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ABSTRACT

The Hoard of Rodotopi in Ioannina (Epirus, NW Greece) and the Copper Single-Edged Shaft-Hole Axes of the Early Bronze Age in the Helladic Area

Christos N. Kleitsas

The hoard of Rodotopi in Ioannina is a set of four copper single-edged shaft-hole axes of the Early Bronze Age. Together with eight isolated similar artefacts from Epirus, they are classified in the type with the conventional name Veselinovo (after Vulpe). Its distribution is mainly located in the regions of Epirus, western-central Macedonia and in the neighbouring areas of Bulgaria or Romania. These were tools and/or weapons with a symbolic character, which were withdrawn from circulation (recycling) to become utilitarian or votive deposits. Furthermore, issues of production, consumption or use, combined with archaeometric data (metallography and chemical analysis), are examined to give a more comprehensive interpretation. This gives us an insight into the networks of ideas, commodities and know-how existing at an early period, when copper working was still at an experimental stage, in general.

KEYWORDS

Epirus, Rodotopi, hoard, single-edged shaft-hole axes, Early Bronze Age

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Introduction

1 The aim of the present study is to scrutinise a group of twelve cast copper single-edged shaft-hole axes from various sites in Epirus, starting from the hoard of Rodotopi. Typology and distribution in Greece and the Balkans, their manufacturing technology and use-wear are examined, while the results of their metallographic and chemical analysis are discussed. These artefacts are part of the wider context of production and utilitarian (weaponry, tools or units of weight and raw material) or symbolic consumption during the Early Bronze Age in the central Balkans. This early cultural ›koine‹ is characterised by both typological and technological elements, while it traces the networks of raw materials, ideas and commodities, trafficking in the specific areas of the Balkans.

2 The hoard of Rodotopi[1] (Fig. 1) in the region of Ioannina was accidentally discovered in 1951 by an unnamed resident of the area and subsequently handed in to the archaeologist Sotirios Dakaris, without any other information on the exact conditions of its recovery. It includes two intact, as well as two broken, single-edged axes cast with circular shaft-hole. The Rodotopi hoard is today on display in the Bronze Age showcase of the renovated Archaeological Museum of Ioannina, in the first room with various other prehistoric antiquities. There, one can mainly see finds of the Late Bronze Age, as

1 Dakaris 1956a, 148 note 2: The kept in the collections of the Municipal Museum of Ioannina and Arta single-edged axes show close affinity with the axes of Skoutari-Dalmatian type. Dakaris 1985, 111 f. pl. 4, 1; Kleitsas 2013, 50–52 fig. 28 (and 108–115 figs. 102–129).

well as the other two hoards of Stephani[2] in Preveza and Katamachi[3] in Ioannina. The significance of the particular assemblage of this article was first noticed by the author during the works for the re-exhibition of the Ioannina Archaeological Museum permanent collections and subsequently analysed in his doctoral thesis (2013) at the University of Ioannina.

3 The basin of Ioannina is situated in the heart of the Epirus hinterland at an elevation of about 470–490 m.a.s.l. Its long axis stretches for approximately 38 km in a SE-NW orientation and its width reaches up to about 10 km. The flatland of Rodotopi lies at the northwest end of the Ioannina basin, bordered on the west and the east by hill ranges (from Rodotopi and Megalo Gardiki to Neochori). Up until recently and before it was drained (1958), lake Lapsista occupied part of Ioannina basin immediately north of Rodotopi in communication with lake Pamvotis of Ioannina. A multitude of archaeological sites are dispersed across the wider district of the Ioannina[4] basin, as well as in the environs of Rodotopi[5], dating from the Palaeolithic period to modern times. Quite important too is the recovery of another three prehistoric metal artefacts[6] in the specific area.

4 The identification of an Early Bronze Age presence still remains problematic, not only in the basin of Ioannina,

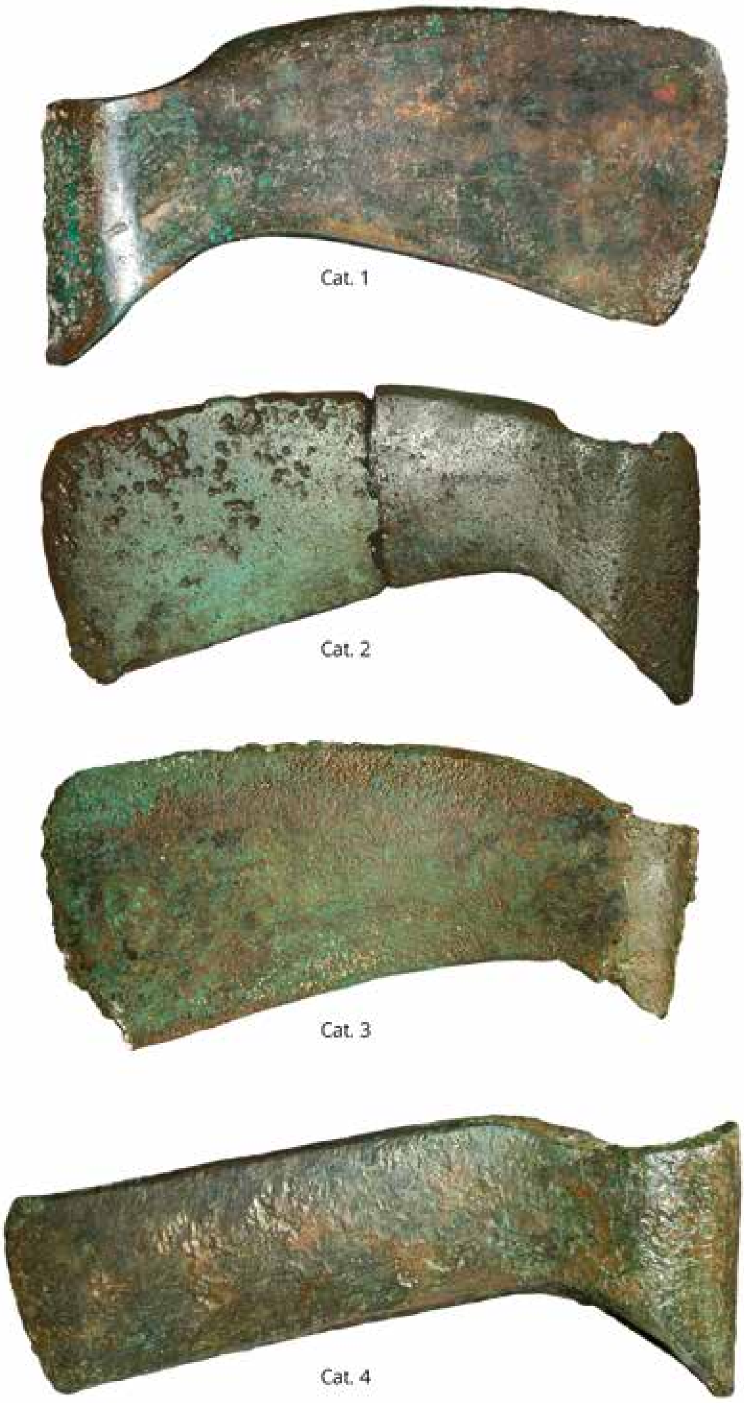

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Fig. 1: The hoard of Rodotopi containing four single-edged shaft-hole axes (Cat. 1–4; scale 1 : 2)

2 Kleitsas et al. 2018, 73–107. The hoard was found in 1985 and is assigned to the Late Bronze Age.

3 Vokotopoulou 1972, 112–119. The hoard was found in 1970 and is also dated to the Late Bronze Age.

4 Dakaris 1956b, 46–80; Zachos 1997, 153–167; Pliakou 2007; Gravani 2007/2008, 179–234.

5 Pliakou 2007, 67. 77 f. 91. 97–99. 105 pls. 26. 29. 42. 43. Pottery of prehistoric times is known from the Megalo Gardiki hill and from the Rodotopi area (Vortopos: temple site). It contains sherds of handmade pottery with plastic decoration (K II), with burnished surfaces (K III) and with matt-painted decoration (K IV). In general, the first two categories span the entire spectrum of the Bronze Age, extending also into the Early Iron Age, while the third one dates from the end of the Bronze Age onwards. Furthermore, handmade pottery of prehistoric date from the Rodotopi area was found at the hill of Goritsa within the modern settlement and in the Bisti cave to the NW of the village.

6 These are a partly preserved and unpublished copper flat chisel (Cat. 13), which was found in 1955 in a field of Rodotopi, a copper single-edged axe (Cat. 5) with circular shaft-hole from Lofiskos (former Tsergiani) to the south of Rodotopi (Hammond 1967, 332 fig. 22 pl. 21), as well as a bronze lanceolate spearhead (AMI 3328) from the hill of Megalo Gardiki to the east (Vokotopoulou 1969, 197 fig. 7 pl. 28). The first two probably date to the Early Bronze Age, while the third one belongs to the end of the Late Bronze Age. They all are random and isolated finds, without any further information on the exact conditions of their recovery.

but also in the whole of Epirus[7], with the exception of three archaeological sites. The first one is Doliana[8], situated NW of the Ioannina basin in the area of the headwaters of the Kalamas river and the now dried-up Grammousti lake. There in 1990, the floor of a rectangular hut was excavated: it had two successive phases, yielding hearths, handmade pottery, clay spindle whorls, lithic artefacts, archaeobotanical and bioarchaeological remains. Four radiocarbon dates (3770–2925 cal. B.C.) place it at the end of the Chalcolithic period and the beginning of the Early Bronze Age. The pottery finds parallels in specimens of the Attica-Kephala culture and the Rachmani phase at Pevkakia in Thessaly, but primarily in the Maliq IIb–IIIa phases of neighbouring Albania. The idiosyncratic Chalcolithic phase of the site has been called ›Doliana culture‹.

5 The second, the site of Goutsoura[9] lies to the SW of Epirus and closer to the sea, in the basin of the Kokytos river headwaters: it was recently excavated by the Finnish Institute of Athens (Thesprotia Expedition). The Goutsoura settlement extends along the ridge of a hill, occupying an area of 0,1 ha. Taking up the baton from Doliana in the chronological sequence, its six radiocarbon dates define a span (2920–2400 cal. B.C.) within phases I–II of the Early Bronze Age. After a hiatus of about 400 years (EBA III), a cremation burial of the beginning of the Middle Bronze Age cuts through the settlement stratum, while at a later stage a burial tumulus (end of the Middle Bronze Age) was erected over it. The settlement stratum contained handmade pottery, among which sherds of ›corded ware‹ stand out, along with clay spoons and spindle whorls, flint artefacts and fauna remains. The pottery finds parallels[10] in Pevkakia, Bosnia, Bulgaria and Romania. Finally, of some interest[11] is a copper punch, a fish-hook and a copper prill, the latter being regarded as a remnant of metalworking activities in the settlement.

7 Papadopoulos 1976, 272: he includes seven sites from Epirus (Aetos, Dodona, Ephyra, Kastritsa, Koutselio, Megali Goritsa, Skala Philiaton) in the Early Bronze Age, remarking on the impossibility of subdivision into phases. Alram-Stern 2004, 751–753: she classifies fifteen sites (adding the sites: Vouvopotamos, Kastriza, Kastri, Doliana, Palaiopyrgos, Meropi, Neochori, Pyrgos Ragiou) in the Early Bronze Age. The dating of the above sites is mainly based on fragments of handmade pottery with plastic decoration, which is but only slightly differentiated in terms of technology (manufacture, decoration, firing) during the Bronze Age. Dated with certainty to the Early Bronze Age I is the site of Agia Marina at Pedini in Ioannina, which is currently under study by a colleague Vasiliki Siozou (Siozou forthcoming) and from which a radiocarbon date (3330–3030 cal. B.C.) has already been obtained.

