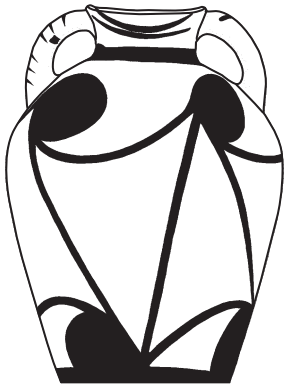
Alatzomouri Pefka

A Middle Minoan IIB Workshop Making Organic Dyes



PREHISTORY MONOGRAPHS 62

Alatzomouri Pefka

A Middle Minoan IIB Workshop Making Organic Dyes

edited by

Vili Apostolakou, Thomas M. Brogan, and Philip P. Betancourt

with contributions from

Vili Apostolakou, Philip P. Betancourt, Thomas M. Brogan, Konstantinos Chalikias, Alison M. Crandall, Joanne Cutler,† Heidi M.C. Dierckx, Andrew Koh, Evi Margaritis, Floyd W. McCoy, Dimitra Mylona, Thomas Palaima, and Marie N. Pareja

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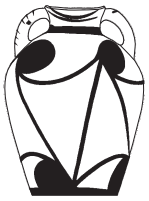

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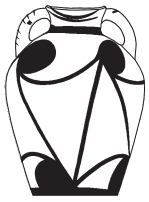

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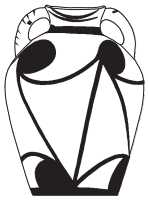
List of Abbreviations

ARCHEM	Archaeochemistry in the Eastern Mediterranean
ASCSA	American School of Classical Studies at Athens
cm	centimeter(s)
cm/sec	centimeters per second
CV	column volume
d.	diameter
dim.	dimension
EBA	Early Bronze Age
EDM	electronic distance measurement
EFT	elliptic Fourier transform
EM	Early Minoan
EPCA	Ephorate of Prehistoric and Classical Antiquities
est.	estimated
F. Time	final time (t_F)
FN	Final Neolithic
g	gram(s)
GC-MS	gas chromatography-mass spectrometry
GPR	ground-penetrating radar
h.	height
HM	Herakleion Museum
I. Time	initial time (t_I)
IGME	Institute for Geology and Mining Exploration
INSTAP	Institute for Aegean Prehistory
INSTAP SCEC	Institute for Aegean Prehistory Study Center for East Crete
km	kilometer(s)
kPa	kilopascal(s)
kV	kilovolt(s)
L.	length
LM	Late Minoan
m asl	meters above sea level
max.	maximum
MBA	Middle Bronze Age
min	minute(s)
min/sample	minute(s) per sample
ml	milliliter(s)
µl	microliter(s)
MM	Middle Minoan
mm	millimeter(s)
µm	micrometers

MNI	minimum number of individuals
mybp	million years before present
m/z	mass-to-charge ratio
NIST	National Institute of Standards and Technology
PAI	Pacheia Ammos Industrial Area
pres.	Preserved
PS	Pseira
rest.	restored
R. Time	retention time (t_R)
sec	second(s)
th.	thickness
THF	tetrahydrofuran
TIC	total ion current
UPLC-MS	ultra-performance liquid chromatography-mass spectrometry
w.	width
wt.	weight



15

Porphureion and *Kalkhion* and Minoan-Mycenaean Purple Dye Manufacture and Use

by

Thomas Palaima

The purpose of this contribution is to support, by reference to specific textual evidence in the Linear B documents relating to the manufacture and dyeing of cloth, the arguments that the MM IIB rock-cut basins and depressions at Alatzomouri Pefka and associated excavated materials (including mortars, tripod vessels for heating, crushed marine shells, and organic residues of murex purple, madder, and weld) do form part of a small industrial workshop operation for manufacturing organic dyes and then coloring fibers. Presented here are new arguments from the clay tablet records for there being two stages of work taking place in separate outlying localities.

As discussed in Chapter 3, the rather small amounts of crushed murex shells (*Hexaplex trunculus*) and the number of basins (9) and depressions for washing of wool suggest that various dyes were being used in separate basins and that the manufacture of the murex dye per se was not taking place on the spot—the shell remains being residue from the first and main stages of actual production of the dye somewhere else, perhaps closer to the shore. The isolation of the Alatzomouri Pefka site would suit the identification of the remains as given over to dyeing.

A new interpretation is proposed here of a Linear B term *ka-zo*, which occurs in a general context that relates to cloth manufacture. In this interpretation, it most likely identifies a location specifically for the production of the dye proper from the murex and is to be contrasted with the term long identified as having to do with the application of the purple murex dye: *po-pu-re-jo* = *porphureio-*.

One site (*da-*83-ja*) in the Linear B tablets (tablet X 976; Pl. 23:f; see below, p. 128) from Knossos is explicitly connected with the purple-dye industry. The Mycenaean term *po-pu-re-jo* identifies either (neuter singular) a "purple-dye workshop" (*porphureion*) or (masculine plural) "purple-dye specialists" (*porphureioi*; Nosch 2004, 33). The term *po-pu-re-jo* is associated with the term *wana-ka-te-ro*, meaning respectively either *wanakteron* (modifying the workshop) or *wanakteroi* (modifying the workers) "of the *wanax* or high king," thereby indicating somehow a primary

royal interest in or monopoly over the installation or specialist personnel and laborers involved.

I believe that the layout of the text on X 976 makes it preferable (I will not say literally more probable, because the matter is beyond "proof") to propose that *po-pu-re-jo*[is *porphureion*, literally "place of purple dye," that is, "purple workshop," and not *porphureioi*, "purple-dye men." The term *po-pu-re-jo*[is raised above the rule line so that it follows upon the place name *da-*83-ja*. This makes it more likely that *wa-na-ka-te-ro*, which is written in shorter and smaller characters along the main rule line, modifies the men who are designated as *to-so*, "so many." Otherwise, I would expect that the scribe would have written *po-pu-re-jo* [directly after *to-so* or on the same line as *wa-na-ka-te-ro*. The text we have thus reads:

at *da-*83-ja* at the *porphureion*
SO MANY royal

The drawing of this tablet in John Chadwick et al. 1986 (p. 404) is not quite accurate. The long vertical stroke of the *da* is actually written on the tablet above the rightmost portion of the upper horizontal of the *na* (and not to the right of it, as mistakenly in the drawing); it seems to intersect the upper horizontal of the *na* a bit. So *da-*83-ja* was written after *wa-na-ka-te-ro*. All these observations suggest that the sequence of writing the sign groups was:

.1 *to-so*
.2 *wa-na-ka-te-ro*
.3 *da-*83-ja*
.4 *po-pu-re-jo*

The order of .3 and .4 could be switched. The text of X 976 then reads, in our interpretation: "This many royal specialists are located at the purple workshop at *da-*83-ja*." Its purpose is to keep track of the workforce, without specifying the many reasons the central administration could have for doing so: from making sure that the required number of workers are at hand to knowing that so many workers are there in case they are needed elsewhere, or to reckon what provisions are needed both to maintain efficiently steady industrial work at hand and to sustain and reward the workers with foodstuffs as a kind of wages.

On Knossos tablet X 976, the *porphureion* is located in the area known as *da-*83-ja*. Marie-Louise Nosch (2004, 34) argues that "it is tempting to locate *da-*83-ja* at the shore, and far from inhabited centers, since purple dyeing is a very foul-smelling craft." We would add that even Royal Purple dyeing would meet these conditions for the placement of sites near to the marine resources necessary for producing the dyes proper and then for using them to dye cloth. Such installations should be in localities away from sizable and higher-status settlements.

In the Linear B tablets from Knossos, *da-*83-ja* is taken as a feminine ethnic adjective used as a place-name designation derived from a basic place name with the distinctive Minoan spelling *da-*83* (where **83* is a sign probably created and most likely used in Linear B to capture a non-Greek sound value in an original Cretan toponym; for discussion of this sign as occurring at Knossos and Pylos, see Melena 2014, 62–63, 82–83, 87–89). We may compare the three ways of referring to the main religious sanctuary site in the Linear B records from the palatial center at Pylos:

(1) the basic noun *pa-ki-ja-na* (with pre-Greek *-ānā* toponymic suffix) represents *Sphagiānā* or the like;
(2) the ethnic plural form *pa-ki-ja-ne* represents *Sphagiānes* or the like;
(3) an adjectival ethnic form, morphologically parallel to *da-*83-ja*, namely *pa-ki-ja-ni-ja*, represents *Sphagiāniā* or the like.

