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HUNTER-GATHERER SPECIALISED SUBSISTENCE STRATEGIES IN GREECE DURING THE UPPER PALAEOLITHIC FROM THE PERSPECTIVE OF LITHIC TECHNOLOGY

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ABSTRACT

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Human occupation of Europe during the late Upper Palaeolithic was facilitated by the adoption of a range of subsistence strategies, honed depending on the extent to which each region was affected by the severity of the last glaciation. One of the ways in which Upper Palaeolithic populations chose to cope with deteriorating conditions and ecological hardship was to intensify their subsistence strategies. This involved the exploitation of new resources and novel locations including inhospitable regions which although visited during earlier periods, were apparently not systematically exploited. This is generally referred to as specialisation, and is considered an important part of both the Upper Palaeolithic as well as modern human behaviour.

The question that this research sets out to investigate is whether these changes in subsistence behaviour were accompanied by similar shifts in technology. In the past, this question has been addressed by focusing on single artefact types. Contrary to this, this research takes a holistic approach to the question of technological specialisation, by considering all aspects of lithic technology, from raw material collection to artefact manufacture. The study is based on three broadly contemporary Upper Palaeolithic sites in Greece, Klithi rockshelter, and Franchthi and Kastritsa caves. By comparing lithic characteristics identified at each of the three sites against a series of theoretical expectations, conclusions are drawn as to the presence of specialised technology, and the validity of the specialised versus generalised site dichotomy in Greece.

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Chapter 1. Introduction

1.1. Aim of the thesis

The aim of this thesis is to explore the connection between specialised subsistence and specialised lithic technology during the late Upper Palaeolithic in Greece. The thesis addresses the question is there any evidence to suggest that at sites where a single animal species was being targeted, lithic production was different to that at sites where a wide range of animals were being hunted?

1.2. Palaeolithic research in Greece, a brief history

Palaeolithic studies in Greece began somewhat later than in other parts of Europe. In the early 19th century Greece was trying to establish an identity for itself after liberation from Turkish rule, by promoting its Classic and Byzantine roots. This emphasis on the archaeology of these periods contrasted with what was going on in much of the rest of Europe, where interests were turning towards the remote past. One reason for this emphasis on the Classical past was and still is, Greece's continuing need to define itself within the Balkans. Moreover, the central role played by the Greeks in much of the rest of the worlds legal, philosophical and scientific development, provided an impetus and focus for the modern state to appropriate and capitalise on. Another perhaps more obvious reason is that the Greek economy was largely rural up until the 1960's, and therefore both the resources and intellectual infrastructure were not in place to undertake the study of what was considered a very ephemeral Palaeolithic past. As Bailey (1992:1-2) suggests, the fact that Palaeolithic sites were so few and far between compared to other parts of Europe, Asia or Africa led to little interest in the Greek Palaeolithic at either the national and international level. For these reasons it is fair to say that Greece found refuge in its classic past throughout the 19th and much of the 20th century, a policy that had and continues to have a large impact on the development of the discipline. However, it is gradually being understood that Greece has much to offer the study of the Palaeolithic. As part of the Balkan Peninsula, the region may have functioned as a second bridge between Europe and the Near East. On the other hand, its peripheral location has important implications for the occupation of what may be considered a marginal area. It also has a number of sites with overlapping chronologies, for instance Franchthi and Theopetra, which contain continuous sequences from the Palaeolithic to Neolithic, and which may provide useful insights as to the nature of these periods in this part of Europe (Panagopoulou 1996).

The development of Palaeolithic research in Greece owes much to the interest and work of foreign archaeologists which although sporadic, has since around the 1930's, led to our current understanding of the regions prehistory. The first of these pioneers was the Austrian, Adalbert

Markovits who worked in Greece from 1928 until 1940. His excavations at Zaimi Cave in central Greece confirmed his strongly contested belief that the region did indeed contain pre-Neolithic evidence for occupation. After the war, work in Greece was undertaken by the French ethnologist Jean Chavaillon and prehistorian Leroi-Gourhan who studied surface scatters in the Eleia region of the western Peloponnese during the early 1960's, along with the German prehistorian Vladimir Milolojcic who worked on Palaeolithic surface scatters in Thessaly in central Greece (Philippaki-Kourtessi 1996). The British prehistorian Eric Higgs undertook extensive Palaeolithic survey in the Macedonian region of northern Greece during the early 1960's, however very little was found. Consequently he shifted attention to the region of Epirus in north-western Greece. Here he was more successful, finding sites including Kastritsa, Kokkinopilos and Asprochaliko, which were subsequently excavated up until 1967. Further south, the American archaeologists Thomas Jacobsen and Michael Jameson undertook research in the Argolid, culminating in excavations at the site of Franchthi cave between 1967 and 1979. More recently, the British archaeologist, Geoff Bailey who had originally worked with Higgs at Kastritsa, undertook further survey in Epirus, leading to the discovery of the site of Klithi rockshelter, and which was excavated between 1983 and 1989 (Bailey 1997a).

This is not to minimise the achievements of Greek archaeologists in documenting the Palaeolithic of the region. Sotiris Dakaris and Dimitris Theocharis played an important part in facilitating research as well as conducting surveys. Theocharis together with Miljocic undertook survey in Thessaly in central Greece during the 1960's, which led to the discovery of a number of open-air Palaeolithic sites along the Pineios river. In the late 1980's, Runnels re-examined the sites identified in the survey and found that some could be dated to the Lower Palaeolithic, a period until then largely undocumented in Greece. Sotiris Dakaris and Augustus Sordinas are another two archaeologists who contributed to the development of Palaeolithic research in Greece during the 1960's. Dakaris collaborated with Higgs in the survey of Epirus and Macedonia, while Sordinas undertook research on the Ionian Islands. For the next two decades, only sporadic Palaeolithic research was conducted by the Greek Archaeological Service and if so, as part of other research projects. However, the situation changed in the 1990's, with a significant increase in research by Greeks, as well as in collaboration with foreign archaeologists. Sites such as Boila in northern Greece, Theopetra in the central part of the country, and Klisoura and Kalamakia in southern Greece were excavated. In addition, a number of Palaeolithic surveys were organised. Although Palaeolithic research in Greece has a relatively recent history and has a long way to go, its contribution has been significant. Greece is no longer the blank page on the Palaeolithic map of Europe, as it was before the early pioneering work of Dakaris and Higgs (1964) in Epirus in particular.

1.3. From fieldwork to the development of a behavioural hunter-gatherer model

As discussed above, the first systematic excavations in Epirus were undertaken by Higgs of Cambridge University, and in southern Greece by Jacobsen and Jameson of the Universities of Indiana and Pennsylvania respectively. At this early stage however, the research aims were simply to document the presence or absence of the Palaeolithic (Dakaris *et al.* 1964:199). In Epirus, Higgs excavated three sites, Asprochaliko rockshelter, Kastritsa cave and the open site of Kokkinopilos. Asprochaliko and Kokkinopilos spanned the Middle to Upper Palaeolithic, while Kastritsa contained evidence for occupation during the late Upper Palaeolithic. The only handaxe found at Kokkinopilos indicates an Acheulian presence, although little more can be said on the basis of a single artefact. Asprochaliko and Kastritsa were used by Higgs to formulate his Palaeolithic transhumance model, which was strongly influenced by pastoral farmers, the Sarakatsani, who had practiced a mobile shepherding way of life up until around the 1950's. Higgs suggested that the two sites were used by people who followed not sheep and goats, but herds of red deer during their seasonal migrations between the coastal lowlands around the site of Asprochaliko in the winter, and the interior uplands where Kastritsa is located during the summer (Higgs *et al.* 1967; Bailey 1992:12). This model was tested in the early 1980's by excavation at the late Upper Palaeolithic site of Klithi, also located in the uplands of Epirus. The results of this excavation suggested that subsistence strategies in the region were in fact much more complex than envisaged by Higgs. Human occupation of the mountains, uplands and coastal plains at various times of the year indicated that people were not simply migrating between areas occupied alternatively during winter and summer, but that they were exploiting a variety of environmental niches when and where available. Moreover, Klithi was dominated by the evidence for the exclusive hunting of ibex and chamois (Bailey 1997c), a pattern which on the face of it appeared very similar to other Mediterranean so called specialised ibex hunting sites located in Italy and Spain (Straus 1987a,b). Although Klithi shed light on a degree of complexity in subsistence strategies much greater than previously envisaged, it also generated new questions, for instance what was the role of technology within these systems? In particular, at sites which appear to be specialised in terms of subsistence, as reflected by a low diversity in animal species hunted as well as often being located in novel and difficult environments, is there any evidence to suggest that specialised technologies were being used?

1.4. Technological specialisation

This relationship between subsistence specialisation and technological specialisation is the central topic of this research. The concept of specialisation in technology has deep roots in archaeology that can be traced back to the 1930's when craft specialisation was seen as one of the principal features of ranked societies (Childe 1936). Over the years, the concept of specialisation has been released from its purely economic connotations by attempts to apply it to hunter-gatherers. Within this context, it has been argued that the first obvious signs of technological specialisation are seen in the Upper Palaeolithic, a period in which the diversity of both tools and non-utilitarian objects proliferated.

Technological specialisation is seen as the result of increasing complexity in hunting techniques, representing an attempt to increase efficiency through standardisation. One way in which to think of this link between specialisation and efficiency is through the concept of planning depth. Planning depth refers to the ability of an individual or group to prepare for future eventualities by ensuring that equipment and materials are available when needed (Binford 1989:19). Binford suggests that the use of more complex tools during the Upper Palaeolithic indicates greater planning depth compared to that possessed by Neanderthals. This apparent shift in planning depth has been one of the central pillars of the study of the Middle to Upper Palaeolithic transition, although it needs to be remembered that what one is talking about here is a relative increase rather than a complete absence in earlier periods (Kuhn 1995:21). Gamble (1995:19) has suggested that previous interpretations (cf. Binford 1989) of planning depth as an individual process where knowledge is essential before any decision can be made and a plan executed, is not necessarily correct. Instead, planning needs to be seen as a social activity (Ingold 1993:343), where a number of factors have to be taken into account. These are not necessarily associated with the specific goal about to be undertaken, but with the enterprise as a whole. For instance in the case of hunting, the relationships between members of the party may be an important factor to the success of the enterprise. Moreover as Gamble suggests (1999:421), decisions are not necessarily made in advance, but can be taken in the doing, in other words while an action is being undertaken.