8 Douzougli – Zachos 2002, 124–138. 143. The ›Bratislava‹ type of pottery (Maran 1998, 344–346 fig. 1 pls. 1–4) stands out with its spiral decoration, filled with white paste, which is mainly encountered at sites of central Greece, as well as in Albania (Maliq, Tren, Podgorie) and in the Balkans still further north. Coleman 2011, 13. 25–29: The Petromagoula-Doliana group has more in common with EBA I than with the latest Chalcolithic material of the Greek mainland and I argue that it can best be regarded as the earliest manifestation of the EBA (Proto-Bronze Age) on the Greek mainland. Deckwirth 2016, 278 note 73: she makes corrections, regarding the results of the archaeozoological analyses from Doliana (Douzougli – Zachos 2002, 138), after personal communication with P. Halstead [cattle (38.8 %) > sheep and goats (36.1 %) > pigs (12 %), instead of the earlier: sheep and goats (36 %) > pigs (12 %) > cattle (8 %)].

9 Forsén et al. 2011, 79–82 (list of sites); Forsén – Forsén 2012, 297–301 (general description); Forsén 2016a, 125 f. 133–138. 141. 143 (stratigraphy-chronology); Forsén 2016b, 194–200. 204–207 (handmade pottery); Forsén 2011, 65–67 (clay spoons); Doulkeridou 2016, 212–217 (flint tools – stone industries); Papayiannis 2016, 227–243 (various small finds); Deckwirth 2016, 261–287 (animal bones: pigs > sheep and goats > cattle).

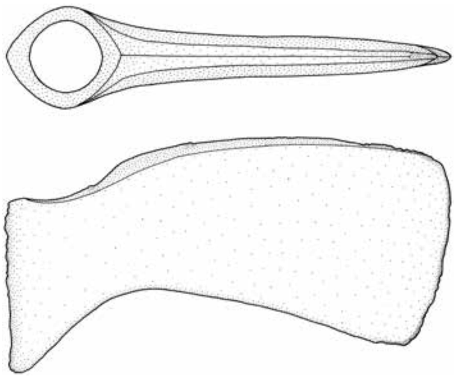
10 Forsén 2016b, 204–207: for the archaeological sites and the relative bibliography.

11 Papayiannis 2016, 229–231. The three copper or copper alloy objects date also to the Early Bronze Age.

Fig. 2–10: Rodotopi, single-edged shaft-hole axes from the hoard (Cat. 1–4; scale 1 : 3)


2 Cat. 1


4 Cat. 2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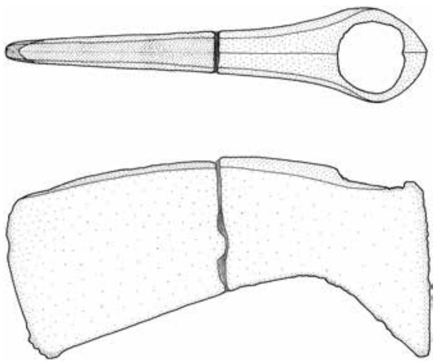
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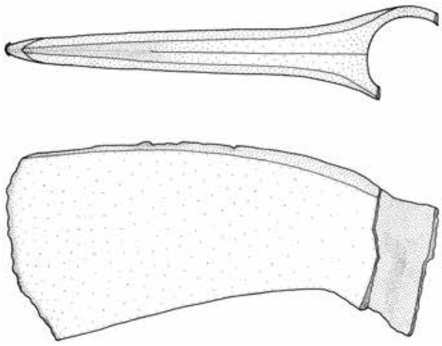
6 Cat. 3


8 Cat. 4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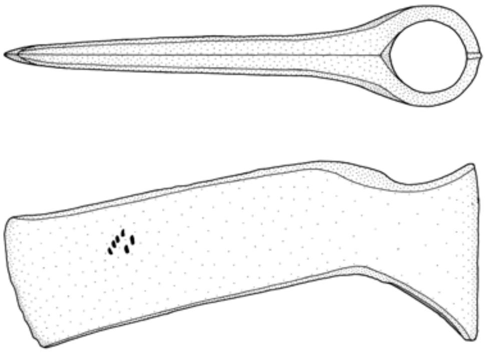
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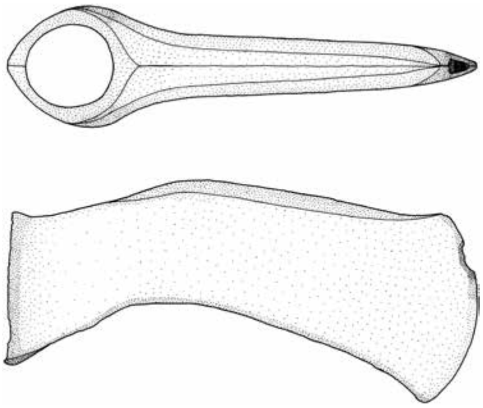
11 Cat. 5

13 Cat. 6



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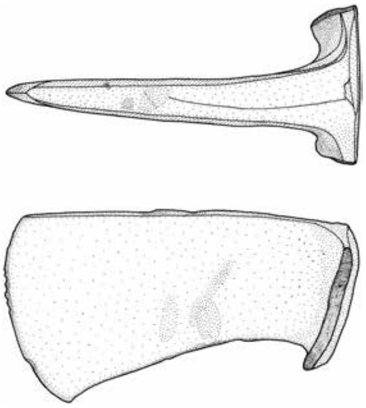

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Cast Copper Single-Edged Shaft-Hole Axes

Fig. 11. 12: Lofiskos, single-edged shaft-hole axe (Cat. 5; scale 1 : 3)

Fig. 13. 14: Terovo, single-edged shaft-hole axe (Cat. 6; scale 1 : 3)

6 A particular group of twelve copper or copper alloy single-edged axes[12] is made up of objects from eight different sites in the wider region of Epirus. These are axes with a circular shaft-hole towards the back and a usually angular or less often rounded butt-end. On the upper side their back is slightly raised in section towards its outside edges, whilst running along its axis, a central line or seam is usually visible, corresponding to the junction of the two stone mould halves, in which these artefacts were probably manufactured. More rarely, a similar line or seam can also be discerned on the lower surface of the axes, where too a large triangular shrinkage cavity is often observed: this is a result of the manufacturing process, discussed further below. As a rule, the blade is larger in its height than the butt-end and preserves quite a few traces of use-wear in most of the examples or has become completely blunted in most of the cases.

7 An assemblage of four axes (Cat. 1–4: Fig. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10) forms the hoard of Rodotopi[13] in Ioannina, of which one (Cat. 4: Fig. 8. 9. 10) displays six leaf-shaped notches on one side and ten on the other, in a probable attempt to fashion a nigh indiscernible marking (as discussed further below). Yet another axe (Cat. 5: Fig. 11. 12) of the type was found a little further south in the area of Lofiskos[14] (former Tsergiani) in Ioannina. Even further south at Terovo[15] in Ioannina and in the Louros river valley two more artefacts were uncovered. The first one (Cat. 14) is today lost, without any recorded information on its shape and dimensions. The second (Cat. 6: Fig. 13. 14) is fragmented, with a part missing from the rear of the shaft-hole and the butt-end. In a secondary

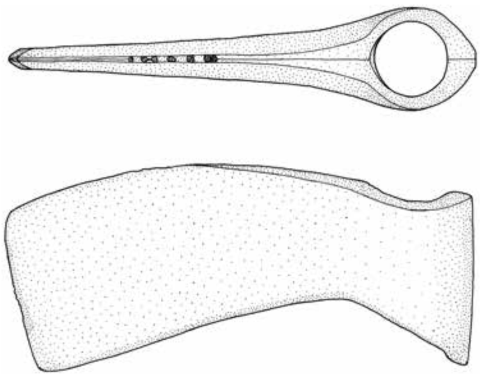
12 Their dimensions vary as follows: length: 13,8–18,8 cm, blade height: 5,3–7,7 cm, butt-end height: 5,2–7,0 cm, outer diameter of shaft-hole: 2,8–4,5 cm, inner diameter of shaft-hole: 2,4–3,5 cm and weight: 653–1451 g.

13 Op. cit. (note 1). From the region of Rodotopi also comes an unpublished cast copper flat chisel (Cat. 13).

14 Hammond 1967, 332 fig. 22 pl. 21. He mentions that he saw it in C. Soulis' possession at Ioannina in 1937.

15 Hammond 1967, 332; Andreou 1983, 232. The second one was found at Chani of Terovo and handed in by Z. Zikos.

15 Cat. 10



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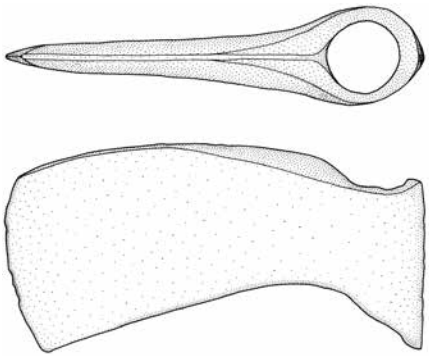
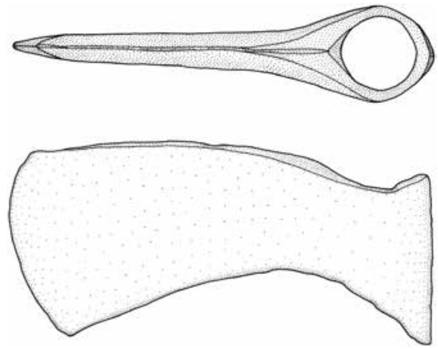


17 Cat. 7



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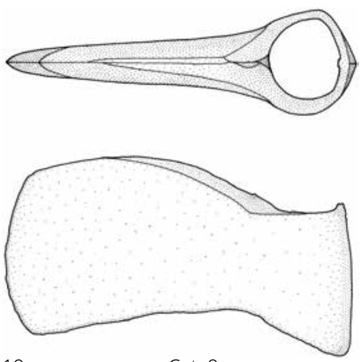
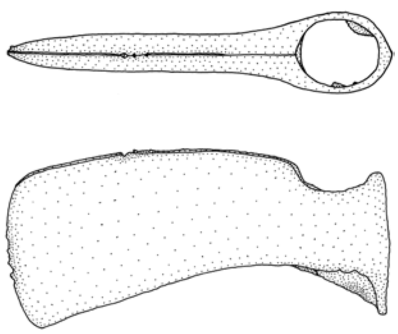


19 Cat. 9



20 Cat. 11

Fig. 15. 16: Pistiana, single-edged shaft-hole axe (Cat. 10; scale 1 : 3)

Fig. 17: Ziros, single-edged shaft-hole axe (Cat. 7; scale 1 : 3)

Fig. 18: Arta, single-edged shaft-hole axe (Cat. 8; scale 1 : 3)

Fig. 19: Vlaherna, single-edged shaft-hole axe (Cat. 9; scale 1 : 3)

Fig. 20: Loutro, single-edged shaft-hole axe (Cat. 11; scale 1 : 3)

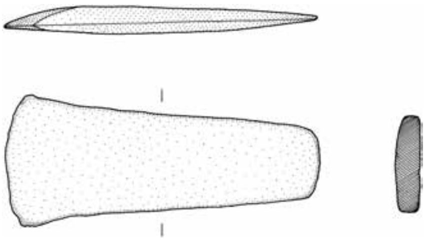
use, the broken sides of the hole were hammered flat, thus transforming the by then blunted axe into an anvil/wedge (a unique occurrence). Four more axes[16] are known from the area of Arta. The first one (Cat. 10: Fig. 15. 16) comes from Pistiana (former Siroupolis) in Arta, the second one (Cat. 7: Fig. 17) from Ziros in Philippiada, the third one (Cat. 8: Fig. 18) from the area of Arta in general and the fourth one (Cat. 9: Fig. 19) from Vlaherna in Arta. The twelfth axe (Cat. 11: Fig. 20) of the type was found at Loutro[17]

16 Hammond 1967, 332 fig. 22; Konstantaki – Spanodimos 2008, 19. 35. The third one is unpublished, while the fourth one was found by the archaeologist P. Karatzeni at the hill of Agios Nikolaos in Vlaherna in 1994.