Other activities located at the site *da-*83-ja* are sheep herding (KN Dv 1086.B with 100 male sheep and female sheep in a missing quantity) and a shipment of olive oil to a *hieron* (sanctuary or holy place). Both activities are consistent with an outlying rural area.

Nosch (2004, 34) follows Pierre Carlier (1984, 52) in being tempted to identify the list of single men each identified by name on what is now known as Knossos tablet V 832 (Pl. 23:g; see below, p. 128) with individuals working at some stage of purple-dye manufacture, handling, and use. The two fragmentary tablets, X 976 and V 832, are assigned to the same scribal hand (225), and both come from the Spiral Cornice Room (I2). This circumstance increases the likelihood that they deal with a shared subject. The temptation is even stronger when one considers the other tablets coming from this area of the palatial center at Knossos.

The five tablets Ak 780–784 from the Spiral Cornice Room (I2) are fragmentary, but they each have ample portions of texts preserved. They all deal with women cloth workers (in one instance identified as of *ne-ki-ri-de* type: Ventris and Chadwick 1973, 562; Aura Jorro 1985, 469, s.v.) who are associated, as on other cloth-worker texts, with groups of girls and boys, designated as older and younger, in these Ak texts in a "schooling" situation (*di-da-ka-re* = *didaskalei*: Aura Jorro 1985, 171). The passing down of cloth-manufacturing skills from older women to younger, including daughters, is well attested in other Linear B tablets from Crete and the mainland. Compare the designation *tu-ka-te* (*thugatēr*; Aura Jorro 1993, 374) and abbreviation *tu* ("daughter"; Melena 2014, 131) at Knossos and Mycenae (Olsen 2014, 162–201, 320–329).

Tablets Ld 785, 786 and 788 from the Spiral Cornice Room refer to cloth that is *ki-ri-ta* (*khrista*; subject to the well-attested process of "anointing" fine cloth), *ke-ro-ta* (*geronta*; old or heirloom cloth), *po-ki-ro-nu-ka* (*poikilonuka*; with edging of variegated colors), and *e-ru-ta-ra-pi* (*eruthraphi*; with red coloring). The Dl tablets from this area make reference to flocks of sheep made up of animals of different specified genders and ages at the site of *e-ko-so*. This site has been located by patterns of toponymic grouping in so-called geographic group I, located theoretically partially in the Mesara Plain and at least "at one remove from the Center at Knossos" (Bennet 1985, 239, ill. 4).

This associational context improves the chances that Knossos V 832 lists individuals as "royal" workers located at the *porphureion* at the site of *da-*83-ja* on Knossos tablet X 976. One of the individuals bears the name *u-ta-jo*. An individual with this name is known as a major "collector" (Olivier 2001, 142–143). Collectors are high-status economic agents, so designated because of their involvement in "collections" (*a-ko-ra*) of economically important livestock. Collectors play a significant role in the economic sector of the palatial center at Knossos and at other palatial centers. The collector *u-ta-jo* is recorded over 50 times in the Knossos Da-Dg series. It is not to be ruled out that the individual on V 832 is the same collector (see below). Other names on V 832 are *hapax* (e.g., *si-ra-pe-te-ṣọ* or *si-ra-pe-te-mẹ* and *ta-u-ro*) or, attested infrequently, for example, *ja-sa-ro* and *ru-ro*. This circumstance increases the likelihood that they are individuals living, or at least based, at a remote location and bearing non-elite names, Minoan-derived like *si-ra-pe-te-X* or Greek-based nicknames like *ta-u-ro* (*Tauros*, bull) and *ru-ro* (*Luros*, a masculine formation of the loan word λύρα meaning lyre).

One other significant suggestion needs to be made here. The fragmentary first line of V 832 ends with traces of a sign consistent with the Linear B sign *we*. There are no indications that this sign is followed by another sign or by the number sign for "1", as in all seven fully preserved entries on lines .2 to .7. This strengthens the possibility that:

(1) line 1 functions as a heading for the tablet; and
(2) the final word of the text of this heading ends *-we*.

The word ending in *-we* likely defines and identifies, from an administrative record-keeping perspective, who the individual men listed on the rest of the tablet, each followed by the numeral 1, are.

We might compare a tablet like Pylos Jn 832. Its fourth section has a heading line (.13) that reads: *a-ta-ra-si-jo*, *ka-ke-we*—that is, *atala(n) sioi khalkēwes* ("bronzesmiths without a *ta-ra-si-ja*" of bronze to work). Other headings with similar structure are: *si-to-ko-wo* ("grain-pourers") on Pylos An 292; *ko-ri-si-jo ta-te-re* ("Korinthian *statēres*"), a term whose precise meaning is unknown, on Pylos An 209; and, with the noun form first and then followed by descriptive terms, *to-ko-do-mo de-me-o-te* ("wall-builders about to build") on An 35 and *e-re-ta a-pe-o-te* ("rowers being absent") on An 724.

If V 832 line .1 is such a header with the same structure—that is, containing a designation of location and/or status followed by the occupational term that defines what role the single individuals play in the economy—then one might propose here a designation such as *po-pu-re-we*, the plural form of historically attested *porphureus*, a worker in purple murex dye.

The *-eus* noun suffix, which has the import "having to do with," is highly productive of such designations in the Mycenaean period, including

even personal names (Ventris and Chadwick 1973, 100–101). For crafts specialists with *Berufsbezeichnungen* in *-eus*, see, for example (Bartoněk 2003, 279–285, with other categories by extension):

knapheus, "fuller" or "felter";
plekeus, "braider" or "plaiter" ("having to do with the Greek verbal action *plek-*");
histeus, "loom specialist" ("having to do with the *histos*, standing or upright loom");
kerameus, "potter" ("having to do with *keram-*, the pre-Greek root for potter's clay");
khalkeus, "bronzesmith" ("having to do with *khalkos*");
g^{w}*asileus* (later *basileus*), "chieftain";
hiereus, "priest" ("having to do with holy things");
wrīneus, "leatherworker" ("having to do with leather"); and
(*h*)*armo(s)teus*, "wheel-joiner" ("having to do with the joined product," i.e., a wheel).

Likewise, the form *porphureion* is most likely formed parallel to the noun **porphureus*, just as as *(h)armoteiōn* "wheel-joining workshop" is formed parallel to *(h)armo(s)teus*. We may note that many of these terms for specialist crafts persons are derived from basic non-Indo-European roots for materials used in production: *keram-*, *khalk-* and *porphur-ā*; and also that the first three terms in the above list (*knapheus*, *plekeus*, *histeus*) are in the sphere of cloth manufacture (for *-eus* and feminine *-eia* craft specialists in ceramics, cloth-working, bronze-working, and horn-working, see Bennet 2008, 159).

Given the scale of cloth manufacture on Crete attested in the Linear B records (Bennet 2007), and the presence of cloth in the Cretan Hieroglyphic and Linear A ideographic repertories (Hieroglyphic logogram **163* on medallion #103.b: Godart and Olivier 1996, 426; Linear A composite logograms A 535 and A 536 on tablet HT 38.3: Godart and Olivier 1976, 72–73; 1985, 222–223; Petrakis 2012, tables XXVI, XXVII), it is reasonable to assume that every effort would have been made to maximize exploitation of the natural resources for dye manufacture and use, wherever those resources existed on the island. This textual attestation of interest in colored cloth production for trade, gift exchange, and socioeconomic differentiation during all phases of the Minoan and Mycenaean palatial system on Crete (from MM II into LM III) coincides with widespread indications of the use of murex dye from MM II onward (for early evidence in East Crete at Palaikastro and Kouphonisi and at MM IB/II Kommos, see Ruscillo 2006, 802–803). Vassilis Petrakis (2012, 84–85) joins Maria Alberti (2007a, 251) in seeing the Knossian textile industry that is well attested in the Linear B tablets as "the adaptation of a pre-existing Neopalatial industry by Mycenaean administrative forms." John Bennet (2008, 157) emphasizes the "deep history" of textile production on Crete and argues that in the Mycenaean phase, the palatial "capture" of this industry was producing even more ligatured variants of cloth than in the Neopalatial period (for more detail on the Minoan and Mycenaean phases of palatially monitored cloth manufacture, see also Burke and Chapin 2015, 34–38). Our argument here then is that the Linear B evidence is relevant to and suggestive of earlier Minoan practices for textile production, including dyeing, as attested in the material record at Alatzomouri Pefka.

