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THE ORGANIZATION OF FLAKED STONE PRODUCTION AT BRONZE AGE LERNA

ABSTRACT

A study of nearly 12,000 lithic artifacts from Lerna was undertaken to determine if the lithics were produced by craft specialists. Analysis indicates that the production of lithics was controlled by part-time craft specialists based in individual households and not controlled by an elite central authority. The evidence of continuity in Bronze Age flintknapping does not support a hypothesis of discontinuity or cultural replacement at Lerna. Any interruptions had little effect on flintknapping technology or formal tool types. A decline in the supply of imported Melian obsidian at the end of Early Helladic III (Lerna IV) suggests an interruption of trade.

The prehistoric site of Lerna in the Argolid has been under investigation for nearly fifty years since excavations began under the direction of John Caskey in 1952 (Fig. 1).[1] The architecture, stratigraphy, and artifacts from this rich and important Neolithic and Bronze Age site have been studied by many scholars, resulting in many publications. Among the most numerous of the finds are the flaked stone artifacts, with successive assemblages spanning the period from the beginning of the Neolithic early in the seventh millennium B.C. to the end of the Bronze Age in the 11th century B.C. These lithics are important for establishing a baseline for the study of Greek lithics, particularly in the Bronze Age, a period very poorly represented by published lithic assemblages.

Study of the Lerna lithics began in the 1960s with an unpublished preliminary report by Perry Bialor, followed in 1976 by a doctoral disser-

1. This report is intended to complement the final volumes that have appeared or are in press on the Bronze Age settlement at Lerna: *Lerna* III, *Lerna* IV, and *Lerna* V. Our involvement in this project began at the suggestion of Elizabeth C. Banks and the late John L. Caskey, and we wish to thank Professor Banks for her longstanding commitment to this project and for her support and encouragement from first to last. The statistical analysis relied upon laboratory measurements made in the 1980s with the assistance of Priscilla M. Murray, and it is a pleasure to thank her here for her many contributions to this project over the years. We also wish to thank Jeremy Rutter, Martha Wiencke, Eberhard Zangger, and Carol Zerner for their many useful comments and suggestions, and the anonymous *Hesperia* reviewers, who commented on all aspects of the study and made valuable suggestions for improvements. Finally, we thank Craig Mauzy for the photographs (Figs. 2–4).

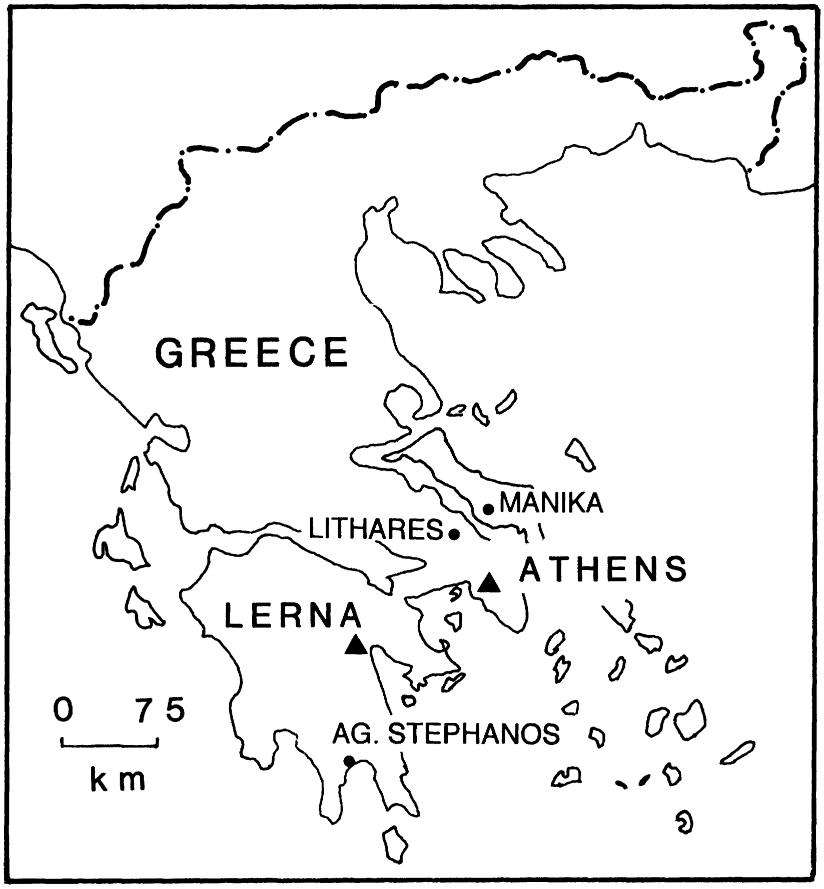


Figure 1. Location of Lerna and other sites mentioned in the text

tation by David Van Horn that sketched an outline of the Lerna sequences.[2] Further studies of the lithics were undertaken after 1980 by a number of researchers. The Early and Middle Neolithic artifacts were analyzed and published by Janusz Kozlowski and his colleagues,[3] and a report on the Bronze Age lithics published by one of us in 1985 focused on the typological and technological description of the Lerna III–V sequence with the view of establishing the character of the successive assemblages or industries.[4] More recently, a smaller number of Late Helladic (Late Bronze Age) lithics were described by Runnels for inclusion in the report on Mycenaean Lerna by Martha Wiencke.[5] Finally, the present report is a study of specialization and continuity in flintknapping in the Early and Middle Bronze Age, specifically the significant settlements of the Early Helladic (EH) II settlement of Lerna III, the EH III settlement of Lerna IV, and the Middle Helladic (MH) settlement of Lerna V. As the 1985 study by Runnels covered the typological and technological characteristics of the Lerna industries, we focus in this article on the economics, social structure, and organization of lithic production.

The 1985 study by Runnels established that the flaked stone artifacts belonged to a relatively stable industry that spanned the entire EH II–MH period. This finding added to the growing body of evidence for the continuity of culture in the Early–Middle Bronze Age on mainland Greece.[6] Only a few chronologically sensitive tool types, technological traditions,

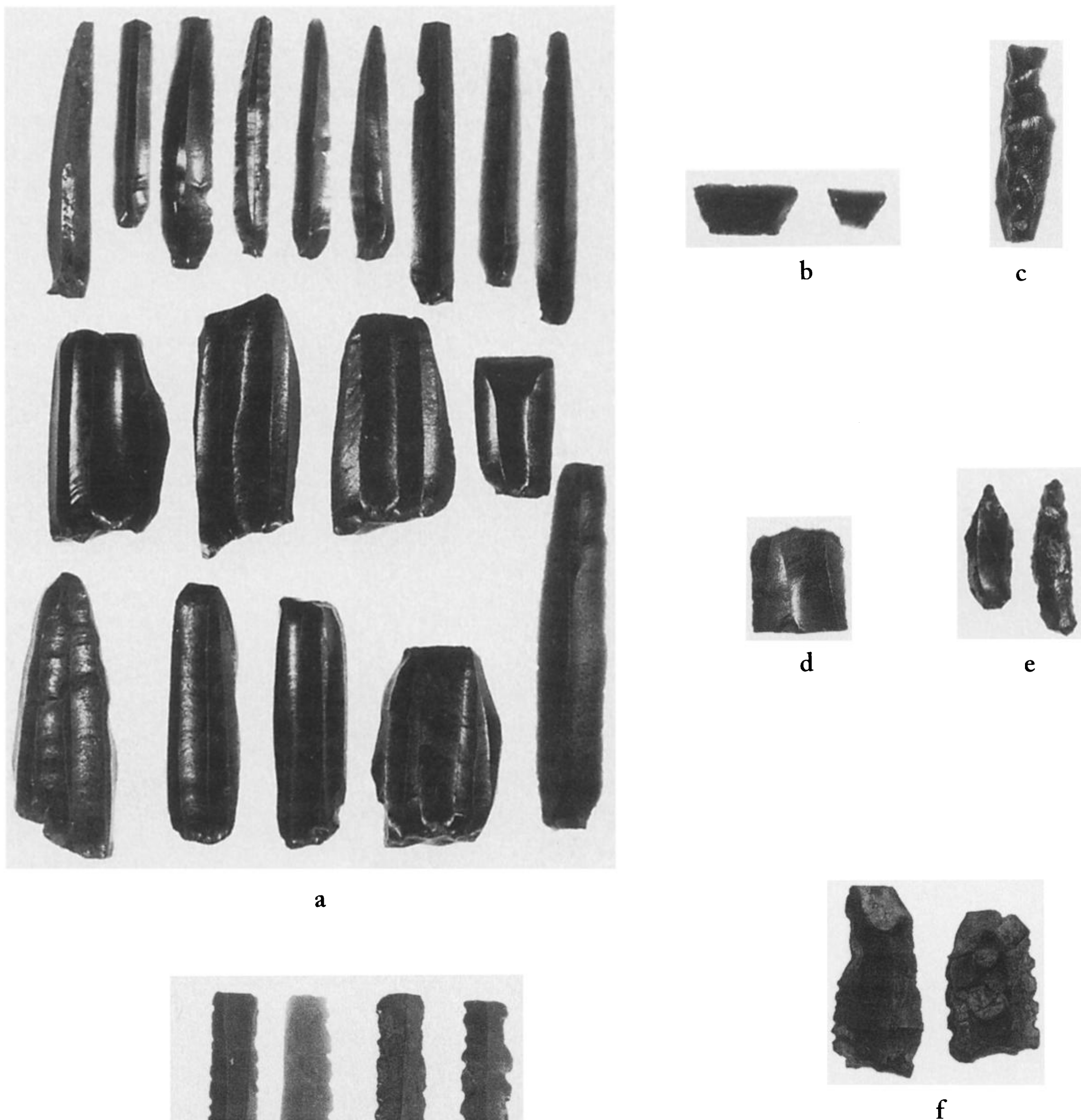
2. Van Horn 1976.
3. Kozlowski, Kaczanowska, and Pawlikowski 1996.
4. Runnels 1985.
5. Wiencke 1998.
6. E.g., Rutter 1993.

and patterns of raw material exploitation were detected at Bronze Age Lerna. The relative number of artifacts and the frequency of raw materials and formal tool types shown in Figures 2–4 reflect the general trends seen overall in the three assemblages (Lerna III, IV, and V). These figures summarize the Lerna lithics and can be used to identify similar materials from other Bronze Age sites. Generally speaking, the use of Melian obsidian to manufacture fine blades by pressure flaking continued through the EH–MH sequence, despite the decline in imported obsidian at the end of EH III. The relatively small array of formal retouched tool types was equally consistent, with notched pieces and lightly retouched sickle elements of nonlocal chert more common in Lerna III (Fig. 2), and pointed pieces (*perçoirs* and *becs*) and heavily retouched sickle elements made on flakes somewhat more common in the Lerna IV (Fig. 3) and Lerna V (Fig. 4) levels.[7] Other changes are equally minor. Hollow-based arrowheads (as opposed to tanged and barbed forms) became more common in EH III and MH. The use of obsidian declines gradually after EH II to be replaced with chert, especially local materials (or relatively local, i.e., from sources not more than 50 km away). This trend is particularly evident during the MH period, with the greatest use of chert occurring in Lerna V.