17 Hammond 1967, 332 fig. 22. This also is a random and isolated find from Aitoloakarnania.

21 Cat. 12

23 Cat. 13



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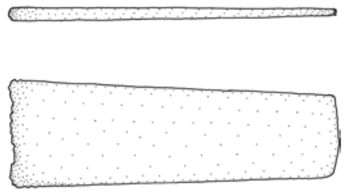

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Fig. 21. 22: Anatoli, flat axe/chisel/adze (Cat. 12; scale 1 : 3)

Fig. 23. 24: Rodotopi, rear part of flat chisel (Cat. 13; scale 1 : 3)

in Amphilochia, just outside Epirus on the east side of the Ambracian gulf. Finally, we should mention two unpublished tools of different types, which in all probability are to be dated somewhere in the Early Bronze Age. These are a cast flat axe/chisel/adze (Cat. 12: Fig. 21. 22) from Anatoli in Ioannina and a copper flat chisel (Cat. 13: Fig. 23. 24) from Rodotopi in Ioannina. Their types are quite common in the Helladic area, the Balkans and Europe throughout Bronze Age.

8 Earlier researchers[18] in Epirus assigned the chronology of these particular copper single-edged axes to the final phases of the Late Bronze Age. Hammond maintains that the typological group of these axes prevailed in the Laibach culture of Slovenia at the north end of the Adriatic sea. From there, it spread across the Danube river valley, then was adopted by the Urnfield culture in Hungary and expanded eastwards into Bulgaria. The same view is also held by Papadopoulos, who supports a probable local manufacture. At the same time, another group of researchers[19] correctly placed these specific artefacts in the Early Bronze Age, a period that at the time was completely unknown in the region of Epirus. Their early chronology is substantiated by typological and archaeometric data, as it will be seen further below, since they are made from copper-arsenic alloys (Cu-As).

9 Another fourteen copper or copper alloy single-edged axes of the Early Bronze Age are recorded from the rest of the Helladic region, eleven out of which come from Macedonia. The biggest assemblage of four artefacts is included in the hoard of Petralona[20] in Chalkidiki (also comprising thirty-eight flat chisels). All of the axes are broken at the same point just before the blade (on two the blade is missing, while a third one preserves only the blade). A similar copper axe is reported from the site Latomeia of Triadi[21] in Thessaloniki. There also are three more surface finds[22]: two from the archaeological sites of Mesimeri Toumba and Plagiari Toumba in the Chalkidiki in Macedonia and a third one, now missing, from Mesimeriani Toumba at Trilofos in the same region. Finally, one axe occurred at each one of the following sites: Mandalo[23] in Pella (excava-

18 Hammond 1967, 332 f. fig. 22; Papadopoulos 1976, 298 f.; Soueref 2001, 106 f.

19 Vulpe 1970, 37; Maran 1989, 130 f.; Maran 2001, 277.

20 Grammenos – Tzachili 1994, 82 f. 98. 100 f.; Maran 2001, 275–284. It was found in 1958 in a pithos (EBA II).

21 Grammenos – Tzachili 1994, 89. A random and isolated find of 1970, made of pure copper.

22 Grammenos – Tzachili 1994, 89–91. Found in 1963 and in 1971. The first two are made of a copper alloy with low arsenic content (Cu-As), while the composition of the third one is not known.

23 Pilali-Papasteriou – Papaeuthimiou-Papanthimou 1989, 24 pl. 370.

tion find), Arhontiko in Giannitsa and a recent one at Paliouria[24] in Grevena, probably belonging to a small hoard (with two more flat chisels). The last three single-edged axes in the Helladic area are encountered in the hoard of Thebes[25] in Boeotia, in the hoard of Poliochni[26] *rosso* on Lemnos and in the hoard of Dhaskalio[27] on Keros. The few single-edged axes, which are datable, all belong to phases II–III of the Aegean Early Bronze Age. To justify their dating to the same period, not only is there typological evidence from the neighbouring Balkans available, but also data from the archaeometric analysis of the Epirotic axes themselves, as discussed below.

10 Likewise, six pieces of bivalve stone moulds are known in the Helladic area, of which five come from the regions of central and west Macedonia. The first is a surface find from Mesimeri[28] Toumba in Chalkidiki, while the second one was found at Agios Mamas[29] Toumba in Chalkidiki and is published in an exemplary manner. Two more pieces of stone moulds come from the settlement of Kryopigado at Aliakmonas[30] in Kozani and another one from the settlement of Anargyroi[31] on the shore of the Cheimaditis lake in Florina. A piece of a sixth stone mould was located in the ›Minoan‹ neighbourhood of the settlement at Koukonisi[32] on Lemnos. Finally, part of a single-use clay mould for the manufacture of a single-edged axe occurred at the settlement of Poliochni[33] on Lemnos. The latter provides clear evidence for the practice of the ›lost-wax‹ casting technique, being known already in the Early Bronze Age.

11 Vulpe (1970) has established the principal typological classification of the Balkan copper and bronze single-edged axes with a circular shaft-hole, which remains effective to the present. All Epirotic examples belong to the first variety of the type with the conventional name Veselinovo (after a site in Bulgaria), whose date falls within the Early Bronze Age. Assigned to the same category of axes are three examples, one apiece from Mesimeri Toumba and Plagiari Toumba in Chalkidiki, and Paliouria in Grevena, to go with three stone moulds from Mesimeri Toumba and Agios Mamas Toumba in Chalkidiki and alongside one of the two moulds from Kryopigado at Aliakmonas in Kozani. The second variety of the Veselinovo type is typological and chronological evolution from the first one, including a stone mould from Koukonisi on Lemnos, which should probably be associated with the fourteen axes from the hoard of Ostrovul Corbului[34] II in Romania. This specific type predominates as the most characteristic group of copper

24 Karamitrou-Mentesidi 2011, 845. This is an important new and basically unpublished find.

25 Maran 1989, 129–136. The hoard was found in 1964 inside a pithos, underneath a floor of an apsidal building and contains six copper/bronze artefacts (double-edged axe, single-edged axe, three chisels and an awl).

26 Bernabò-Brea 1964, 661 f. pl. 173. The hoard was found in room 829 of the red period next to megaron 832, with twenty copper/bronze objects in it (axes, spearheads, daggers, awls, a pin and a small fish-hook).

27 Georgakopoulou 2013, 673–677. The hoard contains three artefacts (single-edged axe, axe-adze and flat chisel). The single-edged axe is made of a copper-tin alloy (Cu-Sn) and preserved in a poor condition (as it was probably an experimental artefact). This site also preserves remarkable traces of metallurgical activities (mainly copper and lead).

28 Grammenos – Tzachili 1994, 90 f. It was found in 1920 in the settlement area.

29 Hänsel 2003, 475–481. On the two main faces are cut depressions for casting a single-edged axe and a triangular dagger, the most characteristic artefact categories of the Early Bronze Age, in general.

30 Karamitrou-Mentesidi – Lokana 2011, 312 f. 320 f. 350. From pits-dwellings 2 and 13a. On the inside of both moulds there are preserved irregular striations in a diagonal arrangement, making a kind of lattice, though they are not decorative. These incisions could be interpreted in two diverse ways: first in the context of the ritual ›killing‹ of artefacts or second as assisting the casting of the metal, by preventing the creation of cracks (they would be then removed from the end product by hammering or even by polishing during the finishing process).

31 Ziota 1996, 548. This is the only mould that preserves metal remains on the inside.

32 Boulotis 2009, 201–206 (mould: 203 f.). Important metallurgical activities were carried out at the site during Koukonisi III phase, which dates to Middle Minoan IIIB – Late Minoan I transitional period. The mould displays six incised lines and two blind holes to help line up the two halves together, while it bears an incised sign-arrow on one narrow side. The occurrence of the mould in late strata can be seen as an intrusive event or interpreted in the context of an unbroken and continuing tradition in metallurgy, something that remains to be proved.

33 Bernabò-Brea 1964, 591 pl. 85; Nakou 1997, 638. From a well next to megaron 605 of Poliochni *verde*.

34 Vulpe 1970, 35–37, pl. 6. Seventeen occurrences are mentioned in Romania and another eight in Bulgaria.

single-edged axes in the Helladic area, since more than half of the axe and mould occurrences (fourteen out of twenty-six axes and four out of seven moulds) belong to it. Its principal distribution cluster is encountered in the regions a bit further to the north and east in the Balkans (mostly in Romania and Bulgaria).

12 Six copper or copper alloy single-edged axes of the Veselinovo first variety were found at sites in Romania[35], along with a piece of a stone mould in the Cernavoda settlement (phase III). Eight more occurrences are known from sites in neighbouring Bulgaria[36]. Finally, two axes with the traits of the type come from Albania[37], an immediate neighbour of Epirus, while a final example is reported from distant Hungary (site Lapujtő). In total, thirty-one single-edged shaft-hole axes and four moulds of the first variety are known from the Balkans.

13 The distinction of artefacts and their classification into types is not always an easy matter. The four single-edged axes from the Petralona hoard in Chalkidiki and a fifth one from Triadi in Thessaloniki belong to Kozarac[38] (or Izvoarele) type, as does one stone mould from Kryopigado at Aliakmonas in Kozani and the clay one from Poliochni on Lemnos. The type is quite widespread in Serbia[39] and in Bosnia[40], where five pieces of clay moulds were also uncovered in two settlements (Debelo brdo and Gradina Alihodže) of the Vučedol culture. A piece of a stone mould comes from the site Pecica in Romania and again of a clay one from Salzburg in Austria, while one specimen occurred at each one of the following sites: Vinkovci in Croatia, Vel'ký Meder in Slovakia and Csáklya in Hungary, raising the number of known moulds of the type to twelve. We complete this survey with the last five Helladic axes (Arhontiko in Giannitsa, Mandalo in Pella, Thebes in Boeotia, Poliochni on Lemnos and Dhaskalio on Keros, along with the last stone mould from the settlement of Anargyroi on lake Cheimaditis in Florina), classified in two relatively close types, bearing Vulpe's conventional names Patulele[41] and Padureni[42].

35 Vulpe 1970, 35–37 pls. 5. 65; Ştefan 2007, 83–88. These are the sites: Tulcea (hoard with three examples), Crivăţ (settlement of Glina culture), Shitu-Pingăleşti (hoard) and an unknown site in Romania.

36 Chernykh 1977, 29–53; Chernykh 1978, 135–152. These are the sites: Veselinovo, Gabrovo, Sevlievo, Plovdiv, Bratsigovo, Stara Zagora (two) and an unknown site in Bulgaria.

37 Prendi – Bunguri 2008, 241–243 tab. 6. These are isolated finds from the sites Rrëmbec-Korçë and Divjakë-Lushnjë.

38 Vulpe 1970, 39–41 pls. 8. 70. He reports occurrences at sites in Romania, Hungary, Serbia, Slovenia, Slovakia and Moldavia, as well as in the hoard of Kömlőd in Hungary (five) and of Stublo in Ukraine (two).

39 Antonović 2014, 90–92 pls. 37–39. She identifies the two varieties Jasika and Baranda in the case of twenty axes.

40 Žeravica 1993, 22–32 pls. 6–8. The study contains thirty-seven axes from Bosnia and Croatia, among which there is a silver axe (with a gold dagger) from the central burial of a tumulus at Mala Gruda in Montenegro: Hansen 2001, 11–59.