The fundamental Minoan nature of the murex purple-dye industry is underscored by the form of the basic root that is used to designate the dye, the sea mollusk from which it is extracted, and the specialist personnel who work with the murex and the dye and within the dyeing process. *Porphurā* has no convincing Indo-European etymology, and the proposal by Pierre Chantraine (2009, 896–897, s.v.)—that it is likely a Semitic borrowing (albeit source unknown) from the Near East—is derived historically from the first edition of Chantraine's *Dictionnaire étymologique de la langue grecque* (1968), published at the stage of scholarly research when the origin of the purple-dye industry was generally associated with the Phoenicians, and before the early existence of the Cretan dye industry was well documented. In fact, no convincing Semitic source word has been suggested. We should note that Robert Beekes (2010, vol. 2, 1223–1224, s.v.) considers the word as coming from a Mediterranean language.

In fact, the root has a feature that strongly suggests that it is Minoan in origin—reduplication in its morphology: pV_1r - p^hV_2r (Palaima and Bibee 2014, 354). The existence of a second term likely derived from an "Aegean" substrate leaves *porphur-* as a good candidate for "Minoan" origin.

Furthermore, the adjectival derivatives of this word attested in Linear B (*porphuryon* and *porphureion*) suggest that it was not yet commonly used as a feminine alpha-stem in the Mycenaean period when those forms were derived and used. As we discussed above, forms in *-eion* derive originally parallel to the noun form in *-eus*, a suffix that is commonly used with non-Indo-European roots. (Later the full locational ending may be used by analogical extension.) And the form in *-ion* with rapid pronunciation *-yon* (*po-pu-ro$_2$*) forms directly from the stem. A derivative from a form in long alpha would yield a Mycenaean spelling *-a-jo*, which is unattested.

So far we have been concentrating on the Knossian Linear B material. But ample records and a rich vocabulary relating to the cloth-production industry and its personnel and their locations are found also at mainland sites (for an analysis of Greek cloth-making terms and their etymological sources, see Barber 1991, 278–280, tables 12.1–12.4; for the technical and occupational vocabulary regarding cloth manufacture at Thebes and other sites, see Alberti et al. 2012, 99–102, pl. XXIXa; for an overview of purple-dye sites in the Aegean, see Vykukal 2011, 26–43; for the murex dye production at Mitrou on the Euboean Gulf northeast of Thebes, see Vykukal 2011, 10–12, 71–84). Within the Thebes tablets (see Nosch 2001–2002), we have records of cloth finishers, spinners, fullers, weavers, and specialist makers of cloth or cloth elements known as *te-pa* and *o-nu-ke*. Most significantly in regards to the royal purple-workers on Knossos tablet X 976, we have references to royal cloth finishers (*asketriai wanak*[*terai*), cloth finishers working in the *woikos* ("house") of the mistress goddess *potnia,* and groups of women identified by feminine adjective forms of the names of prominent collectors (*ko-ma-we*, *pu$_2$-ke-qi-ri*, and *ma-ri-ne-u*). The textual evidence leads to the conclusion that "at Thebes, just as in other palatial centers, the textile production was partly decentralized and controlled by separate authorities closely linked to the palace" (Alberti et al. 2012, 102). Shipments of wool are recorded as going *a-ma-ru-to-de*, with the common allative suffix *-de* designating movement toward a specific destination, here "to Amarunthos," reasonably identified with the toponym later attested on the island of Euboea (Palaima 2011, 68–69, 72, 74, 75, fig. 1), and to a coastal site called *Aigihaliā*.

Among the Thebes tablets there is a text Av 104 [+] 191 (Aravantinos et al. 2005, 6; see below, p. 128) that tracks the movement of groups of men being sent out to or perhaps already at specific locations. The extant numbers of men vary from 6 to 20. The header of the whole text, *ka-zo-de*, is written on the first line in majuscule signs followed by what looks like the occupational name designation that applies to all the men in the various entries on the tablet: *si-to-ko*[*-wo* "grain-pourers" or perhaps "grain-watchers"—that is, guards of the grain supplies.

The word *ka-zo-de* is certainly parallel in its morphology to the form with rapid pronunciation *ka-za* on Knossos tablet Sp 4452, interpreted correctly there as **k^{h}alk-yā* ("of bronze"; Melena [2014, 45] cites *ka-zo-de* as a parallel, and Del Freo [2001, 85] also links *ka-zo-de* with the site of Khalkis). Given the predominance in the Thebes texts of references to: (1) cloth manufacture, cloth specialists, and cloth groups connected with collectors; and (2) coastal sites in Boeotia and on Euboea, and the absence of references to bronze, however, we think it is more likely here that the *ka-zo-de* should be interpreted as **kalk^h-yonde*, from the loan word *kalk^{h}ā* (historical Greek κάλχη) used both for the murex, the marine mollusk, and for the purple dye which is extracted from it (Chantraine 2009, 469, s.v.; cf. Beekes 2010, 629, s.v.). The late adjectival formation *kalk^{h}ion* is used for the purple dye. A metathesized form of this word, identical then in its stem to *k^{h}alk-os*, is attested.

If this proposal is accepted—and it is even more probable that the later famous coastal site of *Khalkis* derived its name originally from the root meaning the marine mollusk *kalkh-* (Kiepert 1878, 255 n. 1; *pace* Bürchner 1899, 2079), an etymology that was forgotten and replaced by association with the much more common and widely used word and material *khalk-os* ("bronze")—we would have within the Mycenaean lexicon exactly the dichotomy of production locations called for by the archaeological remains at Alatzomouri Pefka:

(1) *porphureion*, the place where the dye itself could be handled, refined, and/or used by specialists called *porphureioi* (or *porphurēwes*); and

(2) *kalkhion*, the place where the actual marine mollusks are harvested and crushed in the first stage of dyeing within the cloth production industry.

This two-stage, two-location dichotomy would match what the material remains at Alatzomouri Pefka in the Minoan early palatial period suggest. It is also fitting that the rich vocabulary connected with cloths and dyes in the Linear B tablets reaches back to Minoan language stock and has, as we would expect, terms with Mediterranean substrate roots, borrowings from Near Eastern cultures, and particular Greek terms that reflect the rich history of inter-cultural transmission and adaptation connected with this culturally and economically important industry.

Transcriptions of the Three Main Linear B Texts

Subscript dots mean that there are traces of a sign consistent with the proposed reading, which is, however, not completely certain.

The term *vacat* means that a portion of the tablet is "empty,"—that is, in its final text, that part of an undamaged text surface that could have been written upon has no writing preserved.

A square bracket means that the tablet or tablet surface is missing from the position where the bracket is placed and in the direction toward which the bracket opens up or faces. So, for example, in Knossos V 832 (Pl. 23:f), the second sign group on line .4 begins with a sign read as *a̩*, because there are traces of writing consistent with the sign *a*. The tablet surface is no longer preserved immediately to the right of this sign.

Knossos X 976

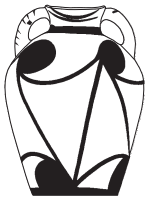
.1a da-*83-ja po-pu-re-jo̩ [
.1b to-so / wa-na-ka-te-ro [
.2 *vacat* [

Knossos V 832

.1 *vest.*[ ] *vest.* [ ]we̩
.2 si-ra-pe-te-so̩ 1 ka-pu-ro 1
.3 ka-na-po-to 1 pi-ma[
.4 ru-ro 1 a̩[
.5 ta-u-ro 1 [
.6 u-ta-jo , 1 [
.7 ja-sa-ro 1
the remaining part of tablet below line .7 is without rule lines;
the tablet is deliberately scored/cut at bottom

Thebes Av 104 [+] 191

.1 ka-zo-de , / si-to-ko[ ]ro-na-de VIR 20
.2 po-to-a2-ja-de VIR[ ]de̩ VIR 10 te-re-ja-de VIR 10
.3 o-ke-u-ri-jo VIR[ ]de VIR 6
.4] *vacat* [ ] *vacat*
the tablet is deliberately cut below;
the entire tablet is written over an erased text



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Discussion and Conclusions

by

Philip P. Betancourt, Thomas M. Brogan, and Vili Apostolakou

In 2007, before the discovery of the workshop at Pefka, Pietro Militello published a well-reasoned survey of what was known about Middle Minoan and later Cretan textile manufacture based on the knowledge available at that time (2007). His suggestions were a very proper conclusion based on what was understood before the discovery of this workshop. He wrote that in Minoan Crete, "wool and linen processing . . . took place at a household level, outside direct Palatial control," and that no large workshops for a Minoan textile industry existed before LM I when (2007, 44):

> Exchange and gifts inside and outside Crete caused this craft to develop and led to the creation of Palatial workshops. These, probably located inside the large central buildings, would not have been created for the production of a surplus. It is probable that specialized craftsmen simply produced what people in the palace needed for private use and for ceremonial and diplomatic activity.