From first to last, a clear preference can be seen for extra-local chert or chalcedony for the manufacture of heavily retouched tools such as drills, sickles, or arrowheads (Figs. 2–4). These are tools that require a tough, durable raw material that could be saved ("curated" in technical parlance), reused, and recycled. Obsidian was used chiefly for the numerous, one-time use ("expedient") cutting edges required for the daily tasks of village farmers. Apart from the carefully made sickle elements that are distinctly different in each phase and which may reflect a change in access to chert acquired by long-distance trade (i.e., from further than 100 km) or a change in sickle technology or reaping practice, there is relatively little change in lithic technology at Lerna from the beginning of the Early Bronze Age (EBA) to the end of the Middle Bronze Age.

To evaluate this finding, which was published in 1985, new analyses were undertaken in 1986–1987 with a detailed computer-based statistical analysis of the evidence by Runnels and Eberhard Zangger. The purpose of the statistical analysis was to evaluate the data for significant correlation in metrical dimensions (such as length, width, and thickness), patterns in technological features such as platform types or cross-sections, and associations between different classes of tools and debitage (e.g., cores, flakes, and blades). It was hoped that this analysis would reveal time-dependent patterns useful for evaluating hypotheses of cultural continuity or cultural change at Lerna, as well as permitting lithic assemblages from undated sites or surface scatters to be more closely dated by comparisons (such as seriation) with the Lerna sequence. The results of this study were essentially negative. No statistically significant patterns or variations were isolated, and associations that were identified were found to be too weakly expressed to rule out the effects on the data of sampling errors, post-depositional formation processes, and the hazards of excavation. It was concluded that further investigations of a statistical nature were not warranted.

7. The lithic types used in this paper are based on categories defined in Runnels 1985.



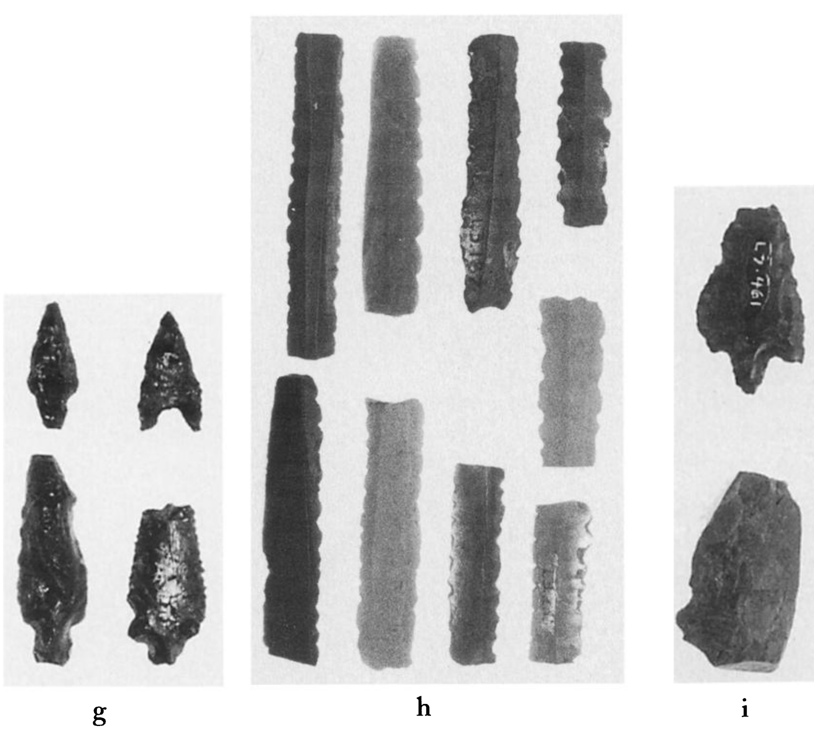
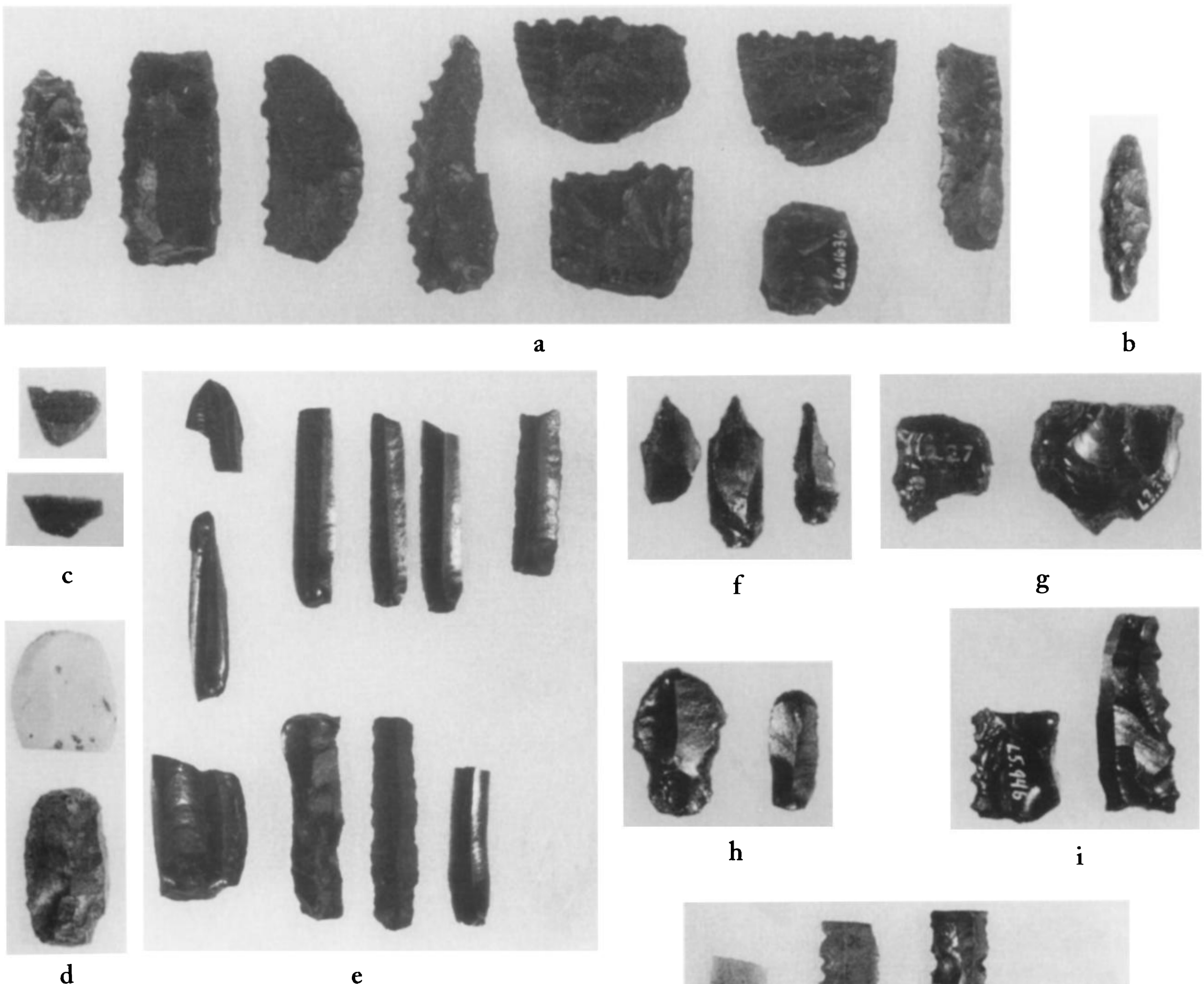


Figure 2. Early Helladic II (Lerna III) lithics (obsidian unless noted otherwise): a) blade cores and blades; b) geometric microliths; c) *lame à crête;* d) truncated piece; e) *perçoirs;* f) denticulated sickle elements; g) projectile points; h) fine chert pressure blades with denticulation and plant gloss i) tanged projectile point and notched piece of local chert. Scale 4:5



