

COLLOQUIUM ROMANUM

ATTI DEL XII COLLOQUIO
INTERNAZIONALE DI MICENOLOGIA

ROMA · 20-25 FEBBRAIO 2006

SOTTO L'ALTO PATRONATO DEL PRESIDENTE DELLA REPUBBLICA

A CURA DI

A. SACCONI, M. DEL FREO, L. GODART, M. NEGRI

II.



«PASIPHAE» · II.

PISA · ROMA

FABRIZIO SERRA · EDITORE

MMVIII

PASIPHAE

RIVISTA DI FILOLOGIA
E ANTICITÀ EGEE

DIRETTORI:

LOUIS GODART · ANNA SACCONI

SEGRETARIO DI REDAZIONE:

MAURIZIO DEL FREO

II.

(2008)



PISA · ROMA

FABRIZIO SERRA · EDITORE

MMVIII

PREMESSA

Nel 2001 decidemmo di creare una rivista internazionale di filologia e antichità egee dal nome "Pasiphae" e di affiancare alla rivista stessa una collana intitolata Biblioteca di "Pasiphae" destinata ad accogliere monografie relative alle civiltà egee.

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Iniziamo ora la pubblicazione della rivista "Pasiphae", che uscirà con cadenza annuale: i numeri I (2007) e II (2008) escono contemporaneamente e contengono gli "Atti del XII Colloquio Internazionale di Micenologia", svoltosi a Roma dal 20 al 25 febbraio 2006.

Roma, dicembre 2007.

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ANNA MICHAILIDOU

LATE BRONZE AGE ECONOMY: COPPER / BRONZE IN LINEAR B SCRIPT AND MATERIAL EVIDENCE

Introduction

The discussion, once again, on metals in the Linear B tablets, has been provoked by a comment appearing in more than one of the reviews on the book *Manufacture and Measurement*.¹ This comment was on the term “coppersmiths”² that was used in this book for the metal-workers of Pylos.³ The trade name of coppersmiths was considered misleading; what the palace of Pylos distributed was not copper but bronze, this been further confirmed by the archaeological and analytical evidence of re-melting bronzes at Nichoria.⁴

Apart from the irrelevance of the trade name (coppersmith or bronze smith alike) to the particular condition of the raw material available to him, the process of recycling bronze (or arsenical copper)⁵ was anyway part of the activities of a smith, whether also equipped with pure copper or not. And the term “coppersmith” is the trade name found in the English dictionaries.⁶ It is furthermore my personal choice to use the word copper as a generic term, leaving the word bronze for the cases

1. A. MICHAILIDOU (ed.), *Manufacture and Measurement. Counting, Measuring and Recording Craft Items in Early Aegean Societies*, Athens 2001 (Μελετήματα, 33).

2. M.-L. NOSCH, “Comptes rendus”, *REA* 106 (2004), p. 357: « La question de savoir si dans les tablettes en linéaire B nous avons du cuivre ou du bronze (en alliage avec de l'étain ou de l'arsenic) n'est que peu abordée. Il est d'ailleurs problématique que plusieurs auteurs de ce volume parlent de bronze, mais traduisent *ka-ke-u* par ‘coppersmith’ ».

3. F. ROUGEMONT, “Comptes rendus bibliographiques”, *Revue Archéologique* (2004), p. 91: « Dans le domaine philologique, on remarquera qu'il est question, à plusieurs endroits, de *coppersmiths* pour traduire le mot mycénien *ka-ke-we* (grec /*khalkewes*/ ‘forgerons’) qui constitue une interprétation discutable; on parle aussi de cuivre, voire d'étain, pour le mot *ka-ko* (grec /*khalkos*/ ‘bronze’). [...] l'hypothèse selon laquelle le mot]*ka-te-ro*, dans la tablette Og 5515, pourrait désigner du plomb (grec /*kassiteros*/) est exclue ». In regard to the above words in the Aegean script, the authors of the book – « bien qu'un seul des auteurs en soit effectivement spécialiste » – know the loan-words of *ka-ko*, *mo-ri-wo-do* and *kassiteros* from their mother language. I will only comment that this review leaves out a whole chapter (the last one, on “Producing and Recording Leather and Other Animal Products”, p. 268-317), not even mentioning the name of the author (K. Trantalidou).

4. C.W. SHELMEKDINE, “Book Reviews”, *AJA* 107 (2003), p. 300: « LH IIIB smiths at Nichoria were remelting bronze, not smelting copper and tin (C. W. Shelmerdine, *AJA* 85 [1981], p. 319-25). This evidence supports taking *ka-ko* and its ideogram AES as bronze rather than copper ».

5. Which should not be called bronze, the term been confined only to the copper-tin alloy.

6. For instance in the *Concise Oxford Dictionary of Current English*, 8th ed. (by R. E. Allen), Oxford, Clarendon Press, 1990. See also the chapter under the title “The coppersmith” in J. G. DERCKSEN, *The Old Assyrian Copper Trade in Anatolia*, Leiden 1996, p. 71ff., about the Old Assyrian smiths (defined in the Kültepe tablets by the generic term *nappāhum* = the ‘blowers’), who were working not only copper and bronze but other metals as well; from the analytical data available it seems that both arsenical copper and bronze were worked.

where analytical results have given specifically the tin-copper alloy as the material of a lump or a finished product. The question of whether copper or bronze was the raw material sent to the smiths of Pylos could be solved by the usual convention copper / bronze⁷ if the question itself were not connected with the main question about tin: why tin is not sent along?

The Linear B tablets surely belong to a period of a very wide use of bronze. In particular for the period of the **PY Jn** tablets and onwards, there is an ongoing discussion about bronze - and scrap metal - as an attainable circulating commodity.⁸ Sherratt gives us a short and to the point picture on the subject of copper / bronze in LM / LH IIIA-B textual / archaeological context.⁹ Should we agree with her that there was « an apparent failure » of the Mycenaean Greek language to distinguish between copper and bronze? The scribe might deliberately use the words *ka-ko* and *ka-ke-u* for both; in ancient Greek literature the term χαλκεύς, occasionally also meant the smith working any kind of metal (copper, gold, silver and even iron).¹⁰ Χαλκός gave the generic trade name to the metal-worker,¹¹ perhaps as having the greatest use value among the other metals; I take the idea from the famous *Debate between Copper and Silver*, a Mesopotamian text where copper speaks to silver with condemn on account of the latter's lower use value.¹²

Further labour specialization in metal crafts is indeed recorded in the Linear B script, as summarized by Morpurgo Davies,¹³ in regard to the material, e.g. the *ku-ru-so-wo-ko*, to some of the end products, e.g. the *ka-si-ko-no*, to the division of labour, e.g. the *a-ke-te* and *pa-ra-ke-te-e-u*; including, with caution, the ambiguous *me-ta-ri-ko-wo* as 'metal pourer', we may recall the organized workshops in the ancient Egyptian tomb paintings, depicting the various stages in metalworking (Fig. 1) even mentioning the annealing process.¹⁴

Copper or Bronze?

It is true that the languages written in cuneiform seem to have separate terms for copper and bronze.¹⁵ But even in Sumerian, the logogram for copper, URUDU, is

7. A. MICHAILIDOU, "Recording quantities of metal in Bronze Age Societies", in *Manufacture and Measurement*, p. 106 and *passim*.

8. E.g. in S. SHERRATT, "Circulation of metals and the end of the Bronze Age in the eastern Mediterranean" in *Metal Makes The World Go Round. The supply and Circulation of Metals in Bronze Age Europe*, Birmingham University, June 1997, C. F. E. Pare (ed.), Oxford 2000, p. 87; also M. ARTZY, *The Jatt Metal Hoard in Northern Canaanite / Phoenician and Cypriote Context*, Barcelona 2006, p. 21.

9. S. SHERRATT, "Potemkin Palaces and Route-based Economies", in *Economy and Politics*, p. 218-19.

10. H. G. LIDDLE, R. SCOTT, *Μέγα λεξικόν της Ελληνικής γλώσσας*, Αθήνα, s.v. χαλκεύς.

11. For χαλκός as a generic term for metal, cf. J. D. MUHLY, *Copper and Tin. The Distribution of Mineral Resources and the Metals Trade in the Bronze Age*, New Haven 1973, p. 175.

12. S.N. KRAMER, *The Sumerians. Their History, Culture and Character*, Chicago 1963, p. 265.

13. A. MORPURGO-DAVIES, "Terminology of Power and Terminology of Work in Greek and Linear B Tablets", in *Colloquium Mycenaeanum*, p. 87-108, where is noted the higher level of the Mycenaean specialization in contrast to Homeric texts.