The picture has been dramatically changed by the discovery of this workshop. The large MM IIB free-standing industrial installation at Pefka was only a small part of what was obviously a gigantic industry producing textiles for export. The organization of this industry must have been divided into small specialized segments that each performed one part of the total output: gathering and processing the murex shells and sending them to the dyeing workshop; gathering the plants to be used; raising the sheep on their grazing land, penning them up and plucking the wool, and delivering the unprocessed wool to the washing and dyeing installations; and carding and spinning the thread, weaving the textiles, and distributing the finished products both within Crete and overseas by ship (for more discussion of this manufacturing system, see Betancourt et al. 2014). The surplus from this industry would have provided some of the trade goods that East Crete needed, like the copper, tin, silver, gold, and lead that supplied the workshops at Gournia and elsewhere with raw materials, as well as the prestige products that maintained the public images of the elites. The many large deposits of

crushed murex shells that occur throughout East Crete (see below) are an indication of the extensive tradition of making dyes from the murex gastropod that existed as early as the Middle Bronze Age. Such a large industry, with many small sections contributing to the whole, can only have been administered by a palatial administration in order to create a large surplus.

Pefka was engaged in the manufacture of large quantities of colored dyes, some of which were used to dye wool on the spot and others that were a surplus that was placed in jars in preparation for shipment elsewhere. This workshop did not raise the sheep or pluck the wool from them. It did not spin the thread or weave the textiles or distribute the finished goods. The arrangement follows the same concept of specialization visible in the Mycenaean Linear B texts where groups of workers receive their food and other needs and labor under a supervisor to achieve the quotas of manufactured goods required by the palace. The Mycenaean specialization was extreme: some women only spin, others only weave, and some make only headbands (Killen 1964, 1966, 1984, 2007). The Middle Minoan version was probably not that specialized, but it was far from simple.

The identification of the archaeological site at Alatzomouri Pefka as a dye workshop is proved by several types of evidence. Analysis by gas chromatography shows that vessels contained both organic dyes and the natural oil from wool called lanolin. Red from madder, yellow from weld, and purple from murex have been identified by their organic residues. The making of purple dye is attested as well by the presence of crushed murex shells. The configuration of the workshop, with a well or cistern, a series of specialized vats with troughs to allow liquid to run back into them, and shallow basins suitable for washing wool, agrees with the normal configuration of an ancient dye works. The finds include the necessary artifacts for such a facility, including an unusually large number of tripod pots for heating liquids and many stone pounders for crushing various materials. The pottery assemblage is industrial in composition, with many amphorae, jars, basins, and jugs and fewer cups and fine vessels than is usual for a Minoan domestic household.

The large quantity of storage vessels found at Alatzomouri Pefka raises the possibility that some installations for Minoan dyeing did not manufacture their own dyes. Many of the storage vessels are transport shapes (such as the amphorae). Some of the dyes, like the murex purple, were made with complex and specialized techniques, and perhaps some weavers would rather import the dye instead of making their own.

A good example of this situation is the town on Pseira, which has no evidence at all for murex purple production but considerable evidence for weaving in the form of loomweights in many different houses (Betancourt 1995a, 10; 1995b, 128; 1998a, 33; 1998b; 1999a, 109; 1999b, 281; 1999c, 54; 1999d; 1999e, 204; 1999f, 36; 1999g; 1999h; 2009a). Weaving on a warp-weighted loom was clearly a common household task. The sheep to provide the wool are attested at Pseira by the presence of their bones (Reese 1998a, 1998b, 1999a, 1999b, 1999c, 2009). The evidence from Pseira suggests that weaving wool was a normal household activity. The Pseirans lived on an offshore island with limited resources, and they had to import many commodities from Crete, including all of their pottery. Although it cannot be proved, they probably imported some colored dyes from the nearby workshop.

It is possible that this workshop was one of several similar installations at Alatzomouri. Hawes excavated tombs about 75 m southwest of the dye workshop in 1904, and she reported a row of five pits about 80 cm^2 in area and 30 cm deep, spaced about 2 m apart (Hawes et al. [1908] 2014, 46). They were empty except for some sherds, which she did not publish or describe. Two residents of Pacheia Ammos reported that these pits were visible in the 1950s, but a search could no longer locate them. The description sounds very similar to the Pefka workshop, suggesting that the scale of the operation in this region was larger than a single installation.

Bronze Age Deposits of Murex Shells in Eastern Crete

Bronze Age sites on Crete contain some of the earliest extant evidence for the production of purple dye in the Mediterranean and point to the island's fundamental role in developing what would

remain a major industry in the wider region throughout antiquity (Forbes 1964, 1966; Kardara 1961; Reese 1987, 2000; Ziderman 1990; Karmon 1993; Stieglitz 1994; Koren 2005; Hughes 2007; Militello 2007; Boesken Kanold and Haubrichs 2008; Macheboeuf 2008; Puybaret, Borgard, and Zérubia 2008; Marzano 2013). The finds on Crete primarily consist of crushed murex shells that were first reported by Robert Bosanquet in large numbers at Palaikastro and Kouphonisi (Bosanquet and Dawkins 1902–1903, 276–277). Since then, many other discoveries of this type of shell deposit have been made, and it is clear that East Crete was a center of production for the industry that manufactured purple dyes from this marine creature (Brogan, Betancourt, and Apostolakou 2012).

Sites with large enough quantities of murex shells to suggest the presence of purple dye production now include the following:

(1) Chryssi (Apostolakou, Brogan, and Betancourt 2012)
(2) Karoumes Siteias (Vokotopoulos 2006, 349–350)
(3) Kato Zakros (Platon 1971, 251)
(4) Kouphonisi (Bosanquet and Dawkins 1902–1903; Guarducci 1940, 104; Reese 1987, 204; Stieglitz 1994, 50)
(5) Makrygialos (Reese 1987, 204; Poursat 2013, 185)
(6) Malia (Reese 1987, 204)
(7) Mochlos (pers. comm., D. Reese)
(8) Nisi-Eloundas (pers. comm., S. Beckmann)
(9) Palaikastro (Bosanquet and Dawkins 1902–1903, 321; Reese 1987, 204; Stieglitz 1994, 50)
(10) Papadiokampos (pers. comm., C. Sofianou)
(11) Petras (pers. comm., M. Tsipopoulou)
(12) Vai-Itanos (pers. comm., J. Moody, O. Rackam, and T. Brogan)

At several sites, the murex remains have been recovered together with EM III–MM II material, indicating a late Prepalatial and Protopalatial date for the earliest developments of this Minoan industry. The Protopalatial finds come from settlements like Petras, Palaikastro, and Malia, farmsteads at Karoumes, Vai-Itanos, and perhaps Nisi-Eloundas, and, finally, remote locations like the cove on the northeastern coast of Kouphonisi. At Palaikastro, what was probably the same deposit identified by Bosanquet was still visible in 1981. More crushed murex shells were found in 1963, and a sample of the deposit (64 shells) was studied by David Reese (1987, 204). The species of murex reported from these sites is typically *Hexaplex trunculus*, though the spiny bodied *Haustellum brandaris* variety is noted in large numbers at Vai-Itanos and Karoumes. Crushed murex shells have also been reported at Neopalatial sites in East Crete, particularly in LM IB contexts, including houses at Mochlos, Palaikastro, Papadiokampos (early Neopalatial), and Chryssi, the villa at Makrygialos, and the palace at Kato Zakros. At these sites, *Hexaplex trunculus* is always the predominant species. Purple dye from the island is also mentioned in a Cretan inscription *IC* III vi 7.6 dated to the early third century B.C. Together, this evidence demonstrates the widespread, longstanding, and significant role the purple dye production played in the Bronze Age economy of eastern Crete.

Parallels for dyeing workshops also exist from later times. A workshop for making purple dye from murex shells has been excavated at Mitrou, in Locris on the Greek mainland (Vykukal 2011). The date is Late Protogeometric. In addition to quantities of murex shells, the excavations discovered many cooking pots and stone tools, including querns, and these artifacts could have been used in the manufacture of the dye.

An installation from the Hellenistic period on the Rachi, a hill near Isthmia, was a workshop engaged in textile making including the preparation and use of dyes (Broneer 1958; Kardara 1961). The site had several cisterns for storing water as well as a 45-m deep well. Four small establishments consisted of a shallow rectangular basin and a pair of circular vats carved into bedrock. The comparison with the rectangular basin and the smaller vats at Pefka is very interesting, and it suggests a similar function, almost certainly the washing and dyeing of wool.