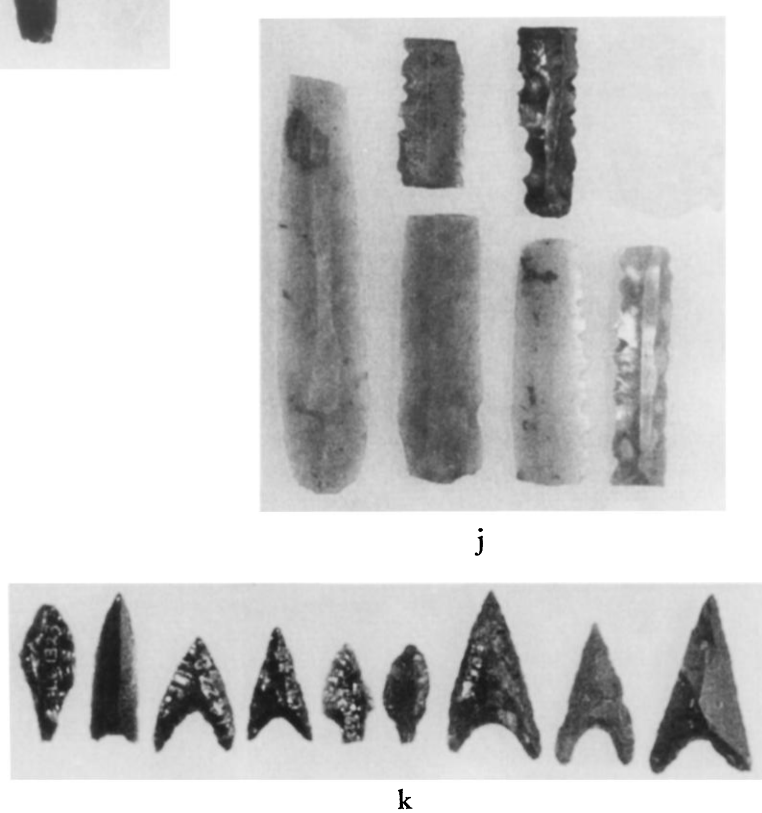
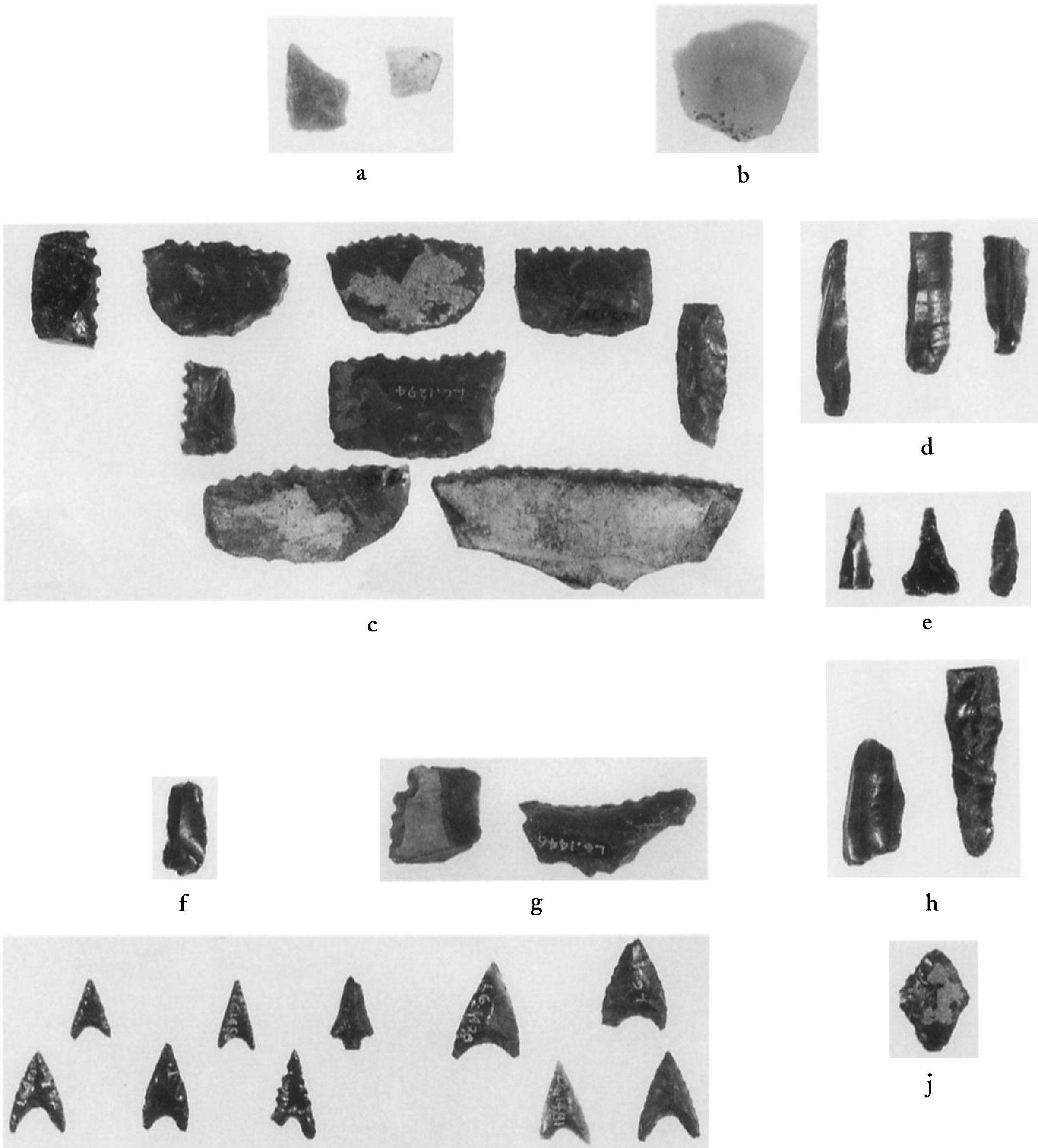


Figure 3. Early Helladic III (Lerna IV) lithics (obsidian unless noted otherwise): a) bifacially retouched, truncated denticulates of local chert with plant gloss; b) tanged projectile point; c) geometric microliths; d) end scrapers of chert; e) blades and cores; f) *perçoirs;* g) *pièces esquillées;* h) end scrapers; i) sickle elements; j) fine chert pressure blades with denticulation and plant gloss; k) projectile points (two at right are of chert). Scale 4:5



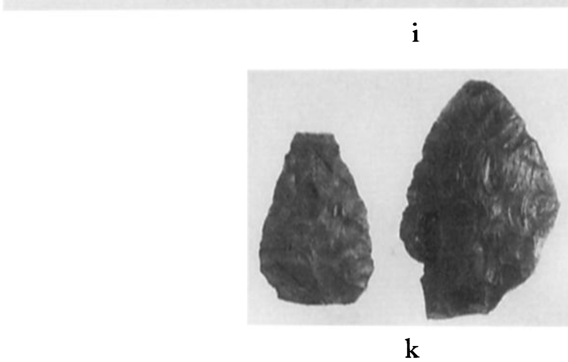


Figure 4. Middle Helladic (Lerna V) lithics (obsidian unless noted otherwise): a) chert truncated pieces; b) chert end scraper; c) bifacially retouched truncated sickle elements of chert d) blades; e) *perçoirs;* f) end scraper; g) sickle elements; h) core and *lame à crête*; i) projectile points (three at right are chert); j) tanged point (Neolithic type); k) chert bifacial artifacts. Scale 4:5

TABLE 1. BRONZE AGE LITHICS FROM LERNA

	Obsidian		*Chert*		
Phase	*n*	*%*	*n*	*%*	*Total*
III	2,176	94.1	136	5.9	2,312
III/IV	627	94.4	37	5.6	664
IV	4,007	92.3	334	7.7	4,341
IV/V	1,056	92.4	87	7.6	1,143
V	2,660	87.1	393	12.9	3,053
Mixed contexts (Bronze Age)	269	95.4	13	4.6	282
Total	10,795		1,000		11,795

Data revised from Runnels 1985, p. 359, table 1.

New material, however, has come to light since 1985. A small set of lithics that had been removed from the storeroom at the Argos Archaeological Museum in the 1950s was returned to Argos from the Corinth Excavation storerooms in the 1990s. An analysis of these newly found Bronze Age lithics revealed that they were of the same types and occurred in the same proportions as the sample already studied, but it was necessary to change some of the counts published in the 1985 preliminary report. A more significant development was the new and more detailed phasing of the excavation lots and architectural phases that resulted from the ongoing study of the ceramics, architecture, and stratigraphy by Martha Wiencke (Lerna III, Mycenaean Lerna), Elizabeth Banks and Jeremy Rutter (Lerna IV), and Carol Zerner (Lerna V). When this new phasing became available, it seemed advisable to examine the lithics anew to see if any significant data could be squeezed from these stones.

In 1997 Hartenberger joined Runnels in the final stage of the study of the Lerna lithics, undertaking the construction and analysis of a new database as part of her M.A. thesis.[8] The newly available sample from the Corinth storerooms was described and added to the totals from the different settlements, and, more importantly, the new phasing data made available since 1987 were used to restructure the chronological distribution of the Bronze Age material as the basis for a new analysis. The present article has benefited from the different methodological and theoretical perspectives that were brought to that work. The counts, shown grouped by final phasing in Tables 1 and 2, should be considered as definitive. Though several other tables published in 1985 could be changed slightly, such as those listing raw numbers of tool types per phase, the overall numbers vary so little from the originally published data that it was not thought necessary to present these details. Instead, our focus here is on the results of the analyses done since 1997.

In this study we examine the spatial distribution of lithics on the site, making use of the new phasing and the availability of architectural plans. Our emphasis is on the organization of flaked stone tool production at Bronze Age Lerna, especially hypotheses related to craft specialization. Statistical analyses of the database are used to evaluate the degree of

8. Hartenberger 1999.

TABLE 2. TECHNOLOGICAL TYPES BY RAW MATERIAL AND PHASE

	Cores		*Cortical Flakes*		*Crested Blades*		*Debris*		*Blades*	
Lerna Phase	*Ob*	*Ch*	*Ob*	*Ch*	*Ob*	*Ch*	*Ob*	*Ch*	*Ob*	*Ch*
III	22	2	232	3	25	0	25	10	879	7
III/IV	5	1	84	3	8	0	9	2	156	1
IV	47	6	515	10	51	0	37	31	979	17
IV/V	9	3	103	6	10	0	9	9	253	6
V	21	21	438	18	21	2	178	33	510	6

Data revised from Runnels 1985, pp. 361, 364, 366, tables 2, 4, 8, and 9.

standardization of obsidian blade production (the focus of Bronze Age flintknapping at this site) and to compare the Lerna findings with data newly available from other sites.

Our study of the indices of standardization, efficiency, error, and skill suggests that flintknapping specialists in the Early to Middle Helladic were more skilled than those of the Neolithic, although specialization was part-time. Independent craftsmanship is confirmed by evidence of an equal distribution of lithic debris across the site, indicating that the House of the Tiles at Early Helladic Lerna was not used to store blades and that its residents probably did not control lithic production. The type of specialization that best fits this context of skilled independent work linked with the organized distribution of blades may be called "managed specialization." We suggest, on the basis of comparison with known distributions of blades and craft products in other site hierarchies, that obsidian blade production was centralized at this regional center. Lerna may be one of several sites that produced predominantly chert or obsidian blades as a site specialty. The presence of part-time specialization in lithics as well as in pottery and metal at Early to Middle Helladic Lerna confirms the social differentiation of occupation proposed for this period, which is based on studies of settlement patterns, site structure, and mortuary ritual.[9]

METHODOLOGY

Excavation techniques used at Lerna in the 1950s were not standardized and they therefore limit the utility of the data collected.[10] The use of trenches of different sizes instead of a grid system makes it difficult to trace artifacts from some trenches back to their architectural context. Some individual groups of artifacts collected in excavation units were later combined in the laboratory as "lots," further complicating the task of mapping the spatial distribution of lithics. Personal communication with Banks, a member of the original excavation team at Lerna, and examination of the

9. E.g., Jameson, Runnels, and van Andel 1994, pp. 348–366; Kardulias 1992; Konsola 1984; Pullen 1985.
10. Banks 1995.

TABLE 2. (*continued*)

Flakes		*Tools*		*Total*	
Ob	*Ch*	*Ob*	*Ch*	*Ob*	*Ch*
843	56	150	58	2,176	136
287	15	78	15	627	37
1,904	169	474	101	4,007	334
499	35	173	28	1,056	87
1,021	130	471	183	2,660	393

original trench notebooks at the Argos Museum aided our selection of trenches that were more carefully excavated and recorded than others with respect to lithics.