As mentioned above, technological specialisation has been interpreted as part of hunting activities. The first systematic attempt to investigate this was undertaken by Straus (1987a,b). In his study of ibex sites in the Basque area of northern Spain and southern France, dated to the Solutrean at around 20,000 years ago, Straus identified an apparent persistent relationship between ibex sites and specific tools including backed bladelets and burins (*ibid.*). A similar pattern was identified in Magdalenian ibex sites excavated in the uplands of the Cantabrian Cordillera mountains of northern Spain, which were dated to between 40,000-28,000 years ago. Some of these sites were used repeatedly for ibex hunting and include Les Eglises, Errala and Rascaño, whereas others such as La Riera, Ekain, Urtiaga, La Vache and Bédeilhac document a more diverse range of activities (Straus 1987a:176). The lithic assemblages of these sites contained tools such as burins, backed bladelets and scrapers in varying proportions. Backed bladelets were usually the predominant group although there was little in the way of a repetitive relationship between their frequency and the proportions of ibex. Notwithstanding, Straus *(ibid:*176*)* suggested that:

> "We are still far from understanding functional relationships between tools and the hunting activities at ibex sites, but they are more complex than originally

thought. Some artefact assemblages are clearly highly specialised and others are more generalised"

The discussion so far has suggested that specialisation in subsistence, technology, and hunting efficiency as linked by the concept of planning depth, is a distinctive feature of the Upper Palaeolithic. However, despite the work of Straus (1987a,b) on the Spanish ibex sites, it remains unclear as to whether specialised subsistence was facilitated by the use of specialised technology. Moreover, what constitutes specialised technology has never been clearly defined. Straus argues that a predominance of backed bladelets may represent a marker for this type of technology, however as he admits, the fact that these occur in non-specialised sites as well, severely weakens the argument.

1.5. Specialised and generalised sites in Greece, three case studies

Three sites were included in the study, Klithi, Kastritsa and Franchthi (fig.1.1). Klithi and Kastritsa are located in the uplands of Epirus in north-western Greece, while Franchthi is located on the present coastline of the Argolid peninsula in south-eastern Peloponnese. All are dated to between 20,000 and 13,000 years ago.

Figure 1.1. The three sites included in the study Klithi, Franchthi and Kastritsa.

The three sites were selected as they were broadly contemporary and excavated in relatively similar ways. More importantly however they have been defined as either specialised or generalised. This characterisation was based on a series of criteria, including not only faunal diversity, but also the range of animal resources potentially available to the inhabitants of the site. The general topography and attractiveness of the site itself for either long or short-term occupation was also assessed. It needs to be remembered that these designations of specialised and generalised were not based on the lithic assemblages and had no bearing on the ways in which the collections were studied. They simply set the scene, whether or not they are in fact specialised or generalised will be made clear in the conclusions.

Based on the criteria set out above, it could be suggested that Klithi represents a specialised site. The rockshelter is located at an altitude of 500m within the Epirus mountains, an area which during the last glacial was only sparsely vegetated, and would have supported only a very small animal population. In fact, caprines which live in rugged and broken habitats would have constituted the only substantial food resource in the area. The cold conditions prevailing at the time, in conjunction with the mountainous location of Klithi would probably have limited its use for much of the year. The picture which emerges for Klithi is of a specialised site visited during specific times of the year, probably during special purpose trips, and with hunters targeting caprines exclusively.

The site of Kastritsa at an altitude of 460m, although similar to Klithi, is located on the open plateau surrounding the modern city of Ioannina and the Pamvotis lake. The fauna indicates access to a wide variety of environmental niches, including open plains, hills and fresh water. These would have provided the occupants of the site with a diversity of resources, including red deer, horse and ibex. The cave is not particularly large, although signs of spatial organisation indicate that it was occupied for longer periods of time. The picture that emerges for Kastritsa is of a more generalised location from which a range of resources were being exploited, and where occupation was probably longer term.

Located on the edge of the previously much larger coastal plain of the Argolid peninsula, the cave site of Franchthi lies at an altitude of 15m above present sea level. Climatic conditions during the occupation of the site would have been typically glacial, but nevertheless less extreme than those in Epirus. The cave is extremely spacious and could have provided shelter for large numbers of people, albeit in slightly precarious circumstances as roof falls appear to have been common. Located overlooking the coastal plain, the sea in the distance and with low hills to the rear of the site, Franchthi would have been ideally placed to take advantage of a wide range of resources. The picture that emerges for Franchthi is therefore of a generalised site in a favourable location with access to a broad range of resources.

The grouping of Klithi as specialised and Kastritsa and Franchthi as generalised is based on an initial assessment of the range of resources potentially exploitable from each. A more detailed discussion about the archaeological signatures of each site will be presented in later chapters. For the moment these groupings provide us with a working model, it remains to be seen whether the lithics support this picture.

1.6. Scope and structure of the thesis

The thesis investigates the relationship, if any, between specialisation in subsistence, and specialisation in technology. Three sites are included in the study, Klithi rockshelter and Kastritsa cave, both in Epirus, and Franchthi cave in Argolid peninsula. The occupation of the sites overlaps broadly with the peak of the Last Glacial Maximum at 18,000 years ago, as well as with subsequent climatic oscillations characterised by gradual warming interrupted by short cold phases. However the assemblages investigated here are restricted to the Upper Palaeolithic. Only lithic material was included in the analysis. The thesis is divided into nine chapters as follows:

Chapter 2 introduces a number of theoretical concepts relevant to the study of technology and regional mobility amongst hunter-gatherers. It concludes with a tabular set of expectations as to the archaeological signatures of specialised versus generalised sites. These are referred to again later in the thesis when the actual signatures from the three sites are discussed.

Chapter 3 details the recording strategy that was applied to all three collections, as well as the advantages and limitations thereof. An outline of statistical and other analytical methods is presented, while the chapter ends with a glossary of lithic terms.

Chapters 4, 5 and **6** present the site specific analysis. Chapter 4 deals with the site of Klithi, chapter 5 with Franchthi and chapter 6 with Kastritsa. Each is divided into three parts, the first a general introduction to the archaeological character of the site, the second a discussion of the morphological aspects of the lithic assemblages and in the third, analysis of its metric characteristics.

Chapter 7 presents an inter-site comparison of the three assemblages. The chapter is divided into two broad sections, in the first a comparison of morphological characteristics and in the second, a detailed analysis of the dimensions of cores, debitage and tools. The aim is to examine whether any consistent patterns can be identified between the three sites that would suggest that lithic production was being differentially organised.

Chapter 8 brings together the results of the individual site and comparative analyses and draws a number of conclusions as to the organisation of technology, and in particular whether so called specialised and generalised sites were differently provisioned in terms of technology.

Chapter 9 discusses the validity of the concept of specialisation in lithic technology and subsistence strategies and reviews the status of Klithi, Franchthi and Kastritsa within the region.

Chapter 2. Hunter-gatherer theory and the concept of specialisation

2.1. Introduction

The aim of this chapter is twofold. Firstly, to introduce a number of concepts and theoretical approaches to the study of hunter-gatherer subsistence, mobility and technological behaviour. Secondly to apply these to the concept of specialisation in subsistence behaviour and technology. The discussion is organised around three broad topics. In section 2.2, hunter-gatherer theory is discussed, taking the view that mobility and technology represent part of the overall adaptive process. In section 2.3 the concept of specialisation in subsistence behaviour and technology is introduced, with a particular emphasis on the Mediterranean. Insights gained are then used in section 2.4 to construct a series of expectations as to the archaeological signatures of such behaviour.

2.2. Hunter-gatherer subsistence, the role of mobility and technology

2.2.1. Mobility strategies, foragers, collectors and serial specialists

Based on a series of ethnographic studies, Lewis Binford introduced the terms forager, collector and serial specialist in order to explain the behaviour that he observed amongst hunters and gatherers. These three concepts he used to describe the ways in which spatial and temporal variability in resource distribution was mitigated through alternative mobility strategies (Binford 1977, 1978, 1979, 1980). More recently these concepts have been discussed and summarised by Kelly (1992, 1995).

Foragers practice high residential mobility, they move frequently but over short distances and as a group, positioning themselves within or close to patches of resources, from where these are encountered and used almost immediately (Woodburn 1980:70). Once these are depleted the group moves on to the next patch, although not necessarily to specific repeatedly occupied locations. The archaeological signature of this behaviour was described by Foley (1981) as "off-site". The cumulative effect of this is broad scatters of material rather than point specific accumulations. The bushmen of the central Kalahari are classic residentially mobile foragers (Lee 1979; Binford 1980). Groups move to patches from where resources are encountered through hunting and gathering. The group moves on once these are depleted, thus generating an archaeology of undifferentiated spreads. At the same time this lack of deliberate reuse of sites results in what Binford (1980) described as fine-grained archaeological signatures. In other words residues relate to a single episode rather than to the accumulated debris of repeated occupation of the same location. Since locations are unlikely to be deliberately reoccupied, investment in site structures and storage or as Kuhn (1995:23) describes it, provisioning of place, is minimal. Foragers tend to occupy less seasonal environments with relatively high Effective Temperature (E.T.), a proxy measure of the length of the growing season (Bailey 1960; Kelly 1995:69). The G/wi of the Kalahari live in an area with an E.T. value of 19.3, however the density of primary plant biomass is low, of the order of just 1.2kg/m^2 (Kelly 1995:114). This low level of productivity necessitates more frequent relocation, the G/wi move up to 11 times a year with an average distance per move of 25km, covering an annual territory of 782km^2

In summary, foragers move often and as a group but over short distances and over comparatively small annual territories. They move between resource patches within which they encounter resources, however they do not necessarily reoccupy the same specific locations. They live in high E.T., mid latitude environments with minimal seasonal change and either high or low primary plant productivity. The archaeological signature of the foraging way of life is of fine-grained scatters. Frequent moves and the lack of site reuse discourages investment in site structures, furniture or storage. Individuals usually only possess what they can carry with surpluses given away in a system of reciprocity or social storage rather than horded.