41 Vulpe 1970, 37–39 pl. 7. Occurrences in Romania, Bulgaria, Serbia and one in Albania.

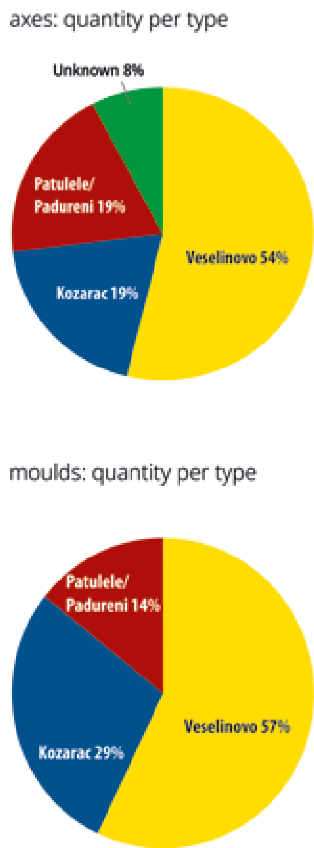
42 Vulpe 1970, 42–48 pls. 8–11. He includes seventy axes from thirty sites in Romania.

25

SITES	AXES					MOULDS				
	Veselinovo	Kozarac	Patulele/Padureni	Unknown		Veselinovo	Kozarac	Patulele/Padureni	Unknown	
Agios Mamas						1				
Aliakmonas						1	1			
Anargyroi								1		
Arhontiko			1							
Arta	1									
Dhaskalio			1							
Koukonisi						1				
Lofiskos	1									
Loutro	1									
Mandalo			1							
Mesimeri	1					1				
Paliouria	1									
Petralona		4								
Pistiana	1									
Plagiari	1									
Poliochni			1				1			
Rodotopi	4									
Terovo	1			1						
Theba			1							
Triadi		1								
Trilofos				1						
Vlaherna	1									
Ziros	1									
TOTAL	14	5	5	2	26	4	2	1	0	7

Fig. 25: Distribution of Early Bronze Age single-edged shaft-hole axes and moulds in Greece. Types and quantities

26



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14 In conclusion (Fig. 25. 26. 27), the twenty-six copper or copper alloy single-edged axes and the seven moulds, which come from a total of twenty-three sites in the Helladic area, typologically belong to known and quite widespread Balkan axe types. In terms of quality and quantity, it is possible to pinpoint three core regions, where local manufacture of axes is considered to be quite probable, if not certain. These are the areas of Epirus, central and west Macedonia, as well as the island of Lemnos in the NE Aegean. As we are going to see further below, the hypothesis of local production is supported in the case of Epirus by macroscopic observations on the manufacturing process, as well as by metallographic and chemical analyses.

Fig. 26. 27: Distribution of Early Bronze Age single-edged shaft-hole axes and moulds in Greece

Manufacturing Technology and Use-Wear Analysis

15 Traces of the stages in the manufacturing process are often retained in various ways on the surface of metal objects. In this section, we will describe the results of macroscopic observation (with the naked eye). We primarily refer to visible casting defects of artefacts made in stone or clay bivalve or open moulds, since in the Early Bronze Age neither the sand casting technique (moulding boxes or ›flask‹ technique) nor the always rarer metallic moulds had been invented. Undoubtedly, single-edged axes for the most part will have been manufactured in stone bivalve moulds reused many times and less often in single-use clay moulds. Manufacturing defects (shrinkage cavities, gas-holes and dirt inclusions) affect the aesthetic appearance rather than the functionality of artefacts. Most of the above defects are rectifiable after the solidification of the metal and the removal of objects from the mould. Here, the main technique of correction in use was cold hammering (optimal for copper-arsenic alloys), which condenses the mass, rectifies surface defects and forms the final shape and the blades of artefacts. The process is usually completed by polishing the surface of the objects with a grinder or a whetstone. The object is now ready for use or barter.

16 Most of the single-edged axes from Epirus (except for Cat. 4. 6. 9) display on the lower narrow side right next to the shaft-hole a roughly triangular cavity with an uneven surface, which reproduces in general the outline of the axes. This is interpreted as a shrinkage cavity (Fig. 28) and is an unintended manufacturing feature that does not affect the functionality of axes. It is created during the solidification of metal in the mould, which begins from the thinnest and remotest points, advancing towards the thickest section, where the shaft-hole is. In the process of formation of different metallic structures inside the mould, the most liquid metal moves to fill any voids, as may be produced during the initial solidification at the remotest and thinnest points. This occurrence can be prevented by adding more molten metal and so refilling the mould, an easy procedure, but not applied in our case. Furthermore, the occurrence of the triangular cavity implies that the pouring channel (runner) was placed next to the shaft-hole, at what becomes the underside of the axe, when in use. An important manufacturing defect that tells against the functionality of axes is gas or blow-holes, which leave small polished pits on the surface or worse voids within. The pits are caused by the

28

Fig. 28: Shrinkage cavity on lower side of four single-edged shaft-hole axes (Cat. 1. 2. 5. 10)

29

release of gas or moisture, trapped in the mould during the casting: they can be avoided by preheating the mould and attaching a riser tube for letting any gas out (venting). Such pits are observed on three axes (Cat. 1–3: Fig. 29) and a flat chisel (Cat. 13) from Rodotopi in Ioannina. Finally, most of the objects preserve small cavities, indicating dirt inclusions.

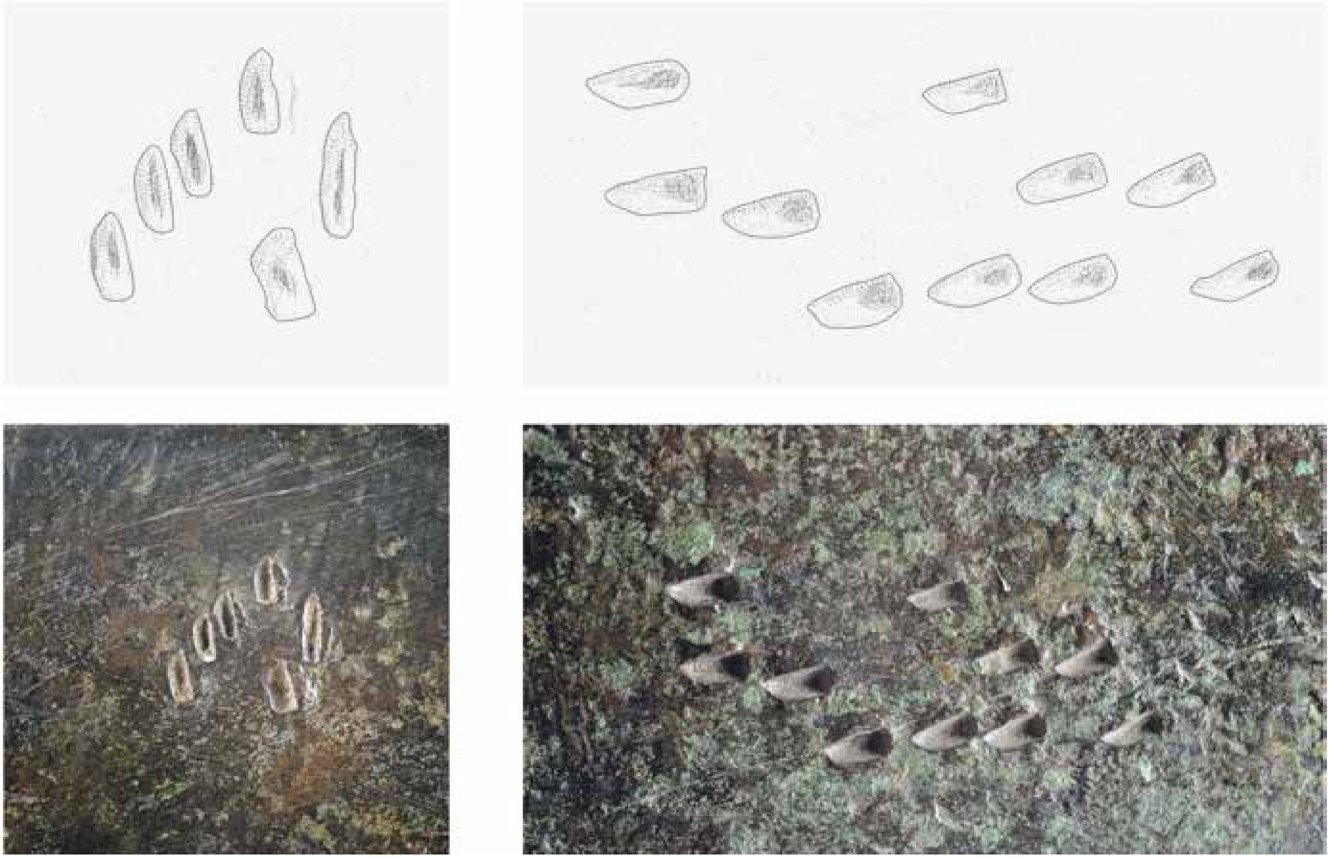
17 Almost all of the Early Bronze Age single-edged axes in Epirus bear traces of the joint of the two halves of the stone mould. One axe (Cat. 6) stands out as an exception, because these specific traces have been erased, following the process of a later systematic hammering for its transformation into an anvil/wedge and its second use as such. Traces of such seams appear in the form of a midrib along the raised back of the axes, on the butt's angular back and as a groove or rib along the lower narrow side. Most of the objects have certainly been hammered after their removal from the mould and then well polished, since only a few small hammering pits can be seen on the surface of just one axe (Cat. 4). Once again, the exception are the hammering pits on the axe (Cat. 6), acquired in the course of its use as an anvil/wedge, for working smaller artefacts on with a hammer.

18 The unique transformation of the single-edged axe (Cat. 6: Fig. 30) from Terovo into an anvil or wedge after the breakage and abandonment of the axe *qua* axe was achieved in this manner. The edges of the broken shaft-hole were hammered in towards each other, closing the hole and turning the end into an almost square surface, flat to slightly curved. This surface has become exceptionally polished by repeated hammer blows, when it functioned as the anvil's working surface for shaping other small objects on (a small shrinkage hole is preserved in the middle of it). The distortion now visible on the body and blade of the axe was most probably caused by intensive use. A pair of notches on both the upper and lower narrow sides served to fasten the anvil firmly to its base. Finally, on one face it bears six larger leaf-shaped notches in the middle and three smaller ones on the upper part, in an effort to decorate or personalise it, but this line cannot be pursued any further.

Fig. 29: Gas or blow-holes on the surface of a single-edged shaft-hole broken axe (Cat. 3)

Fig. 30: Butt, blade, upper-lower views of a single-edged shaft-hole axe-anvil/wedge (Cat. 6)

30



31

Fig. 31: Leaf-shaped notches on the two faces of a single-edged shaft-hole axe (Cat. 4; drawings scale 3 : 1)

19 Another exceptional case appears in a single-edged axe (Cat. 4: Fig. 31) from the Rodotopi hoard, which bears six and ten leaf-shaped and wedge-like in section notches on its two sides, respectively. These indentations were executed with a small pointed object, before the metal was completely solidified and when it was still soft, as the metal is marginally lifted by pressure. Subsequently, the object was hammered and polished. In all probability, these particular traces indicate an effort to provide the artefact with a workshop marking and proclaim ownership, unless of course these are unconnected linear components of some decorative theme. In terms of quality, this axe is the best object in the hoard and remains still the only functional one of the four axes. As in the previous case from Terovo, where the craftsman used his imagination, in this one too he might have so marked his pride or ownership (or have been about something else: weight).