Other problems complicating the spatial analysis are the variations among trenches in both recording techniques and recovery of artifact types. Banks notes that the recording system was "not rigorously standardized," resulting in variation in the amount of information and detail recorded in the trench notebooks.[11] Lack of systematic sieving of deposits and variable patterns of collecting by trench supervisors severely limited the quantity and distribution of debitage and flaked stone collected. Two strategies have been used here to lessen the effect of these problems. First, in comparing administrative and domestic contexts in Lerna III (EH II), the lithic samples from the House of the Tiles contexts were compared with lots from domestic architectural contexts over the rest of the site. The individual architectural contexts other than those in the House of the Tiles (a so-called corridor house) were combined for this comparison, thus reducing the influence of trenches with particularly skewed patterns of lithic recovery. Second, intrasite comparison of domestic structures in Lerna IV (EH III) relied upon samples from the well-defined house contexts from trench G where excavation was overseen by one supervisor.[12]

As Banks has noted,[13] potsherds and other small finds from excavation units were combined after study in the laboratory into lots of different sizes, and many artifacts were evidently discarded in the process. Lithic artifacts were treated differently. The collection of lithics in the trenches varied according to the trench supervisor, but the lithics that were collected appear to have been placed in separate paper envelopes and were not washed, sorted, or combined in lots like the other artifacts. The lithics stored in the Argos Museum remain in these bags and we treated each bag as a single sample. It is not possible to evaluate these samples statistically to determine the probability of their being representative of the population of lithics at Bronze Age Lerna, but there is also no reason to believe that any *systematic* bias affected their collection and preservation.

11. Banks 1995, p. 1.
12. E. Banks (pers. comm.).
13. Banks 1995, p. 2.

CRAFT SPECIALIZATION AND SOCIAL ORGANIZATION

Independent specialization at its most basic level has been found to occur cross-culturally in both nonhierarchical and ranked societies similar to those in Neolithic and Bronze Age Greece.[14] It is also attested for ceramics and metallurgy in the Aegean Bronze Age, with evidence provided by the high degree of skill attained, manufacturing techniques, and modern chemical sourcing of clays.[15] The growth and development of specialization during the Early Bronze Age was probably due to a combination of variables. Increasing population density, although a possible cause, has been shown to be less useful for explaining ethnographic specialization than multicausal approaches.[16] One study of ethnographic data focused on full-time, attached, and patronized types of specialization and found that each type correlates strongly with social and political complexity.[17] Attached specialization is defined as specialization under the control of a person in the ruling political authority that involves the production of prestige items for use in exchanges or political statements.[18] In Greece, the rise in socioeconomic complexity during the Early Helladic may have catalyzed the development of attached specialization in some crafts, though this does not also hold true for independent specialization.

The importance for elites of controlling prestige goods is thought to be derived from the use of the goods for communication and from their rarity. Flintknapping at Lerna was a means of producing large numbers of standardized, utilitarian tools, and therefore does not fit the usual description of attached specialization. Though elites may try to control the distribution of surplus as a way to gain power, they are rarely involved in controlling specialized subsistence tools for political purposes.[19] Excavated sites show no large-scale storage for redistribution of subsistence goods,[20] and it was more likely that elites controlled the production of rare marble figurines or metal tools than mass-produced stone blades, if they controlled the production of any goods at all. Such a system of elite control over only prestige goods (and not over obsidian production) has been suggested for MH and LH Messenia.[21]

Independent specialization, although previously thought to occur only in complex societies, has been found to occur in all types of societies.[22] Researchers argue that independent, part-time specialization is present in nearly all of 53 societies sampled from the Human Relations Area Files (HRAF) database of world cultures, and does not correlate with any particular type of society or degree of social complexity.[23] Although independent craft specialization may not be a characteristic of complexity, its degree of intensity may increase over time if there is an increase in social complexity. For example, part-time specialization has already been suggested for pottery and lithics in the Greek Neolithic,[24] and specialization in these crafts probably continued in some form into the Bronze Age, as is the case for the lithic industry generally in the Near East.[25] Attached specialization of prestige goods may have begun with the increasing social complexity seen in the EBA, but independent specialization in flint-

14. Karimali 1994, pp. 381–382; Vitelli 1993, p. 248; Perlès 1990, p. 35.
15. Tripathi 1988, pp. 68–69; Vaughn, Myer, and Betancourt 1995, p. 702; Attas, Fossey, and Yaffe 1987.
16. Torrence 1986a; Clark and Parry 1990, p. 321.
17. Clark and Parry 1990, p. 321.
18. Earle 1981, p. 230.
19. Brumfiel and Earle 1987, p. 6.
20. Pullen 1985, pp. 375–377.
21. Parkinson 1999.
22. Cross 1993; Clark and Parry 1990.
23. Clark and Parry 1990, p. 320.
24. Perlès 1992, p. 135; Vitelli 1993, p. 248.
25. Rosen 1989, p. 112.

knapping continued in this period using the same techniques as in the Neolithic. Independent lithic production may nevertheless have involved a greater intensity of production with the beginning of the Bronze Age, as trade and regional demand for blades grew, which in turn required increased skill and efficiency in blade manufacture.

Previous scholarship has pointed to some kind of control over obsidian blade production in the Bronze Age, which we believe is better described as independent or managed production. Control of attached production and the finished blades has been inferred previously from the sealings found in corridor houses and the unequal distribution of blades around the Peloponnese.[26] The sealings found at the House of the Tiles are evidence of record-keeping of the movement of goods, although we do not know if obsidian blades were included in these records. Analysis of the distribution of lithics at Lerna shows that blades were distributed across the site and not concentrated in the corridor house, which seems to indicate that they were not stockpiled in this building.

The use of the term "managed specialization" in the discussion of independent production is appropriate in describing blade production at Lerna. This term has been coined to describe this type of production because the literature on craft specialization does not include a term that adequately describes independent production of the sort we see at Lerna.[27] In managed specialization, production and the distribution of goods are facilitated on behalf of the specialists by managers but are otherwise independent of elite control. The distribution of blades from centralized production sites along with the skill used to produce precision-knapped pressure blades would suggest that labor was organized to some extent, but not necessarily overseen by the elite.

Lithic production in the Early Bronze Age has been characterized by most writers as a part-time occupation, as has been suggested for both Lerna and Agios Stephanos.[28] The authors of the report on lithics from the southern Argolid survey proposed the existence of part-time attached specialists based on their finding of a concentration of blade cores at Fournoi Focus, a large Early Bronze Age center (hereafter referred to as Fournoi), while cores were rarely found on smaller sites in the region.[29] The detection of the intensity of specialization is difficult archaeologically because part-time and full-time workers may differ only in the amount of debris produced at varying scales of production. If lithic debris is discarded offsite, it may be difficult to tell whether the debris left in a household results from part-time or full-time specialization, as it will be almost impossible to trace the exact household origin of an offsite debris deposit. Full-time specialists are often associated with urban societies in which elites commissioned craft production and provided food through redistribution systems, and textual evidence may sometimes be the only evidence for such specialists. Lerna is not an urban site and no texts are available to determine the presence of full-time specialists. It is our working hypothesis that the production of lithics from the Neolithic to the end of the Middle Bronze Age at Lerna was the work of part-time, independent specialists.

26. Jameson, Runnels, and van Andel 1994, p. 363; Kardulias and Runnels 1995, p. 97.
27. E.g., Costin 1991; Clark 1995.
28. Runnels 1985, pp. 366–367; Kardulias 1992, p. 441.
29. Kardulias and Runnels 1995, pp. 96–97.

DETECTING SPECIALIZATION

Standardization, Efficiency, and Skill

Standardization is a key variable for identifying craft specialization, though it may characterize several different activities. Products may be made with standardized dimensions for the sake of efficiency or because one individual is producing a more consistent product than other individuals.[30] Consumer demand and functional needs (e.g., a standard or durable shape) may also dictate the dimensions of a particular tool.[31] Given the variability that persists despite efforts to standardize craft products, the degree of standardization is still the best measure of independent specialization, particularly when relative differences in standardization among regional or temporal units are being measured.[32] The present study includes a comparison of standardization in blade dimensions from Neolithic and Bronze Age Lerna. This comparison enables us to identify EH II as a period when relatively more specialized production coincided with increased social complexity in Lerna III.

TABLE 3. COEFFICIENTS OF VARIATION OF DIMENSIONS OF BLADES AND BLADELETS BY PHASE

Lerna Phase	*Period*	*n*	*Width*	*Thickness*
II	Neolithic	202 blades*	27.0	36.4
III	EH II	81 blades	13.0	26.6
		199 bladelets	16.8	25.7
IV	EH III	76 blades	22.9	30.3
		261 bladelets	18.7	25.4
V	MH	90 bladelets**	16.3	26.2

* Data for the Neolithic sample are taken from Lerna II, which has the largest sample size of blades available from Neolithic levels: Kozlowski, Kaczanowska, and Pawlikowski 1996, p. 318. Bladelets were not separated out and are included in the 202 blades.
** The sample of blades from Lerna V was too small to allow calculation of a CV.

