - the acropolis of Thebes. Most of the bronze was involved in the production of offensive and defensive equipment. In the process of analyzing of archaeological material from Thebes and literary sources, the educational function of the objects made of bronze, such as tripods, was also revealed. Bronze object served as a mediator of relations between a man and the past.

Key words: bronze, copper, tin, Mycenaean civilization, Thebes, Uluburun shipwreck, Cape Gelidonya shipwreck.

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Introduction

The main aim of this paper is to reveal the centres out of which copper and tin has been received in the Aegean region, to characterize this process, to track the path of supply of the mentioned metals and to discover significance of metallurgy of bronze for Mycenaean civilization.

To achieve this goal, it is required to collect and analyze considerable volume of archaeological (including the nautical one) data and to look into the natural-science investigations allowing one to determine the regions which served as points of origin of the metal. Moreover, the question of the volume of non-ferrous metals delivery into the Aegean region for the purpose of bronze manufacturing is of fundamental importance since mainland Greece — the heart of Mycenaean civilization — practically doesn't keep a reserve of copper and tin. Can it be said that marketing of these metals took place in Late Bronze Age (around 1600–1200 B.C.) or rather this phenomenon should be attributed to the gift exchange between elitist representatives of ancient civilizations? All of the preceding demands an interdisciplinary study, which we have embarked within the framework of the present paper.

The early public-type European civilization has started its formation around 1600 B.C. in mainland Greece. It is conventional to designate it as Mycenaean (named after an archaeological site): Mycenae, parallel with the other such states of mainland Greece, represented an hierarchical power system headed by kings, with advanced bureaucratic machinery, system of written language, interregional exchange within the limits of the Mediterranean, as well as the system of the internal product redistribution over subject territories [1–5].

The fact that development of metallurgy was important for coming into being of Aegean civilizations was substantiated by C. Renfrew [6]. In the researcher's opinion, technological progress has taken place in mechanical arts, primarily pyrotechnic discoveries in pottery. A raw of social changes has affected metallurgy distinctly. Firstly, a need for metal arms has risen due to the military aggression strengthening (which has been archeologically documented by discovery of the Early Bronze Age fortification). Secondly, growth of demand for gold and silver luxury goods has taken place. Thirdly, laying valuable metal objects with the deceased has become customary, which also pushed up demand for such goods in the market. Enlargement of interregional exchange has affected development of metallurgy as well, since additional raw material has become available. The above-mentioned changes have made metallurgy the key factor of civilizations development in the Aegean region. During the period under our

study, bronze has been required practically in all spheres of human activity as the main alloy for Mycenaean civilization. What was the scale of exchange by metals for bronze production and from which regions raw materials has been supplied to Aegean region? Let us look more specifically at the data of nautical archaeology.

Artifacts from the excavations of Uluburun and Cape Gelidonya shipwrecks as a source of data on delivering raw materials for bronze manufacturing into Aegean region

The Uluburun (southern Turkey) shipwreck excavation has discovered the largest and plentiful collection of artifacts and raw material meant for trade exchange dated to XIV B.C. This collection occupies the core place in studying the Mediterranean interregional exchange during Late Bronze Age. There has been lifted up about 17 tons of artifacts, which are under investigation by representatives of scientific community until now (Fig. 1, Fig. 2.1, Fig. 2.2).

Calculations made on the base of the lifted load, show that the total vessel capacity has made up at least 20 tons of the cargo [7]. The most part of the artifacts is of Syro-Canaanite or Cypriot origin. This pointed to the fact that the vessel has been headed toward Aegean and the vessel itself was Syro-Canaan or Cyprian. The first version seems to be convincing, as there could be four Canaanite merchants on board; one of them was the chief one and probably the ship's captain. Such a conclusion has been made on the grounds of analysis of about 150 balance weights. Most of the weights have been based on the reference in shekel (about 9.3 g). Each of four merchants has had two sets of the weights of this standard. One set of weights (with smaller nominal) has been meant for fine weighing of valuable objects and precious metals, and the other one (with larger nominal value) has been composed of arched weights for weighing of more heavy everyday goods [8]. Moreover, the lamps which might be used by crewmen and stone anchors are of the Syro-Palestinian origin.