Collectors move less often as a group with the gathering of resources organised logistically (Binford 1980). The main residential hub is maintained perhaps on a seasonal or even annual basis, and it is here that most of the group resides. From this central place individuals range out in order to intercept resources which tend to be available at very specific locations and for short periods of time. In many cases supplies for the next few months or even longer are obtained during these forays, therefore requiring storage and delayed consumption (Woodburn 1980:98). Collectors tend to live in more seasonal low E.T. and thus higher risk environments (Bailey 1960; Kelly 1995:67). Binford's (1978) classic study of the Nunamiut of Brooks Range, Alaska identified many of the defining characteristics of the collector way of life. The central residential hub in which the majority of the group resides is located close to critical, although predictable, resources such as fuel and at which a wide range of activities are undertaken consistent with the site being the main settlement. More spatially and temporally restricted resources are intercepted by task specific logistically organised groups, often travelling over considerable distances. The Nunamiut cover a total annual territory of between 5,200 and 20,500 km^2 (Kelly 1995:112). Resources can only be intercepted at very specific times of the year and locations in the landscape. In the case of the Nunamiut, sites are positioned along the route taken by migrating caribou during autumn and spring. They are repeatedly occupied and are generally task specific, predominantly observation, ambush, and butchery.

In summary, collectors occupy large residential sites over long periods of time and repeatedly, with similarly repeatedly occupied special purpose sites at some distance visited seasonally, from where specific resources are intercepted within a small temporal window of opportunity. Groups practising logistical mobility live in highly seasonal low E.T. high latitude environments (Bailey 1960; Kelly 1995:67). The archaeological signature of collectors is coarse-grained palimpsests, with significant evidence for investment in site furniture, shelters and storage.

Serial specialists cannot be easily defined as collectors although they inhabit similar high latitude seasonal low E.T. environments (Binford 1980:17). In fact they practice a way of life much more akin to residentially mobile foragers, albeit seasonally oriented. Serial specialists move as groups, locating themselves close to seasonally available resources. Some examples include Arctic groups such as the Netsilingmiut (Netsilik) (Balikci 1968) and Baffinland Inuit (Hantzsch 1977), who hunt seals during midwinter and spring. Seals only use their own breathing holes so, once all of the animals within a certain radius of the camp have been taken, the group will have to move on. Summer is the lean time for both these Inuit groups, with solitary encounter hunting of moose and fishing (Kelly 1995:129). The Netsilik move 14 times a year, covering a territory of 6000km^2, with an average distance per move of 16.8km while the Baffinland Inuit move 60 times a year, covering 25,000km^2, with an average distance per move of 12km (*ibid.*:112). Other northern latitude serial specialists included equestrian bison hunters such as the Crow, Pawnee, Kiowa and Blackfoot. These groups needed to move frequently but over relatively short distances, and tended not to repeatedly occupy the same location, their main priority was to stay close to the bison. However, once camp had been struck and hunting begun, the bison would have simply moved off, so rapidly diminishing returns (*ibid.*:129). The use of horses enabled these groups to move rapidly and often, and over large territories. It also allowed materials to be transported and thus investment in sites and storage would be minimal. By following the herds of bison on the hoof, a ready supply of resources throughout the year would have been virtually guaranteed.

In summary, serial specialists move in much the same way as lower latitude residentially organised foragers, although they are tethered by the seasonal nature of their environment. Like collectors they live in high latitude low E.T. environments, although unlike classic residentially organised collectors they do not have access to spatially and temporally predictable resources. Settlements are located close to resources, although they are not necessarily repeatedly occupied. The archaeological signature of serial specialists is fine-grained and off-site. Investment in structures such as site furniture or shelters will be low, while evidence for storage will be limited.

2.2.2. Artefact strategies

Describing lithic technology as problem solving strategy implies a dynamic set of repeatedly adopted behaviours. These will be reflected in aspects such as artefact design, manufacture and maintenance, provisioning, time stress and risk, and the use of raw materials.

2.2.2.1. Artefact design

Five design elements should be distinguishable within any lithic technology, although not necessarily all at once. These are reliability or maintainability, flexibility or versatility and portability (Nelson 1991:67).

Reliable technologies are those that are able to function under any conditions. They are over engineered, solidly constructed, strong and generally large, and tend to be used at well below their maximum capacity. They are assembled with both redundant and standby components arranged in parallel, and are usually task specific (Bleed 1986:739-740). In view of high manufacture and maintenance costs reliable technologies tend only to be discarded once completely worn out. They are most appropriate when failure costs are high (*ibid.*:741).

Maintainable technologies tend to be simpler, with elements arranged in series, each doing its own job. Thus if any component fails, the whole system fails (*ibid.*:740). Maintainable technologies tend to be used in situations where the costs of failure are relatively low (*ibid.*:740-741). In order to illustrate the differences between the two systems, Bleed (1986:742) compared the technology of the !Kung San of the central Kalahari and the Amazonian Yanomamo, with that of the Nunamiut of Brooks Range, Alaska and the Copper Inuit of northern Canada. The classic toolkit of the !Kung, consisting of bow, arrow, spear, quiver and carrier bag has many of the characteristics of a maintainable system. Light, portable and generalised, it can be used at all times and for a wide range of hunting tasks. However if an element fails, for instance the bow fractures, much of the system becomes inoperable. On the other hand, the Nunamiut use highly reliable technologies with numerous systems in parallel (*ibid.*:743). More than 70% of their annual food supply is obtained within a window of opportunity of only 30 days (Binford 1979:256), and therefore any failure in technology would be disastrous. Toolkits are therefore composed primarily of reliable high quality extensively curated elements that are carefully made and maintained. Moreover, additional parallel systems in the form of caches are strategically located around the landscape (*ibid.*).

Flexible tools are those which can be modified or changed in shape to fulfil a wide variety of needs. Nelson (1991:70-1) uses the analogy of the Swiss Army knife to illustrate this type of technology. Although not actually modified, the overall form of the tool is changed as different elements for instance blades, scissors or tweezers are either opened or closed.

Versatile tools are those that are used for a wide variety of purposes without being modified. A good example of a versatile tool is the machete of the Maya which is used for skinning, butchering, chopping, pounding, grinding and scraping (*ibid.*:71).

Portability is an important aspect for anything which has to be carried by an individual and worked by hand (*ibid.*:73-6). Portable toolkits are essential when moving from place to place as transportation costs are a function of mass and size. Limitations imposed by transport costs can be to some extent mitigated by the use of lightweight alternatives to stone, composite artefacts, multifunctional tools, transported cores and the caching of critical elements (Brannan 1991). If portability is achieved through toolkits consisting of only a few items, then conservation of these may be expected. This can be achieved by minimising waste during re-sharpening and maximising the utility of elements. For instance, bifacial disk cores maximise the amount of material available for tool production from a given mass of raw material (Nelson 1991:74). Cryptocrystalline materials such as flint or obsidian are ideal for manufacturing portable tools. They allow finely shaped narrower forms to be produced, thus limiting weight in relation to utility. On the other hand, crystalline materials are difficult to shape and result in more wastage and less control of form (*ibid.*:75). Kuhn (1994:435) suggests that cores are the single most efficient artefacts to carry, although if the use of more than one tool is envisaged, a better overall strategy would be to carry a selection of smaller blanks and retouched pieces. Either way, a balance needs to be struck between utility and potential returns, and the amount of effort expended in carrying artefacts or raw materials. The latter is reduced through standardisation, multifunctional tools or the use of lightweight alternatives to stone (*ibid.*).

2.2.2.2. Manufacture and maintenance

In developing his models of hunter-gatherer mobility, Binford (1977, 1979) highlighted the relationship between the amount of energy invested in technology and the type of environment in which they were used. Artefacts were described as either curated or expedient.

Curated technologies tend to be manufactured in advance of their projected use, with significant amounts of effort expended in manufacture, repair, transport and storage. They tend to be carried by individuals as part of their personal gear and are often associated with risky activities. They tend only to be discarded once completely worn out, usually at residential sites rather than in the field (Binford 1977:33-4, 1979:262-4). Since the mid 1980's a number of other definitions have been suggested which give Binford's original formulation of the concept of curation more explicit meaning. Several categories have been suggested, including Type 1, Type 2 or delayed curation, leading some to propose an end to the use of the term curation altogether (Shott 1996:262).

Expedient technology is less ambiguous, and according to Binford (1977:33-4, 1979:262-4), is situational and opportunistic, or to use Shott's (*ibid.*:268) definition, expediency signifies low curation. Further, Shott (*ibid.*:267) suggests that curation can be defined as:

> "the degree of use or utility extracted, expressed as a relationship between how much utility a tool starts with and how much of that utility is realised after discard"

This definition encapsulates many of the elements implicit in Binford's dichotomy, such as long distance transport, recycling of artefacts and anticipation of future use, but it also emphasises that curation is also a relationship between an artefact and its value or utility (*ibid.*:267-8). Additional criticisms have been levelled at Binford's dichotomy, including that curation is influenced by many factors, such as raw material availability and mobility (Bamforth 1986; Andrefsky 1994; Marks 1988:277). Bamforth (1986:40) in particular argues that tools will be maintained and recycled only when raw materials are in short supply, or when the cost of replacement outweighs that of repair. It is clear that the dichotomy between curated and expedient needs to be seen rather as a continuum and that the degree to which one or the other predominates will vary in relation to circumstances. In other words they are more likely to be interwoven in order to achieve different aims within the same set of adaptive strategies (Nelson 1991:64). Nelson (*ibid.*:65) suggests that if an item is manufactured and then discarded where it was initially made, it can be classified as expedient, while if it is carried to another location and then discarded, it should be described as curated.

2.2.2.3. Provisioning

Provisioning strategies through forward planning ensure that technology or raw materials to fashion them are available when needed. Kuhn (1995) introduces the term technological provisioning to describe this process, which he suggests crosscuts both curation and expediency and involves planning depth, transport and maintenance (*ibid.*:22). Artefacts carried by the individual he termed the provisioning of individuals (*ibid.*:23). Provisioning of individuals can be considered as similar to Binford's (1979) personal and co-opted situational gear. Personal gear consists of artefacts regularly carried by individuals and made in advance in order to accomplish a specific task. Situational gear comprises artefacts made or co-opted to accomplish a specific task, and once used they are either reshaped or discarded (*ibid.*:264-6). The alternative strategy Kuhn (1995:23) refers to as the provisioning of places. Repeatedly visited locations are stockpiled with tools and raw materials in anticipation of future needs. Here again parallels with Binford's (1979) passive gear and site furniture can be drawn. Passive gear comprise seasonally used materials in storage (*ibid.*:257), or artefacts associated with the functioning of sites such as anvils, hearths or seat stones (*ibid.*:264).