14. E.g. B. SCHEEL, *Egyptian Metalworking and Tools*, Ailesbury 1989 (Shire Egyptology Series, 13), p. 30.

15. For instance in Sumerian copper is URUDU and bronze is ZABAR and the relevant names in Akkadian are *erû* and *siparru*; it seems that most of the ancient Indo-European languages did not

sometimes used as a generic term for metal, in such a case preceding the record of the object made of bronze, its specific qualification, ZABAR, always following the name of this object.¹⁶ Furthermore, it seems that there was no uniform validity of a simple *erû* = ‘copper’ and *siparru* = ‘bronze’ equations in Akkadian of the Neo-Assyrian period, as the term used for ‘bronze’ in regard to finished products, *siparru*, meant ‘copper’ when referring to unworked metal (and occasionally when referring to worked copper too).¹⁷ In regard to this ambiguity during the 1st millennium, at least, Moorey concludes:¹⁸ « This is not surprising since copper and bronze may not be separated consistently by eye, least of all by the inexpert. It is a potential *confusion* that almost certainly *also applied to administrative records in earlier periods* » (my emphasis).

To return to the Linear B script, the AES ideogram itself is, according to Lejeune,¹⁹ the sign of the axe; it seems as if the axe, a metal tool / weapon *par excellence*, became the semantic sign for its raw material – we may add here that in Accadian the name for the mould is ‘the mother of the axe’.²⁰ Gillis has done all the work in gathering the bibliography for her useful discussion on the subject of copper or bronze, with more scholars adapting bronze both for the word *ka-ko* and the ideogram AES.²¹ This preference for bronze, stated from the beginning in *Documents*, is explained by the use of the above as determinants to finished products made usually of bronze.²² But if we decide, as Muhly does, to remain with the view that *ka-ko* (and the ideogram AES) may refer both to copper or bronze – which is consistent with the ancient, as well as the modern Greek use of the term – we might expect that a further distinction by the ‘untrained scribal eye’²³ was unimportant or unreliable to Mycenaean bureaucrats; besides, the scribe will have considered to be evident the

distinguish between copper and bronze, apart from the Hittite with *ku(wa)nnan* meaning ‘copper’ (and blue glass-paste) and *harašu* ‘bronze’ (J. D. MUHLY, *Copper and Tin*, cit., p. 174, 176-77).

16. H. LIMET, *Le travail du métal au pays de Sumer au temps de la IIIe Dynastie d’Ur*, Paris 1960, p. 31, 191.

17. On this ambiguity I cite also the following comment on « the use of URUDU (the usual logogram for *erû*) as a determinative and the occasional generic use of *erû* – in what was technologically becoming a ferrous age – as ‘non iron’ [...] If both *erû* and *siparru* when referring to metal in an unfinished state, denote ‘copper’, then there is no obvious way left in Akkadian to refer to unfinished bronze [...] Why are the same finished objects summarized as *erû* in the heading of the text and as *siparru* at the end? » (J. A. BRINKMAN, “Textual Evidence for Bronze in Babylonia in the Early Iron Age, 1000-539 BC”, in *Bronze-working Centres of Western Asia c. 1000-539 BC*, British Museum, July 1986, J. E. Curtis [ed.], London 1988, p. 137-138, mostly on the basis of C. ZACCAGNINI, “La terminologia Accadica del rame e del bronzo nel I millennio”, *Oriens Antiquus* 10 [1971], p. 123-144).

18. P. R. S. MOOREY, *Ancient Mesopotamian Materials and Industries. The Archaeological Evidence*, Oxford 1994, p. 254, from where the above citations to C. ZACCAGNINI, “La terminologia”, cit., and J. A. BRINKMAN, “Textual Evidence for Bronze”, cit.

19. M. LEJEUNE, “Les forgerons de Pylos”, *Historia* 10 (1961), p. 409-434 (= *Mémoires* II, p. 174).

20. H. LIMET, *Le travail du métal*, cit., p. 124.

21. C. GILLIS, “The Smith in the Late Bronze Age. State Employee, Independent Artisan, or both?”, in *Techne*, p. 506-509.

22. *Docs*², p. 351.

23. J. A. BRINKMAN, “Textual Evidence for Bronze”, cit., p. 138.

particular meaning of the word depending on the item recorded each time. So, let us proceed to some comparisons of the type of recorded items to the archaeological and analytical data available.

As an example, in the well known tablet **KN Oa 734**, the ideogram AES defining an ox-hide ingot is definitely used here for copper, as the analytical work on this type of ingot (*167) has resulted in copper, never as yet in bronze; the ideogram AES placed over the oxhide ingot (which is further specified by the sign *pe*, possibly in its meaning as *pelekys*)²⁴ might have been added in order to clarify the metal of the specific ingot, namely that this ingot was of copper and not of tin, since we now know that the ox-hide shape was one of the forms in which tin circulated as well, as evidenced by the Uluburun finds.²⁵

On the contrary, in the tablet **KN R 1815**, the [*e*]-*ke-a ka-ka re-a* HAS 12 should rather be understood as made of bronze in accordance to the majority of analyses of spearheads by Mangou and Ioannou.²⁶ One of the arguments for usually taking *ka-ko* and AES as ‘bronze’ has been the absence, as yet, of a word or an ideogram for ‘tin’ in the Linear B script.²⁷ This absence may be due to the fact that the surviving texts do not provide us with the narrative of smithery; we have no recipes as in the Near-Eastern texts.²⁸ For instance, in regard to the same weapon as in the **KN R 1815**, we may cite a text from Ebla:²⁹

1,5 (sicli) di stagno da fondere con 10,5 (sicli) di rame (per) 1 punta di lancia (del) re: NP

We see here the definition of the quantities of weight of the metals participating in the alloy to be used for the manufacture of a (bronze) spearhead for the king. If we calculate its weight (whether in Eblaitic or Mesopotamian shekels) this is a little less than 100 gr, so in good accordance with the weight of the Mycenaean short spearheads or points of javelins (Fig. 18 and Fig. 19) that are discussed below in regard to the tablet **PY Jn 829**.

24. If the determinant *pe* can stand here for *pelekys* (cf. *IDA*, p. 153); we know of a unit *pelekys*, later in Cyprus and Crete. One should mention also the concept of *pelekys* as “valore circolante” by N. PARISE (*La nascita della moneta*, Roma 2001, p. 85) and also the work by N. SVORONOS, “Μαθήματα Νομισματικής: πελέκεις και ημιπελέκεις”, *Διεθνής Εφημερίς Νομισματικής Αρχαιολογίας* 9 (1906), p. 161-89.

25. C. PULAK, “The Copper and Tin Ingots from the Late Bronze Age Shipwreck at Uluburun”, in *Anatolian Metal I*, Y. Yalçin (ed.), Bochum 2000 (*Der Anschnitt*, Beiheft 13), p. 137-157.

26. With very few exceptions: cf. the relevant table by E. MANGOU, P. V. IOANNOU, “On the Chemical Composition of Prehistoric Greek Copper-based Artefacts from the Mainland Greece”, *ABSA* 94 (1999), p. 81-100.

27. While words for ‘tin’ are known in Sumerian, Akkadian, Hittite, Egyptian and Ugaritic: J. D. MUHLY, “Sources of Tin and the Beginning of Bronze Metallurgy”, *AJA* 89 (1985), p. 279 and n. 39.

28. In descriptions of the manufacture of bronze in cuneiform texts, the amounts of copper and tin are specified by weight and their totals equal the weight of the bronze produced, indicating that what the craftsmen were weighing was metallic tin and not cassiterite (SnO₂): J. D. MUHLY, “The Bronze Age Setting”, in *The Coming of the Age of Iron*, T. A. Vertime, J. D. Muhly (ed.), New Haven 1980, p. 46, with the relevant text from Mari; also J. D. MUHLY, “Sources of Tin”, *cit.*, p. 278.

29. The text is given here as translated in Italian by A. ARCHI, *Testi amministrativi di metalli e tessuti*, Roma 1988 (*ARET VII*).