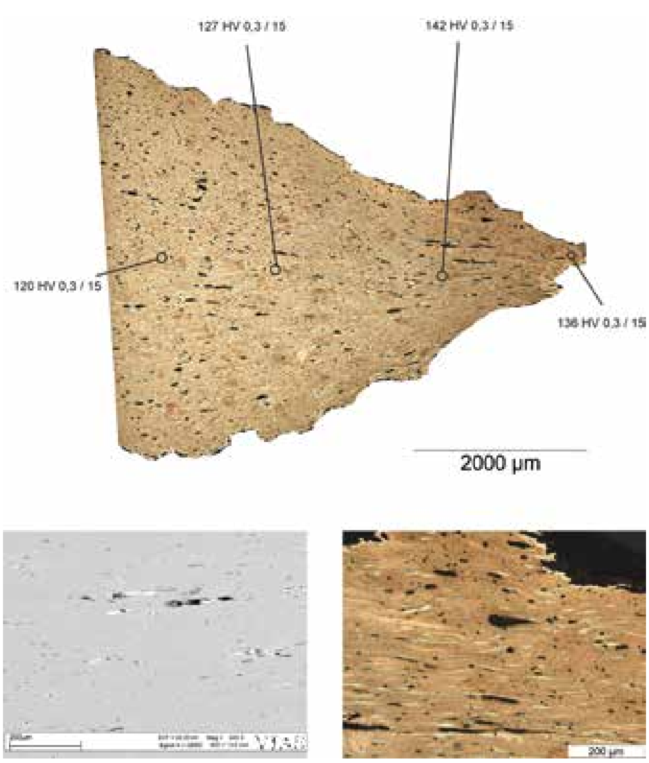
20 The most characteristic use-wear traces and damage on these single-edged axes, as tools for cutting and shaping wood or as offensive weapons (either truly functional or even symbolic items), are encountered on their blades. Three axes are broken (Cat. 2. 3. 6) and almost all (except for Cat. 4) have a blunted blade with shorter or longer indentations and notches on it (Fig. 32), being thereby rendered non-functional. Seven similar wedge-like notches also occur on the back of one axe (Cat. 10: Fig. 32). It is surprising to note the fact that none of the above axes bears any attempt to resharpen their blades, in order to be used again. Furthermore, they had not even been recycled and that too at a period, when people were still experimenting with the ›recipes‹ of copper, in order to obtain the best possible results. The interpretation of a ritual ›death‹ remains open to discussion.

32

21 This article now presents the first metallographic analyses[43] to have been carried out on copper or copper alloy artefacts of the Early Bronze Age from Epirus: three single-edged axes (Cat. 2. 3. 6) and a flat chisel (Cat. 13) from Rodotopi and Terovo in Ioannina. Sampling focused mainly on a point on the blade of two axes (Cat. 2. 3:

Fig. 32: Blunted blades and back of three single-edged shaft-hole axes (Cat. 1. 3. 10-two)

43 The analyses were carried out at the Archaeometallurgical Laboratory of the Vienna Institute for Archaeological Science (VIAS) in Austria by Dr. Mathias Mehofer, who had previously conducted the sampling at the Archaeological Museum of Ioannina. An optical light microscope Olympus BX 51 was used, as well as a scanning electron microscope Zeiss Evo 60 XVP, fitted with energy-dispersive X-ray fluorescence spectroscope EDX-Inca 400, Oxford Instruments. See: Mehofer – Kucera 2005, 56–63. For the forming process of metallic microstructure from casting to hammering: Papadimitriou 2008, 273–275.



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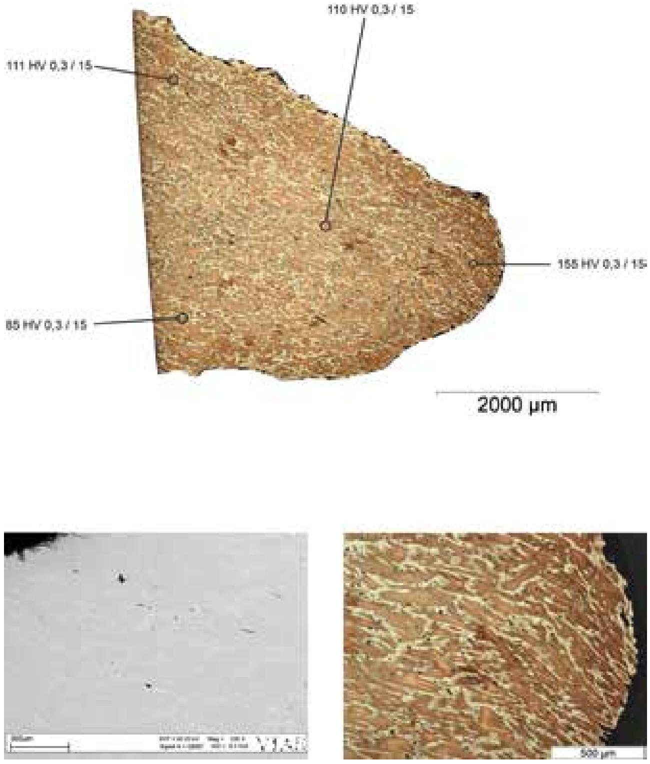

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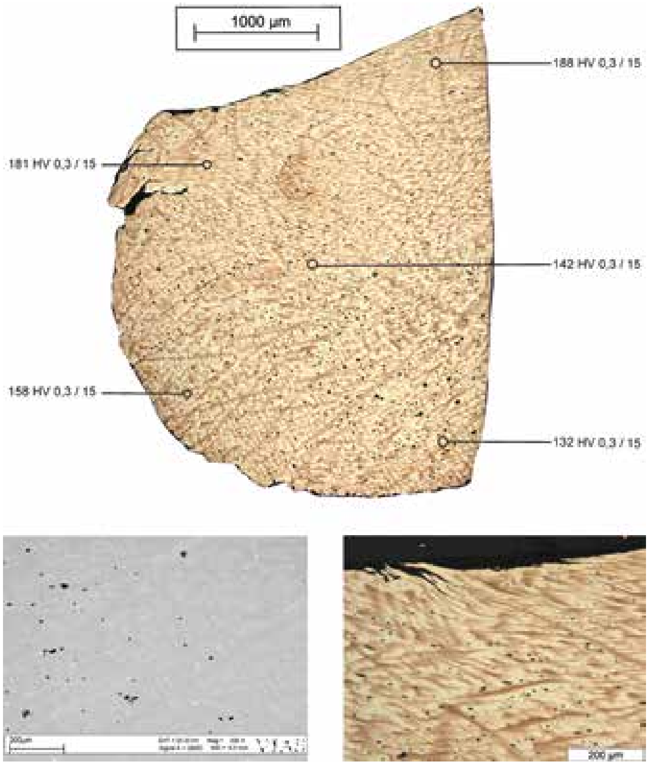
Fig. 33: Micrographs with overview of the hardness test and the microstructure (Cat. 2)

Fig. 34: Micrographs with overview of the hardness test and the microstructure (Cat. 3)

Fig. 33. 34), on the anvil's working surface, formed out of the broken butt-end of the axe (Cat. 6: Fig. 35) and on the chisel's (Cat. 13: Fig. 36) butt-end. The metallographic samples were examined with an optical metallographic microscope and with a scanning electron microscope (SEM), while their hardness was measured on Vickers (HV) scale. The analyses allow the investigation of the manufacturing process of casting (phases and alloy elements), as well as those following the solidification of the metal and its removal from the mould (annealing, hot or cold hammering). The results are given immediately below.

22 Bimetallic alloys (copper with low arsenic contents) were recognised throughout. All four samples retain the initial solidification texture, displaying elongated crystals and dendrites. There are also to be observed various smaller inclusions (lead and bismuth) as microsegregations. At the blade edge of the two axes and less along the rest of the portion analysed, a marked distortion and elongation of both the crystals, which have acquired the form of thin fibres, and of the inclusions is evident. A similar distortion occurs not only on the upper working surface of the axe-anvil, due as much to cold hammering after the casting of the tool as to its second use, but also near the outer surface of the sample from the chisel. These particular traces indicate intensive cold hammering after the casting process. Hardness testing determines increasing values from near the butt-end to the blade of the two axes (120–142 and 85–155 HV 0.3/15). The axe-anvil shows an increasing hardness towards the working surface (132–188 HV 0.3/15), as is the case with the chisel too (96–147 HV 0.3/15) towards the outer surface. To summarise, these objects are cast from bimetallic alloys, as it is established by the chemical analyses too. After the solidification of the metal and its removal from the mould, there followed intensive cold hammering to condense the mass and form the final shape and the blade profile of the artefacts. Nevertheless, very small voids were retained in the microstructure as shrinkage cavities. Cold hammering sets some limitations on the



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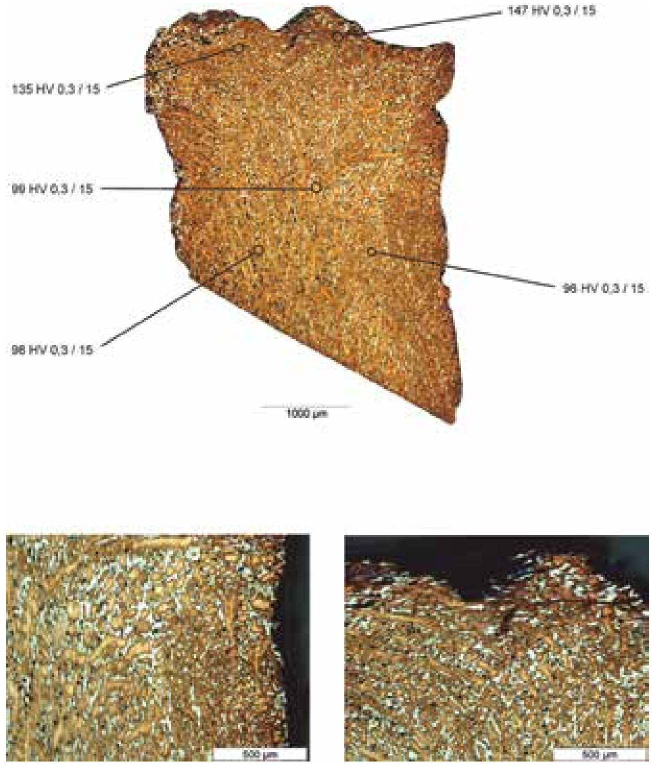

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amount of final working of artefacts, since the technique of annealing had not yet been employed in the specific area. The latter is applied mainly to bronze alloys, while it is almost incompatible with the unstable element of arsenic, at least at high temperatures. Only one of the Early Bronze Age single-edged axes (from Dhaskalio on Keros) from the Helladic area was manufactured by a copper-tin alloy.

Fig. 35: Micrographs with overview of the hardness test and the microstructure (Cat. 6)

Fig. 36: Micrographs with overview of the hardness test and the microstructure (Cat. 13)

Chemical Analysis

23 Chemical composition analyses[44] (Fig. 37. 38) were conducted on four single-edged shaft-hole axes (Cat. 2. 3. 5. 6) and a flat chisel (Cat. 13) from Rodotopi, Lofiskos and Terovo in Ioannina. For the chemical analyses the method of Energy Dispersive X-Ray Fluorescence (EDXRF) was used. The results are of particular interest, as they

No.	Cat. no.	Inv. no.	Sample no.	Material	Artefact
1	2	4372	MA–092893	Copper	One-edged shaft-hole axe
2	3	4373	MA–092098	Copper	One-edged shaft-hole axe
3	5	114	MA–092039	Copper	One-edged shaft-hole axe
4	6	10966	MA–092097	Copper	One-edged shaft-hole axe-anvil/wedge
5	13	9875	MA–092100	Copper	Flat chisel

37

Fig. 37: The identity of the five analysed copper objects from Epirus

44 The analyses were performed at the Curt-Engelhorn-Zentrum Archäometrie (CEZA) in Mannheim, which is an Institute of the University of Tübingen in Germany. All of the analyses were funded by the Institute for Aegean Prehistory (INSTAP – USA), to which I extend my warmest thanks for making this interdisciplinary archaeometrical project possible. For the chemical analyses a Quant'X machine of the Thermo-Fischer company was used. See: Lutz – Pernicka 1996, 313–323.