Another possible dye works from this period is the Citadel House at Mycenae (Bowkett 1995). Although the excavators regarded the building as a domestic complex with facilities for making wine or olive oil, Laurence Bowkett considered the presence of plaster floors and evidence for drainage as more likely signs of dyeing fabrics. He also noted

the presence of spindle whorls and spools as a sign of spinning and weaving. The absence of large numbers of vats at this site might be explained by the use of portable basins. He also suggested that features like presses, usually regarded as signs of the manufacture of wine or olive oil, could be used to press the excess dye out of fibers.

Other possibilities also exist. They include an installation at Halieis (Jameson 1969, 322–324), regarded as a dye works by Bowkett on more limited evidence (1955). All of these post-Minoan establishments are slightly different, and they may not all be dye works, but the identifications are based on the presence of a few of the many features that are all present at Pefka: drains leading to containers, access to water, multiple basins or vats, large numbers of cooking pots, many jars and other containers for liquids, stone pounders and grinders, and mills or mortars. None of these post-Minoan workshops have vast numbers of crushed murex shells or evidence from the scientific analyses of organic traces that confirm the presence of dyes or lanolin.

For the configuration of an ancient dyeing establishment from somewhat later, an especially good comparison for the installation at Pefka is offered by a Roman workshop at Athribis, in Egypt (Petrie 1908, 11, pl. 35 [bottom left]). The Athribis workshop was near Hellenistic and Roman buildings, but like the facilities at Isthmia and Pefka, it was isolated from the local community. It had many points in common with the Minoan workshop. The facility at Athribis included a well, a large shallow basin near the well that would be suitable for washing wool, and a number of smaller vats to accommodate more than a single color at the same time (red and blue colors were noted as stains inside different vats). These various parallels indicate that the technology of dyeing required a specific set of features, so it is not surprising that installations from various periods often share several points in common.

Probable Relation to Gournia

The large size of the installation at Pefka and the likelihood that a second such workshop was nearby leave little doubt that the output of the facility at Pefka was more than a household production. The recent discovery that the palace at Gournia had already been constructed in MM IIB (Buell and McEnroe 2017, 8) provides good evidence for the probable authority that managed the installation. Most of the pottery from the workshop matches the style of ceramics made at Gournia (see this vol., Ch. 4). The other finds at the workshop (including the stone tools and the clay drains) are too general to associate with a specific site, but their classes are also common at Gournia. The most likely hypothesis is that the dye works was managed by the palatial authority located nearby, and that it helped provide the goods that supported the palatial state.

Comments on the Colors Produced

The production and use of organic dyes is a worldwide activity. Thousands of natural materials produce pigments, and their adoption and independent development must have occurred many times in the history of the world. Organic dyes differ from the pigments made by grinding up colored, nonorganic materials like red ocher and yellow ocher in that they are soluble in water, and they can penetrate and color fabrics easily. Some of them are more stable than others, and they can provide useful colors that do not fade much with exposure to light and air.

In Crete, the Minoan development and use of colorants is only a short chapter in the history of colored fabrics in the island. Traditional dyeing and weaving was practiced in Crete as a household industry until the early 20th century (Fragkaki 1974). The production of fabrics, especially for carpets and clothing, was a normal part of the domestic economy of many households. Like other parts of the world, natural dyes formed an important aspect of the craftwork tradition. Madder, which grows wild in Crete and is easy to use to produce a variety of red tones, may be one of the dyeing practices handed down from the Bronze Age (Sandberg 1994, 77). It has been an important aspect of the craftwork tradition in Crete until modern times (Fragkaki 1974, 93–94).

Although the polychromy of Minoan clothing as depicted in wall paintings suggests that several additional dyes were used in Crete, evidence at Pefka was only discovered for four colors: yellow

from weld, red from madder, red from bugloss, and the purple made from the murex gastropod. Based on the wall paintings, it would not be surprising if the yellow of crocus, blue from indigo, and other colors may have been made here as well. A different class of red dye is made from *Kermococcus vermilio*, an insect that lives on an oak species that grows in Crete (*Quercus coccifera*; Warren 1972, 262). Red dye can also be made from the root of alkanet (*Anchusa tinctoria*), and this plant also grows in Crete (Warren 1972, 263). Dried stigmas of the saffron crocus (*Crocus sativus*) make a yellow dye, and crocus is known from Linear B. In spite of these possibilities, only four dyes can be positively associated with this workshop based on our present level of knowledge and limited analyses. The ways that these colors are made are well known, and it is useful to compare the methodologies with what was available in the workshop.

For all these colors, the wool to be dyed would need to be washed first. The presence of lanolin as a residue in pottery (see this vol., Ch. 13) indicated that the oil removed from the wool in the washing process was retained as a useful product. It was probably produced in substantial quantities.

Madder

The presence of madder is confirmed by analysis using gas chromatography (see this vol., Ch. 13). Madder dye is produced from *Rubia tinctorum*, a plant that grows wild in Greece (Warren 1972, 263). The madder plant is easily recognizable because it has pairs of leaves that sprout from the stem. It has small yellow flowers. Because the root is what is used for the dye, the madder must be dug up, and it is cut into small pieces and crushed. The pieces can be soaked overnight, and the resulting red mixture is then heated in water (but not boiled) along with the washed wool (McRae 1993, 75–76; Sandberg 1997, 85). Alternatively, the hot liquid could be poured into a vat, and the wool could be immersed.

The red color comes from the pigment alizarin. The color derived from madder can vary considerable in hue from a yellowish red to a deep and clear red to dark brownish violet. Many factors affect these different variations, including the mineral content of the soil where the plant grew, the temperature and alkalinity or acidity of the water, and other factors (Sandberg 1997, 84). The color is fairly colorfast, but mordants increase its permanence.

Everything necessary for making dye from the madder plant is present in the workshop. Stone tools could be used to macerate the roots. The water would come from the well or cistern. The many tripod vessels could be used for the heating operation, but as this system would only yield small quantities of finished fabrics, more likely several tripods would be used to prepare the dye, and their contents would be poured into a vat where large quantities of the wool could be immersed.

Echium (Bugloss)

Seeds of the plant named *Echium* (commonly called viper's bugloss) were identified from carbonized remains (see this vol., Ch. 8). Several species of the plant grow wild in Crete (Huxley and Taylor 1984, 119; Sfikas 1987, 188–189). *Echium* grows about 25–40 cm high, and each plant has many flower-bearing stems that are covered with white hairs. Blue or violet flowers grow on the stems. A red dye can be manufactured by heating the root.

Murex Purple

Both analyses of vessel contents (see this vol., Ch. 13) and pieces of crushed murex shells indicate that purple was one of the dyes produced at this facility (for the chemistry, see Fouquet and Bielig 1971; Baker 1974; Michel and McGovern 1987; McGovern, Lazar, and Michel 1990; 1991; Michel, Lazar, and McGovern 1992; Clark and Cooksey 1999; Cooksey 2001; for additional bibliography, see Koren 2005, 136–149). Thomas Palaima may be correct when he suggests that some of the initial stages could have been performed nearby at the seashore, but that would still be a part of the same workshop (see this vol., Ch. 15). The analysis proves that murex purple was present in several containers at the site.

Before this project, murex purple in Crete was identified chemically only from later workshops

(McGovern and Michel 1984, 67; McGovern and Michel 1985, 1514A; McGovern, Lazar, and Michel 1990, 1991; Karmon 1993; Koren 2008). Modern replication has duplicated the process (Bruin 1967, 306; Ruscillo 2005). Among the many mollusks with glands that secrete a chemical that can be made into a permanent purple dye are three different species of the Mediterranean members of the Muricidae Family (commonly called murex shells). They include *Stramonita haemastoma*, an Atlantic species that is less common in the Aegean, and two other gastropods that are more common in the Mediterranean, *Hexaplex trunculus* and *Bolinus brandaris*.

Murex shells make up a large family of gastropods with about 1,000 individual species. They live in both temperate and tropical seas around the world. The animals are carnivorous, and many species feed on other mollusks. The murex drills a hole through its prey's shell with a radiating extension called the radula, and the drilling action is assisted by the secretion of acid from a special gland. Because murex shells do not have many predators (aside from man), colonies can grow until they consist of many thousands of individuals if an abundant food supply is available nearby.

The production of dyes in various hues and intensities by using these and other marine shells is well understood (Michel and McGovern 1987). Although Pliny the Elder provides the best ancient description of the production of dye from marine shells (*HN* 22.2–3), purple dyes and their history and technology are discussed by other ancient writers as well (the most important references are: Arist. *Hist. an.* 5.15.22–25; Poll. *Onom.* 1.45–49). A chemical in the animal's hypobranchial gland that opens into the animal's mantle cavity can be extracted as a milky fluid that changes color when it oxidizes. Many thousands of shells are required in the process of making the dye because of the small amount of fluid secreted by each murex gastropod.