From texts from Mari we learn that tin in form of ingots was shipped to the palace of Mari where it was kept in the storeroom, the seal-house or the courtyard.³⁰ The ship that sunk at the Uluburun, after having been loaded with ingots of tin and ingots of Cypriot copper, was on its way to the Aegean destined for a Mycenaean port.³¹ When the copper ingots were unloaded, they will have been weighed before storage, because the majority of the Uluburun oxhide ingots display a variation in weight from 29 to 20 kilograms (average weight 23.9 kg).³² The necessity of weighing before storage, is evidenced by the inventory of ingots at Knossos, in particular the tablet **KN Oa 730**, where the obvious distinction between the ingot (*167) and the talent (*118) recalls similar accounting practices in the Near East, as Zaccagnini has summarized.³³ So we are certainly faced with the question of where the relevant Knossian inventory of tin ingots is.

A view has been forwarded to the effect that in the tablet **KN Og 5515 + 5518 + 5539** (Fig. 2) the word *ka-te-ro* may mean 'tin'.³⁴ I would suggest an alternative view for investigation by experts. If the word *ka-te-ro* may be read as καρτερός/όν, we note that in Homeric texts both this epithet and its equivalent κρατερός mean 'strong, resistant, brave',³⁵ referring either to objects, like arrows, shields, chains, or to persons, once defining the Trojan army (*Il.* 5, 591-592: Τρώων εἶποντο φάλαγγες καρτεραί).³⁶

Strength and resistance are the qualities of bronze, that is copper reinforced by alloying it with tin. This word in its meaning as 'reinforced', if applied to bronze,³⁷ would justify the word κρατερώματα in Hesychios *Lexicon*, in accordance to other relative ancient Greek words.³⁸ Highly indicative of the concept of metal lying

30. J. D. MUHLY, "The Bronze Age Setting", cit., p. 37.

31. C. PULAK, "Who were the Mycenaeans aboard the Uluburun Ship?", in *Emporia*, p. 295-310.

32. C. PULAK, "The Copper and Tin Ingots", cit., p. 143.

33. E.g. in C. ZACCAGNINI, "Aspects of Copper Trade in the Eastern Mediterranean during the Late Bronze Age", in *Traffici micenei nel Mediterraneo*, Palermo 3-6 dicembre 1984, M. Marazzi, S. Tusa, L. Vagnetti (ed.), Taranto 1986, p. 413-424.

34. In the first publication of the tablet by J. T. KILLEN and J.-P. OLIVIER ("155 Raccords de fragments dans les tablettes de Cnossos", *BCH* 92 [1968], p. 131) it is stated by Olivier that on this tablet « Il ne manque probablement aucun signe à gauche (ce qui exclut la seule restitution possible, *wa-na-ka-te-ro*); si *ka-te-ro* est un mot complet, il s'agit d'un hapax ». For the current tentative meaning as 'tin', see S. SHERRATT, "Potemkin Palaces", cit., p. 219, where she quotes Killen's view that this word might very plausibly be read as *kas(s)teros*, a syncopated form of a non-Greek loan word (Babylonian *kassitira*); cf. *DELG* s.v. κασσίτερος; C. GILLIS emphasizes that there is no connection with the Accadian word *annaku* ("The Smith", cit., p. 509 n. 20); for more on tin, see also J. D. MUHLY, *Copper and Tin*, cit., and J. D. MUHLY, "Sources of Tin", cit.

35. According to *DELG* s.v. κράτος (κάρτος), this word « qui relève d'une racine exprimant la notion de 'dureté' ... signifie 'force' notamment force physique [...] à κράτος respondent divers adjectives: 1. κρατύς 'puissant' ... d'où le verbe dénomiatif κρατώνω, ép. καρτώνω 'renforcer, consolider, ...' [...] 2. κρατερός ... καρτερός 'fort, puissant, brutal' ... καρτερώνυχες (epithète de chevaux notamment) ... ».

36. H. G. LIDDEL, R. SCOTT, *Μέγα Λεξικόν*, cit., s.v. καρτερός κρατερός; cf. also *ibid.*: « σίδηρος ὅπερ καρτερώτατός ἐστιν » also « ἀδάμαντος ἔχοντα κρατερόφρονα θυμόν ».

37. The initial use of the word κεράννυμι (κράμα) been for the mixture of liquids (wine and water): H. G. LIDDEL, R. SCOTT, *Μέγα Λεξικόν*, cit., s.v. κεράννυμι.

38. H.G. LIDDEL, R. SCOTT, *Μέγα Λεξικόν*, cit., s.v. χαλκώματα and ἀργυρώματα.

behind the meaning of ‘strong / brave’, is the following passage from Sophocles, where human resistance to misfortunes is paralleled with the strength of iron *when turned to steel* (S. *Ai.* 650-651):

ὄς τὰ δεῖν' ἑκαρτέρουν τότε, βαφῆ σίδηρος ὄς.

If the adjective *ka-te-ro*³⁹ was used at Knossos in order to define ‘copper turned to bronze’,⁴⁰ then bronze was seen simply as the reinforced copper and the generic term *ka-ko* prevailed in Pylos tablets and later in Homer, where the adjective *καρτερός* is used in its meaning as ‘resistant, strong’. Defining copper by various determinants⁴¹ is not unusual in Near-Eastern texts. For instance ‘copper from the mountains’ is translated as the mineral of copper or the blister copper;⁴² in this way of thinking, the *ka-ko na-wi-jo* mentioned in the tablet **PY Jn 829** may very well stand for ‘blister copper coming by ship’ (as Muhly has already suggested),⁴³ and one might even proceed to distinguish *ka-ko na-wi-jo* as subsequently meaning ‘unalloyed copper’, from (*ka-ko*) *ka-te-ro* as meaning ‘copper alloyed with tin’, unless it meant the ‘hammered copper’, as is Limet’s explanation for the ‘cuiivre fort’ in the Ur III tablets.⁴⁴ Furthermore, *Καρτερός* is also a personal name (e.g. one of the Alexander’s generals) and the name of a river in Crete after a Byzantine general. Still, the word *κατερώματα* in Hesychios lexicon,⁴⁵ as meaning the specific mixture of tin and copper, remains a question for further investigation; *κατέρωμα* is the word for bronze used by Greek scientists.

Moving from palace inventories to allotments of metal, we note that J. Smith⁴⁶ clearly states that *ka-ko* and AES in **Jn Series** (and elsewhere) might mean both copper or bronze, depending on the word’s particular context. On the basis of remarks by Zaccagnini and also Melena, that the totals in some of the tablets reproduce the weight of one or more ingots or even half-ingots of copper,⁴⁷ she

39. Perhaps more related to *καρτερός/όν* than to the Elamite word *kassitira*? (H. G. LIDDEL, R. SCOTT, *Μέγα Λεξικόν*, cit., s.v. *κασσίτερος*).

40. In such a case, the weight recorded of 4 talents and some double minas might represent a load of bronze either in the form of bun or slab ingots, or a hoard of craft items (perhaps for recycling). Similar is the way of recording ivory in **KN Og 7504 + 7844** as *e-re-pa-ta* of 30 double minas weight. In the same **Og** series there are records of the weight of lead (**KN Og 1527** *mo-ri-wo-do*) and possibly of AES in a quantity of 10 double minas (**KN Og 5551**).

41. According to Theophrastus (*Lap.* fr. 2 Wimmer), an hapax in Homer of *ἐρυθρός χαλκός* might denote the pure copper (J. D. MUHLY, *Copper and Tin*, cit., p.175 n. 32), but perhaps it is more a poetic reference to the colour, not used as a technical term.

42. For various records, see H. LIMET, *Le travail du metal*, cit., p. 33ff.

43. J. D. MUHLY, “The Crisis Years in the Mediterranean World: Transition or Cultural Disintegration?”, in *The Crisis Years: The 12th Century B.C. From beyond the Danube to the Tigris*, W. A. Ward, M. S. Joukowsky (ed.), Dubuque, Iowa, 1992, p. 18; C. GILLIS, “The Smith”, cit., p. 508 n. 16.

44. H. LIMET, *Le travail du métal*, cit., p. 39: *urudu kal-ga* = ‘cuiivre fort’; there is a view that the Greek *χαλκός* derives from the word *kal-ga* (cf. DELG, s.v. *χαλκός*).

45. Hesychius Alexandrinus Lexicon [M. Schmidt], vol. II, Amsderdam 1965, p. 532: *κατερώματα*: μίξις χαλκοῦ καὶ κασσιτέρου.