Fig. 38: Chemical composition (EDXRF) of the five EBA objects (Cu-As) from Epirus. All values are given in mass percent. Zn and Bi were always below the detection limit of 0.2 and 0.01 %

Cat. no.	Fe	Co	Ni	Cu	As	Se	Ag	Sn	Sb	Te	Pb
2	<0.01	<0.01	0.140	98	1.07	<0.005	0.155	0.005	0.049	<0.005	0.71
3	<0.02	0.01	0.200	98	1.32	0.007	0.124	0.006	0.058	<0.005	0.38
5	<0.02	<0.01	0.053	99	0.76	<0.005	0.070	0.006	0.085	<0.005	0.22
6	0.19	<0.01	0.060	96	2.55	0.009	0.027	0.029	0.072	<0.005	0.53
13	<0.02	<0.01	0.070	98	2.00	0.008	0.088	0.014	0.047	<0.005	0.13

38

provide us with useful information on the manufacturing technology, on the alloys of copper used and ultimately on the level of technological skills in the area of Epirus, which geographically is away from the large Balkan trade and production centres. After all, there is not any direct metalworking tradition established throughout the Bronze Age, but only quantitative and qualitative data from copper and bronze artefacts.

24 The chemical composition analyses demonstrate a high content of copper (96–99 %) with small quantities of arsenic[45] (0.76–2.55 %). On the basis of these ratios, it is barely possible to characterise as an alloy the metal, of which the five objects were manufactured, given that one of them contains arsenic under 1 %, which possibly represents a natural component of the metal ore (it occurs in sulphide minerals, such as enargites, tennantites, arsenopyrites) and not necessarily an addition. Notwithstanding their characterisation as alloys or not, their small arsenic content is not sufficient to improve the properties of the pure copper, for which purpose a content higher than around 2 % is required (when worked solely by cold hammering or even with low temperature annealing). This critical level of the arsenic content occurs only in two out of the five artefacts. The optimal level is considered to lie between 3–4 %, with that of around 2–7 % considered broadly suitable. Arsenic has positive effect in the casting as an antioxidant agent, but by being an unstable element, it evaporates easily. It is characteristic mainly of alloys of the third millennium B.C., soon being replaced by tin because of its dangerous toxicity, which can cause poisoning and death to people and animals, as well as environmental contamination for agriculture and animal husbandry.

25 Older chemical analyses[46] on two copper single-edged axes of the Veselinovo type from Macedonia (Mesimeri Toumba and Plagiari Toumba in Chalkidiki) are similarly characterised by low arsenic contents (1.70 and 0.48 %). A third axe of a different type from Latomeia at Triadi in Thessaloniki seems to have been made of pure copper (As: 0.06 %). Similar analyses[47] were conducted on all three axes of Veselinovo type from the hoard of Tulcea in Romania, demonstrating equally low arsenic contents (0.61–1.75 %), while the same trend is also observed on axes[48] of the type from Bulgaria. Moreover, in the same major research project (SAM), involving chemical analyses, carried out on thousands of objects from the whole of Europe, there were also included four copper single-edged axes[49] of Kozarac type from the Petralona hoard in Chalkidiki. Once more, these are made of alloy with a small amount of arsenic (1.05–1.60 %).

26 In conclusion (Fig. 39) most of the axes appear to be alloys of copper with small quantities of arsenic[50] (1.05–2.55 %), with but a few artefacts of pure copper (Cat. 5, Plagiari, Triadi and one from Tulcea, with arsenic in the range of 0.06–0.76 %,

45 Charles 1967, 21–26; Northover 1989, 111–118.
46 Grammenos – Tzachili 1994, 112. In none of the three samples was tin traced.
47 Junghans et al. 1968, 248 f. (nos. 8845–8847).
48 Chernykh 1978, 146 f. These also are artefacts made of pure copper or mainly of a copper-arsenic alloy.
49 Junghans et al. 1968, 262 f. (nos. 9333–9336).
50 Suitable/optimal percentage contents of arsenic occur in artefacts of the Kythnos hoard: Lesley Fitton 1989, 38.

Fig. 39: Available/comparable chemical data of fifteen copper single-edged axes

Cat. no.	Ni	As	Ag	Sb	Pb
2	0.14	1.07	0.15	0.05	0.71
3	0.20	1.32	0.12	0.06	0.38
5	0.05	0.76	0.07	0.08	0.22
6	0.06	2.55	0.03	0.07	0.53
13	0.07	2.00	0.09	0.05	0.13
Mesimeri	0.08	1.70	0.06	0.14	0.41
Plagiari	0.07	0.48	0.04	0.04	0.99
Tulcea	0.07	1.75	0.04	–	–
Tulcea	0.02	1.35	0.02	0.04	–
Tulcea	0.06	0.61	0.04	–	0.14
Petralona	0.46	1.60	0.07	0.08	0.53
Petralona	0.30	1.05	0.08	0.11	0.12
Petralona	0.42	1.60	0.08	0.10	0.10
Petralona	0.37	1.45	0.04	0.05	0.54
Triadi	0.34	0.06	0.07	0.01	0.18

39

as borderline alloys), whereas very few are made of a developed copper-tin (Dhaskalio on Keros), the occurrence of which signals the arrival of the new technology in the Aegean islands and further eastwards. These islands, due to their central geographical position and the presence of useful ores (Kythnos, Siphnos, Seriphos), chronologically are foremost locally in the taking up of new technological advances. Looking at the Figure 39 that illustrates comparable chemical data for the fifteen single-edged axes, we notice that with regard to nickel (0.02–0.08 %), the two axes of the Rodotopi hoard (Cat. 2. 3: 0.14–0.20 %) stand out slightly and even more so the five axes of Kozarac type from the Petralona hoard and from Triadi in Chalkidiki (0.30–0.46 %). The levels of silver are more stable (0.02–0.09 %), although the two Rodotopi axes again are slightly conspicuous (Cat. 2. 3: 0.12–0.15 %). The content of antimony is between 0.01–0.14 % and that of lead between 0.10–0.99 %. Lead content (up to around 1 %) is considered to be a natural element of the metal ore and not an addition.

Discussion

27 The four copper single-edged axes from the hoard of Rodotopi in Ioannina and the other eight isolated ones from the rest of Epirus are the only metal finds of the Early Bronze Age in the region, with the exception of two copper artefacts from Goutsoura in Thesprotia and two probable ones (Cat. 12. 13) from Anatoli and Rodotopi in Ioannina. There are, it should be remembered, just three excavated archaeological sites (Doliana and Agia Marina in Ioannina, Goutsoura in Thesprotia), which are securely dated with radiocarbon dates to successive phases of the Early Bronze Age (I–II, while phase III is not yet attested) in the region. The local material culture is characterised by conservative local features (mainly handmade pottery), but also by the first trade contacts with more northern cultures of the Balkans (pottery of ›Bratislava‹ type from Doliana and ›corded ware‹ pottery from Goutsoura). In relation to the copper axes, it seems that the tells and the settlements of central and west Macedonia respectively, stretching between Epirus and the central Balkans to the NE (Bulgaria and Romania), provided a connecting link.

28 The main hoard of the four copper single-edged axes from Rodotopi in Ioannina is not accompanied by any information on the exact location of its deposition or manner of concealment. It may have been a utilitarian assemblage: the breakage and disuse of three of its axes resulted from their previous intensive use and for their concealment an easily accessible spot was chosen, the ultimate aim being to retrieve them for recycling. On the other hand, it cannot be excluded that they were a votive deposit: here therefore, the breakage and disuse of the three axes would have been part of their ritual ›death‹ (as in the case of Petralona hoard, where patterned breakage of the blades is noticed) and their deposition could have been made in some inaccessible spot with no prospect of retrieval. Indeed, in this part of Ioannina there were in the past areas of stagnant waters (water-land) difficult to access. The neighbouring Lapsista lake only recently became dried-up (1958), as we have already mentioned in the introduction.

29 The axes of the Rodotopi hoard, as well as the remaining eight artefacts of the type from Epirus, display manufacturing defects (shrinkage cavities and gas or blowholes). These defaults could have been rather easily prevented (by keeping the mould topped up with liquid metal and by preheating the mould to a suitable temperature). The objects are in fact essentially made of pure copper, as the arsenic content in the alloy is very low and not high enough to improve the properties of the metal. The preoccupation with the typological and manufacturing homogeneity or uniformity of axes in the region implies probable local production or at least an exclusive preference for them in terms of consumption. In any case the craftsmen, who manufactured them, were taking their first steps in the mastering of their craft, still experimenting with the ›recipes‹ and the end-products of their workshops at the onset of the new era (Early Bronze Age).

30 The overall conservatism of the geographically isolated Epirus is to be juxtaposed against the experimentation, seen in the new copper technology: smiths seized the chance of expressing their imagination and creativity, conveying now indefinable ›messages‹ to the final recipients-users. The copper single-edged axe (Cat. 6), which after its disuse was turned into an anvil/wedge, so acquiring a second ›life‹, is an exceptional case of independent and opportunistic thinking. Equally distinctive is the example of another copper single-edged axe (Cat. 4), on the two faces of which are worked small notched entities with an indefinable meaning. The eight axes of Epirus (omitting those from Rodotopi) are isolated occurrences of artefacts with a utilitarian or/and symbolic character. Quite impressive is the fact that, after the blade of all these axes became blunted, no effort was made to repair the same by hammering and re-sharpening (limitations imposed by the nature of the alloy).

31 In the rest of the Helladic area, the second core region for copper single-edged axes in Macedonia is of importance, as there is primary evidence for the local production of this type of axes in the region, which thus extends as an intermediate zone between Epirus and the Balkans. The remaining examples (from Lemnos, but mainly from Keros and Thebes) come from hoards[51] and mark the southernmost boundaries for the geographic distribution of the type across the Helladic mainland and the Aegean islands. The functional potentialities of copper single-edged axes[52] have been studied in the Balkans with interesting results. The arrival of tin technology already in the third millennium B.C. can improve the properties of the alloy, but the era of single-edged axes was also gradually coming to an end at least for the Helladic area, as the double-edged axes of Minoan-Mycenaean inspiration begin to prevail from the end of that millennium onwards.

32 The study of the copper single-edged shaft-hole axes of Epirus is not particularly helpful with issues of chronology, as this is established only in a few cases (Manda-

51 Branigan 1969, 1–11. He includes a catalogue of the early metal hoards (EBA–MBA) from the Helladic area.

52 Maran 1998, 259–271 (metallurgy); Popescu 2006, 431–450 (potentialities); Doumas 2011, 165–179 (toolkit).

lo, Thebes, Poliochni, Dhaskalio). On the basis of some parallels from the Balkans, they are mainly dated to the phases II–III of the Early Bronze Age, without excluding the possibility of a slightly earlier or even later extension. Even so, we do gain an important insight into the typology and manufacturing technology in the wider context of the Balkan area, which otherwise would not have been brought into consideration. Future excavations or finds are required to further clarify the chronological framework, within which these artefacts were manufactured, used, consumed, deposited or potentially recycled inside the particular cultural horizon of Epirus. Until then, we trust that our study might be of some help to the researchers of Early Bronze Age metallurgy within the wider region of Balkans and Europe.