Fig. 1. Reconstruction of the ship's cargo of Uluburun shipwreck (*Photograph made by author*)

Most of the cargo was raw material, but there was the finished commodity too (ceramic, made of ivory, glass, faience, gold and silver; weapon, etc.), part of which, reasoning from its quantity and value, matches the category of the gift exchange between the elites or has belonged to high-ranking people on board. The principal cargo — it's quite another matter. It has amounted to about 10 tons of copper ingots and 1 ton of tin ingots, which, taking into

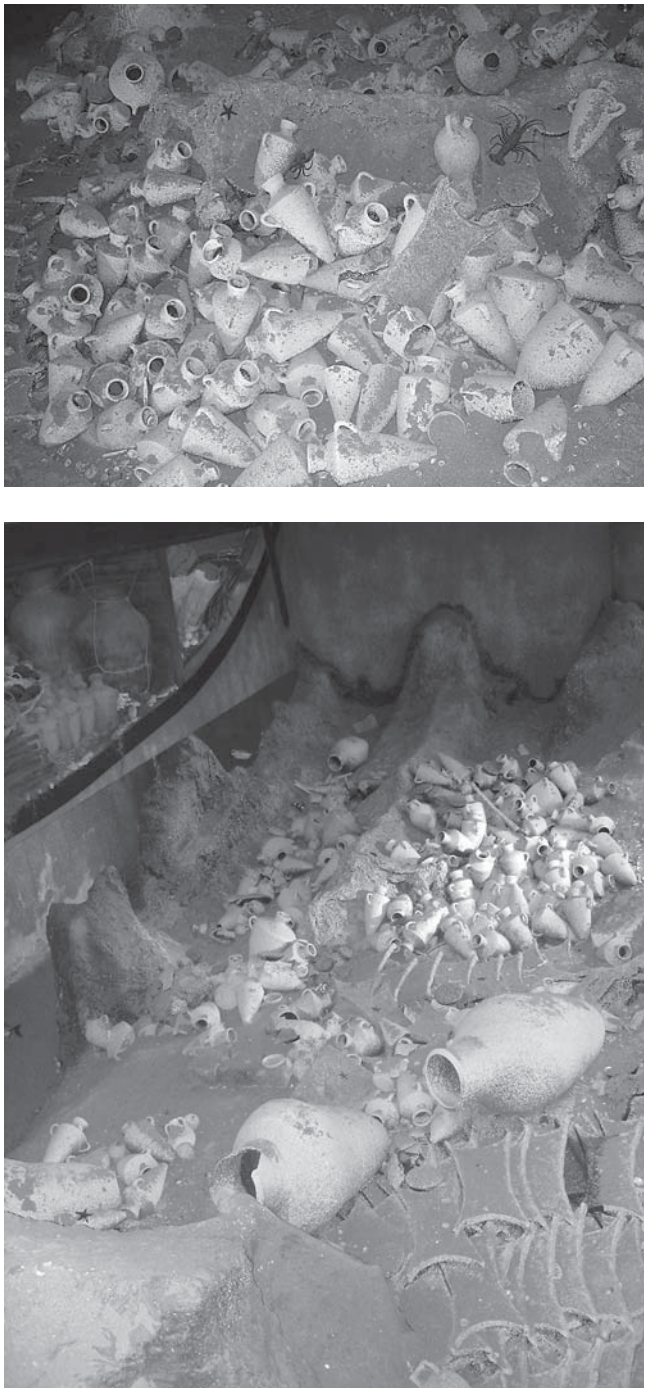

Fig 2.1 – Fig. 2.2. Reconstruction of the assemblages of ceramic vessels and copper ingots of Uluburun shipwreck in resting position on the seabed (*Photograph made by author*)

account volume of the cargo, allows to refer it to the category of full-scale commerce regarding that period of time. It is precisely this main part of the cargo that is of paramount importance for the present paper.

Ingots of these shipwrecks are the largest unified collection of metal ingots of the Bronze Age. Most of them (348 pieces) are Cyprian copper in the shape of big rectangular sheets; weight of each is about 24 kg, but it was slightly higher before corrosion. In addition, there were found 6 copper ingots of less weight (about 10 kg each) and 120 ingots of other shapes [9]. All these ingots are made of pure copper [10]. Data on lead-isotope analysis are needed at present stage of our study. Such investigations are actively used in the modern historiography with reference to the Mediterranean region during the Bronze Age, as it is shown by L. Steel [11]. Analysis of Uluburun shipwreck has shown that copper ingots originate from Cyprian copper ores; the most part of them has been cast of copper from a single source, probably in Apliki, and other mines located in the north-western part of Cyprus. Thus, copper of this shipwreck is of Cyprian origin, practically as nearly all copper ingots of that period of time, found in the Mediterranean region [7].