46. In her most useful article on “The Pylos Jn Series”, *Minos* 27-28 (1992-1993), p. 172-73, 175.

47. J. SMITH, “The Pylos Jn Series”, cit., p. 175 n. 16, with the citation of J. MELENA’s review of Y. Duhoux, *Aspects*, in *Minos* 16 (1977), p. 245-246, and of C. ZACCAGNINI, “Aspects of Copper Trade”, cit., p. 415.

further proceeds to distinguish between fragments from copper oxhide ingots versus fragments from bronze bun ingots (or scrap of bronze) among the recorded allocations of metal (Fig. 3).⁴⁸

Both literally evidence from a Hittite text and visual and analytical work on the Uluburun copper ingots, indicate that breaking the ingots was not a difficult task, the method will have involved beating with hammer, some time after local heating, while tin ingots could be broken only with cold chisels.⁴⁹

In the search for good archaeological context for fragments of ingots, one may point to finds from Mochlos (East Crete): fifteen fragments of copper ingots, of Cypriot provenance, from a foundry hoard in the artisans quarter⁵⁰ give a total weight of 2.033 kg, that is near to the quantity received by each smith in some of the tablets; most of the pieces weigh less than 231 gr, that is less than AES N 1, and according to Soles they were broken so that they could be weighed more easily in a balance pan. To take an example of a date closer to the period of the **Jn** tablets, a fragment of an oxhide copper ingot from the Akropolis at Salamis⁵¹ weighs 1.7 kg, that is around the amount of M 1 N 3, in Linear B denominations. Fragments of ox-hide copper ingots – along with a complete one (Fig. 4) – were also found in Mycenae;⁵² in a table (Fig. 5) with certain elements in the chemical composition of ingots from the Mainland Greece,⁵³ only a bun ingot from Mycenae and a slab ingot from Tiryns are of bronze. Some of the bun and slab ingots from the Cape Gelidonya wreck proved to be of bronze. However, since fragments from Kommos⁵⁴ and even whole bun ingots from the Uluburun wreck are of copper,⁵⁵

48. J. Smith suggests that in cases of record of a total, when this is equal or greater than 26 kg, it points to copper ingots, while, when the recorded total is less than 26 kg, this means that the smiths received ingots of bronze; whenever no total is recorded in the tablet, she assumes an allotment of scrap metal, possibly of bronze (J. SMITH, “The Pylos Jn Series”, cit., p. 185, 194, fig. 14).

49. C. PULAK, “The Copper and Tin Ingots”, cit., p. 145; A. HAUPTMANN, R. MADDIN, I. PRANGE, “On the Structure and Composition of Copper and Tin Ingots excavated from the Shipwreck of Uluburun”, *BASOR* 328 (2002), p. 19; also E. MANGOU and P. V. IOANNOU, “Studies of the Late Bronze Age Copper-based Ingots found in Greece”, *ABSA* 24 (2000), p. 214.

50. J. S. SOLES, Z. A. STOS-GALE, “The Metal Finds and their Geological Sources”, in *Mochlos IC*, p. 46, 54; a half oxhide ingot (of 15 kg) was also found at Mochlos, as well as the earliest tin ingot of the Aegean (J. S. SOLES, “From Ugarit to Mochlos”, in *Emporia*, p. 432-434); a half ingot of LM IIIC period was found together with a quarter ingot in Haghia Triada (N. CUCUZZA, N. H. GALE, Z. A. STOS-GALE, “Il mezzo lingotto oxhide da Haghia Triada”, *Creta Antica* 5 [2004], p. 137-153).

51. Y. G. LOLOS, “Cypro-Mycenaean Relations ca. 1200 BC: Point Iria in the Gulf of Argos and Old Salamis in the Saronic Gulf”, in *Sea Routes. Interconnections in the Mediterranean 16th – 6th c. BC*, University of Crete, Rethymnon, 29 September – 2 October 2002, N. Chr. Stampolidis, V. Karageorghis (ed.), Athens 2003, p. 112.

52. All found in hoards, see for instance in A. B. KNAPP, J. D. MUHLY, P. M. MUHLY, “To Hoard is Human: Late Bronze Age Metal Deposits in Cyprus and the Aegean”, *RDAC* 1988, p. 246-247 (with references).

53. It is only a part of the published table in H. MANGOU, P. V. IOANNOU, “Copper-based Ingots”, cit., p. 214, tab. 4.

54. H. BLITZER, “Minoan Implements and Industries”, in *Kommos I*, Part 1, J. W. Shaw, M. C. Shaw (ed.), Princeton 1995, p. 500-501; also J. D. MUHLY, R. MADDIN, T. STECH, “Cyprus, Crete and Sardinia: Copper Ox-hide Ingots and Bronze Age Metals Trade”, *RDAC* 1988, p. 281-298.

55. 121 ingots of plano-convex, discoid or bun shape (of an average weight of 6.2 kilograms) were found in the wreck: C. Pulak, “Copper and Tin Ingots” cit., p. 143

this means that bun and slab ingots were commonly but not exclusively made of bronze.

If we now turn to the end products, we know that in general tools and weapons were mostly made of bronze, large vessels were manufactured of copper plates because these were more easily hammered into shape, but other vessels, like lavers for instance, were made of bronze.⁵⁶ If we have a look at the table of analyses by Mangou and Ioannou,⁵⁷ we see that large hydriae and cauldrons (Fig. 6)⁵⁸ from the shaft graves at Mycenae were made of copper, as was also a similar hydria from a chamber tomb from Asine, of a later date (Fig. 7).⁵⁹ We know that the hydriae were continuously repaired and so kept for a long time before being deposited in graves. Perhaps the material used had also to do with the shape and the use requirements of the vessel; both a small censer from Akrotiri (Fig. 8) and a very large one from the Vapheio tomb are made of copper,⁶⁰ apart from the difference in size and date. Further analyses in future, with the non destructive, though less accurate, XRF method, will show if there was a tendency in later times towards a wider use of bronze also for vessels, as Matthaeus suspected.

Apart from the consistency of the metal, the quantity sent to the smiths should be greater if vessels were the required products. I have in hand the weights of two vessels from Akrotiri,⁶¹ a bronze laver (circa 1,600 gr) and a copper tripod cauldron (circa 2,000 gr). Thanks to the kindness of the staff of the National Museum, we have the exact weight of a rather small jug (h = 29 cm) from the chamber tomb 47 at Mycenae (14th - 13th cent. B.C.):⁶² it weighs 1,174 gr (Fig. 9). So, approximately one vessel per smith might be expected for an allotment of M1 N2; or, if we turn to weapons, five daggers like the one from Akrotiri (of 13% tin content) for the same quantity (Fig. 10).⁶³

We may conclude in regard to the **Jn** tablets: a) bronze (under the name of *ka-ko*) could certainly be the material sent to the smiths if the products required were tools, weapons and some shapes of vessels, b) copper (under the name of *ka-ko*) might represent a better quality allotment for elaborate vessels, c) in regard to the quality of bronze sent to the smiths, Evely and Northover have shown that even a low

56. Cf. H. MATTHAEUS, *Die Bronzegefäße der kretisch-mykenischen Kultur*, München 1980 (Prähistorische Bronzefunde II,1), p. 323ff.; D. EVELY, *Minoan Craft, Tools and Techniques. An Introduction*, vol. 2, Jonsered 2000, *passim*; E. MANGOU, P. V. IOANNOU, "Copper-based Artefacts", cit., p. 92ff., tab. 4a.

57. E. MANGOU, P. V. IOANNOU, "Copper-based Artefacts", cit., p. 94, tab 4a.

58. K. DEMAKOPOULOU (ed.), *The Mycenaean World*, Athens 1988, no. 218.

59. K. DEMAKOPOULOU (ed.), *The Mycenaean World*, cit., no. 220. This is of LH IIIA date, while the finds from the Shaft graves belong to LH I, too early perhaps for comparison to the content of the **Jn** tablets.

60. E. MANGOU, P. V. IOANNOU, "Copper-based Artefacts", cit., p. 92, tab. 4a.

61. Unfortunately, weight values of metal finds are almost nowhere cited in excavation reports or publications; copper / bronze items from Akrotiri are quite near both chronologically and stylistically to some of the finds from the shaft graves at Mycenae.

62. A. SAKELLARIOU, *Οι θαλαμωτοί τάφοι των Μυκηνών*, Αθήνα 1985, p. 123, pl. 33.

63. For more on the quantity required for the production of particular items cf. *Docs*², p. 356 and A. MICHAILIDOU, "Recording quantities of metal", cit., p. 92ff.

percentage of tin is sufficient to produce a hard tool, depending on the abilities employed in hammering and annealing.⁶⁴ Besides, if, for instance, daggers were the products required, the palace may have sent a specific alloy of around 12-13% tin content.⁶⁵

This means that there was no need for tin to be sent from the palace to the smiths of the periphery, since *either copper or bronze* would on occasion be sufficient, therefore this may be the reason why tin is not recorded in the tablets of the **Jn** series.