Blade and bladelet measurements were compiled in order to measure standardization of blade production at Lerna and used to calculate the standard deviation and coefficient of variation (CV) of their widths and thicknesses (see Table 3). The CV is a statistic derived from the standard deviation and the mean [(100 × standard deviation) / mean] that scales the former according to the mean and permits valid comparisons between samples. Only width and thickness are considered here because length is often altered by breakage and snapping. The sample used for the calculation of the CVs represents 50% of the Early and Middle Bronze Age lithics from dated contexts at Lerna and for which measurements were available. Since blades were not separated from bladelets in the published Neolithic data,[33] the data from Lerna II are for the combined categories. Blade width at Lerna in the Neolithic (CV of 27.0) displayed wide variation, and variation in blade thickness was also greater in the Neolithic with a CV value of 36.4, versus 30.3 at most for the Bronze Age. The lowest variation in width for blades (CV of 13.0), as well as the second-lowest spread in thickness of

30. Costin 1991, p. 3.
31. Odell et al. 1996, p. 385; Torrence 1986b, p. 197; Clark 1981, p. 8.
32. Costin 1991, pp. 34–35.
33. Kozlowski, Kaczanowska, and Pawlikowski 1996.

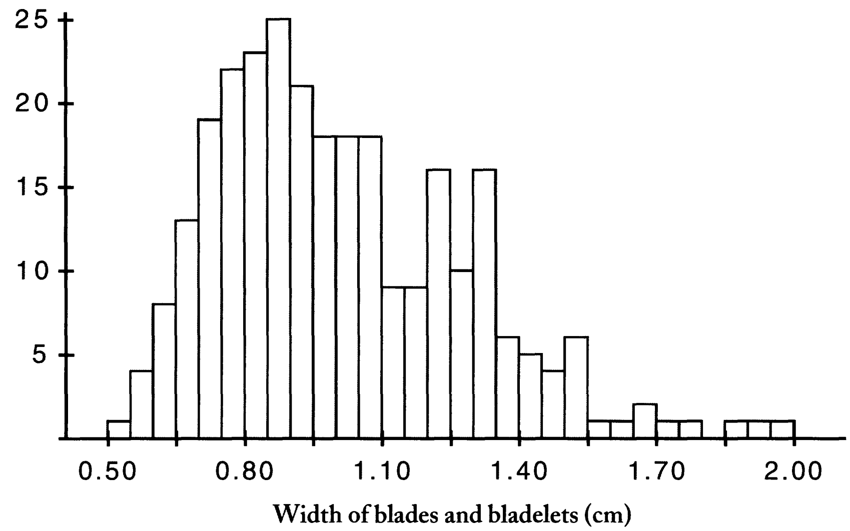


Figure 5. Histogram of blade and bladelet widths from Lerna III (EH II); n = 280. Histogram bars are each 0.05 cm wide.

bladelets (CV of 25.7), occurs in Lerna III (EH II). Similar data on blade dimensions have been published for the site of Agios Stephanos in Laconia, an EH site with a similar CV of blade thickness and even lower standardization in width.[34] The coefficients of variation for the blades suggest that the blades show more standardization as one moves from the Neolithic into the Bronze Age, particularly the earliest phases.

A bladelet is defined here as a blade with a width less than 1.15 cm, which is the approximate boundary between two modes of blade and bladelet widths evident in the graphed data (Fig. 5). The distribution of widths in this histogram does not approximate a normal distribution, as would be expected if there was only one type of blade. The coefficient of skewness for the width data is 0.786, a high value when zero in a range of 0 to 1 indicates a normal distribution. When blade and bladelet categories are separated and their dimensions analyzed separately, they exhibit lower standard deviations and CVs than when combined, an observation contributing to our conclusion that there was a real division between the two sizes of blades. The combined data for Lerna III exhibit higher CVs in width (28.3) and thickness, with separated data showing the low CV values of blade width as 13.0 and bladelet width as 16.8. The split between blades and bladelets is clearly standardized and supports the hypothesis that there were two categories of blades.

Efficiency is another useful indicator of craft specialization when considered together with standardization and skill. It is assumed that efficiency improves in specialist manufacture because specialists spend many hours at their work and may make increasingly effective use of tools, techniques, and raw materials. Costin cites efficiency as useful for detecting independent specialization "where goods convey little social information."[35] Given the nature of utilitarian specialization at Lerna, efficiency is a particularly appropriate criterion for the analysis of sickle blades, one of the most important and largest categories of formal tools. Efficiency is clearly connected with standardization in blade dimensions as a means to

34. Kardulias 1992, p. 440.

35. Costin 1991, pp. 38–39; see also Pollock 1983.

conserve raw materials, and is also connected to a degree of skill, which permits efficient production and is necessary for striking regularly shaped blades.[36]

Evidence for efficiency in flintknapping at Lerna can be seen in the skilled preparation and use of blade cores, which were intensively worked and reduced with little waste. One certain indicator of efficiency is the presence of blade core trimming pieces such as crested blades (*lames à crête*). These pieces indicate efficient production and preparation of cores: the need for large amounts of flaking to create the ridges that guide blade removal was eliminated by first shaping a crested blade to guide the first blade removal.[37] The relative frequency of complete crested blades varies from the Neolithic to the Middle Bronze Age, with a peak in EH II. The highest frequency of these blades is in Lerna III (n=30), where they represent 1.30% of the total assemblage. By contrast, the smaller Neolithic sample (n=12) from several phases displays lower frequencies (0.96% and 0.89%).[38] Lerna IV continues the Lerna III pattern with a relatively high frequency (1.20%) of crested blades, though their presence declines to 0.76% in Lerna V (MH). Efficiency in core production therefore rises in the Early Helladic, precisely when there is evidence for relatively more skilled production.

Another measure of the efficient use of blade cores is the relative frequencies of blades with trapezoidal or triangular cross-sections. The initial removal of blades usually detaches blades with triangular cross-sections as the knapper makes use of one dorsal ridge to guide the blow that removes the blade. With further detachment of blades, trapezoidal sections occur as the core diameter is reduced and more blade scars are left on the ever-smaller surface of the core. A predominance of trapezoidal blades in an assemblage, therefore, indicates thorough use of cores, whereas triangular blades indicate a knapper not fully exploiting the core or preferring products from early stages of removal. A large percentage of trapezoidal blades indicates the knapper's skill, as well as efficiency, in controlling the core while removing precisely shaped blades.

Three-quarters of the blades and bladelets from EH–MH Lerna have trapezoidal sections, a larger percentage than in the Neolithic. If trapezoidal blades indicate efficiency and standardization, they might be expected to occur more frequently in the Early Helladic when crested blades are more common. Table 4 lists the frequency of trapezoidal blades for both the Neolithic and Bronze Age at Lerna and it is clear that the highest frequency of trapezoidal blades is indeed in the Early Helladic (Lerna III and IV). A chi-square test on the observed numbers of trapezoidal blades over time found the differences to be statistically significant (χ^2=16.18, α=.05). Overall, the pattern of intensive use of cores shown by percentages of crested and trapezoidal blades suggests that Lerna III was the phase during which raw material was most efficiently worked.

Fine pressure blades are difficult to produce in a standardized fashion, a fact confirmed by many modern experimental flintknappers. One way to measure acquired skill in standardized pressure-blade production is to examine cores for errors. Error rates can be estimated by noting the presence or absence of hinge fractures on cores, which would have interfered with the efficient removal of blades of standard dimensions. Flintknapping

36. Runnels 1985, p. 367; Clark 1987.

37. For a diagram of a crested blade, see Debénath and Dibble 1994, pp. 27–28.

38. Kozlowski, Kaczanowska, and Pawlikowski 1996, p. 361.

TABLE 4. FREQUENCIES AND RELATIVE PERCENTAGES OF TRAPEZOIDAL BLADES BY PHASE

Lerna Phase	*Trapezoidal Blades (%)*	*Total Blade Sample (n)**
Neolithic**		
I/II	60.0	63
II	66.5	173
II/IIc/IId	67.8	261
Bronze Age		
III	78.8	203
IV	78.6	126
V	72.2	133

* Sample includes trapezoidal and triangular blades.
** Neolithic data from Kozlowski, Kaczanowska, and Pawlikowski 1996, p. 361, table 21.

invariably produces hinge fractures when badly aimed blows destroy the ridges used to guide blade removal. A large number of hinges on cores indicates a high rate of error. In order to study error rates in production, all available Bronze Age cores from Lerna were examined for the presence or absence of hinges. Both flake and blade cores were included in order to increase the sample of cores available for this general measure of skill in lithic manufacture. Although the flake cores may have been handled less carefully than blade cores, we presume that the same knappers worked obsidian cores to remove both flakes and blades and that they attempted to flake all cores efficiently in order to preserve raw materials. Thus, the hinges on any cores are an indication of less-than-skillful knapping. Some flake cores are, in any case, made from reworked blade cores.

Many cores from the Early and Middle Helladic phases of Lerna exhibited some hinge fractures, from 73% in Lerna III, to 61% in Lerna IV, to a high of 81% in Lerna V. As hinges tend to develop even when flintknappers are both skilled and careful, a further refinement of this measure is required. Hinges may be termed "minimal" when the gradually curved termination is shallow and "severe" when the termination is abrupt, sharply curving, and lipped (Fig. 6). Since a severe hinge fracture is more likely to bring precise blade removal to a halt, these are significant errors worth counting, even if the classification of hinge fractures as minimal or severe is at best subjective. The hinges found on each core were accordingly identified as either minimal or severe, and the proportion of cores with severe hinges was found to increase over time. The Lerna III sample had the lowest frequency of severely hinged cores (50%), while Lerna IV had 53% and the succeeding Lerna V sample had 60% of its cores severely damaged by these errors. A lower error rate during Lerna III confirms the findings of greater flintknapping skill in this period.

We have already noted the use of the crested blade as an advanced method of shaping blade cores that required skill. The frequency of use of crested blades peaks slightly in Lerna III (EH II), though their appearance from the Neolithic through the Middle Helladic indicates that skilled blade production continued with basically similar technology. Thus, the

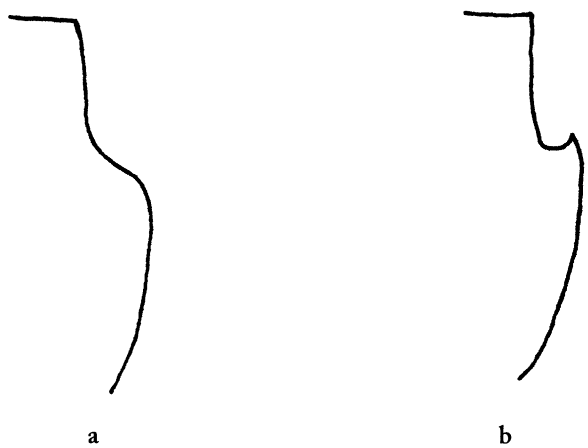


Figure 6. Schematic side view of two cores, with platforms at the top, showing (a) a minimal hinge fracture and (b) a severe hinge fracture

variation in the factors investigated (blade width CVs, trapezoidal blade sections, and errors resulting in hinge fractures) suggests that the level of efficiency and skill peaked in Lerna III while the continuous use of crested blades indicates that some skills continued without much change through the Middle Helladic.