Based on this distinction between provisioning strategies, Kuhn (1995) suggests that in the case of high residential mobility the provisioning individuals would be best, while when locations are occupied for extended periods or reoccupied often and regularly, a strategy of provisioning places would be more suitable. However, he admits (*ibid.*:25) that the relationship between mobility and technological provisioning is not mutually exclusive. Other aspects may affect the extent to which either of these strategies will predominate, for instance the size of territories exploited, the durability of artefacts, the presence of raw materials, and the time required for artefact manufacture or repair (*ibid.*:22, 27; see also Binford 1979:261).

2.2.2.4. Time stress and risk

Both time and risk are important aspects which will impact on planning strategies and the organisation of technology. It is suggested that mobile communities use the downtime period between routine activities to repair broken tools. These are manufactured in advance, for later use when time and resources may be more restricted (Binford 1979; Torrence 1983,1989). Time scheduling is associated with risk management (Torrence 1983,1989). By scheduling activities, conflicting demands on time during critical periods is avoided, and thus the risk of failing to meet dietary requirements (*ibid.* 1983).

2.2.2.5. Lithic raw materials

Access to ample quantities of raw material of sufficient quality is essential for the manufacture of lithic artefacts, while their movement provides a key to understanding the spatial scale of territories (Féblot-Augustins 1993: 212; Gamble 1986:331; Kuhn 1995:27; Geneste 1988). Mobility, whether residentially or logistically organised provides the context for the embedded collection of raw materials, primarily whilst engaging in basic subsistence. Only very rarely will people schedule the collection of raw materials as the primary goal (Binford 1979:259). In his study of the transport of flint during the Middle Palaeolithic in France, Geneste (1988:63) identified differing patterns of raw materials use at increasing distances from source. Within the local zone of 5km radius, 85% to 95% of all lithic material was collected. From the intermediate zone between 5km and 20km radius, 5% to 20% was collected, while from the distant zone of over 20km, only 2% of raw material was derived (see also Féblot-Augustins 1993:215). This suggests that raw materials could be used to assess mobility rates.

The presence of raw materials is critical to the organisation of technology (Bamforth 1986; Marks 1988; Andrefsky 1994). If known to be available at locations being visited, there would be less incentive to manufacture artefacts in advance. On the other hand if raw materials were rare, technology produced in advance and raw material transport would tend to be more common. According to Binford (1979:260), there is a close relationship between the distance that is covered for obtaining raw materials and their value. However as suggested, raw materials are likely to have been collected as an embedded task, and thus their cost not directly related to distance covered. Moreover, these costs may have been further reduced by systems of exchange established between communities (Féblot-Augustins 1993:243).

2.3. Specialisation in subsistence strategies

Specialised subsistence strategies value the procurement of one type of plant or animal while ignoring all others. In terms of hunting this has been described by Orquera (1984:77) as:

> "an activity that achieves with a specific kind of animal a very high degree of integration accompanied by much less interaction with other resources of the region"

Alternatively it can be defined as a pattern that either through the deliberate or inadvertent product of a hunting method, tends to focus on a specific age or sex within a single species (Stiner 1994:313-4, 1990:336).

2.3.1. Specialised subsistence during the last glacial

Specialised subsistence becomes more visible during the Upper Palaeolithic (Freeman 1973), and in particular after the Last Glacial Maximum (LGM) at around 18kyr (Gamble 1997:232). Although not a simultaneous phenomenon across the whole of Europe, it appears to follow the retreat of the ice at around 16kyr in southern Europe and 13kyr in northern Europe (*ibid.*). High-resolution ice cores from Greenland indicate that the climate in Europe during the last glacial was subject to dramatic and rapid changes (Macklin *et al.* 1997:356). However, after the LGM, the climate in the eastern Mediterranean became warmer (Watts *et al.* 1996:127; Bailey 1997c:661). This led to a rise in sea level and a corresponding loss of valuable subsistence areas such as the coastal zone in Epirus and the Adriatic plain in the northern Balkans (Bailey *ibid.*:673). These ecological fluctuations would have impacted on the spatial and temporal availability of resources, thus imposing new dietary risks on the population. It has been suggested that one way in which these conditions were dealt with was to intensify both the scale and frequency of residential mobility (Gamble 1997:239). This would have allowed for the exploitation of a greater range of resources, as they became available during the seasonal cycle. An alternative option would have been to adopt more repetitive patterns of behaviour (*ibid.*:208), which would have optimised potential subsistence returns by reducing redundancy in technology and time.

Palaeolithic sites in central and western Europe (Straus 1987a,b; West 1997), and the eastern Mediterranean (Bietti 1990; Miracle and Sturdy 1991; Bailey 1997c; Gamble 1997; Whallon 1999), indicate that a wide range of ungulates may have been the target of these specialised hunters, including reindeer, horse, red deer and ibex. The majority of sites well dated to within the Upper Palaeolithic were occupied during a period of declining temperatures and increasing aridity which occurred during the late glacial, and which would have impacted upon plant and animal communities. In central Europe, large grazing mammals such as bovines and mammoths would have migrated to more favourable environments to the south and east, while species such as horse, reindeer and ibex are more likely to have adapted to local conditions, so providing food resources for Epigravettian populations (West 1997:128-9). During these climatic changes the number of available prey species decreased both by taxa and number, a factor which itself would have led to apparently more species specific hunting. Klein (1999:534) argues that Upper Palaeolithic and possibly earlier sites are dominated by the bones of a single species simply because those were the animals which were dominant in the area. This is a valid argument however it needs to be remembered that not only does specialisation indicate the focused hunting of one prey species, it also documents the shift towards a new mode of subsistence in which novel and often difficult niches such as mountains begin to be exploited, primarily after the Last Glacial Maximum (Straus 1987a,b; Gamble 1993:196).

Similar although less conclusive evidence for specialisation does occur at late Mousterian sites which show a bias toward single prey species (Gaudzinski 1995:63; Klein 1999:533-4; Stiner 1990:331). An example of one of these possible early specialised sites is Teshik Tash in Tashkent, located at an altitude of 1,500m above sea level. The fauna was dominated by Siberian mountain goat, while the lack of carnivore bones strongly supports Neanderthal predation as the primary bone accumulator (Gamble 1993:193-4). The evidence so far suggests that specialised subsistence strategies developed as a response to increasing uncertainty during the late glacial and may extend back perhaps even to the latter phases of the Middle Palaeolithic. In an evolutionary sense, the advent of selective hunting introduced a new ecological relationship between human predator and animal prey, which became part of the adaptive repertoire and probably set the foundations for the later domestication of ungulates (Stiner 1990; Gamble 1997).

2.3.2. The Ibex sites, a strong case for specialised subsistence

Usually found at altitudes of between 500m and 1,500m above sea level, the so-called ibex sites are located across the Mediterranean province from the Cantabrian mountains of Spain in the west (Straus 1987a,b), through Italy (Bietti 1990; Phoca-Cosmetatou *in press*) and Bosnia (Miracle and Sturdy 1991), and finally to Greece (Bailey 1997c). It has been suggested that specialisation in food procurement as expressed by ibex hunting describes a mode of activity facilitated by the presence in Europe of anatomically modern populations (Straus 1987a,b; Gamble 1993:196; Bailey 1997c:673-4). The reasoning being that the supposed increases in planning depth and improvements in technology associated with the Upper Palaeolithic made it all possible. According to Gamble (1993:193), the mountainous areas inhabited by ibex can be rich in food resources but more difficult to exploit than lowland areas. Forays into these areas would only have been possible with the degree of forward planning and anticipation that has become synonymous with the Upper Palaeolithic. Evidence that forward planning was involved in the hunting of ibex is present in the faunal remains at Klithi. The site was repeatedly visited during the summer months when ibex would have been in poor condition and solitary (Gamble 1997;238; Sturdy *et al.* 1997:612). In addition, the elusive nature of the sure-footed ibex would have made hunting difficult until the adoption of technologies first seen in the Upper Palaeolithic (Straus 1987a,b). These include the use of long-range projectiles such as bow fired arrows. The bow is an effective and accurate weapon and can be used in a variety of situations and on animal of various body sizes (Churchill 1993:13,15).

Two examples of sites where this type of behaviour is reflected are located in the Balkans. They include the Greek site of Klithi in the mountainous Epirus region and the site of Badanj located in Herzegovina. Klithi was used primarily for ibex hunting while at Badanj, red deer was the primary quarry. Both sites produced evidence for intensive occupation at specific times of the year when the physical condition of the animals would have been favourable to the hunters. At Klithi during the summer the ibex would have been in relatively poor condition, solitary and less alert. At Badanj the relatively fat-rich female red deer would have been an attractive quarry (Gamble 1997:239). Proteins and fats are crucial for human neurological development during childhood as well as the maintenance of adult health (Stiner 1990:336). This becomes even more important in cold environments where animal fat mitigates the lack of carbohydrates and essential vitamins such as 'C' and 'D' in particular.

2.3.3. Specialisation in technology

2.3.2.1. Craft specialisation

The concept of craft specialisation was formalised during the late 1930's by Childe (1936) as a way of describing the organisation of production in post Neolithic stratified societies, where some individuals were exclusively involved in production of non-subsistence goods and services. In these societies, a surplus was produced in order to support these craft specialists (Milliken 1998; Clark 1995). In the decades following the work of Childe, the discussion of craft specialisation and its implications for the structure of past societies has grown immensely, expanding not only within archaeology but also amongst other disciplines such as politics, economics and philosophy (Brumfiel and Earle 1987). One of the primary aims of these discussions was to define the framework within which craft specialisation had occurred. The following points were suggested:

- Craft specialisation was motivated by individuals who wanted to see themselves in a position of economic prosperity.
- Craft specialisation required the presence of a centralised leadership whose responsibility was to provide environments where economic prosperity could increase.
- Craft specialisation involved social and economic differentiation, as well as interdependence between producers and consumers. In particular, it was suggested that social groups who organised production and exchange employed specialisation to maintain social inequality and to fund new institutions of control (*ibid.*:3).