Pliny describes catching the mollusks with baited traps (*HN* 9.125, 133; see also Poll. *Onom.* 1.4), a collection process repeated in experiments by Deborah Ruscillo (2006, 809–813). The finds of murex shells at Pefka were mostly small pieces resulting from crushing, but only a few hundred were found. This amount is a small number for murex purple production, suggesting that the main crushing probably occurred closer to the sea, and that most of the animals were brought to the workshop after preliminary processing to avoid transporting the weight of the whole shells. Crushing is normal for Aegean workshops where the shells were usually broken to remove the animals along with their fluid (good descriptions are provided by Reese [1980] and Ruscillo [2006, 813–814]). The bodies were crushed, mixed with salt water, and allowed to steep for three days before heating the fluid for several days (Pliny recommended nine days of heating in lead cauldrons).

Modern replications of the dyeing process contribute important information on the results (Koren 2005; Ruscillo 2006). Final colors varied from pale violet to red to blue depending on different additives and on variations in the process of manufacture. For the blue color, for example, the fabrics were dipped before the liquid was allowed to steep (Ruscillo 2006, 814). Boiling during the heating process produced gray rather than violet (Ruscillo 2006, 814). An obvious secondary product consisted of vast numbers of crushed shells, and they were occasionally removed from the workshop for new purposes like floor packing (for Thera, see Karali-Yannacopoulou 1990, 413–414; for Kommos, see Ruscillo 2006, 802–803; for general considerations, see Alberti 2008).

Weld

Weld is a plant that can grow almost 2 m high (McRae 1993, 80–81). Its scientific name is *Reseda luteola*. Weld contains luteolin, which is a yellow pigment. Its shiny leaves grow in rosettes, and pale yellow flowers appear on spiky stalks. It blooms early in the summer. The entire plant is used for the dye, and leaves can be picked so that the plant continues to grow, or the entire plant including the roots can be harvested.

The color derived from weld is variable in hue, ranging from yellow to reddish yellow to greenish yellow. The dye does not require a mordant because it is colorfast. The plant can be used either fresh or dried. The plant is cut into pieces and heated in water to create the luteolin dye. Repeated stirring is necessary because the dye sinks to the bottom of

the pot. The washed wool must be soaked to absorb the yellow, and it can be dried and immersed again for a deeper color.

Ceremonial Activity

A surprisingly large body of evidence indicates that the workers at the installation performed many ceremonies is association with their manufacture of dyes (Betancourt, Brogan, and Apostolakou 2016). So many factors affect the final colors that result from organic dyes that it is easy to see how supernatural powers might be invoked in the transformation of materials from items like madder root into permanent red color or a gastropod from the sea into Royal Purple.

The association of MM IIB ceremonial pottery with places where crafts were manufactured is not limited to the site of Alatzomouri Pefka. In addition to its evidence for workshops and domestic quarters, Quartier Mu at Malia also had offering tables and tubular stands that suggest ceremonial activities (Poursat and Knappett 2005, 146, pl. 54: 1186–1194; Poursat 2013, 135). Excavation of the Middle Minoan craft workshop area at Poros also discovered evidence for ceremonial activity including figurines, bull horns, and "sheep bells" (Dimopoulou-Rethemiotaki 1993, 451, pls. 140:c, 141:b). The invoking of divine assistance in craft production may not have been unusual. The following items from Pefka can be placed in the ceremonial category:

(1) A triple vessel (**348**) and a matching rhyton (**440**)
(2) A kernos consisting of several miniature tripods attached to the rim of another vase (**494**)
(3) A series of open tripod offering stands decorated with small cups or tiny circles in their interiors (**469**–**491**)
(4) Two tripod kalathoi (**492**, **493**)
(5) A four-legged offering stand (**495**)
(6) A cylindrical stand (**441**)

This evidence suggests that several different ceremonial practices were performed at the site. Liquid libations involving the changes in visible color caused by mixing different liquids can be envisioned for the triple vessel and its matching rhyton. Burned offerings are indicated by the open tripod bowls by the evidence of carbon inside them. No evidence survives to explain how the kernos was used. The cylindrical stand would have held a cup with an unburned offering. Each of these practices is discussed separately.

Liquid Offerings

A rhyton (**440**) and a compound vessel consisting of three small jars joined together (**348**) are painted solid black and decorated with white dots and splashes on the exterior. They were both found smashed in the well.

The rhyton belongs to a specialized class of vessel with two holes, one at the top for filling and another at the base to allow liquid to stream out (Koehl 2006, 269–271). Unless the hole at the base was blocked, any liquid poured in at the top would flow out immediately. The example from Pefka has an almost conical shape with a wide mouth, a tiny hole at the base, and a convex profile from rim to lower tip. A good parallel is a similarly shaped vessel made of stone found at Akrotiri on Thera (Warren 1979, 89). Rhyta with wide mouths and no feet could have functioned either as rhyta or as funnels for filling vases with small mouths. Koehl discussed the class in detail in his monumental volume on the subject (2006). He suggests that the vessel cannot be a funnel if its lower opening is so small that it would clog easily and it does not have a constriction near the tip to make it easy to fit inside a vase's mouth. Both of these conditions apply to the example from Pefka. Koehl proposes the use of rhyta of this design in passing liquid from one location to another.

This practice must be the case with the example from Pefka because it seems to form a set with the triple vessel. Like the rhyton, the three joined containers have an allover coat of dark slip with a decoration of white dots. The two items are the only ones from the site with this decoration. The triple vessel is manufactured as three small, rounded

vases with a spout at the front and two jars without any spout at the back. A handle rises above the group. Openings exist from each back vessel to the spouted jar at the front, but no opening connects the jars at the back. The arrangement of openings allows two different liquids to be mixed in the front jar by tipping the vessel forward. The mixture could then be poured out of the spout at the front.

The analysis by gas chromatography contributes information on how this vessel was used (see this vol., Ch. 13). The front jar and the left rear jar contained murex purple. The right rear jar contained uric acid or a urate, indicating the presence of urine. This evidence indicates that the ceremony involved mixing urine and murex purple dye and pouring it out the front. Pliny describes this mixing from Roman workshops, stating that the mixing improved the appearance of the purple color (*HN* 9.64). Ammonium hydroxide probably is the active ingredient in the urine. It and other additives, such as lichens, can be mixed with the purple to alter its color more toward red, which might be regarded as improving it. The triple vase would mix only a small amount of dye. If the goal were only to mix colors, of course, one would not need a fancy triple vessel and a matching rhyton. One could simply pour the liquids into another container. These special vessels were surely ritual items designed to seek divine assistance in the successful transformation of raw materials into useable dyes.

Burned Offerings

The offering stands that can be probably associated with burned offerings at Pefka are of several types. The first type is too poorly preserved for a complete vase to be reconstructed. The evidence consists of two surviving miniature tripod vessels that were attached to the rim of another clay container, producing a kernos (**494**). Tripod vessels are regularly associated with fire, so it is possible that these miniatures were intended as offering receptacles.

The second class is preserved in over 20 examples. The vessels consist of open bowls supported on tripod legs. A large group has either tiny cups or small, three-dimensional clay rings or impressed circles in their interiors (**469**–**491**). All of the bowls are made of the red-firing clay associated with cooking vessels and other vases designed to be in contact with fire. They seem to form a series, from vessels with actual cups inside them to bowls holding symbolic images, with the majority having only impressed circles in the interior of the open bowl. All of them survive only as fragments (mostly found in the well or cistern).

The offering stands incorporate aspects of three different classes of Minoan ceremonial equipment. The kalathos, an open bowl with a flaring rim, is one of the few pieces of Bronze Age cult equipment that was still being used for offerings in the Greek Archaic period (Prent 2005, 419). This shape forms the main part of the form. The three legs on the offering stands reference the Minoan tripod offering table, a ceremonial vessel that was often made of stone (Nilsson 1949, 14). Minoan offering tables had three legs that supported a shallow open container. They could be very elaborate, with plaster covering the surface and painted as a fresco (Doumas 1983, pl. 60). The addition of multiple images of a small vessel inside the bowl, a form often called a kernos, is also a common piece of Minoan cult equipment (for a stone offering stand decorated on the interior with drilled tiny circles, see Karetsou 2014, 144, pl. 6:3 [Kophinas]). The kernos is a multiple vessel, often consisting of many miniature containers attached inside a larger one.