A last indicator of the knapper's skill is the thickness of blades and bladelets, since regular practice and skill are necessary to produce very thin blades with little variation. Neolithic data were combined with measurements of Early and Middle Bronze Age lithics in order to investigate blade thickness, and the thicknesses of blades and bladelets were combined in order to calculate the means with a larger sample size for each phase.[39] The mean thickness is greatest during the Early Neolithic (0.31 cm in the early Lerna II sample) and then decreases slightly in the subsequent Lerna II (0.28 cm) and Lerna III (0.28 cm) samples. Lerna IV (EH III) has blades with the lowest mean thickness overall (0.26 cm), paralleling the highly standardized blade thickness CVs also found in that phase. Mean thickness increases again in Lerna V (MH) to a value of 0.31 cm. This observation, in addition to the blade thickness CVs discussed above, suggests that blade production in Lerna IV involved manufacture of standardized, thin blades.

The measures of standardization, efficiency, and skill are relative measures best used in combination. Greater specialization in the Early Helladic period versus the Neolithic and Middle Helladic can be inferred from all three measures in a diachronic analysis that emphasizes relative specialization. Given the established baseline of part-time specialization in the Neolithic, it is probable that the indicators of greater skill and efficiency in the Early Helladic are a result of more organized, skillful, and efficient (though still part-time) specialization.

Intrasite Comparisons

Independent specialization is evident at Lerna from the even distribution of blades across domestic and administrative contexts, which points to a lack of elite control over resources. Study of possible administrative

39. Kozlowski, Kaczanowska, and Pawlikowski 1996, pp. 313, 318.

(corridor house) and domestic spatial contexts allows assessment of the spatial distribution of lithic production and administrative control over production. Access to the final architectural phasing has made possible intrasite comparisons of contexts, splitting lithic proveniences between the House of the Tiles and domestic houses in Lerna III and among individual domestic houses in Lerna IV. Throughout the Aegean, evidence of elite control over sources of copper, silver, lead, obsidian, and andesite appears to be lacking in the Early Bronze Age,[40] in contrast to the situation in the Late Bronze Age. Centralized control of resources is not suggested by intrasite studies; finished artifacts are usually uniformly distributed across sites and not concentrated in the corridor houses. Metals are found at small sites such as Zygouries,[41] and most studies of ceramic production indicate that ceramics were produced at almost all sites, with few controlling regional production centers.[42]

The data on independent production summarized below are from Lerna III (EH II), the period of the corridor houses, and Lerna IV (EH III), which contains exclusively structures identified as small dwellings. Since little domestic architecture is preserved from Lerna III,[43] the assemblage from the House of the Tiles has been compared to the material collected from the rest of the site, which has been combined into one sample. The corridor house assemblage is similar to material found in the small domestic structures in the rest of the site, and the uniform distribution of blades and blade waste across the site suggests that blade production was neither centralized nor controlled by the administrative corridor house. Comparison of the assemblages from the small dwellings in Lerna IV (see below) illustrates the generally similar types of lithics among domestic contexts, and confirms that lithic production was distributed across the excavated area of the site in EH III.

Intrasite studies are difficult to interpret because both ethnographic and archaeological studies have indicated that sedentary peoples usually discard materials away from the places they are used, especially if the debris is sharp and dangerous underfoot.[44] Though both discard and cleaning may have affected the contents of the House of the Tiles and other houses at Lerna, a sufficiently large sample of the lithic material from the houses provides some indication of the production that took place within them. The sample from the House of the Tiles may also not be representative of its use as a dwelling if, as has been suggested in the past, it burned while it was still unfinished and under construction.[45]

The corridor houses at EH sites have long been regarded as storage or redistribution centers, given their central location, size, and, in the case of the House of the Tiles, the presence of clay sealings. By combining information from original notes, excavation notebooks, and lot lists, we isolated the lithics found in the corridor house at Lerna. The House of the Tiles yielded a sample of 141 pieces of flaked stone, which constitutes 6% of the total sample from Lerna III. The relative frequencies of lithic types found in the corridor house are listed in Table 5 along with those from other Lerna III structures. As noted above, the similar percentages of types between the House of the Tiles and the combined sample of Lerna III domestic contexts suggest that blades were not concentrated or stored in

40. Pullen 1985, p. 374; Torrence 1986b; Runnels 1988, p. 269.
41. Pullen 1985, p. 374.
42. Pullen 1985, p. 377.
43. Caskey 1960, p. 293.
44. Murray 1980; Santley and Kneebone 1993.
45. Caskey 1960, p. 293.

TABLE 5. RELATIVE FREQUENCIES OF TECHNOLOGICAL TYPES FROM ADMINISTRATIVE AND DOMESTIC CONTEXTS IN LERNA III

	Technological Type (%)							
Context	*Cores*	*Cortical Flakes*	*Crested Blades*	*Flakes*	*Blades*	*Tools*	*Other*	*Total*
House of the Tiles	1	12	2	36	36	11	2	100
Domestic structures	1	10	1	40	38	9	1	100

Sample sizes: House of the Tiles (n=141); domestic structures (n=2,094).

the corridor house, which one might expect if blade specialization was attached to elite control. Instead, the assemblages from the domestic houses and the corridor house each comprised about 37% blades.

The differences in frequencies listed in Table 5 were tested by a chi-square analysis and found to be statistically insignificant. Technological type and spatial context were found to be independent of each other since the total chi-square value for the table was less than the value required to show statistical significance (χ^2=5.16, α=.05). Any slight differences in relative frequency apparent in Table 5 are therefore statistically insignificant, and we conclude that the corridor house assemblage does not differ substantively from the Lerna III combined sample.

Comparison of the proportions of lithic technological types from different structures allows us to identify the spatial distribution of flintknapping activity across the site. The hypothesis of production controlled by the inhabitants of the House of the Tiles would be supported only if production debris was concentrated in that building. Flintknapping debitage found in other domestic contexts would point to decentralized and independent production. To determine the spatial distribution, lithic findspots were gathered from Banks's manuscript on the Lerna IV settlement (*Lerna* V). Only houses yielding a sample of at least 20 flaked stone artifacts have been included, the number necessary to calculate a chi-square test but one that severely limits the number of houses available for analysis.

Although few statistically significant differences among the assemblages emerged from this analysis, it was clear that almost all houses contained lithic debitage. Observed and expected values for three basic lithic technological categories were compiled for houses from each of the three subphases. Examination of architectural subphase 1 of Lerna IV included three houses with respective samples of 50, 61, and 28 pieces of flaked stone. In this subphase, the lithics are not distributed evenly between the houses in the categories of debitage (cortical flakes, crested blades, and cores), flakes, and blades/bladelets. The lack of production debitage from one house, called "house C" here, is statistically significant (χ^2=14.5, α=.05). No other lithic categories have counts that significantly deviate from the expected. The lack of production debris in house C thus indicates that retouched stone tools were not produced in this house, though flakes and blades were found there.

The next architectural phase, subphase 2 of Lerna IV, also exhibits some general statistically significant differences between houses, although no house appears to have specialized in the production of a particular type. Examination of this subphase included three houses, with samples of 30, 32, and 57 pieces of flaked stone, and again used lithic types grouped into three general categories. The chi-square value for all of the expected values of these categories exceeded the critical value (χ^2=11.6, α=.05), indicating that the distribution of types of lithics was not independent of the three different house contexts. Though the houses in subphase 2 differ slightly in their proportions of types of flaked stone, all three houses possess some production debris even when the small size of samples is taken into consideration. The widespread distribution of debitage, therefore, suggests that lithic production was not strictly confined to a few houses occupied by specialists.

Lithics from the houses of subphase 3 of Lerna IV also show a slight deviation from expected values sufficient to suggest that the technological types were not distributed independently of house context. The chi-square value for all of the expected values exceeded the critical chi-square value (χ^2=12.6, α=.05), showing that there were statistical variations between houses. All three houses contained debitage, however, and no specific lithic type was confined to any particular house. Overall, the presence of debitage in eleven of the twelve houses examined is evidence for widespread production across the site. The fact that lithic manufacture apparently took place in most of the houses examined supports the hypothesis of independent production.

Another means of determining the spatial distribution of specialization in lithic production in Lerna IV is the analysis of the intrasite distribution of blade production debris. If blade production was controlled by an elite, manufacture might be expected to be restricted to only a few specialists, whose production was then carefully monitored. If, on the contrary, all households produced blades, an elite would have found it difficult to regulate such widespread production. The presence of blade production debris was examined among the houses of Lerna IV in order to determine the locations of blade manufacture; blade cores were separated from flake cores for this analysis. The distribution of blade cores in the Lerna IV houses suggests that many houses participated in blade production in this phase of the settlement. Fifty-five blade and bladelet cores were identified from this phase. Of these cores, eighteen are securely associated with a particular household. These cores are from fifteen different contexts and only three of the cores are from the same house or bothros as another core, which shows that blade production debris was spatially widespread. The fifteen contexts are dispersed between ten different buildings, suggesting that many primary contexts in buildings are associated with blade production. Although this distribution cannot prove the existence of independent production, it is consistent with the hypothesis of several independent part-time specialists operating rather than a few full-time specialists controlled by a central overseer.