Now we touch on the question about tin ingots, discovered in the same place. Many of these ingots have been divided into sections (predominantly square) before being put aboard. This can mean that the ingots had not been obtained directly from the initial source but had been probably gathered after division and allocation. Chemical analysis had shown that tin was pure to one's delight [10]. Unfortunately, it is not possible to detect precisely quantity of tin, being placed on board at the moment of shipwreck because part of it has been lost as a result of corrosion, but 1 ton has been lifted up during excavations. This amount might be enough to produce 11 tons of bronze in case of being smelted with copper in the 1:10 ratio.

In the Bronze Age, tin has been shipped to Mediterranean from Levantine coast. By and large, all sources of tin origin are still not clarified completely. But lead-isotope analysis has shown that Uluburun tin ingots are from two separate sources: one of them has been located in the Taurus Mountains (southern Turkey), the second — outside Mediterranean, perhaps, somewhere in Afghanistan region [9]. It may be suggested that copper and tin ingots have been delivered on the Syro-Palestinian coast before being loaded on the vessel which has been shipwrecked later on.

The second shipwreck (Cape Gelidonya, western side of the mouth of the Bay of Antalya) dated to around 1200 B.C. Cargo of the ship has been about 1 ton of metal, mainly in the form of 34 ingots of practically pure copper with a weight of about 25 kg each. Lead isotope analysis has shown that copper has its origin from the same region of Cyprus, as copper of ingots from Uluburun [12]. In addition to these ingots there were found another 20 smaller discoid ones, also of Cyprian origin. However, the other 17 of 18 smaller flat slabs with rounded ends with weight of 500 g each have been made of copper which had its origin from Lavrion (Attica, Greece). Moreover, traces of tin ingots have been also revealed (white substance, the laboratory analysis of which has detected it as tin oxide), but there is no way to determine their quantity.

The laboratory investigations have leads to new conclusions, essentially enlarged geography of metals' origin. In addition to Cyprian ingots, the other artifacts have been made of metals, arrived from Lavrion, the Taurus Mountains, from copper mines of Timna in Israel and even from Sardinia [12].

The ship, like the Uluburun one, might be Syro-Canaanite or Cyprian, since pythos, anchor and ship's lamp, found out during excavations, are of Cyprian origin, but personal belongings and balances based on Near-Eastern standards have been found here and are also originated from the Syro-Palestinian region.

We have made clear in what way copper and tin have arrived to Aegean region, including mainland Greece. But what has happen with these metals next? Is there any evidence of their processing and bronze goods manufacturing? In this regard, ancient Mycenaean centre Thebes, which has been located in central mainland Greece, in Boeotia (nowadays Viotia) is highly indicative.

Palace workshops of Thebes, artifacts of bronze and narrative evidence

Prolonged archaeological dig on Kadmeia, the Acropolis of Thebes, had revealed a great deal of zones, which are identified as Mycenaean workshops on a basis of the findings of explorers. In comparison with the other places of the Mycenaean mainland Greece, it is just Thebes, in 15 locations of which the workshops are known, represents at present the most of such manufacturing zones of the Late Bronze Age. The findings, illustrating function of the premises, includes raw materials, different stone, bronze and ivory tooling, casting moulds, partly processed and finished wares, wastage, sections and half-finished products [13]. These workshops are placed directly on the Acropolis of Thebes, in location of Mycenaean palace, which points to direct control of the palace administration over manufacturing process. The most of these workshops has been specialized in producing jewellery and ivory articles, but even in these manufacturing processes bronze has been used, and findings of the bronze artifacts collections testify scale of production. The workshops, discovered in Argolida (at Mycenae, Tiryns and Midea) represent an analogous picture.

Moreover, large quantity of bronze has required for manufacturing Mycenaean weapons, chariots and tripods. Even for Early Bronze Age in Crete (III Millennium B.C.) it has been calculated that 80% of metal output from this island is weapon [14].

As regards the mainland Greece of Mycenaean period, as early as shaft graves of the Grave Circle A in Mycenae show that group of warriors lied here; their military

experience was much higher than that of Cretans. Tens of swords, spears, daggers and knifes have been found in tombs. Bones of buried speak for themselves: some of the deceased have received mortal head wounds; traces of the healed wounds have been revealed on skeletons of the others. Part of the skeletons has characteristic changes of leg bones, which are testimony to running with heavy weight (presumably, the matter concerns training with heavy shields). Two types of such shields (figure-of-eight and long rectangular) are pictured on daggers from shaft graves, where armed soldiers are fighting with lions. Besides, scene of siege, in which aggressors are battling in appointed order depending on sub-units (soldiers with swords, lance-knights and archers) is depicted on famous Mycenaean rhyton (funnel-shaped drinking vessel) from these burial places dated to 16th century B.C.