The tablet Jn 829 once again

This tablet is still giving rise to questions and discussions, and we shall refer here to two recent views.

From the text by Perna (2004), we present the following points (with our emphasis in italics):

« En **Jn 829** tous les districts des deux provinces sont énumérés et pour chaque district sont mentionnés un *ko-re-te* et un *po-ro-ko-re-te*, soit les principales autorités du district, tenues de prélever et de livrer au Palais *les quantités de métal exigées pour chaque district* ».

« Il y a, de toute façon, une différence remarquable entre la demande des six produits **Ma** et la demande du bronze. Dans la série **Ma** la demande est faite *aux districts*. En **Jn 829** au contraire, les destinataires de cette réquisition ne sont pas les districts, dans le sens du territoire, mai *les sanctuaires* qui se trouvent dans chaque district ... ».

Perna thus supports the view that the *ko-re-te-re* and *po-ro-ko-re-te-re* are responsible for delivering to the palace a specific amount of metal collected from the sanctuaries of their district.⁶⁶

From the article by Del Freo (2005) we present the following points (with our emphasis in italics).

64. P. NORTHOVER, D. EVELY, "Towards an Appreciation of Minoan Metallurgical Techniques. Information Provided by Copper Alloy Tools from the Ashmolean Musum, Oxford", *ABSA* 90 (1995), p. 83-105.

65. Cf. the tin percentage in daggers in E. MANGO, P. V. IOANNOU, "Copper-based Artefacts", cit., tab. 4 (continued); we must also note the percentages 11% tin in the bun ingot from Mycenae and 17% tin in the slab ingot from Tiryns (*ibid.*, p. 215), both in a ratio suitable for casting, but the first one being the optimum and the second one near the highest acceptable on processing grounds.

66. M. PERNA, *Recherches sur la fiscalité mycénienne*, Nancy 2004, p. 263-267. He points out that the quantity of metal required from each district is obviously 11 N (apart from four districts contributing around 15 to 18 N) and the total estimation of demand of the palace was 200 N of metal, almost equally divided between the two Provinces (99 N and 101 N respectively). He brings attention to Killen's comment that « the higher contributors on this Jn tablet are the lower contributors in the Ma series » but gives the explanation that we should not compare the capacity production of a district with the wealth of the sanctuaries in the same district (or with the wealth of the local officials, as I would like to add here).

« ... Et si, comme tout le monde le reconnaît, les impôts de la série **Ma** concernaient directement *les communautés de village*, il est improbable que les sujets fiscaux de **Jn 829** aient été *des sanctuaires* ».

« Il est possible d'interpréter le ligne 3 de **Jn 829** comme un enregistrement concernant du métal *pour les navires sous forme de pointes d'armes* ».

« Ainsi, par exemple, il est possible que les *ko-re-te-re* et les *po-ro-ko-re-te-re* aient recueilli les *impôts des districts*, les *ka-ra-wi-po-ro* ceux qui étaient dus par les sanctuaires et ainsi de suite ».

Del Freo⁶⁷ thus suggests that we have here a record of the future delivery of ready-made spearheads and points of javelins as a tax of the districts, whose collection was the responsibility of the above local administrators; by contrast, any contribution by the sanctuaries would be collected by the *ka-ra-wi-po-ro*, a logical suggestion for what was to be recorded on a tablet to follow, perhaps like the preserved **Jn 881 + 896**.⁶⁸

Del Freo's view, if accepted, should necessarily imply the following:

1. This tablet (**Jn 829**) would be the first *indirect* evidence of the movement of finished metal products to the palace of Pylos in return to the allocated metal (thus implying the second stage in the *ta-ra-si-ja* mode of production).

2. These particular weapons (spearheads and points of javelins) would have been manufactured in the periphery and not in the palace area.⁶⁹

3. A recording of their specific destination (as e.g. *for the ships*) would be useful for their future arrangement, most probably they were meant to be stored separately, as is the case of the arrowheads found in the palaces of Pylos (in the so-called Northeastern Workshop)⁷⁰ and Knossos (in the so-called Arsenal).⁷¹

I. We now proceed to our first question: since the provenance from the local sanctuaries is rejected by Del Freo, from whom would the *ko-re-te-re* and *po-ro-ko-re-te-re* collect these bronze spearheads, *within* their district?

One might suggest the smiths of their district, implying that these local administrators – and not the *qa-si-re-we* for instance – were the responsible for collecting the weapons under delivery; but since the working places of the smiths and the contributing districts as a rule have different names (apart of 4-5 cases), this would also imply a *ta-ra-si-ja* system with a different way of allocation (by localities of the smiths) from the way of collection (by administrative towns). Since the palace administration did not base the allotments on the districts and most scholars, Del Freo included, do not relate directly this tablet with the allotment

67. M. DEL FREO, "L'expression *ka-ko na-wi-jo* de la tablette Jn 829 de Pylos", in *Emporia*, p. 793-803.

68. *Ibid.*, p. 801.

69. As DEL FREO also points out (*ibid.*, p. 799 n. 56) and this is in accordance to DUHOUX's suggestion about weapon industry in the periphery (*Aspects*, p. 102).

70. *PoNI*, fig. 317. Such a storage of weapons is in accordance to a recent view that this place was not a workshop but a redistributive center – a clearing house for goods entering the palace complex as a whole: L. BENDALL, "A Reconsideration of the Northeastern Building at Pylos: Evidence for a Mycenaean Redistributive Center", *AJA* 108 (2003), p. 181-231.

71. *PoMIV*, p. 836ff.

tablets,⁷² the simple explanation would be that in **Jn 829** we have the record of a particular tax (impôt) in weapons, contributed by certain groups – other than smiths – from each district. Who were these groups or persons? They might be of any profession, because, as Lejeune remarked for the **Ma** tablets, the demand for certain commodities from particular groups of the districts does not take into account « leur aptitude ou inaptitude à produire les denrées requises ».⁷³ The contributors should merely be in possession of or of easy access to spears and javelins.

II. Thus we come to the second question: why is there, for every district, a separate record for the nearly steady amount to be collected by the *ko-re-te* (in 12 out of the 16 cases) and a separate record for the steady, always smaller, amount to be collected by the *po-ro-ko-re-te*? Unless the two officials of each district were collecting from two distinct unrecorded groups of no particular interest to the scribe, the simplest answer would be that the metal recorded represents not a communal but a *personal tribute* and the nine districts of Pylos are listed in this tablet not as contributing communities but as the place names defining each one of the two administrators who are expected to offer some of their weapons.⁷⁴ Perhaps this personal tribute was under the pretext of a religious task, if instead of ‘for the ship’ one prefers to use ‘for the temple’ as a definition of the *wanax*’s residence place where also the palace sanctuary was (taking *νότος* as « a designation of a “dwelling place” together with an evident inclination towards cult usage »⁷⁵). An offer of weapons would form an appropriate tribute to a goddess such as the deity from the acropolis of Mycenae depicted with a helmet (Fig. 11).⁷⁶ This personal tribute by the registered officials, whether destined to be a military equipment for those on board the ships (as Del Freo) or specified on the tablet as derived from their own property,⁷⁷ was not recorded as *e-ke-a*, since only the points of metal could be weighed and their value thus be measured; this tax would result in

72. Besides, M.-L. NOSCH, “More Thoughts on the Mycenaean *ta-ra-si-ja* System” in *Fiscality*, p. 181, clearly states that *ta-ra-si-ja* is a palace production system, while taxation is a palace acquisition system.

73. M. LEJEUNE, “Sur la fiscalité Pylienne Ma”, in *Colloquium Mycenaicum*, p. 149 (§ 12).

74. Such a hypothesis might answer Bennet’s question: « If all districts are called upon to produce bronze by the palace, why do we not have records of bronze-working in all districts? » (J. BENNET, “The Mycenaean Conceptualization of Space or Pylian Geography (...yet again)”, in *Florent*, p. 141).

75. S. HILLER, “*Ka-ko na-wi-jo*. Notes on Interdependences of Temple and Bronze in the Aegean Bronze Age”, in *Colloquium Mycenaicum*, p. 194.