Elite redistribution and control over subsistence products have been proposed for Lerna based on the interpretation of the sealings found in the corridor house. Wiencke suggested that the sealings belonged to an archive in the House of the Tiles,[46] and Renfrew argued that the individual seal designs indicate individual ownership. In Renfrew's view the sealings were used by an elite to control redistribution, perhaps of food.[47] Despite the appeal of this hypothesis, several features of the sealings and their distribution suggest that they may not have been used for recording redistribution. If the sealings were indeed used by an elite to record inventories, it would be logical to find them only in corridor-house contexts. Sealings are also found, however, in nonadministrative buildings at Lerna.[48] Moreover, if sealings were used to designate the contents of storage containers containing agricultural staples, one would expect to find only a small number of designs among the sealings instead of the seventy designs that have been identified. The large number of seal designs can perhaps be explained by assuming that many products were recorded, or that many individual farmers produced goods for redistribution. However the sealings were used, the large number of owners, products, or producers implied by the multiple seal designs does not fit a model of specialization in a few goods. A further weakness of the redistribution model is the lack of storage facilities or large pithoi in the corridor houses, which would be needed to stockpile goods for redistribution, although pithoi are commonly found in small domestic structures.[49]

Independent specialization in blade production at Lerna, therefore, is supported by the uniform distribution of blades across the site during Lerna III and the widespread production of blades in domestic contexts in Lerna IV. The frequencies of blades in the assemblages of the corridor house and the rest of the Lerna III structures show no statistically significant differences, which indicates that blades were not concentrated in the House of the Tiles. The comparison of domestic contexts in Lerna IV detected no specialties in production for the houses, and only one house lacking lithic production debris. The number of blade cores per house demonstrates that blade production took place in at least ten different houses. If attached production was practiced at Lerna, blades would probably have been concentrated in the corridor house, where a few carefully controlled specialists produced them. The deviation from the expected pattern for attached production when viewed together with the utilitarian, mass-produced character of the blades suggests that independent production is the most likely type of craft specialization practiced at Lerna.

Centralized Blade Production within the Region

Having established that independent blade production occurred at Lerna, in this section we suggest that Lerna may have been a regional flintknapping center. Blade production was perhaps concentrated at Lerna where there is evidence of large-scale production, with the blades then distributed to other settlements in the region. If Lerna was a regional center for blade production, one would expect blade production debris, especially cores, to be found chiefly at Lerna and not at smaller outlying sites in the immediate region. This is indeed the pattern detected for the EBA in the southern Argolid. An intensive survey project there reconstructed a hierarchy of

46. Heath 1958; Wiencke 1969.
47. Renfrew 1972, pp. 387–388.
48. Wiencke 1969, pp. 502–503, 508–509.
49. Pullen 1985, p. 285; Wiencke 1989.

TABLE 6. RELATIVE FREQUENCIES OF RAW MATERIALS AT FOUR EH PRODUCTION CENTERS

	Ag. Stephanos		*Lerna III*		*Lithares*		*Manika*		
Raw Material	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*Total*
Obsidian	1,068	91.0	2,176	94.1	970	94.2	1,020	96.3	5,234
Chert	105	9.0	136	5.9	60	5.8	39	3.7	340
Total	1,173		2,312		1,030		1,059		5,574

settlements in the Early Helladic period, with a clear concentration of cores, crested blades, and other production debitage at one locality (Fournoi). Smaller, outlying sites contained only finished blades, which were presumably manufactured at Fournoi and then distributed down-the-line to villages, hamlets, and individual farmsteads.[50] The manufacture of blades at Fournoi was apparently a site specialty, since other regional centers (A6, C11, and A33) did not have similar blade production debitage.[51] Blade production concentrated at Fournoi resembles the obsidian blade industry at Lerna, and both sites were perhaps regional centers where the production of blades was a site specialty. In our view, Lerna may have been similar to other sites with specialized blade production in the Early Helladic period, such as Lithares (Boeotia), Manika (Euboea), and Agios Stephanos (Laconia). Preliminary reports on the lithic industries from Lithares and Manika point to specialized production, and refer to Manika as a regional production center with a possible workshop,[52] while Lithares has several rooms with relatively high concentrations of obsidian suggestive of the same function.[53] An unpublished dissertation containing more detailed information from these two sites and the publication of the lithics from Agios Stephanos have both permitted comparison with the results of our analysis of core reduction and blade production at Lerna.[54]

The role of obsidian and chert in the flaked stone industries from Agios Stephanos, Lerna, Lithares, and Manika is shown in Table 6. The majority of pieces at each site were of obsidian. Beyond this general similarity in raw materials, the sites were examined for differences in blade production, decortication, and flake production. A chi-square test was performed to evaluate the significance of variation between assemblages, and evenness was measured to determine the range of types of debitage that characterized the different assemblages. Using the data presented in Table 7, a chi-square test was performed to determine if the technological types represented in obsidian at the sites were present in the proportions expected for sites of their sample size. A chi-square analysis of the data resulted in a chi-square value that exceeded the critical value (χ^2=1099.98, α=.05), showing that significant differences existed. Therefore, the categories of technological types and sites are dependent on one another, and the null hypothesis of an independent association between these two variables is rejected. The relative frequencies listed show the basic differences between the industries of the sites.

50. Kardulias 1992; Kardulias and Runnels 1995.
51. Jameson, Runnels, and van Andel 1994, pp. 353–358.
52. Sampson 1985, pp. 75–78.
53. Tzavella-Evjen 1985, p. 20.
54. Karabatsoli 1997; Kardulias 1992.

TABLE 7. OBSERVED AND EXPECTED FREQUENCIES OF OBSIDIAN TECHNOLOGICAL TYPES AT FOUR EH SITES

Technological Type	*Ag. Stephanos*		*Lerna III*		*Lithares*		*Manika*	
	n	*exp.*	*n*	*exp.*	*n*	*exp.*	*n*	*exp.*
Blades	534	412.59	913	840.63	303	374.73	272	394.05
Cores	13	27.55	22	56.13	53	25.02	47	26.31
Debris	117	67.13	118	136.78	52	60.97	42	64.12
Crested blades	31	79.99	25	162.97	185	72.65	151	76.39
Flakes	264	286.89	866	584.53	99	260.57	177	274.00
Cortical flakes	109	193.85	232	394.96	278	176.06	331	185.14
Total	1,068		2,176		970		1,020	

Underlined values represent a significant departure from expected values.

Several counts of technological types stand out from the rest and indicate possible trends in production (these values are underlined in Table 7). Blade production is indicated by the presence of crested blades, and Lithares and Manika show more evidence of blade production than Agios Stephanos and Lerna. If the blades produced were retained on the site, a significant percentage of blades and crested blades would be expected to be found there. Although the number of blades is higher than expected in the Agios Stephanos assemblage and low at Manika, Manika has ample evidence of blade production in the form of crested blades. Manika may have exported its finished blades, with the result that it has significantly fewer blades than expected, unlike the other sites. Primary reduction of obsidian is also attested by a statistically significant number of cortical flakes left over from the knapping of raw nodules. The discovery of a greater number of cortical flakes than expected at Lithares and Manika therefore suggests that primary knapping of raw nodules took place at these sites more often than at the others.

In contrast to the other sites, Lerna shows a focus on both blade and flake industries. Blade production at the site is indicated by the blade cores discussed above, though the sample does not have a particularly large number of crested blades compared to the other sites examined. Its abundance of flakes, relative to the number expected, indicates that flake production was important on the site, pointing to on-site core reduction and the manufacture of flake tools. Lithares, on the other hand, has a significantly greater number of crested blades and cores than expected, indicating that it was probably heavily involved in blade production, which is supported by the low frequency of flakes in the sample.

The evenness statistic is useful for quantifying the diversity in the industries of these sites and confirming the results of the chi-square tests. A measure of evenness can distinguish diverse lithic industries with many products from those specialized industries with only one or a few types of products by quantifying the range of the debris.[55] A high evenness value is indicative of an equal distribution of debris across technological categories, while low evenness shows that a majority of the lithic debris is from

55. Bobrowsky and Ball 1989.

TABLE 8. RELATIVE FREQUENCIES OF CHERT TECHNOLOGICAL TYPES AT FOUR EH SITES

Technological Type	*Ag. Stephanos* *n*	*%*	*Lerna III* *n*	*%*	*Lithares* *n*	*%*	*Manika* *n*	*%*	*Total*
Blades	23	21.9	35	25.7	20	33.3	12	30.8	90
Cores	2	1.9	2	1.5	6	10.0	6	15.4	16
Debris	18	17.1	24	17.7	6	10.0	2	5.1	50
Crested blades	—	—	—	—	2	3.3	5	12.8	7
Flakes	53	50.5	72	52.9	7	11.7	13	33.3	145
Cortical flakes	9	8.6	3	2.2	19	31.7	1	2.6	32
Total	105		136		60		39		340

only one or two types of production. Calculations of evenness for the four Early Helladic sites confirm the blade-based or flake-based nature of the obsidian industries that were indicated by the chi-square analysis. Manika and Lithares (with evenness values of 0.88 and 0.89) have a relatively equal distribution of categories, while Agios Stephanos is in the middle range with a value of 0.74. Lerna has the lowest value of evenness of the four sites (0.67), even though it has the largest sample. Lerna's low evenness value shows that, relative to the other sites, only a few of its technological types make up the bulk of its industry. The measurement of evenness for the four sites examined shows that Lerna had the most specialized obsidian production, while counts of the technological types represented suggests that an equal emphasis was placed on flake and blade technologies.

Due to the small size of the sample available, chi-square and evenness tests could not be calculated for the chert industries. Relative frequencies of chert cores, crested blades, and flakes differ substantially between sites and permit the identification of a site that may have specialized in producing chert blades (Table 8). Relative frequencies of blades range from 22% to 33% of the chert industry at the four sites and indicate that all of the sites used chert blades, whether locally made or imported. The production debris also shows pronounced differences among the sites. Manika ranks highest in both cores and crested blades, suggesting that it may have produced relatively more chert blades than the other sites. Its percentage of crested blades (12%) is particularly striking compared to the maximum of 3% of this type at Lithares and the lack of these pieces at Agios Stephanos and Lerna III, especially considering the latter sites have larger assemblages. The small sample from Manika may be slightly skewed, but sample size is probably not the only explanation of the difference. The high frequency of cores in the Manika sample also indicates that flakes or blades were produced. Overall, Manika is the most likely site to have been a producer of chert blades for export.

Agios Stephanos and Lerna have chert assemblages derived from flake production only, which probably resulted from the production of formal and expedient tools. The lack of chert crested blades at these sites further supports the hypothesis that blade production did not take place there.