So far, concepts of specialisation were very much focused on societies whose members were ranked on the basis of economic status. Progressively however, the emphasis has shifted towards the recognition that the ability to produce specialised technologies involved a number of different dimensions. These included new methods, materials and a change in overall economic and social strategies (Torrence 1986; Arnold 1984; Brumfiel and Earle 1987; Clark 1995; Milliken 1998). From this perspective craft specialisation should be defined as an adaptive process and therefore a phenomenon practised by all social groupings and not only highly ranked ones. Individuals who increased their competence in a limited range of products should be considered as craft specialists regardless of the time frame or cultural context (Milliken 1998:1).

Evidence for craft specialisation can be identified in the Palaeolithic, for instance in bead production, with two early examples from the sites of Abri Blanchard in France and Sunghir in Russia, both dated to Aurignacian. At Sunghir the buried remains of a man and two children were covered by thousands of ivory beads. Experimental work has demonstrated that this quality of beadwork required a high degree of metric and morphological standardisation as well as a significant investment of time, up to 3,500 hours (*ibid.*:2).

2.3.3.2. Technological specialisation

Technological specialisation is defined as the presence of tools designed to perform very limited ranges of tasks (Orquera 1984:79), while their specific form is achieved through deliberate manufacture and maintenance (Durden 1995:409-410). Craft specialists produce items that are then used by others, whereas technological specialisation relates to the technology itself, and in particular what it is honed to do. It says less about the skill of the maker, but everything about the use to which the tool is put. Specialised technologies tend to be produced from blade blanks, as they provide a wider range of opportunities for the manufacture and maintenance of tools as opposed to flakes

(Mellars 1989:339; Nelson 1991). Moreover, blades permit the production of more standardised tool forms (Orquera 1984:348-9; Mellars 1989:345; Bar Yosef and Kuhn 1999:324). The concept of standardisation forms a key element of the rest of the thesis, and is defined as the routinisation of manufacturing techniques in order to eliminate wasted time and the incidence of errors (Torrence 1986:43-4; Kuhn 1995:435). One measure of the success of this standardisation strategy is the reduction in size and shape variability of its output (Arnold 1984; Torrence 1986:85; Dowd 1998:147; Kvamme *et al.* 1996; Eerkens 1998; Marks *et al.* 2001).

What these suggestions emphasise however, are technological solutions rather than establishing a theoretical framework for examining technological strategies as they operated on a day-to-day basis. Specialisation needs to be seen as only part of overall planning and organisation, another being mobility strategies. Moreover, technology needs to be seen as a problem solving strategy (Binford 1979; Gamble 1986:38; Torrence 1989; Kuhn 1995:15), able to adapt in order to optimise returns for a given investment of energy, time (Foley 1985), or risk (Torrence 1983, 1989) within the context of regional mobility strategies.

How would this technology have enabled more effective exploitation of the environment? Activities would have been facilitated by specific toolkits (Orquera 1984:79). The hunting of birds for instance requires the use of blunt arrows in order to disable without damaging feathers, useful as arrow fleches (Bergman 1993:101). Similarly, at Kastritsa cave in Greece (chapter 6) shouldered points may have been specifically used for the hunting of prey such as cattle, equid and red deer (Bailey 1997c:672). Alternatively, the presence of distinctive artefacts at one site and their corresponding absence from others may not always have resulted from purely practical reasons. It may reflect different social identities of the people who frequented the sites (Sinclair 2000). Differences in archaeological signatures from the sites of Kastritsa and Klithi may provide support for this (Adam and Kotjabopoulou 1997:252-3).

2.4. The archaeological signature of specialised and generalised sites

Chapter 2 has introduced a significant number of concepts, all of which will be applied in one form or another throughout the following chapters. In particular, they provide a theoretical background for the key question being asked, was specialised subsistence facilitated by specialised technologies? In the following table these concepts are used to generate a series of expectations as to what we may expect to find at specialised as opposed to generalised sites, and is based on the following two working assumptions. Firstly, that the inhabitants of both types of site could be considered as potentially from the same population group. Secondly, specialised sites were located in novel and by implication more difficult and risky environments, whereas sites where a more generalised mode of subsistence was adopted, tend to be located in more benevolent locations. Whether or not these assumptions bear any relation to the results discussed in the following chapters remains to be seen. Whatever the case, the table of expectations provides a series of markers against which to compare the archaeological signatures of the three sites under study.

Table 2.1. Hypothetical model for the investigation of lithic technology at generalised as opposed to specialised sites.

(Based on Binford 1977, 1979, 1980; Torrence 1983, 1989; Bleed 1986; Straus 1987a;b; Nelson 1991; Kuhn 1995; Hayden *et al.* 1996; Andrefsky 1998; Bar Yosef and Kuhn 1999; Marks *et al.* 2001)

Characteristics	**Generalised sites exploiting a wide range of resources, located in benevolent environments**	**Specialised sites exploiting a restricted range of resources, located in risky environments**
Size and diversity of assemblages	Large lithic assemblages with high diversity of debitage and tools. All knapping stages from unworked nodules to abandoned cores.	Small lithic assemblages with low debitage and tool diversity. Emphasis on latter stages of the core reduction sequence.
Raw materials	Use of local or exotic or both depending on availability. Provisioning of people or places. Broad range of secondary and inner debitage.	Predominant use of exotic, irrespective of availability. Provisioning of people. Predominance of inner debitage.
Core use and discard	Formal and informal shapes. Cores more frequently discarded and at a wider range of sizes.	Predominance of formal shapes. Low rate of core discard at more reduced stages.
Tool manufacture or maintenance	High incidence of tool manufacture.	Predominance of tool maintenance.
Artefact design	Maintainable and reliable, curated and expedient.	Reliable and curated types predominate.

Chapter 3. Methodology

3.1. Introduction

This chapter outlines the practical aspects of the research including fieldwork and the analysis of the sampled lithic assemblages. It begins with a discussion of the aims and limitations of the recording strategy, followed by a detailed presentation of the methods as well as an inventory of typologies used. As outlined in chapter one, the sites sampled included Klithi rockshelter, Franchthi cave and Kastritsa cave, which have all been defined as either specialised or generalised.

3.2. Fieldwork and permits

Analysis of the assemblages from all three sites took place during several study seasons between 1998 and 2000. The collection from Klithi was studied in Aristi and then subsequently in Klidonia, two remote but very picturesque villages in the Zagori region of the highlands of Epirus. The material from Franchthi was examined at the Archaeological Museum in Nauplion, with that from Kastritsa studied at the Archaeological Museum in Ioannina (see fig. 1.1, also chapters 4-6). Permission to work on these collections was kindly given by the directors of the relevant excavations and the Greek authorities. Professor G. Bailey of the University of Newcastle upon Tyne supported my application to work on material from Klithi and Kastritsa. Professor C. Perlès of the Université Paris X-Nanterre and Professor C. Vitelli of Indiana University gave their permission for work to be undertaken on the Franchthi collection. The Ephorate of Spileology and Palaeoanthropology in Athens as well as the Ephorates of Prehistoric and Classical Antiquities in Ioannina and Nauplion issued study permits.

3.3. The sampling strategy, objectives and constraints

The aim of the research was to investigate whether specialised subsistence strategies which appear to become more common during the Upper Palaeolithic, required the use of specialised lithic technology. In order to do this, representative samples from each of the assemblages needed to be studied in order to allow them to be categorised and compared. Considering the relatively low tool proportions in all of the collections, the samples had to be quite large. In addition, the sampling strategy was aimed towards generating representative collections from a range of focal points at each of the sites in order to better reflect the variety of activities undertaken. The sampling strategy was organised on the basis of weight of bags of lithic material from the various stratigraphic contexts (quadrants at Klithi, strata at Kastritsa and phases at Franchthi, see chapters 4-6). The bags from each of these contexts were weighed together and then a random set of bags selected to equal roughly a third of the total. This strategy was modified at Franchthi where the numbers of lithics were smaller; in this case 50% of the total weight was included in the study. All of the material from these bags was then analysed. As discussed in more detail in the individual site chapters, in certain cases the initial goal of sampling one third of the weight from each context could not be achieved. This was the case mainly at Kastritsa cave, where as explained in chapter 6, the problem lay in the way that material from the site had been sorted and stored at the Archaeological Museum of Ioannina. Excavated lithic material was stored on the basis of the excavation trench from which it came, the result being that samples from different layers were kept together in the same bag. Consequently, a considerable amount of time had to be spent locating and weighting samples suitable for analysis. Despite these constraints however, the assemblage from Kastritsa was in the end large enough to allow valid comparison.

3.4. The recording process

Recording of the lithic assemblages was organised on the basis of the general classificatory schemes of Tixier (1963) and de Sonneville-Bordes and Perrot (1954, 1955, 1956a,b). In addition, the methods applied by Adam (1989), who investigated the assemblages of Klithi and Kastritsa, Perlès (1987) who undertook analysis of Franchthi, and Roubet (1997a,b,c) who worked on Klithi, were followed. The recording of the assemblages was kept as simple and as concise as possible. Its aim was to catalogue all the major units of the core reduction sequence including raw materials, the core themselves, debitage and tools. All materials were examined irrespective of whether they were complete or broken, although they were recorded as such. Pieces smaller than 10mm maximum dimension (chips or debris) were catalogued but not measured, apart from if they had been retouched. Dimensions were recorded in millimetres to one decimal place using a pair of Kennedy digital callipers and included length, width and thickness, and if present, platform width and thickness. Length was measured along the axis of percussion although if this could not be determined, along the longest axis. Width was measured perpendicular to length, and thickness between the dorsal and ventral surfaces across the thickest part of the blank excluding the proximal or distal ends, usually in the middle. Retouch width was measured for scrapers, perpendicular to the axis of the blank between the ventral surface and the upper extent of removals (see for instance Kuhn 1995).