The offering stands from Pefka are all burned in the interior instead of the exterior, in contrast with the case for cooking vessels. The analysis of **484**, a sherd with good surviving evidence for the burning inside the bowl, revealed the presence of dibromoindigo, indicating the presence of murex purple (see this vol., Ch. 13). Most likely dyed wool was burned inside the offering stand. Burning and fire are common in rituals that consecrate offerings to supernatural powers in the ancient Aegean (Nilsson 1949, 95–96; Burkert 1985, 60–64). Burning dyed wool has not been noted before, but it seems a fitting offering for this class of workshop.

Unburned Offerings

Unburned offerings must represent a very different class of ritual. In this Minoan practice, an offering is placed in a bowl that rests on a cylindrical

stand. The exact meaning is still unclear. The earliest examples seem to be from MM I–IIB (Betancourt et al. 2003b, 46, no. 4.57 [Pseira]). Many of the examples (but not all) have cutout sections and no solid base, indicating that they are stands rather than cylindrical containers. They have a rich bibliography (see, e.g., Cadogan 1973; 2009; Gesell 1976; Betancourt et al. 1983; Varouhakis 2011).

The use of the tubular clay stands is proved by an example with the bowl in place on its upper end from Kommos (Watrous 1992, pl. 42:1652). Its purpose was clearly to hold a vessel. The purpose of the base is apparently to elevate the vessel above the ground. The ritual function is underscored by a series of elaborately decorated tubes from LM IIIB and later. The later stands are embellished with various symbols of the Minoan religion, including horns of consecration and birds. Snakelike raised clay moldings are present on some of the examples. By the end of the Bronze Age, the stands were set up inside small shrines (Gesell 1976).

The End of the Workshop

The workshop at Pefka was a short-lived site. The pottery is almost all from a single period, at the end of MM IIB. A single Final Neolithic fragment (**1**) and one fragment from EM III (**2**) are casual pieces from before the workshop was founded. Five vessels are from EM III to MM I (**3**–**7**). One Hellenistic sherd was also discovered (**579**). These isolated fragments that have no joins with other sherds probably washed down the slope from the agricultural field uphill to the south, where the use of manure for fertilizer probably brought in many fragments of pottery from various periods (for an extensive bibliography for the practice of manuring, see Betancourt 2006, 245).

The pottery has many parallels from MM IIB, leaving no doubt about its stylistic affinities. It is most similar to the ceramics from Gournia (Hawes et al. [1908] 2014; Betancourt and Silverman 1991; Soles 1991; Watrous 2000, 2012a). The sealstone carved in a prism shape from a soft stone is from the same period (**580**). The final date of the workshop is MM IIB.

The violent destruction of the workshop coincides with a long series of other destructions in East Crete at this time. The large town of Gournia was destroyed (Hawes et al. [1908] 2014, pl. VI). Malia has a massive destruction at the same time (Poursat and Knappett 2005). The town on the offshore island of Pseira was destroyed, and its cemetery was abandoned (Betancourt 2003, 138–139). Refugees escaping from the lowland towns took refuge at Monastiraki Katalimata, a high site on a narrow cliff overlooking the isthmus of Ierapetra (Nowicki 2008). The most likely interpretation for these destructions is warfare. People do not seek refuge on high cliffs from the threat of earthquakes or other natural disasters.

Final Comments

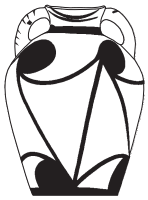
Minoan cloth was multicolored (Barber 1991, 314–315). Any survey of the wall paintings of Bronze Age Crete and nearby regions shows that the costumes of both men and women used complex fabric designs in red, yellow, blue, white, and purple (Immerwahr 1990; Doumas 1992; Morgan, ed. 2005; Jones 2015; Pareja et al. 2016). These coloristic effects must have been a major contribution to the reason that textiles were important as Minoan exports (Burke 1999; Militello 2007). The foundation for an industry using many dyes has to have been supported by workshops that dyed fibers using the various colors necessary for this practice.

The later steps in the preparation of cloth are not attested at this workshop. Evidence like spindle whorls and loomweights are not present in the archaeological record in sufficient numbers to suggest an industry. The implication is that this was a specialized workshop engaged in only one part of the long process from raising sheep to marketing finished woolen goods. The evidence supports the observation of Brendan Burke that in Minoan Crete, "each phase of cloth manufacture tends to be specialized and concentrated within workshop contexts" (Burke 1999, 77).

When the evidence for dye manufacture from this site is considered along with the evidence furnished by the site of Chryssi Island (Apostolakou,

Betancourt, and Brogan 2010; Apostolakou et al. 2014), the picture of Minoan dye manufacture is much more complete. The settlement on Chryssi Island south of eastern Crete engaged in collecting murex shells in large quantities from MM II to LM IB, in order to produce purple dye in local workshops. By contrast, the quantity of murex shells discovered at Pefka suggests that only a tiny amount of the gastropods were delivered to the site as residue from the production of purple dye, which took place elsewhere (e.g., on Chryssi; see this vol., Ch. 7). The evidence strongly supports a two-step process, with the marine creatures harvested and processed near the shore at various locations and shipped to the workshops in quantity for manufacture into dyes. The same conclusion is suggested by the Mycenaean evidence from the Linear B texts that use two different words for the two classes of workshop (see this vol., Ch. 15).

Workshops for making dyes like the one at Alatzomouri Pefka may have been common, but their location outside the Minoan settlements makes them rare as archaeological sites. They must be included in any analysis of the Cretan economy, however, because they will have provided the necessary materials to support the elaborate coloristic effects that made Minoan cloth a distinctive product in the Aegean.



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Abbreviations follow the conventions of the *American Journal of Archaeology*.

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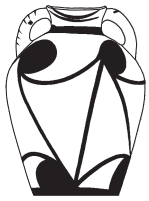

Figures

FIGURE 1

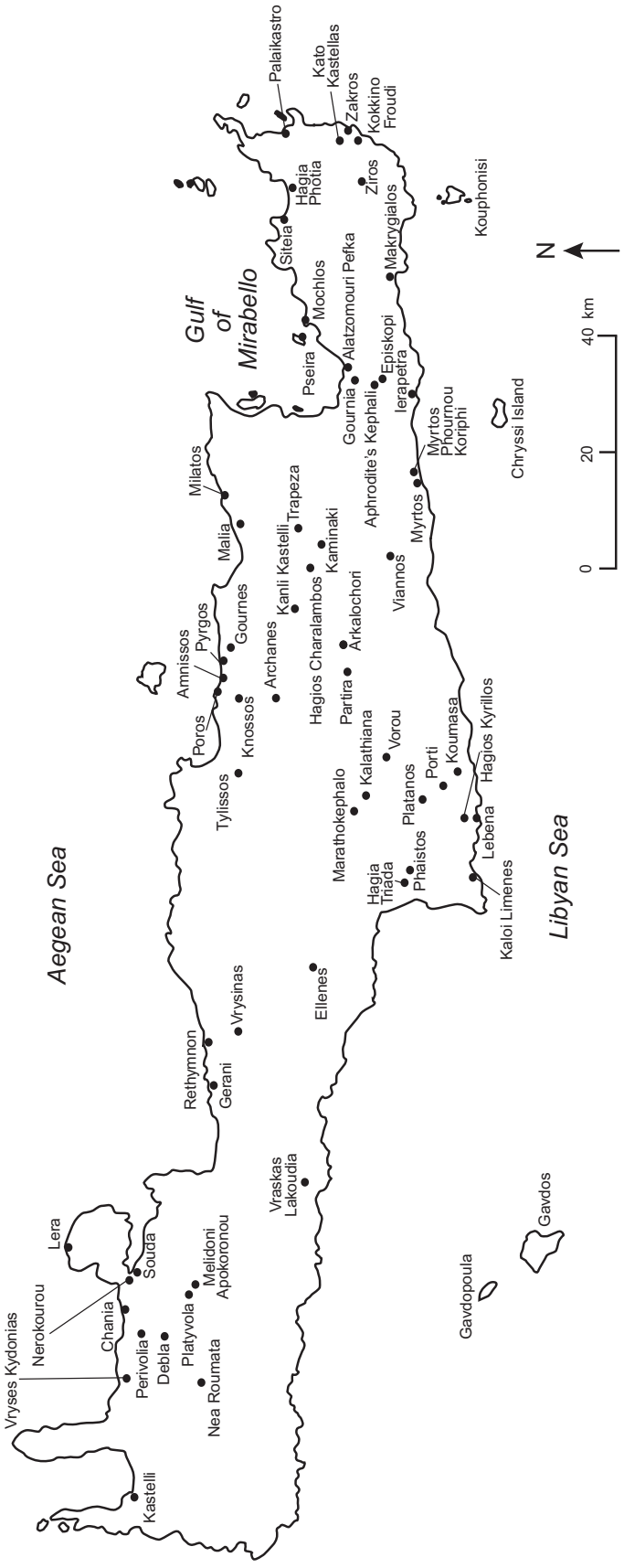

Figure 1. Map of Crete. Drawing P. Betancourt.