Catalogue of the Early Bronze Age Copper Artefacts from Epirus

Cat. 1

Copper single-edged shaft-hole axe, AMI 4371 (Fig. 1. 2. 3. 28. 32)
Rodotopi in Ioannina, handed-in hoard (1951).
Length: 17,6 cm; blade height: 7,5 cm; butt height: 6,9 cm; inner diam. of hole: 2,6–3,0 cm; outer diam. of hole: 3,8–4,0 cm; weight: 1243 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and midrib on it, angular butt at the back, triangular shrinkage cavity and groove left from the mould on the underside. Manufacturing defects due to gas-holes and dirt inclusions, use-wear of small extent on the surface, while the blade is blunted and non-functional. Brown-green oxidation on the original polished surface.

Cat. 2

Copper single-edged shaft-hole axe, AMI 4372 (Fig. 1. 4. 5. 28. 33)
Rodotopi in Ioannina, handed-in hoard (1951).
Length: 16,7 cm; blade height: 6,5 cm; butt height: 7,0 cm; inner diam. of hole: 2,6–2,9 cm; outer diam. of hole: 3,6–3,8 cm; weight: 1028 g.
Cast copper single-edged axe with circular shaft-hole. Raised back and midrib on it, angular butt at the back, triangular shrinkage cavity and groove left from the mould on the underside. Broken across the middle and joined from two fragments, with chipping along the back in the front half, while the blade is blunted and non-functional. Manufacturing defects due to gas-holes and dirt inclusions, use-wear on the surface. Brown-green oxidation on the original polished surface.

Cat. 3

Copper single-edged shaft-hole axe, AMI 4373 (Fig. 1. 6. 7. 29. 32. 34)
Rodotopi in Ioannina, handed-in hoard (1951).
Length: 17,1 cm; blade height: 7,4 cm; butt height: 5,2 cm; weight: 1096 g; neither inner nor outer diameter of hole is preserved.
Cast copper single-edged axe with circular shaft-hole. Raised back and midrib on it, triangular shrinkage cavity and groove left from the mould on the underside. Broken, rear part of butt missing, with additional crack on the underside of the blade too. Chipping along the back in the front part, while the blade is blunted and non-functional. Manufacturing defects due to gas-holes and dirt inclusions, use-wear on the surface. Brown-green oxidation on the rough surface.

Cat. 4

Copper single-edged shaft-hole axe, AMI 4374 (Fig. 1. 8. 9. 10. 31)
Rodotopi in Ioannina, handed-in hoard (1951).
Length: 18,8 cm; blade height: 5,3 cm; butt height: 7,0 cm; inner diam. of hole: 2,7–3,1 cm; outer diam. of hole: 3,7–4,0 cm; weight: 942 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and midrib on it, rounded butt at the back, with central rib left from the mould on the underside. Small blade with chipping, probably non-functional. Six small, almost leaf-shaped notches on one side and ten on the other, made by a fine pointed tool after the solidification of the metal, probably to create workshop or private marking on the axe. On the surface quite a few small hammering pits. Brown-black oxidation on the original polished surface.

Cat. 5

Copper single-edged shaft-hole axe, AMI 114 (Fig. 11. 12. 28)
Lofiskos (former Tsergiani) in Ioannina, isolated find from donation.
Length: 18,6 cm; blade height: 7,5 cm; butt height: 6,0 cm; inner diam. of hole: 3,2–3,5 cm; outer diam. of hole: 4,3–4,5 cm; weight: 1451 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and midrib on it, angular butt at the back, triangular shrinkage cavity and groove left from the mould on the underside. Use-wear of small extent on the surface, chipped, the upper corner of the blunted and non-functional blade missing. Brown-black oxidation on the original polished surface.

Cat. 6

Copper single-edged shaft-hole axe-anvil/wedge, AMI 10966 (Fig. 13. 14. 30. 35)
Terovo in Ioannina, handed-in isolated find (1983).
Length: 14,0 cm; blade height: 7,7 cm; butt height: 5,9 cm; weight: 1214 g; neither inner nor outer diameter of hole is preserved.
Cast copper single-edged axe with slightly raised back at the top. Broken, rear part missing, through which a circular shaft-hole most probably passed. The two parts of the broken butt were hammered forward, creating three cracks in them and making an almost flat or slightly curved surface, thus transforming the unusable axe into an anvil/wedge. This surface has been exceptionally polished by successive hammer blows and bears in the middle a still discernible, but small shrinkage cavity. On the body of the axe a slight distortion can be discerned, caused by prolonged use, while the blade is blunted and non-functional. Wear traces and pits visible on the back, the body and the lower part, some of them caused by the fastening of the anvil to its base, along with a few small dirt inclusions. On one side six bigger leaf-shaped notches in the middle and three smaller ones on the upper part, in an effort to create decoration or marking. Brown-red oxidation with greenish incrustation.

Cat. 7

Copper single-edged shaft-hole axe, AMA 125b (Fig. 17)
Ziros in Philippiada, handed-in isolated find (1953).
Length: 16,6 cm; blade height: 7,0 cm; butt height: 6,7 cm; inner diam. of hole: 2,8–3,1 cm; outer diam. of hole: 3,8 cm; weight: 1090 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and midrib on it, angular butt at the back, triangular shrinkage cavity and groove left from the mould on the underside. Small areas of use-wear on the surface and the back, the blade is blunted and non-functional. Brown-black oxidation on the original surface.

Cat. 8

Copper single-edged shaft-hole axe, AMA 125c (Fig. 18)
Arta (unknown provenance), isolated find.
Length: 16,7 cm; blade height: 7,4 cm; butt height: 6,7 cm; inner diam. of hole: 2,8–3,0 cm; outer diam. of hole: 3,8 cm; weight: 974 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and midrib on it, angular butt at the back, triangular shrinkage cavity and groove left from the mould on the underside. Several areas of use-wear on the surface and the back, the blade is blunted and non-functional. Brown-green oxidation on the original surface.

Cat. 9

Copper single-edged shaft-hole axe, AMA 6731 (Fig. 19)
Agios Nikolaos of Vlaherna in Arta, surface collection isolated find (1994).
Length: 13,8 cm; blade height: 6,5 cm; butt height: 5,9 cm; inner diam. of hole: 2,7–3,1 cm; outer diam. of hole: 4,1 cm; weight: 820 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and midrib on it, angular butt at the back. Small areas of use-wear on the surface, the blade is blunted and non-functional. Brown-black oxidation with greenish incrustations on the original surface.

Cat. 10

Copper single-edged shaft-hole axe, AMI 113 (Fig. 15. 16. 28. 32)
Pistiana (former Siroupolis) in Arta, isolated find.
Length: 18,5 cm; blade height: 6,5 cm; butt height: 6,9 cm; inner diam. of hole: 2,8–3,0 cm; outer diam. of hole: 3,9–4,0 cm; weight: 1231 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and central midrib on it, angular butt at the back, triangular shrinkage cavity and groove left from the mould on the underside. Horizontal incisions and small areas of use-wear on the surface, the blade is blunted and non-functional, seven notches made by blows on the back. Brown-black oxidation on the original polished surface.

Cat. 11

Copper single-edged shaft-hole axe, AMA 125a (Fig. 20)
Loutro in Amphilochia, handed-in isolated find (1952).
Length: 15,2 cm; blade height: 6,0 cm; butt height: 5,6 cm; inner diam. of hole: 2,4–3,0 cm; outer diam. of hole: 2,8–3,1 cm; weight: 653 g.
Cast copper single-edged axe with circular shaft-hole. Intact, with raised back and midrib on it, angular butt at the back, triangular shrinkage cavity and groove left from the mould on the underside. Chipping and distortion at two points on the hole and the back, while the blade is blunted and non-functional. Brown-green oxidation on the rough surface.

Cat. 12

Copper/bronze flat chisel/axe/adze, AMI 5893 (Fig. 21. 22)
Anatoli (marshy lake) in Ioannina, handed-in isolated find (1975).
Length: 12,5 cm; blade width: 5,2 cm; butt width: 2,7 cm; blade thickness: 0,2 cm; butt thickness: 0,2 cm; maximum thickness: 1,1 cm; weight: 292 g.
Cast copper/bronze flat and unperforated chisel/axe/adze. Intact, with small areas of use-wear on the surface and the functional blade. Cast in a single-open mould, with surface alterations on one face. Blade plano-convex in section, probable used as adze, while the butt is rounded and wedge-like. Brown-green oxidation on the corroded surface.

Cat. 13

Copper flat chisel, AMI 9875 (Fig. 23. 24. 36)
Rodotopi in Ioannina, handed-in isolated find (1955).
Preserved length: 13,0 cm; maximum width: 4,3 cm; butt width: 3,3 cm; maximum thickness: 0,5 cm; butt thickness: 0,3 cm; weight: 137 g.
Cast copper flat chisel. Broken, front part and blade missing. Cast in a single-open mould. Manufacturing defects caused by gas-holes and dirt inclusions, appearing as small irregular cavities, small areas of use-wear on the surface. Brown-green oxidation on the corroded surface.

Cat. 14

Copper single-edged shaft-hole axe (today lost)
Terovo in Ioannina, isolated find.
Cast copper single-edged axe with a circular shaft-hole.

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References

Alram-Stern 2004 E. Alram-Stern, Die Ägäische Frühzeit 2. 1: Die Frühbronzezeit in Griechenland, Veröffentlichungen der Mykenischen Kommission 21 (Vienna 2004)

AMA Archaeological Museum of Arta

AMI Archaeological Museum of Ioannina

Andreou 1983 I. Andreou, Τέροβο, ADelt B 38, 1983, 232

Antonović 2014 D. Antonović, Kupferzeitliche Äxte und Beile in Serbien, PBF 9, 27 (Stuttgart 2014)

Bernabò-Brea 1964 L. Bernabò-Brea, Poliochni I. Cittá preistorica nell'isola di Lemnos (Rome 1964)

Boulotis 2009 C. Boulotis, Koukonisi on Lemnos. Reflections on the Minoan and Minoanising Evidence, in: C. F. Macdonald – E. Hallager – W.-D. Niemeier (eds.), The Minoans in the Central, Eastern and Northern Aegean – New Evidence. Acts of a Minoan Seminar Athens 22–23 January 2005, Monographs of the Danish Institute at Athens 8 (Athens 2009) 175–218

Branigan 1969 K. Branigan, Early Aegean Hoards of Metalwork, BSA 64, 1969, 1–11

Charles 1967 J. A. Charles, Early Arsenical Bronzes. A Metallurgical View, AJA 71, 1967, 21–26

Chernykh 1977 E. N. Chernykh, Ob evropeyskoy zone circumpontiyskoy metallurgicheskoy provintsii (CMP), ActaACarp 17, 1977, 29–53

Chernykh 1978 E. N. Chernykh, Gornoe delo i metallurgiya v drevneyshey Bolgarii (Sofia 1978)

Coleman 2011 J. E. Coleman, The Petromagoula-Doliana Group and the Beginning of the Aegean Early Bronze Age, in: D. Katsonopoulou (ed.), Helike IV. Ancient Helike and Aigialeia: Protohelladika. The Southern and Central Greek Mainland (Athens 2011) 13–44

Dakaris 1956a S. I. Dakaris, Προϊστορικοί τάφοι παρά το Καλμπάκι Ιωαννίνων, AEphem 95, 1956, 114–153

Dakaris 1956b S. I. Dakaris, Αρχαιολογικές έρευνες στο λεκανοπέδιο των Ιωαννίνων, in: Αφιέρωμα εις την Ήπειρον εις μνήμην Χρίστου Σούλη (Athens 1956) 46–80

Dakaris 1985 S. I. Dakaris, Epiro e Magna Grecia fino all'età arcaica, in: Magna Grecia, Epiro e Macedonia. Atti del Ventiquattresimo Convegno di Studi sulla Magna Grecia Taranto 1984 (Taranto 1985) 103–131