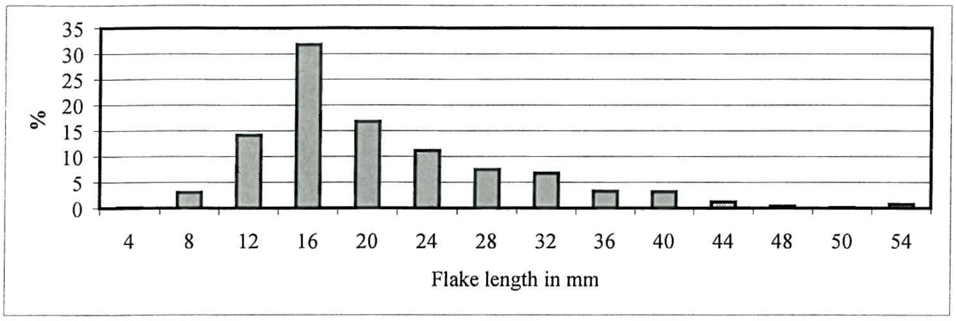
3.5. Analysis of the lithic assemblages, structure and methods

The analysis of the lithic assemblages from the three sites was therefore divided into two parts. The first deals with the morphological characteristics of the assemblages by examining aspects such as raw material provisioning, indicators as to the nature of the core reduction sequence, and the nature of tools themselves. The aim was to present the basic structure of each of the assemblages, which in turn shed light on the nature of site's occupation based on the premise that lithic technology represents a problem solving activity. The second part of the analysis focuses on the metric characteristics of debitage and tools, the aim being to assess size standardisation as an index of specialised production.

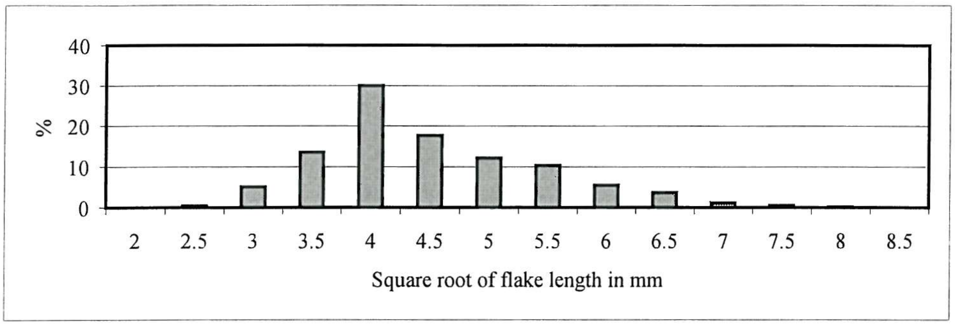
This analysis is also divided into two smaller sections. The first presents the basic dimensional character of each assemblage while in the second, standardisation is examined on the basis of variance and size dispersion using the coefficient of variation (CV) and the F significance test. CV provides a measure of the amount of variance, as is calculated by dividing the standard deviation (SD) by the mean, so removing the influence of size differences. This will be discussed later in this section, however for the moment the way that SD is calculated will be outlined, and in particular how it can be affected by data which is not normally distributed.

Standard deviation is the root of the sum of the absolute difference between each measure and the mean for the whole sample, divided by the number of measures in the sample minus one. In other words standard deviation provides a measure of how much collectively the sample varies in comparison to the mean, the more variable the collection, the greater the standard deviation will be. From this it is clear that there are two aspects that will affect the comparative use of standard deviation. The first is the validity of the mean, which is directly related to the degree to which the shape of the frequency distribution of the collection approximates the normal distribution. The second relates to the fact that standard deviation reflects not only size dispersal with respect to the mean, but also the size of the objects themselves. So for instance a collection of handaxes would be expected to produce a larger standard deviation than say leaf points, simply because of the differences in their overall sizes. This will be made clearer in the next section, but first let us consider the effect of the normal distribution on the calculation of the mean.

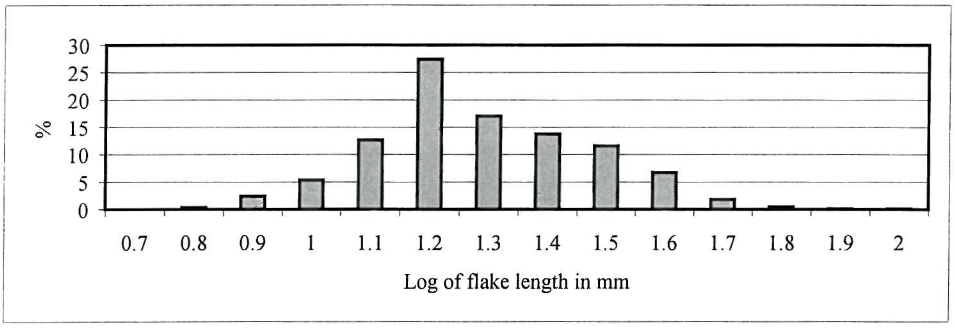
It is always useful when presenting data to include frequency histograms, in this way the shape of the distribution can be assessed and its effect on the mean verified. There are two main ways in which a population will deviate from normality, if they have more than one central tendency, in other words bimodal or skewed with long positive or negative tails. In this case the mean and the central tendency or mode will not coincide and therefore the mean will be less representative. The most common way in which distributions deviate from normality amongst lithic assemblages is with long positive tails. In other words it contains small numbers of objects much larger than the bulk of the rest of the collection. One way in which to account for this, and therefore to make the calculation of the mean and standard deviation more representative, is to force the distribution to be normal. The easiest way of doing this is to take either the root or log of the values (Shennan 1988:111-2). The effect of this is to squeeze the frequency distribution from the right. Which method to use depends on the extent to which the distribution is positively skewed. This is illustrated in the following three frequency histograms generated using the length in millimetres of unretouched flakes from Klithi.



a.



b.



c.

Figure 3.1. Length distribution of unretouched flakes from Klithi using real (a), square rooted (b), and log transformed data (c).

In the first frequency histogram, the real measurements show a significant positive tail. In the second, the lengths were square rooted and it can be seen that the distribution has been squeezed up from the right. As with logs, this is because the effect of taking roots on numbers is not linear. Rooting a large number has relatively more effect than it would on a small number. This effect is even more pronounced with logs and as can be seen in the final frequency histogram, the distribution approximates the normal distribution quite closely. Whether one uses logs or roots is a judgement which needs to be made, however the general pattern appears to be the longer the positive tail, the more likely it is that taking logs would produce a closer approximation to the normal distribution. It needs to be remembered that once a method has been decided upon, it must to be stuck to. Mixing frequency distributions based on real data, rooted values or logs must be avoided. In this thesis, all transformed distributions were on the basis of logged data.

On a cautionary note, the effect that logging of dimensions has on basic parameters such as means and standard deviations needs to be considered. As outlined above, the effect of taking logs is not linear. Large numbers are altered relatively more than smaller ones. So for instance, if we wished to compare the length of handaxes with the length of backed bladelets, admittedly a rather pointless exercise, it would be found that the procedure has relatively more effect on the handaxes than it would on the bladelets. If we then used a simple measure such as standard deviation to look at size dispersal around the mean for the two groups, we would find that the handaxes would appear relatively less dispersed than in fact they would if real values were used. So for instance in a more realistic comparison, say between unretouched bladelet and flake widths, the taking of logs would have relatively more influence on the shape of the distribution of flakes than bladelets. Although once the decision has been made to use log transformed data little can be done to remedy this, however it needs to be borne in mind when comparing objects very different in size.

It has been shown above that the shape of the distribution needs to be broadly normal in order for one to have confidence in means and standard deviations. One difficulty with standard deviation is that it is dependant on the size of the artefacts themselves. If we think again about the handaxe and backed bladelet example, then both groups of artefacts were similarly dispersed around the mean, lets say with a percentage difference of 10%, then for backed bladelets this may relate to an absolute difference of only a couple of millimetres. Amongst handaxes however, a 10% difference may relate to a real difference of 20mm. In other words bigger artefacts overall will have larger standard deviations compared to smaller ones. One way around this problem is to use the coefficient of variation (CV) instead of standard deviation. The coefficient of variation is very similar to standard deviation, in fact it is simply the standard deviation divided by the mean. In this way the effect of size is eliminated (Shennan 1988:43-4). The approach has been use in a number of studies (Arnold and Nieves 1992; Blackman *et al.* 1993; Kvamme *et al.* 1996; Eerkens 1998; Marks *et al.* 2001). In order to confirm that the differences suggested by the CV values were significant, the *F* test was used. This compares variance around the mean for two sets of data using the *F* critical value (Fletcher and Lock 1991:82-3; Arnold and Nieves 1992; Kvamme *et al.* 1996; Shennan 1997:88-9) for a given significance level. For a given significance level if the *F* ratio is larger than the *F* critical then the null hypothesis must be rejected, in other words that the two variances are significantly different. Having established a measure of variance on the basis of CV, and confirmed whether they are in fact significant on the basis of the *F* test, the analysis proceeds by giving a graphical illustration of the differences based on log transformed data again. This method was developed exclusively for the purposes of the research and hopes to provide an alternative method in the assessment of size variability. Cumulative frequency histograms of proportional differences between the mean and each value are plotted as follows. For each group the absolute difference between values and the mean are expressed as percentages. A cumulative frequency histogram is produced for these new values, and then plotted. To assess whether two distributions are significantly different, the *Kolmogorov-Smirnov* (KS) significance test is used. This compares the observed difference with an expected distribution of differences derived theoretically on the basis of sample sizes (Shennan 1988:60-61). If the observed difference ($Dmax_{obs}$) is larger than that calculated ($Dmax_{.05}$), then the null hypothesis is rejected, implying that the proportional variance between the two assemblages is significantly different. In this way, both the CV values and *F* test results can be graphically verified.

3.6. Categories used to record the lithic assemblage

3.6.1. Raw materials

Raw materials, all of which were cryptocrystalline were grouped simply by eye based on colour, texture and experience of the range available at the three sites. They included flint and to a lesser extent radiolarite, jasper and chalcedony, the latter mostly at Franchthi. The nature and sources of much of this material remain poorly understood and therefore any discussion as to their provenance needs to be considered as speculative.

3.6.2. Cortex proportions

All debitage and tools were described in terms of the presence of outer nodular cortex. The only group not included were unworked and partially worked nodules. The various groups were described as follows:

Primary blanks represent the very first removal and had a dorsal surface completely covered by cortex.

Secondary blanks had a dorsal surface partially covered by cortex.

Inner blanks were completely free of cortex.