FIGURE 2

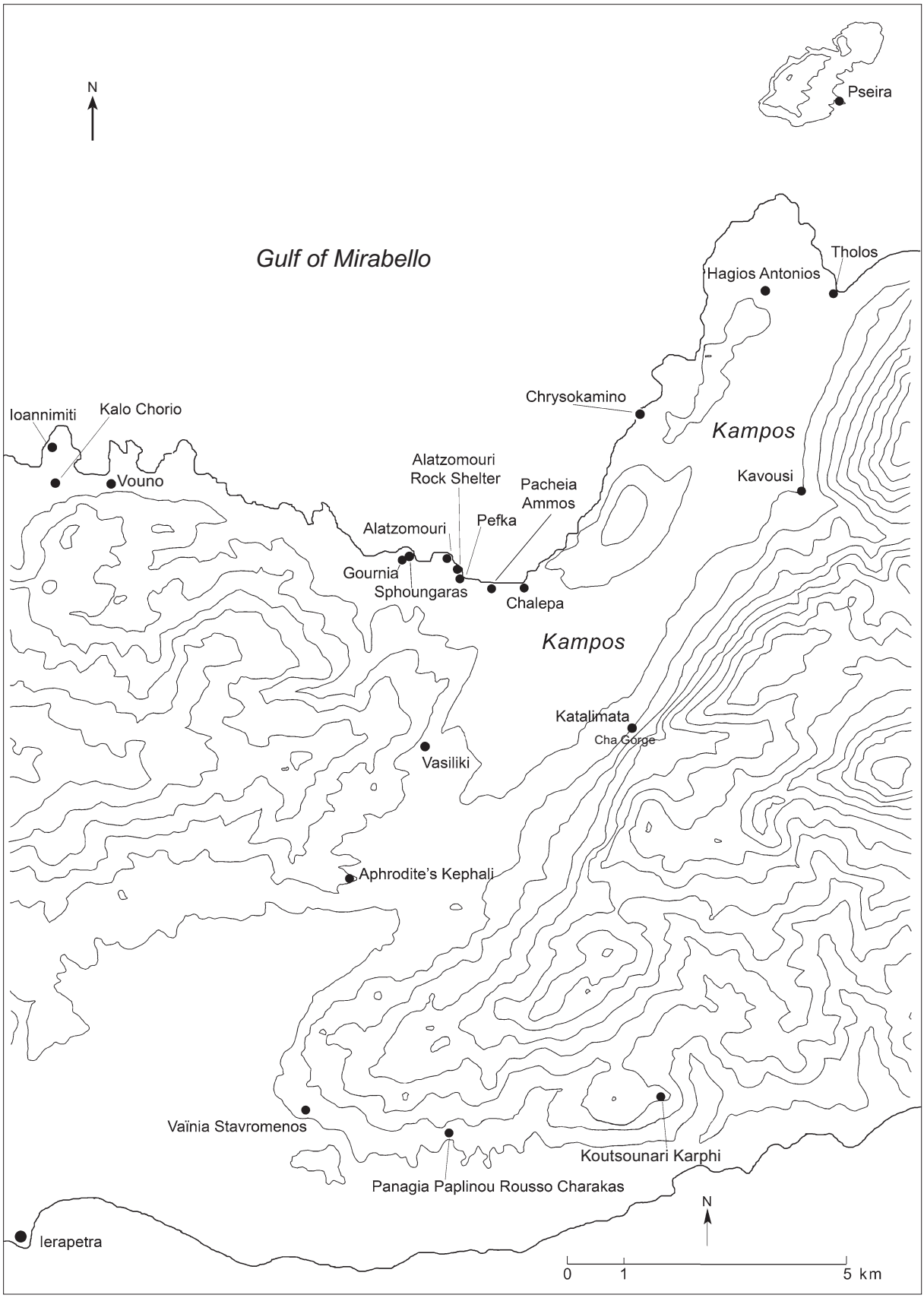

Figure 2. Map of the isthmus of Ierapetra. Contour interval 100 m. Drawing A. Insua and P. Betancourt.

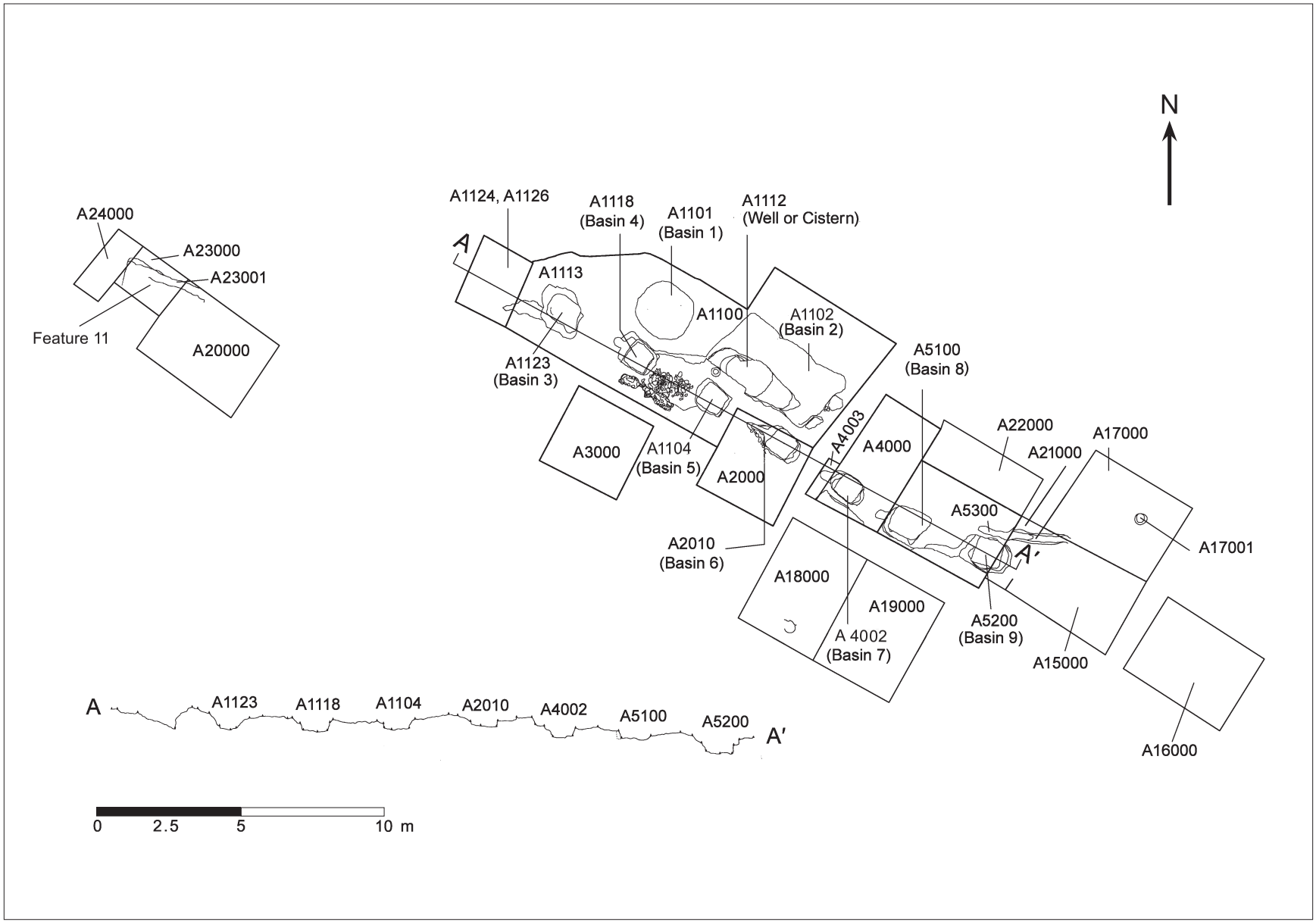

Figure 3. Plan of the Pefka workshop showing the excavated trenches and section A through the row of basins. Drawing A. Insua, N. Goshen, and P. Betancourt.

FIGURE 3