Deckwirth 2016 V. Deckwirth, Faunal Remains of Goutsoura. The Early Bronze Age Strata, in: Forsén et al. 2016, 261–287

Doulkeridou 2016 S. Doulkeridou, The Chipped Stone Assemblage from Goutsoura, in: Forsén et al. 2016, 211–226

Doumas 2011 C. G. Doumas, Searching for the Early Bronze Age Aegean Metallurgist's Toolkit, in: P. P. Betancourt – S. C. Ferrence (eds.), Metallurgy. Understanding How, Learning Why. Studies in Honor of J. D. Muhly, Prehistory Monographs 29 (Philadelphia 2011) 165–179

Douzougli – Zachos 2002 A. Douzougli – K. Zachos, L'archéologie des zones montagneuses. Modèles et interconnexions dans le Néolithique de l'Épire et de l'Albanie méridionale, in: G. Touchais – J. Renard (eds.), L'Albanie dans l'Europe préhistorique. Actes du Colloque de Lorient 8–10 Juin 2000, BCH Suppl. 42 (Paris 2002) 111–143

Forsén 2011 J. Forsén, Spoons to Fill the Cups, in: W. Gauss – M. Lindblom – R. Angus K. Smith – J. C. Wright (eds.), Our Cups Are Full. Pottery and Society in the Aegean Bronze Age. Papers Presented to Jeremy B. Rutter (Oxford 2011) 65–67

Forsén 2016a B. Forsén, The Bronze Age Site of Goutsoura. Location, Stratigraphy and Date, in: Forsén et al. 2016, 121–144

Forsén 2016b J. Forsén, Bronze Age Pottery from Goutsoura, in: Forsén et al. 2016, 191–210

Forsén – Forsén 2012 B. Forsén – J. Forsén, Surface Contra Subsurface Assemblages. Two Archaeological Case Studies from Thesprotia, Greece, in: S. Kluiving – E. Guttmann-Bond (eds.), Landscape Archaeology between Art and Science. From a Multi- to an Interdisciplinary Approach (Amsterdam 2012) 295–305

Forsén et al. 2011 B. Forsén – J. Forsén – K. Lazari – E. Tikkala, Catalogue of Sites in the Central Kokytos Valley, in: B. Forsén – E. Tikkala (eds.), Thesprotia Expedition II. Environment and Settlement Patterns, Papers and Monographs of the Finnish Institute at Athens 16 (Helsinki 2011) 73–122

Forsén et al. 2016 B. Forsén – N. Galanidou – E. Tikkala, Thesprotia Expedition III. Landscapes of Nomadism and Sedentism, Papers and Monographs of the Finnish Institute at Athens 22 (Helsinki 2016)

Georgakopoulou 2013 M. Georgakopoulou, Metal Artefacts and Metallurgy, in: C. Renfrew – O Philaniotou – N. Brodie – G. Gavalas – M. J. Boyd (eds.), The Settlement at Dhaskalio (Cambridge 2013) 667–692

Grammenos – Tzachili 1994 D. V. Grammenos – I. Tzachili, Ο θησαυρός των Πετραλώνων της Χαλκιδικής και άλλα χάλκινα εργαλεία της ΠΕΧ από την ευρύτερη περιοχή, AEphem 133, 1994, 75–116

Gravani 2007/2008 K. Gravani, Η αρχαιολογική έρευνα στο λεκανοπέδιο των Ιωαννίνων, Dodone 36/37, 2007/2008, 179–234

Hänsel 2003 B. Hänsel, Eine Gussform für Axt und Dolch aus Nea Olynthos von der Chalkidike, in: E. Jerem – P. Raczky (eds.), Morgenrot der Kulturen. Frühe Etappen der Menschheitsgeschichte in Mittel- und Südosteuropa. Festschrift für Nándor Kalicz (Budapest 2003) 475–481

Hammond 1967 N. G. L. Hammond, Epirus. The Geography, the Ancient Remains, the History and the Topography of Epirus and Adjacent Areas (Oxford 1967)

Hansen 2001 S. Hansen, Waffen aus Gold und Silber während des 3. und 2. Jahrtausends v. Chr. in Europa und Vorderasien, in: H. Born – S. Hansen (eds.), Helme und Waffen Alteuropas, Sammlung Axel Guttmann 9 (Mainz 2001) 11–59

Junghans et al. 1968 S. Junghans – E. Sangmeister – M. Schröder, Kupfer und Bronze in der frühen Metallzeit Europas, Römisch-Germanisches Zentralmuseum. Studien zu den Anfängen der Metallurgie (Berlin 1968)

Karamitrou-Mentesidi 2011 G. Karamitrou-Mentesidi, Παλιουριά, ADelt B 66, 2011, 845

Karamitrou-Mentesidi – Lokana 2011 G. Karamitrou-Mentesidi – C. Lokana, Η ανασκαφή στη θέση Κρυοπήγαδο Αλιάκμονα Βοΐου, in: Το Αρχαιολογικό Έργο στην Άνω Μακεδονία 1, Aiani 2009 (Aiani 2011) 301–327

Kleitsas 2013 C. N. Kleitsas, Η μεταλλοτεχνία της Ύστερης Εποχής του Χαλκού στην Ήπειρο. Οι θησαυροί και τα εργαλεία (Ph.D. diss. University of Ioannina, Ioannina 2013)

Kleitsas et al. 2018 Ch. N. Kleitsas – M. Mehofer – R. Jung, The Late Bronze Age Hoard of Stephani in Preveza, Epirus, NW Greece, AA 2018/1, 73–107

Konstantaki – Spanodimos 2008 A. Konstantaki – C. Spanodimos, Μνημεία και αρχαιολογικοί χώροι της Λάκκας Σούλι του νομού Πρέβεζας, Epeiroton Koinon 2, 2008, 15–43

Lesley Fitton 1989 J. Lesley Fitton, Esse Quam Videri. A Reconsideration of the Kythnos Hoard of Early Cycladic Tools, AJA 93, 1989, 31–39

Lutz – Pernicka 1996 J. Lutz – E. Pernicka, Energy Dispersive X-Ray Fluorescence Analysis of Ancient Copper Alloys. Empirical Values for Precision and Accuracy, Archaeometry 38, 1996, 313–323

Maran 1989 J. Maran, Die Schaftlochaxt aus dem Depotfund von Theben (Mittelgriechenland) und ihre Stellung im Rahmen der bronzezeitlichen Äxte Südosteuropas, AKorrBl 19, 1989, 129–136

Maran 1998 J. Maran, Kulturwandel auf dem griechischen Festland und den Kykladen im späten 3. Jahrtausend v. Chr. (Bonn 1998)

Maran 2001 J. Maran, Der Depotfund von Petralona (Nordgriechenland) und der Symbolgehalt von Waffen in der ersten Hälfte des 3. Jahrtausends v. Chr. zwischen Karpatenbecken und Ägäis, in: Lux Orientis. Archäologie zwischen Asien und Europa. Festschrift für H. Hauptmann (Rahden 2001) 275–284

Mehofer – Kucera 2005 M. Mehofer – M. Kucera, Rasterelektronenmikroskopie in der Archäologie. Zum Einsatz naturwissenschaftlicher Methoden in der archäologischen Forschung – Teil 1, Archäologie Österreichs 16, 2005, 56–63

Nakou 1997 G. Nakou, The Role of Poliochni and the North Aegean in the Development of Aegean Metallurgy, in: C. G. Doumas – V. La Rosa (eds.), Η Πολιόχνη και η Πρώιμη Εποχή του Χαλκού στο Βόρειο Αιγαίο, Athens 1996 (Athens 1997) 634–648

Northover 1989 J. P. Northover, Properties and Use of Arsenic-Copper Alloys, in: A. Hauptmann – E. Pernicka – G. A. Wagner (eds.), Old World Archaeometallurgy. Proceedings of the International Symposium Heidelberg 1987 (Bochum 1989) 111–118

Papadimitriou 2008 G. Papadimitriou, The Technological Evolution of Copper Alloys in the Aegean during the Prehistoric Period, in: I. Tzachili (ed.), Aegean Metallurgy in the Bronze Age. Proceedings of an International Symposium Held at the University of Crete, Rethymnon, 2004 (Athens 2008) 271–287

Papadopoulos 1976 T. I. Papadopoulos, Η Εποχή του Χαλκού στην Ήπειρο, Dodone 5, 1976, 271–338

Papayiannis 2016 A. Papayiannis, Small Finds from Bronze Age Goutsoura, in: Forsén et al. 2016, 227–243

Pilali-Papasteriou – Papaeuthimiou-Papanthimou 1989 A. Pilali-Papasteriou – A. Papaeuthimiou-Papanthimou, Νέες ανασκαφικές έρευνες στο Μάνδαλο Δ. Μακεδονίας, 1985/1986, Εγνατία 1, 1989, 15–28

Pliakou 2007 G. Pliakou, Το λεκανοπέδιο των Ιωαννίνων και η ευρύτερη περιοχή της Μολοσσίας στην κεντρική Ήπειρο. Αρχαιολογικά κατάλοιπα, οικιστική οργάνωση και οικονομία (Ph.D. diss. Aristotle University of Thessaloniki, Thessaloniki 2007)

Popescu 2006 A.-D. Popescu, Beyond Typology. Metal Axes and Their Potential, Dacia 50, 2006, 431–450

Prendi – Bunguri 2008 F. Prendi – A. Bunguri, The Early Bronze Age in Albania (Pristina 2008)

SAM Studien zu den Anfängen der Metallurgie

Siozou forthcoming V. Siozou, Αγία Μαρίνα Πεδινής Ιωαννίνων. Ένας οικισμός Τελικής Νεολιθικής / Πρώιμης Χαλκοκρατίας, in: Το Αρχαιολογικό Έργο στη Βορειοδυτική Ελλάδα και τα Νησιά του Ιονίου 2, Ioannina 2017 (forthcoming)

Soueref 2001 K. I. Soueref, Μυκηναϊκές μαρτυρίες από την Ήπειρο (Ioannina 2001)

Ştefan 2007 C. E. Ştefan, Un topor din cupru aflat în colecţiile Muzeului Naţional de Antichităţi, MatCercA 3, 2007, 83–88

Vokotopoulou 1969 I. Vokotopoulou, Νέοι κιβωτιόσχημοι τάφοι της ΥΕ ΙΙΙΒ–Γ περιόδου εξ Ηπείρου, AEphem 108, 1969, 179–207

Vokotopoulou 1972 I. Vokotopoulou, Θησαυρός χαλκών πελέκεων εκ Καταμάχης Ιωαννίνων, AAA 5, 1, 1972, 112–119

Vulpe 1970 A. Vulpe, Die Äxte und Beile in Rumänien I, PBF 9, 2 (Munich 1970)

Zachos 1997 K. L. Zachos, Τοπογραφικά Ελοπίας. Το λεκανοπέδιο των Ιωαννίνων κατά την Ύστερη Χαλκοκρατία και την Πρώιμη Εποχή του Σιδήρου, in: Αφιέρωμα στον N. G. L. Hammond, Εταιρεία Μακεδονικών Σπουδών, Παράρτημα »Μακεδονικών« 7 (Thessaloniki 1997) 153–167

Žeravica 1993 Z. Žeravica, Äxte und Beile aus Dalmatien und anderen Teilen Kroatiens, Montenegro, Bosnien und Herzegowina, PBF 9, 18 (Stuttgart 1993)

Ziota 1996 C. Ziota, Ανάργυροι, ADelt B 51, 1996, 548

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ADDRESS

Dr. Christos N. Kleitsas
Ephorate of Antiquities of Ioannina
Archaeological Museum of Ioannina
Ioannina
Greece

chklitsas@culture.gr
GND: http://d-nb.info/gnd/1707346-7

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