3.6.3. Cores

Cores were defined as having evidence for intentional removals (Andrefsky 1998:xxii) for the production of blanks for tools (Inizan *et al.* 1992:84). The attributes of cores recorded included type of removals (flake, blade or bladelet), number and location of platforms, cortex proportion and core shape (defined as geometric or amorphous). The following metric attributes were recorded in millimetres:

Length from primary (largest) platform across the body of the core.

Width or the longest axis across the primary, largest or final platform.

Thickness measured perpendicular to longest axis across the platform.

Unworked platform perimeter or circumferential length, measured around the primary or final platform.

Worked platform perimeter or the circumferential length around the primary or final platform from which flakes, blades or bladelets had been removed.

Platform preparation including trimming from the platform down the flaking axis, facetting across the platform, or a combination of both.

Direction of flaking described as longitudinal if along the axis of percussion, or multidirectional if across.

Reasons for abandonment including size, raw materials, hinge or step fracturing and unknown.

3.6.4. Debitage

Debitage included all unretouched or unworked pieces, including those with possible edge damage (see Inizan *et al.* 1992:84; Andrefsky 1998:xxii), and were grouped as follows:

Flakes included any piece with a ventral flake surface. Laminar flakes or those blade like in shape but not more than twice as long as wide (often encountered at Klithi) were included in this category.

Blades have regular ventral surfaces and a length twice their width, but with the latter not less than 12mm.

Bladelets have regular ventral surfaces and a length twice their width, but with the latter not exceeding 12mm.

Atypical pieces are fragments over 10mm in maximum dimension with a regular ventral surface but which could not be grouped as either flakes, blades or bladelets.

Chips are similar to atypical pieces having a regular ventral surface, but were less than 10mm in maximum dimension.

Debris were those pieces with no diagnostic features, generated during knapping and heat spalling, and included all size fractions.

3.6.5. Technical pieces

These are associated with the manufacture or maintenance of either core or tools, and were grouped as follows:

Crested blanks were defined by Inizan *et al* (1992:84, fig.34) as blades or flakes with triangular cross section, usually with bifacial removals creating a ridge of negative bulbs, which act as a guide for removals from the platform.

Core rejuvenation blanks were used to rejuvenate the flaking surface of a core, in most cases through the removal of hinge and step fractures. Their dorsal surfaces were characterised by negative scares, steps and hinges.

Core tablets were discs of material removed from the top of the core by striking across the flaking surface just below the platform edge. In this way the platform was removed exposed a new surface from which flaking could proceed (Inizan *et al.* 1992:95).

Microburins were the ends, usually proximal, of retouched blades or bladelets. The end to be removed was notched and then struck so as to produce a sharp burin termination. A special category of microburin was the Krukowski, which according to Tixier (1963:142) were backed bladelets or blades with the end detached by a blow from the side. It is difficult to distinguish these from accidentally breakage of backed pieces (*ibid.*). Both types were grouped as microburins, in agreement with Roubet (1997a) but contra Adam (1989:51).

Burin spalls were pieces detached and discarded during the manufacture of burins (Inizan *et al.* 1992:78, fig. 30)

3.6.6. Tools

A tool is regarded as any artefact intentionally modified by retouch or the burin technique, in order to produce a recognisable shape (Adam 1989:54). The by-products of the manufacture of burins, that is burin spalls, were included as tools if they had retouch, and were usually grouped as bladelets with linear retouch. In retrospect it may not have been wise to describe them as tools as the retouch was probably associated with earlier shaping of the blank prior to removal. However they were an insignificant part of the collections, comprising no more than two or three pieces. The classification of tools into the groups as outlined below was based on macroscopic analysis and therefore only the most obvious edge damage was noted. Edge damaged pieces were not classified as tools, but were grouped simply as debitage (Andrefsky 1998:75).

Backed artefacts had deliberate abrupt, crossed or semi abrupt continuous retouch on one or more edges. They can be made on flakes, blades or bladelets and their retouch appears to have been focused towards producing a blunted thicker edge, presumably so as to be held safely or hafted (Andrefsky 1998:xxi). Backed artefacts can also be pointed at one or both ends (Inizan *et al.* 1992:76). In order to keep the backed bladelet group as representative as possible, single backed and double backed bladelets were grouped together as backed bladelets, as were Dufour bladelets with very fine marginal semi-abrupt retouch along one or both edges (Adam 1989:49, de Sonneville-Bordes and Perrot 1956b:554).

Microgravettes were made on bladelets and sometimes blades, usually pointed and often longer than ordinary backed bladelets (Adam 1989:51, de Sonneville-Bordes and Perrot 1956 b:547).

Shouldered bladelets or lamelles à cran were laterally retouched, usually abruptly, in order to create a straight edge and slender curved shoulder, they were also often pointed.

Geometric microliths were fragments of backed bladelets or blades which had been snapped and retouched usually along one edge, usually abruptly to produce geometric shapes including trapezes, triangles or crescents (Tixier 1963:127).

Aurignacian blades had intensive semi-abrupt scalar retouch along one or both lateral edges, with distal retouch producing a curved edge and pointed tip (Adam 1989:41 quoting de Sonneville-Bordes and Perrot 1956b: 552). They probably functioned as scrapers (*ibid.*).

Artefacts with linear retouch were flakes, blades or bladelets with simple low angle retouch along one or more edges. The retouch was not always regular or continuous (Roubet 1997a).

Truncations were made on flakes, blades or bladelets and consisted of continuous abrupt retouch across the blank either horizontally or diagonally (Tixier 1963:125-6; Inizan *et al.* 1992:100).

Notches and denticulates were grouped together in the study. Notches had one or more concavities in their edges while denticulates consisted of a succession of small notches (Tixier 1963:119-21; Inizan *et al.* 1992:85).

Borers had single pointed ends shaped by bilateral retouch, producing one or two shoulders (Tixier 1963:63).

Burins had at least one burin facet produced by a burin blow and the removal of a burin spall (Tixier 1963:67). Although burins can be divided into several subgroups depending on the number and location of facets, in this study they were all grouped as burins in order to generate reasonable sample sizes.

Scrapers were made on flake, blade and rarely bladelet blanks. According to the location of retouch or edge damage, they were defined as side or end scrapers. Side-scrapers were continuously retouched along one or both lateral edges producing a straight, convex or concave edge. End-scrapers had continuous non-abrupt retouch on one or both ends creating a more or less rounded nose (Adam 1989:53; de Sonneville-Bordes and Perrot 1956b: 552, 1954:328).

Composite tools were those that combined the morphological features of more than one type. De Sonneville-Bordes and Perrot (1955:76-7) defined six types of composite tool (see also Tixier 1963:92), however following the suggestion of Adam (1989:48), only two types were recorded in this study, end-scraper/burin and end-scraper/truncation.

Miscellaneous/Atypical refers to retouched artefacts that could not be classified within any of the above groups either because they were unique (miscellaneous) or broken beyond recognition (atypical).

3.6.6.1. Types of retouch

Three aspects of retouch were recorded in this study and included position, localisation and angle (Inizan *et al.*1992:97).

Position refers to the direction in which the retouch was initiated. **Direct** retouch was initiated from the ventral to the dorsal surface, while **inverse** was from the dorsal to ventral. **Alternating** retouch shifted from one face to another along the same edge of the tool. **Alternate** retouch was from either the dorsal or ventral face along one edge, and then the opposite face along the other (*ibid.*:94, fig.44).

Localisation described where on the blank the retouch was lateral, distal, proximal or lateral (*ibid.*:90, fig.40).

Angle was formed by removals relative to the face from which they are initiated. **Abrupt** retouch formed an angle of approximately 90°, **semi-abrupt** of 45° and **low angle** of 10° (*ibid.*:75, fig.26).

Chapter 4. Klithi rockshelter

4.1. Introduction

Klithi was discovered in the late 1970s by a team of British archaeologists, and represented a continuation of work which had begun during the previous decade with the excavation of Asprochaliko and Kastritsa by Higgs (Bailey 1992:2-4).

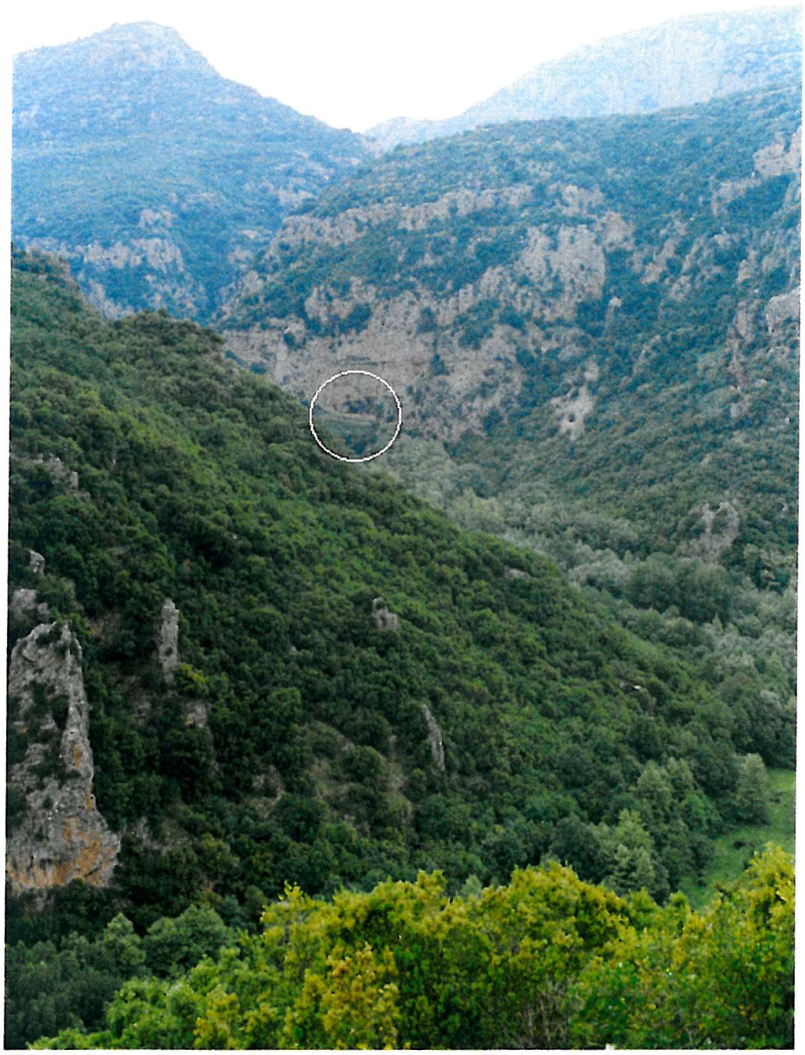


Plate 4.1. Northwest facing view across the Vikos Gorge towards Klithi rockshelter, photographed during fieldwork in 1998.