Similar military experience is noted not only in Mycenae, but in Mycenaean burials in other places. Moreover, the burials contain not merely offensive weapons, but fragments of the defensive one, including parts of helmets made of wild boar tusks. The best known is complete protective armour of the early Mycenaean time from the tomb in Dendra, not far from Mycenae. It consists of simple cuirasses: the breastplate and the back plate. Large collar has protected the neck and lower part of the face. Shoulders have been also covered by curved shoulder guards. Lower part of the armour represents overlapping semicircular plates. Construction of such bronze armour may be called lamellar.

It is hard to tell whether such armour has been representative for Mycenaean warriors or its construction is unique: nothing of the kind has been found in Mycenaean tombs (at least, there is not the second complete armour of that kind). Its images are also absent: most of illustrative reconstructions place a warrior in this armour onto chariot basing on the fact that such armour had to be heavy for fights on foot. At that, chariots probably have not been used directly in the battle; they rather served as a means of warrior transportation and delivery to a battlefield. Moreover, real construction of such armour has shown that although it has been relatively heavy (should be carried by sturdily-build man), it could be suitable for fights on foot as well, and in other words, combat movements in it are quite possible. The armour from Dendra compares well with the medieval ones by heaviness and possibility to move being equipped in it; and probably this comparison explains its usage. The armour may be compared with some tournament armours of the beginning of 16th century A.D. According to such interpretation, this Mycenaean armour has been meant not for a field battle but rather for a single combat, which is quite in agreement with the model of Mycenaean society, in which top social status of aristocracy has rested on personal fighting skills [15].

However, let us return to Thebes. Notwithstanding the fact that more such complete armour as the one from Dendra is not found, investigations of the finds form Thebes has shown that metal defence has been distributed in Aegean region in the Late Bronze Age. Different artifacts from storerooms of "Arsenal" in Thebes, dated to around 1300 B.C., are identified as parts of metal armours. The shoulder guards, presented among them, are of smaller size respect to the ones of Dendra armour and they lack the wide "wings" that cover the Dendra cuirass to protect chest and back. This fact probably evidences the development of such type of defence which may evolve towards simplifying its forms to improve warrior's mobility [16].

Bronze was also required for manufacturing metal components of chariots, which appeared in mainland Greece in 16th century B.C., and for their decor. Besides, large tripods have been also made of bronze. Tablets with the Linear B script of Knossos enumerate these objects, which have been kept in Minoan palace. In Homer's poetry, a tripod was a bronze vessel resembling cauldron at three legs (Fig. 3); it was of exceptional value. Just like these are they known in Greece archeologically as well, starting from the Early Iron Age, but finds before 8th century B.C. are very rare. Perhaps, it is because of the fact that during the most part of the Early Iron Age, low level of the bronze circulation in society had not allow to made many so large vessels over expensiveness, and for similar

Fig. 3. Bronze cauldron on a separate tripod of iron rods ending in bronze oxen claws (7th century B.C. Delphi) (*Photograph made by author*)

reasons, a tripod being once produced has been used for a very long time. Moreover, the main material at the disposal of explorers is composed of offerings in the major sanctuaries, have legalized their position only in the Late Geometric period (8th century B.C.). Supposedly during the "Dark Ages" period (11th — middle of 8th centuries B.C.) and especially by its end, parallel with increase in trade and population, elite of Greek communities has invested in producing so outsize works of art, which symbolize their riches and social status. Aristocracy might exhibit such tripods at symposia in their houses or dedicate them in the sanctuaries. These tripods often were decorated by highly artistic ornamental pattern, sometimes with the symbols directly associated with military elite. For example, by images of a warrior with raised spear, which is probably the most common reminiscence of the Homeric heroes. Later on, tripods has become an ordinary reward for wins in Greek games, for example, in Olympia or Delphi, but in the Late Geometric and the Early Archaic Period (8th — 7th centuries B.C.) a tripod first of all was a symbol of power and social prestige [17].