76. K. DEMAKOPOULOU, *The Mycenaean World*, cit., no. 149. Since the metal is not yet offered, it is not recorded as *χαλκός ιερός* (in regard to an objection by A. LEUKART, “Autour de *ka-ko na-wi-jo*: quelques critères”, in *Colloquium Mycenaicum*, cit., p. 186). We should add here the « paucity of evidence for taking room 92 as a shrine » according to L. BENDALL, “A Reconsideration of the NE Building”, cit., p.186.

77. In case *ka-ko na-wi-jo* denotes ownership, following an original meaning of ‘de la maison’ according to A. LEUKART, “Autour de *ka-ko na-wi-jo*”, cit., p. 186-187; what is very interesting is what Leukart said, in regard to the officials of the tablet, after his paper, in the discussion that followed: « je ne voulais pas dire qu’ici ce sont les fonctionnaires eux mêmes qui réquisitionnent, mais plutôt qu’ils contribuent de leurs propres biens à la demande du palais » (*ibid.*, p. 195).

a useful accumulation of weapons⁷⁸ (in any case contributing to the return of metal) right to the centre of power; it may easily have been a regular personal tax, unless one chooses to view it as part of the circumstances of a particular temporary event, such as, for instance, a sudden loss of an expected ship's load of metal.

III. In regard with the number of weapons received by the palace, for the total of 50 kg of the tablet **Jn 829**, Del Freo leaves out the possibility of arrows – which we may count on a range of weight between 4.3 gr to 1.5 gr. for each (Fig. 12).⁷⁹ He suggests a number of about 200 to 300 spearheads or javelin-heads, on the basis of a limited sample of weight values available⁸⁰ and in accordance to the 200 javelins recorded in the tablet **Vn 1341**.⁸¹

Thanks to the help of the colleagues in the National Museum we may add some more weight values to the discussion.⁸² A long spearhead from the palace of Pylos mentioned by Del Freo,⁸³ does not appear to have been functional, not even consisting of the two parts published together (Fig. 13); another from Dendra, of an early 14th cent. date (Fig. 14), is 35 cm long⁸⁴ and of 237 gr weight. If we look for shorter spearheads,⁸⁵ we can add here the weights of 210.65 gr and 171.65 gr for two – almost complete – spearheads (Fig. 15-16) from the chamber tomb No. 47 at Mycenae (14th-13th cent.);⁸⁶ they both display the same length (24-25 cm), as do also two spearheads of the 14th and 13th cent. respectively (Fig. 17) of possibly a similar average weight.⁸⁷ An even shorter spearhead from Epidauros, is considered

78. Cf. also the **PY Wr 1480** nodule (C. W. SHELMEERDINE, J. BENNET, “Two New Linear B Documents from Bronze Age Pylos”, *Kadmos* 34 [1995], p. 123-132) and the possible function of its find place, the so-called N.E. Workshop, as a storage and redistributive place: « the large number of sealings in the North East Building suggests that this was one of the principal places to which goods were brought when they first came onto the citadel » (L. BENDALL, “A Reconsideration of the NE Building”, cit., p. 203); also G. S. FLOUDA, “Inscribed Pylian Nodules: Their Use in the Administration of the Storerooms of the Pylian Palace”, *SMEA* 42 (2000), p. 224.

79. Some have been weighed in the National Museum at Athens; *PoNI*, fig. 292.

80. Also, on the basis of the length of two spearheads from Pylos (see n. 84, 85), he correctly points out that the spearheads from the Warrior Graves at Knossos are longer (up to more than 50 cm) like those from the Shaft graves, while spearheads of a later date are shorter.

81. J. L. MELENA, “40 Joins and Quasi-joins of Fragments in the Linear B Tablets from Pylos”, *Minos* 31-32 (1996-97), p. 17 n. 19; according to L. BENDALL, “A Reconsideration of the NE Building”, cit., p. 221, this tablet is more connected to archery.

82. I am very grateful to Alexandra Christopoulou, Eleni Mangou and Eleni Konstantinidou for the facilities provided; to Eleni Morati for the photographs; to Lena Papazoglou for continuous help, information and fruitful discussions.

83. It was found in Room 7 of the palace (*PoNI*, p. 93, fig. 274).

84. A length of 35 cm is ascribed to a spearhead of LH IIIA2 from a chamber tomb at Pylos (M. DEL FREO, “L’expression *ka-ko na-wi-jo*”, cit., p. 802 n. 74), published in *PoN* III, p. 188, fig. 243, 8.

85. Cf. S. IAKOVIDIS, “The Mycenaean Bronze Industry”, in *Early Metallurgy on Cyprus, 400-500 B.C.*, S. D. Muhly, R. Maddin, V. Karageorghis (ed.), Nicosia 1982, p. 222, for the tendency for shorter spearheads after the middle of the 13th cent., this probably indicating a change in tactics.

86. A. SAKELLARIOU, *Οι θαλαμωτοί τάφοι*, cit., p. 124, pl. 33.

87. Ch. Intzesiloglou has kindly sent me from the Archaeological Museum at Volos the information on the weight value of the spearhead from Iolkos: it is 220 gr.

as point of a javelin (Fig. 17-18):⁸⁸ its length is 15 cm and its weight 103.3 gr, both numbers being very close to another point from the Akropolis of Mycenae (Fig. 19) of a length of 16.5 cm and a weight of 100.8 gr.

We notice an obvious standardization in clusters of length, not necessarily resulting in an exactness of weight. This will therefore have been the reason, in case of a tax in weapons, why they are recorded by weight and not by number. If we take an average of 200 grams for a spearhead and 100 grams for a javelin-head, then each *ko-re-te* contributing the quantity of M 2 should give 10 spearheads (or 20 points of javelins) and each *po-ro-ko-re-te* contributing the quantity of N 3 should give about 3 spearheads (or 7 points of javelins). Perhaps they were free to offer whatever they had of the two types, provided they totaled to the expected weight.

In order to take an example, if the two officials from *a-ke-re-wa* happened to be short in spears and javelins (since they used them also in hunting), they would have to order a total of 13 spearheads from the 8 non-*po-ti-ni-ja-we-jo* smiths (of the tablet **Jn 310**) who were capable of producing 60 spearheads with their metal supply of 12 kilograms. Christos Boulotis, kindly drew my attention to a fresco from Tiryns (Fig. 20) where men on chariots carry two spears in one hand.⁸⁹ It certainly is open to question whether an offer of 10 spearheads by a *ko-re-te* would have been a heavy tax for him. In **PY Nn 831**, the *ko-re-te* listed among other persons, is giving 24 *SA* while the others give only from 1 to 4 *SA*.⁹⁰ One *ko-re-te* named Klymenos is also known as the commander of one sector of the coastguard.⁹¹ In our search for their wealth, we may also consult the tribute of gold in the **PY Jo 438** tablet, where nine *ko-re-te-re* (and two *po-ro-ko-re-te-re*) are mentioned among other important officials (the *qa-si-re-u* included) and they offer gold, perhaps in form of vessels? Here one might compare the weight of gold given by a *ko-re-te* (e.g. N 1) and a *po-ro-ko-re-te* (P 3) to the weight of golden vessels available from the archaeological record (Fig. 21-23), though some are of an earlier date.⁹²

Regardless of whether we accept Del Freo's suggestion or not, regarding weapons already made, if we take that the tablet **Jn 829** is the beginning of a record of *personal tribute* by all the officials mentioned in the first two lines, the important point is that this tribute is expected in metal,⁹³ in this way of thinking, the *o-pi-su-ko* mentioned in the second line of **Jn 829**, might be recorded in the **Jn 881** tablet⁹⁴

88. Of LH IIIB-C date, published by V. ARAVANTINOS, "Μυκηναϊκά εκ Παλαιάς Επιδαύρου", *AD* 29^A (1974), p. 79-87 (fig. 2); K. DEMAKOPOULOU, *Mycenaean World*, cit., no. 233.

89. As noted by S. IAKOVIDIS, "Bronze Industry", cit., p. 222.

90. For this tablet M. PERNA ("La culture du lin en Grèce mycénienne et au Proche-Orient ancien", in *Emporia*, cit., p. 806) comments: « il s'agit donc d'une list de differents quantités de lin que des individus, enregistrés au nominative, doivent livrer au palais »; cf. T. G. PALAIMA, "Maritime Matters in the Linear B Tablets", in *Thalassa*, p. 304.

91. J. CHADWICK, *The Mycenaean World*, Cambridge 1976, p. 75.

92. But cf. *IDA* for the ideograms of vessels; also A. MICHAILIDOU, "Recording Metal", cit.; K. DEMAKOPOULOU (ed.), *Troja, Mycenae, Tiryns, Orchomenos*, Athens 1990, nos. 239, 257.