A few bladelets of chert may have been produced during Lerna III (one bladelet and one flake core came from this phase). The primary reduction of chert may have taken place at Lithares, to judge from the relatively high frequency (32%) of cortical flakes and the high frequency of cores in the sample. Overall, the relative frequencies of technological types at these four sites suggest that Manika was a center of chert blade production, perhaps for export to Lerna and other sites, and that the primary reduction of chert may have occurred at Lithares.[56]

The presence of specialized blade manufacture at regional centers such as Lerna, Lithares, and Manika may indicate that blades were exported to lower-order sites, as suggested for the southern Argolid. The pattern in the southern Argolid is far from clear-cut, however, since other large sites in the region with corridor houses (e.g., A6) yielded finished blades only and no debris to indicate that blades were produced there.[57] Although the three major sites (Lerna, Lithares, and Manika) considered in this study specialized in manufacturing blades and exporting them, it is not at all certain that all large sites did so. Major sites in the southern Argolid may have specialized in the production or exchange of another craft good, such as the andesite mortars found in the Argolid in the Early Helladic period.[58] The lack of regional survey data for the Lerna, Lithares, and Manika hinterlands makes it even more difficult to test these hypotheses. Until further analysis is possible, we suggest that obsidian and chert blades were produced and distributed in the Early Helladic and possibly Middle Helladic period from Lerna, Lithares, Manika, and Fournoi.

DISCUSSION

The nature of flaked stone production at Bronze Age Lerna and the social context of the organization of this production have been described above. The specialization of the blade industry over time and the evidence for lithic production debris across the site were examined and compared with the lithic industries from the broadly contemporary sites of Lithares, Manika, and Agios Stephanos. The presence of part-time craft specialization in production was confirmed by the high degree of standardization, efficiency, and knapping skill exhibited in the lithics. Standardization in blade production is supported by the low coefficients of variation in blade and bladelet width and thickness, and was found to be especially significant in Lerna III and IV. Such low variability in dimensions indicates consistency, skill, and time spent practicing core preparation and blade detachment.

Efficiency in production is shown also by the predominance of blades with trapezoidal sections, indicating that cores were used until exhausted. Skill is evident in the greater use of crested blades in the Early Helladic than in the Neolithic. Declining error rates from the Neolithic to the Bronze Age indicate increasing skill and efficiency, with the fewest errors in producing cores seen in Lerna III (EH II), evidently a period when production was held to high standards. These numerical measures suggest

56. The importation of chert blades into Lerna was also noted earlier in Runnels 1985, p. 360.

57. Jameson, Runnels, and van Andel 1994, p. 358.

58. Runnels 1988, pp. 270–271.

consistency and ability resulting from at least part-time specialization, which carried over from the Neolithic tradition but expanded beyond the earlier tradition in terms of skill and standardization.

Spatial analyses were employed to assess the issue of control of production. The variation in structures uncovered in Lerna III permits comparison of the House of the Tiles with other buildings of the same phase, while comparisons among domestic structures are possible during the succeeding Lerna IV period. The House of the Tiles in Lerna III does not vary significantly in its lithic assemblages from the frequencies of lithic types found in other structures, and this lack of a higher concentration of blades (i.e., caching) at the corridor house suggests that the building's occupants were not concerned with centralizing control of blade production or storage in that building.

Specialized production of obsidian and chert blades is attested in the Neolithic and Early Bronze Age, and standardization of blades and levels of skill and efficiency peaked in Lerna III (EH II). It is generally acknowledged that some political nucleation and regional centralization occurred at this time, indicated by newly fortified "central places" with monumental buildings.[59] Specialized blade production at Lerna may be a result of the site becoming a regional center with increasing social complexity. The concurrent rise in population may have stimulated centralized production to meet greater demand for basic tools. Skilled blade production at Lerna may have served partially to provide blades to surrounding villages, along the lines of a regional hierarchy characterized by the distribution of goods outward from central sites seen in the EBA in the southern Argolid, where possible specialized production sites for chert or obsidian blades were observed.

Unlike the manufacture of prestige goods, which may have also involved specialization at specific sites, the production of flaked stone represents a utilitarian industry that probably remained independent and uncontrolled because it did not convey social information. Even part-time specialists who made blades at sites where specialized production was routine were most likely independent of the local elite. Flaked stone objects rarely vary in style in a way useful for conveying social information. Utilitarian production of blades, especially for sickles, one of the most important agricultural implements at this time, was also probably independent of the ruling chief because essential goods and equipment such as pottery and stone tools are often produced by independent specialists for nonelite demand.[60] For these reasons, the Lerna chieftain(s) probably saw no need to regulate strictly the production of sickle blades and other simple tools.

Specialization in blade production at Lerna may have been greatest in Lerna III because of the economic efficiency that results from centralized production, rather than its utility for a political power. Though it has been suggested that social complexity is often correlated with specialization,[61] the relationship between these two variables depends on the crafts in question. Specialization, for instance, in the production of pottery and lithics is evident in the Neolithic, but, unlike lithics, the significance of ceramics for

59. Wiencke 1989.
60. Gero 1983, p. 41.
61. Brumfiel and Earle 1987.

communication purposes increased sharply in the Early Helladic as social complexity and status differentiation increased.[62] Metallurgists differed from potters and flintknappers in using rare and costly raw materials, and sponsorship by political authorities was probably necessary to defray the heavy costs in mining, transport, and fuel incurred by this craft. The differences in the costs of production and importance of the final products for the crafts of metallurgy and flintknapping may account for the different levels of control and specialization seen in the Bronze Age. Greater socioeconomic complexity, in addition to the specific demand for sickles and other agricultural tools, probably stimulated independent lithic production, although emerging political aspects of the complexity generally had little influence on this type of craft production.

CONCLUSION

After many years of research and analysis, what has the study of the Bronze Age lithic industries from Lerna contributed to our understanding of the site, the period in general, and lithics in particular? If we stand back and regard the cultural sequence of Lerna from the earliest Neolithic to the latest phase of the Bronze Age, the overwhelming impression is one of continuity. The Neolithic traditions of blade production and use of Melian obsidian persist from the Neolithic through the Bronze Age without significant change, which shows the persistence of a technological tradition and implies in its turn an essential cultural continuity.

A similar pattern of continuity is evident in the typological sphere, where we see the ongoing production of retouched tools such as sickle elements, arrowheads (both tanged and hollow-based types), end scrapers, pointed tools (*perçoirs, becs*), and scaled pieces (*pièces esquillées*). The profile of this tool kit matches, in our view, the needs of village farmers for agricultural tools, woodworking implements, and weapons for hunting and warfare.

It was long an axiom of archaeology that flintknapping and stone-tool use gradually faded away when bronze tools and edged weapons were added to the material culture of the Aegean world after the end of the Neolithic,[63] but the nearly 12,000 lithics from Bronze Age Lerna demonstrate clearly the continuing importance of stone tools in this period. Even the rather limited degree of craft specialization in EH–MH Lerna, which appears to have been part-time in nature and relatively unregulated by the central authorities, is evidence for the ongoing economic and technological value of lithic artifacts in Bronze Age society. On a practical level, the small but discernible shifts in the frequency of retouched tool types, as well as changes in their forms, are useful for seriation and the dating of surface sites encountered in survey work.[64] Stone tools are not as sensitive chronological indicators as potsherds, but they are nevertheless useful, especially in circumstances where other evidence is lacking.[65]

One of the most striking aspects of the lithics from Lerna is the use of imported raw materials during both the Neolithic and Bronze Age. In the

62. Attas, Fossey, and Yaffe 1987.
63. Runnels 1982.
64. See examples in Karabatsoli 1997; Kardulias 1992; and Kardulias and Runnels 1995.
65. E.g., Tartaron, Runnels, and Karimali 1999.

Neolithic, chalcedony blades for sickle elements and reaping knives were imported as finished blades from an unknown source, perhaps Bulgaria.[66] This fact implies highly organized and sustained long-distance trade. Equally interesting is the high percentage of imported Melian obsidian, typically accounting for more than 90% of the artifacts. These patterns continue in the Bronze Age settlements, especially in the Early Helladic phases. Sickle elements were still made from chert pressure blades imported in finished form from an unidentified source, and the Melian obsidian that dominates the Bronze Age assemblages is testimony for the steady, uninterrupted, and secure flow of that material from Melos to the mainland in the EBA, a practice carrying profound implications for our understanding of the political stability that permitted such untroubled commerce. The precise details of the economic and social organization of these different patterns of raw material acquisition will no doubt continue to stimulate research.

The Bronze Age lithic industries at Lerna reflect the essential continuity of the age, and if there is any evidence for change or an interruption in the cultural sequence it is seen only in the transition from Lerna IV (EH III) to Lerna V (MH), and these changes are relatively minor. A decline in the skill of blade production has already been discussed, but the most notable change is seen in the supply of obsidian, which declines in the Middle Helladic (as does the importation of chert blades). The use of local chert increases during Lerna V. The basic technology of flintknapping and retouched tool manufacture, however, shows few changes. Chert flakes are now used to replace blades, and heavily retouched sickle elements with geometric outlines steadily replace types that are made on pressure blades. Hollow-based projectile points replace tanged and barbed forms. The apparent break in the age-old flow of Melian obsidian and the interruption of chert trade networks are the most noticeable of the changes, and they are difficult to explain. The steady rise in the availability of bronze implements may be part of the explanation, but other factors such as the possible role of Minoan control of the Aegean sea lanes may have been in play.[67] Too little is known of the specifics of Bronze Age obsidian trade or the production of lithics at other sites to draw firm conclusions.

When viewed within the context of the Bronze Age Aegean world, stone tools appear to be relatively insignificant, and it is undeniable that they have received little attention from Aegean prehistorians. We hope that the study and publication of the lithics from Lerna may serve to encourage other Aegean prehistorians to make greater use of lithic evidence. The contribution to our understanding of the social and economic structure of the Bronze Age settlements may be modest, but it is clear that lithics are vestiges of past cultural systems and provide valuable evidence for the interpretation of the past. If the study of the lithic artifacts from Lerna stimulates the collection of larger and better samples from other Bronze Age sites, especially those with contexts that permit the detailed analysis of the spatial distribution of these artifacts with relation to other classes of artifacts and architectural features, the goal of this project as it was conceived in 1979 will have been achieved.

66. Kozlowski, Kaczanowska, and Pawlikowski 1996.

67. E.g., Runnels 1982.

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