It is particularly remarkable that according to the concepts of ancient Greeks, the legends, rooted into the Mycenaean time, and the goods (primarily made of bronze), concerned with them, have been a means of educational sphere of the ancient Greek cities. Thereupon, the story of Herodotus is very indicative. In his passage (*Hdt.* 5.57.61), a mention was made of mythical hero Kadmos, Phoenicians and the introduction of the alphabet in Greece. The legends of Kadmos position him into the Mycenaean period, but the introduction of the alphabet in Greece has took place in the 8th century B.C. Probably, the historical traditions of different times have been mixed in the legends of Kadmos. According to diverse versions of these legends, he was a founder of new dynasty in Thebes; a hero, fortified Kadmeia or even all Thebes, or has been also considered as the ancestor of some Boeotian clans [18]. In the text of Herodotus it is stated that Kadmos with Phoenicians has arrived to Boeotia, and they have cleared written language for Hellenes. Herodotus further recounts that in Boeotian Thebes in the temple of Apollo Ismenios he saw him-self the Kadmean letters, inscribed on three tripods. Let us note that place of location of the temple of Apollo Ismenios in Thebes is known, and the sanctuary itself has been excavated in 1910 by A. Keramopoullos. This sanctuary has been supposed the most famous and ancient in Thebes [19]. Herodotus doesn't claim that he has read these letters himself, so it is not clear which writing he had seen exactly. As Herodotus has been told, one of the tripods has been marked by an inscription, indicating that the object was dedicated by Amphitryon (a mythic hero of Thebes, Hercules' adoptive father). Some of researchers believe that the tripods were Mycenaean, and the inscriptions mentioned by the ancient historian, has been written by the Mycenaean Linear B script [20]. Regardless of the fact that it couldn't be proved, these bronze tripods have been nevertheless considered by Herodotus as something very old. In addition, seven centuries later Pausanias (*Paus.* 9.10.4) had seen among the tripods of the same sanctuary the one, dedicated by Amphitryon, which has been attributed to the Mycenaean times by the Theban tradition of the times of Pausanias. Apparently, both witnesses talk about these bronze objects as of something extraordinary. However that may be, whether these tripods relate to the Mycenaean period, or to the 8th century B.C. as Symeonoglou believes [21], in Thebes there was an ancient tradition of manufacturing status bronze goods rooted into the Mycenaean time.

If Symeonoglou is in the right, then part of spoken tradition has been kept safe in a time after collapse of Mycenaean civilization (around 1200 B.C.) and has become apparent in an inscription on the bronze tripod. In that way the bronze object serves as a mediator of relations between a man and the past, the local and national history; it have an influence upon self-determination, self-awareness and education.

Conclusion

An integrated state-type society has existed in Aegean region during the period from around 1600 to around 1200 B.C.; it is conventional to call it a Mycenaean civilization. Metallurgy of bronze has been life-supporting for coming into being and development of Mycenaean society, which has been appeared in high demand for bronze objects and has been stipulated by aristocratic and marital nature of the society, religious views as well as by development of palace economy. Excavations of Uluburun and Cape Gelidonya shipwrecks have showed that the main source of copper deliveries to Aegean was Cyprus. However, there have also existed sources of this metal in Lavrion in Greece, in the Taurus Mountains of Anatolia, in Israel and in Sardinia. Volume of deliveries allows one to speak about real marketing of metals. Even in the early 1980s the researchers has believed that the Mycenaeans have monopolize maritime trade in the Eastern Mediterranean, but excavations of the aforecited shipwrecks has clearly shown the Near-Eastern or Cyprian origin of the vessels (the latter doesn't change the whole picture, since Cyprus of that time has been a part of a cultural circle of the Middle East), which corresponds with the Egyptian evidence (tomb paintings and Amarna tablets) [12]. This evidence brings copper and tin ingots into correlation with the Syrians not the Mycenaeans. An opinion on Mycenaean monopoly has been formed due to the presence of Mycenaean ceramics in the Middle East and on Cyprus, but the excavations of the shipwrecks testify an existence of the reverse supply of metal raw material, copper and tin, which upon receipt by the Mycenaeans has been turned into the benefits of their own culture. Reasoning from the supply volume as well as from the literary Near-Eastern of different times, it could be supposed that there existed two levels of trade: the first was the national one under the aegis of the king's court and presented by the shipwreck in Uluburun; the second

one was private, it is presented by the cargo of less weight from the shipwreck near Cape Gelidonya. In mainland Greece the bronze artefacts have been produced in various palace workshops, which in the largest quantity are known from the archaeological excavations on Kadmeia, the Acropolis of Thebes. Most of the bronze was involved in the production of protective and offensive armaments, as well as tripods and chariots. In the course of the analysis of archaeological material from Thebes and from literary sources, an informational and educational function of bronze items, such as tripods seen by Herodotus in the temple of Apollo Ismenios in Thebes, has been revealed. Status of dedication of bronze goods to sanctuaries and legendary history went hand in hand in the educational space of the city of the ancient period, using legendary heroic Mycenaean past as the cornerstone of self-determination and self-awareness of the Greeks.

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