93. In whatever form, e.g. one *po-ro-ko-re-te* might contribute 3 heavy chisels (cf. A. MICHAILIDOU, "Recording Metal", cit., p. 95, 97, tab. 1).

94. M. DEL FREO, "L'expression *ka-ko na-wi-jo*", cit., p. 796 and n. 24.

as giving 4.5 kg of copper / bronze from his own property.⁹⁵ This may have been one of the mechanisms through which the palace of Pylos recovered the commodity which had the greatest use value, plus a concrete exchange value.

Epilogue

It is currently accepted that in the series of the **Jn** tablets we have around 270 smiths in various localities, but not in accordance with the names of towns, with the exception of 4 to 5 cases (the town *a-ke-re-wa* being one of them). So, perhaps we may proceed from modest conclusions to further suggestions:

1. The smiths on these particular tablets *are not recorded* as being resident smiths of the towns. The account of the metal allotments, therefore, seems indeed to be more related to what the palace expects in return, although this is nowhere stated.

2. For some at least of the localities mentioned for the smiths, the mode of recording gives us a picture of a large workshop, e.g. in the tablet **Jn 310**. An argument in favour of the idea of a workshop and not just a guild of the smiths (from the town *a-ke-re-wa*), seems to me to lie in the recording of the *do-e-ro* without a distinction if they are attached to the secular or to the *po-ti-ni-ja-we-jo* craftsmen.⁹⁶ I wonder if the other smiths of the town of *a-ke-re-wa* recorded in the tablet **Jn 693** were those not attached to this presumed workshop.⁹⁷

3. However, since we are dealing with a workshop,⁹⁸ why there is a separate record of metal for every smith? It may represent his personal obligation to the palace or / and his personal privilege,⁹⁹ if we retain the basic meaning of the word *ta-ra-si-ja* in *Documents* as an amount allocated by weight for processing, and take also into account the idea that every smith might need metal for other clients too.

4. This is because clients other than the palace will have existed. We may think of the sanctuaries profiting from the *ta-ra-si-ja*¹⁰⁰ (provided that the *po-ti-ni-ja-we-jo ka-ke-u*, also working in the workshop, belongs to a sanctuary)¹⁰¹ and at least of some title bearing persons who could afford it, like the mentioned *ko-re-te-re*, or the *o-pi-su-ko*. A person named *ka-ra-wi-so* in **Ja 1288**, whether giving or taking metal,¹⁰² may also afford it to be one of these clients, while more humble clients

95. Or from *their* own property in case more than one *o-pi-su-ko* are recorded in the tablet **Jn 881**, as T. G. PALAIMA (“Maritime Matters”, cit., p. 304) thinks it is possible.

96. And taking into account that the *do-e-ro*, no matter how skilled they might be (as J. SMITH, “The Pylos Jn Tablets”, cit., p. 183, n. 44 and 45), are not recorded by their own name.

97. The explanation given by SMITH is that the palace may have required the working of different forms of copper or bronze by different smiths at *a-ke-re-wa* at different times (*ibid.*, p. 196-197).

98. Y. DUHOUX also refers to « ateliers » and to « corvée » labour through the *ta-ra-si-ja* system (*Aspects*, p. 105, 115); S. LUPAK, “Deities and Religious Personnel as Collectors”, in *Fiscality*, cit., suggests independently founded workshops.

99. M. LEJEUNE, “Les forgerons”, cit., p. 171.

100. As also S. LUPACK, “Deities and Religious Personnel”, cit., p. 102.

101. According to J. HOOKER, *Linear B. An Introduction*, Bristol 1980, # 219, the designation of *po-ti-ni-ja-we-jo* is not enough evidence for such an attachment.

102. This tablet from the North East Building points to a possible ownership by a person named *ka-ra-wi-so* of about 4.5 kg of copper or bronze.

could bring along objects for repair or recycling. In regard to repair work, perhaps the record of AES M 3 in **Jn 832** is not irrelevant to the person next to it, who is nominated as *pa-ra-ke-te-e-u*. If we accept the meaning of ‘bateur’ (after the word *πλακτετής*),¹⁰³ then he was the expert in metal plate producing therefore in need for an amount of metal (as the others of the same trade name in **Jn 750**),¹⁰⁴ this person in tablet **Jn 832** may have need the amount of metal for the plates that were to be attached to damaged vessels (as evidenced from metal finds), working in collaboration with the *a-ke-te-re* listed in the same tablet, who, if they were ‘réparateurs’,¹⁰⁵ would have to have been highly skilled in such demanding work, which only the ‘decorators’ and ‘finishers’¹⁰⁶ might be capable of doing properly.

5. The placement of the activity of metal-working, somewhere in between the palatial and the non-palatial sector as pictured by Whitelaw,¹⁰⁷ is perhaps supported by a view expressed in regard with the register of men in the tablet **An 261**, namely that these were highly qualified smiths sent to work in the palace.¹⁰⁸ I wonder whether we should not put more emphasis on the function of the allotment **Jn** tablets as *an account of the present supplies of the workshops in metal and human capital* (the *do-e-ro* thus included),¹⁰⁹ since the verb *ἔχοντες* and *ἔχουσι* are in the present tense.¹¹⁰ This would be in accordance with a recent view that the **Ma** tablets « ne correspondent pas à un bilan annuel comme on l’a souvent pensé, mais notent simplement la situation au moment de l’incendie du palais, situation très variable selon les districts ».¹¹¹

6. One way or other, apart from the smiths, other people will have been in possession of metal to be also used for their needs in exchange, and this metal, in whatever form or consistency, will have come from the palace under various conditions, but also through private barter activities that resulted in some wealth: some of the persons named on a **Jn** tablet have a dependent personnel of up to 31 persons,¹¹² some names of smiths like *Εὐπλοῦς* or *Εὐτροπος* seem to suggest men

103. *Aspects*, p. 107.

104. Cf. the suggestion that the word derives from **pa-ra-ke-te-e-a₂* (‘lámina metálica’): *DMic. s.v. pa-ra-ke-te-e-u*.

105. *Aspects*, p. 107 (with reference to Heubeck).

106. J. T. KILLEN, “The Knossos Ld (1) Tablets”, in *Colloquium Mycenaeanum*, p. 167.

107. T. WHITELOW, “Palatial Involvement in Ceramic Production and Consumption” in *Economy and Politics*, p. 9, fig. 8.

108. S. DEGER-JALKOTZY, “Working for the palace: Some Observations on PY An 261”, in *Studies Killen*, p. 79.

109. It is further decided that in two place-names an additional amount should be sent to all smiths working there, e.g. J. SMITH, “The Pylos Jn Series”, cit., p. 189 (with references); R. PALMER, *Wine in the Mycenaean Palace Economy*, Liège – Austin 1994 (Aegaeum, 10), p. 74-76.

110. E.g. J. SMITH, “The Pylos Jn Tablets”, cit., p. 208: « the present tense of the verb (*e-ko-te*) in the allotment tablets indicates that the smiths already have the metal in their possession ».

111. P. CARLIER, “A propos de la bureaucratie mycénienne”, in *Fiscality*, cit. p. 29. Of course there is no connection among the two series of tablets, and the tribute in **Jn 829** « représente seulement l’exigence réelle en bronze pour la manufacture d’un certain nombre d’armes » (M. PERNA, *Recherches sur la fiscalité*, cit., p. 266), or it represents the particular quantity of spearheads, in regard to Del Frego’s suggestion.

112. Lupack takes the owner of 10 persons on the tablet **Jn 431** as possibly being a priest.

who travelled,¹¹³ perhaps acting as businessmen, as well.¹¹⁴ I agree with Sacconi on « la fonction monétaire exercée par le bronze »¹¹⁵ for the Mycenaean economy, which was partly a monetary economy; in the preceding Minoan economy, as discussed elsewhere, a monetary system functioned along with simpler barter exchanges.¹¹⁶ As Pare has so cleverly put it in the title of a book « metals make the world go round ».¹¹⁷ The exchange value of metal was measured mainly by its weight; this may be the reason, according to the evidence to date, why the palace, when recording products of metal-working or temporary allotments of metal vessels for ceremonies,¹¹⁸ it records them by their number, while when accepting metal tributes, it is their weight¹¹⁹ that the scribe writes down.

113. Cf. πολύτροπος as characterizing Hermes, the god of commerce.

114. This view for some of the smiths acting as entrepreneurs is further developed by D. NAKKASSIS in his Ph.D. thesis (personal communication, for which I thank him warmly).

115. A. SACCONI, “La ‘monnaie’ dans l’économie mycénienne. Le témoignage des textes”, in *Emporia*, p. 69-74. Bronze rather than pure copper might be in the hands of ordinary or even semi-elite people.

116. A. MICHAÏLIDOU, “Measuring Weight and Value in Bronze Age Economies in the Aegean and the Near East: A Discussion on Metal Axes of No Practical Use”, in *Metron*, p. 301-314.

117. C. F. E. PARE (ed.), *Metals Make The World Go Round. The Supply and Circulation of Metals in Bronze Age Europe*, Proceedings of a Conference held at the University of Birmingham, June 1997, Oxford 2000.

118. As in **PY Tn 316**, see more recently: T. G. PALAIMA, “Kn02 – Tn 316”, in *Florent*, p. 437-461 (with references).

119. Tablets **PY Jn 829**, **Jn 881**, **Jo 438**.



Fig. 1. Melting, casting and plate producing depicted in an Egyptian Fifth Dynasty tomb at Giza (after B. SCHEEL, *Egyptian Metalworking and Tools*, Ailesbury 1989, fig. 27)



Og 5515 + 5518 + 5539
]ka-te-ro L 4 M[

Fig. 2. The tablet KN Og 5515 + 5518 + 5539 (after *CoMIK III*)

TABLET	PLACE NAME	TOTAL LINE?	AES	TABLET GROUP	AES TYPES
Jn 601	<i>po-wi-te-ja</i>	yes	L 3 M 12	A/South	Cu ingot
Jn 310.1	<i>a-ke-re-wa</i>	no	M 12	A/South	Cu ingot
Jn 310.14	<i>a-ke-re-wa</i> (<i>po-ti-ni-ja-we-jo</i>)	no	M 12	A/South	Cu ingot
Jn 413	?	yes	M 26?	A/South	Cu ingot
Jn 431.1	<i>a-pe-ke-i-jo</i>	yes	L 1 M 24	A/North	Cu ingot
Jn 431.16	<i>a-pe-ke-e</i> (<i>po-ti-ni-ja-we-jo</i>)	yes	M 27	A/North	Cu ingot
Jn 389	<i>a-ka-si-jo-ne</i>	yes	M 27	A/North	Cu ingot
Jn 415	<i>ru-ko-a₂-ke-re-u-te</i>	yes	L 1 M 4	A/North	Cu ingot
Jn 320	<i>o-re-mo-a-ke-re-u</i>	yes	L 1 M 26	A/North	Cu ingot
Jn 478	<i>wi-ja-we-ra₂</i>	yes	M 26	A/North	Cu ingot
Jn 845	?	yes	M 12	B/ finished	12 kg. ingot
Jn 937	<i>]me-no</i>	no	M 18?	B/finished	scrap
Jn 605	<i>a-pi-no-e-wi-jo</i>	no	M 9	B/finished	?
Jn 692	<i>na-i-se-wi-jo</i>	no	M 12	B/finished	scrap
Jn 725.1	<i>e-ni-pa-te-we</i>	yes	L2 M 18	B/working	ingot ?
Jn 725.14	<i>]nu-we-jo</i>	no; (but erased on line 22?)	M 17+	B/ working	ingot or scrap?
Jn 725.18	<i>na-i-se-wi-jo</i> now erased	yes, but erased	M 12	B/working	ingot or scrap?
Jn 725.23	<i>a-ke-re-wa</i>	yes	M 12	B/working	12 kg. ingot
Jn 693.1	<i>a-ke-re-wa</i>	no	M 16	B/working	scrap
Jn 693.5	<i>a-pu₂-we</i>	no	M 26	B/working	scrap
Jn 832.1	<i>ro-u-so</i>	no	-	C	-
Jn 832.9	<i>a-to-mo</i>	no	M 3	C	scrap?
Jn 750	<i>a-si-ja-ti-ja</i>	no	M 24+	C	scrap?
Jn 658	<i>e-ni-pa-te-we</i>	yes	L 3 M 20	D	ingot?
Jn 706	<i>pa-to-wo-te</i>	yes	L 1 M 20?	D	ingot?

Fig. 3. Table showing presence / absence of totaling lines and probable types of metal allotted (after J. SMITH, "The Pylos Jn tablets", fig. 14)



Fig. 4. An ox-hide copper ingot from Mycenae of 23.6 kg weight (the Numismatic Museum at Athens)

Found in	Number	Description	Cu	Pb	Sn	As
Mycenae	7664.1	Fragments of	94.32	n.d.	n.d.	0.51
4						
(Poros	7664.2	oxhide ingots	95.70	n.d.	n.d.	0.65
Wall Hoard)	7664.3	" "	94.24	n.d.	n.d.	0.26
" "	7664.4	" "	88.98	n.d.	n.d.	0.70
" "	7664.5	" "	91.50	0.52	n.d.	0.82
" "	7664.6	" "	96.73	n.d.	n.d.	0.60
" "	7664.7	" "	91.68	n.d.	n.d.	0.33
" "	7664.8	" "	96.37	n.d.	n.d.	0.66
" "	7664.9	" "	96.52	n.d.	n.d.	0.01
" "	7664.10	" "	93.72	0.02	n.d.	0.63
" "	7664.11	" "	87.64	n.d.	n.d.	0.37
" "	7664.12	" "	87.64	n.d.	n.d.	0.37
" "	7663	Bun ingot	86.35	0.62	10.81	0.39
Tiryns	6227	Slab ingot	79.71	0.41	16.69	0.42

n.d. = not detected

Fig. 5. The percentages of copper (Cu), lead (Pb), tin (Sn), arsenic (As) in copper-based ingots (after E. MANGO, P. V. IOANNOU, part of the tab. 4)



Fig. 6. Copper cauldron from Mycenae, Shaft Grave III (after *The Mycenaean World*, no. 218)



Fig. 7. Copper hydria from Asine, ch. tomb (after *The Mycenaean World*, no. 270)



Fig. 8. Copper censer from Akrotiri, Thera



Fig. 9. Small jug from ch. tomb 47 at Mycenae, 1,174 gr (NMA)

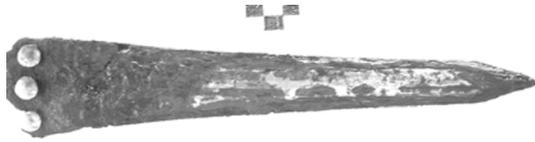


Fig. 10. Bronze dagger from Akrotiri, Thera, 303 gr



Fig. 11. Fresco fragment from the Mycenae Cult Center (after *Mycenaean World* no. 149)



Fig. 12. Metal points of arrows from Pylos (NMA)



Fig. 13. Metal spearhead from Pylos (NMA)



Fig. 14. Bronze spearhead from Dendra, 35 cm (NMA)



Fig. 15. Bronze spearhead from ch. tomb 47 at Mycenae, 25 cm (NMA)



Fig. 16. Bronze spearhead from ch. tomb 47 at Mycenae, 24 cm (NMA)



Fig. 17. Bronze spearheads from a cist grave at Iolkos (Volos), 25.6 cm, and from a ch. tomb at Spercheios valley, 25.5 cm, and a javelin-head from a ch. tomb at Old Epidauros, 15.5 cm (after *Mycenaean World* nos. 231, 232, 233)

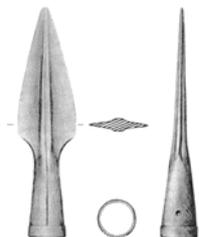


Fig. 18. The Old Epidauros javelin-head
(after V. L. Aravantinos)



Fig. 19. A javelin-head from the hoard at
akropolis of Mycenae, 16.5 cm



Fig. 20. Fragments of frescoes from Tiryns
(after *Mycenaean World* no. 149)



Fig. 21. A small gold cup (LH IIIA) of 66,7 gr,
a value equivalent to P 3 in Linear B
(after *Mycenaean World* no. 59)



Fig. 22. A gold cup (LH I) of 64 gr, a value
equivalent to P 3 in Linear B (after *Troja,*
Mycenae, Tiryns, Orhomenos, no. 239)



Fig. 23. A gold cup (LH I) of 254 gr, a value
equivalent to N 1 in Linear B (after *Troja,*
Mycenae, Tiryns, Orhomenos, no. 257)