Work at Klithi (pl.4.1) began in 1983 and continued up until 1988 (Bailey 1997a). The results of the excavation pointed towards a site apparently used exclusively for the hunting of the mountain goats, *Capra ibex* and *Rupicapra rupicapra* (Gamble 1997). On this basis, the site has come to be regarded as an example of specialisation in subsistence and by implication, in lithic technology. It is the validity of this link that this thesis aims to investigate. The chapter is structured as follows:

- An introduction to the main environmental and cultural features of the site, in order to set the scene and to characterise the nature of its occupation.
- Analysis of the basic assemblage characteristics, such as raw materials, cores, debitage and tools.
- Analysis of the lithic assemblage in terms of metric characteristics.
- Analysis of the lithic collection in terms of metric standardisation.

The study is based exclusively on the lithic samples studied as part of this research, although the results of other studies, for instance those of Adam (1989), Roubet (1997a,b), and Shawcross and Winder (1997) are used in a comparative sense.

4.2. The site

Geographic setting

The Klithi rockshelter is located within limestone cliffs on the south-facing bank of the Voidomatis river, which flows within the Vikos gorge in the Pindus mountains of Epirus (fig.4.1). The site is situated at an altitude of 430m above mean sea level, although only about 30m above the present level of the Voidomatis. Far above the site rise the peaks of the Pindus mountains to an altitude of 2650m above sea level (Bailey 1997a:3). The Pindus, along with the Dinaric Alps of the former Yugoslavia and the Rhodope mountains of Bulgaria, form part of the Balkan peninsula characterised by high altitude rugged broken topography. During the last glacial, the area would have formed a transition between the continental periglacial tundra of the central and eastern European plains, and the low arid steppe landscapes of the Near East. The Pindus mountains formed the southern extent of ice formation in eastern Europe (Bailey and Gamble 1990:150).

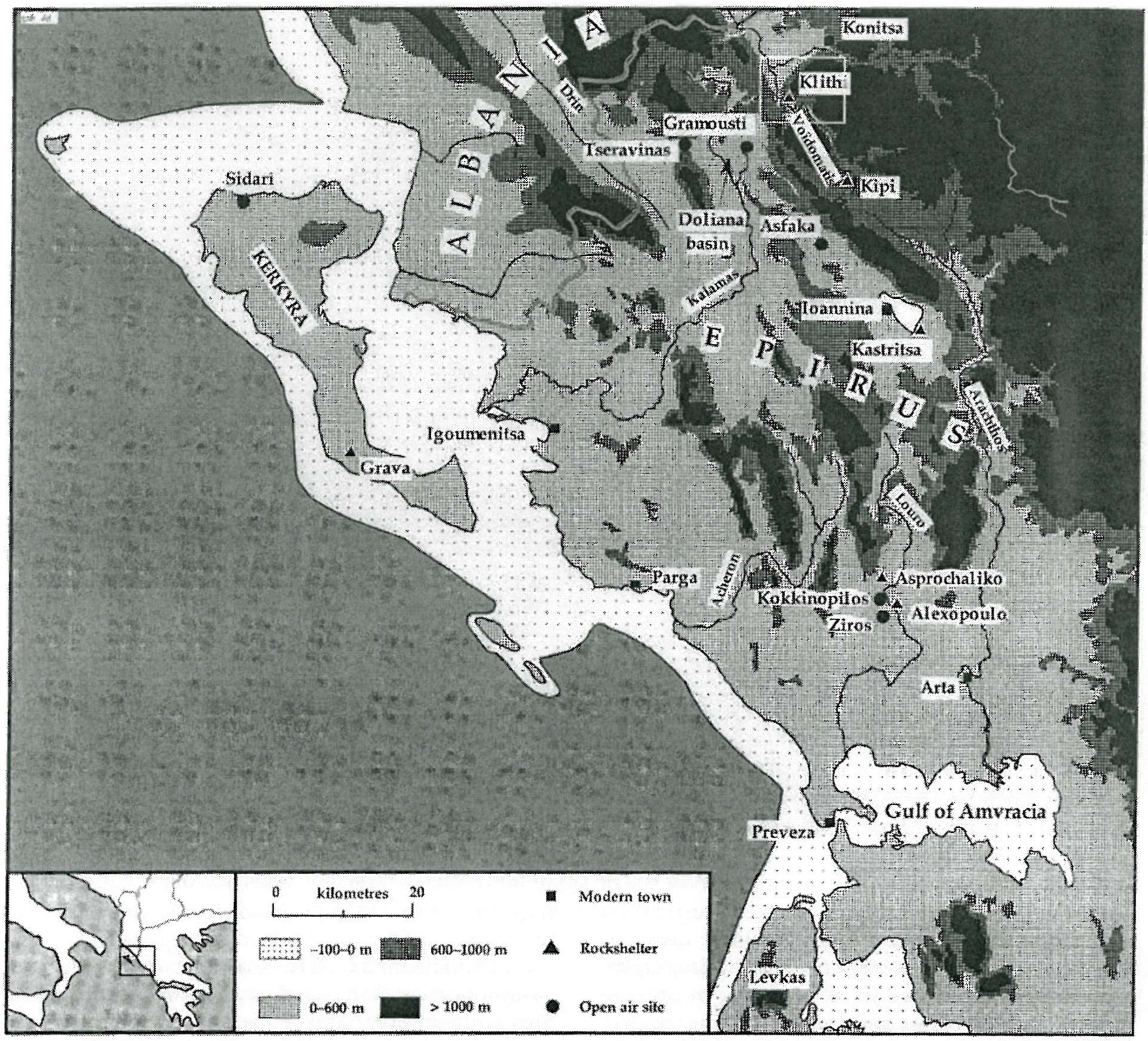


Figure 4.1. Map of Epirus showing the location of the principal Palaeolithic sites including Klithi rockshelter (from Bailey 1997a:6).

Chronology and stratigraphy

The occupation of the site is bracketed between about 16,500 and 13,000 years ago, but then with additional evidence for sporadic use at about 10,500 years ago. In climatic terms, the site is associated with conditions of extreme cold which occurred during the last glaciation but also some warmer intervals during the Bølling/Alleröd interstadial (Bailey 1997c:655). The geological sequence of the site consisted of ten stratigraphic units (strata 1-10, with the upper stratum 20 consisting of goat dung and contaminated deposits). These strata were identified across the whole of excavation and were numbered from the bottom of the deposits upwards (Bailey and Woodward 1997:64-94). However, these layers do not necessarily define neat geological or cultural horizons, while post-depositional agents such as animals have resulted in the loss of some spatial and temporal resolution (*ibid.*).

Environmental setting

Flora

Evidence for the nature of the floral environment around Klithi during its occupation has been inferred from pollen samples taken from Rezina marsh and Gramousti lake in the highlands of Epirus (Willis 1997). Unfortunately little can be said about the environment during the LGM as most of the evidence was confined to the period after 13,000 years ago, and only in the Gramousti sequence. In general terms however, the evidence indicated an open tundra environment in the Gramousti basin during the last glacial, comprising herbaceous plants such as *Artemisia*, Chenopodiacae and Compositae (*ibid.*:404). Some trees may also have been present in both the lowlands and at higher altitudes. In the lowlands, as suggested by the Rezina sequence, species such as oak and pine were recorded with an additional component of hornbeam, fir and willow. At higher altitudes, the Gramousti sequence suggests the presence of hazel, elm, lime, alder, oak, pine, hornbeam, fir and willow (*ibid.*:411). These tree species are unlikely to have had any impact on human subsistence during the LGM, as they would have been present at low density and in restricted locations. The absence of carbonised plant remains at Klithi, despite an extensive program of wet sieving and flotation, strongly suggests that plant resources were not an important component of the overall diet (*ibid.*).

Fauna and animal exploitation strategies

The faunal residues at Klithi are typical of the exploitation of high altitude territories, with ibex (*Capra ibex*) and chamois (*Rupicapra rupicapra*) comprising 99% of total identifiable bones. Based on this, Klithi has been characterised as a specialised hunting site (Gamble 1997). Other animals such as beavers, birds, fish and lagomorphs were also recorded in the fauna of the site, albeit in very small quantities, suggesting that they formed a very small additional component to the Klithi diet, perhaps only during periods of stress (*ibid.*:235). The bones of carnivores and other animals such as deer were extremely rare, leading to the suggestion that they were not deliberately targeted in the Klithi area but were brought back to the site from elsewhere (Bailey 1997c:664). Gamble (1997:231) suggests that the low carnivore counts are a strong indicator of the poor subsistence potential of the environment around Klithi, which discouraged animal species besides the mountain goat.

As far as the dietary strategies adopted by the inhabitants of Klithi are concerned, the structure of the faunal assemblage has revealed a number of interesting points. The groups who visited the site and were hunting in the area, usually carried back to the rockshelter, only those caprine parts of medium to high food utility. The processing of these carcasses was then intensive, implying that the aim of consumers was either to extract as much usable meat as possible, or simply to satisfy a snacking habit (*ibid.*:235-7). According to Gamble (*ibid.*:237-9), the fauna from Klithi suggests that the site was visited primarily during the summer months, with occasional occupation during spring. The groups who visited the rockshelter would have ranged in size from between five and fifteen individuals of mixed age and gender, possibly including infants and the elderly. The presence of the latter two groups are suggested by the fact that the consumption of food appears to have taken place almost exclusively at the site, with only small proportions being carried away. The implication is that some members of the group were less mobile and had to be provided for. The duration of visits was probably no longer than two months and generally less than one (*ibid.*).

Spatial characteristics of the site

The site is approximately 25m wide and 10m deep, with the rock overhang rising 40m above the shelter floor (Bailey *et al.* 1984:14). Its overall surface area is approximately 450m^2, although the drip and shade lines of the overhang would have restricted the living area (Galanidou 1997:227). Internally, the most significant feature of the site was the repeatedly used burning zone in the north-western corner of the shelter (fig.4.2).

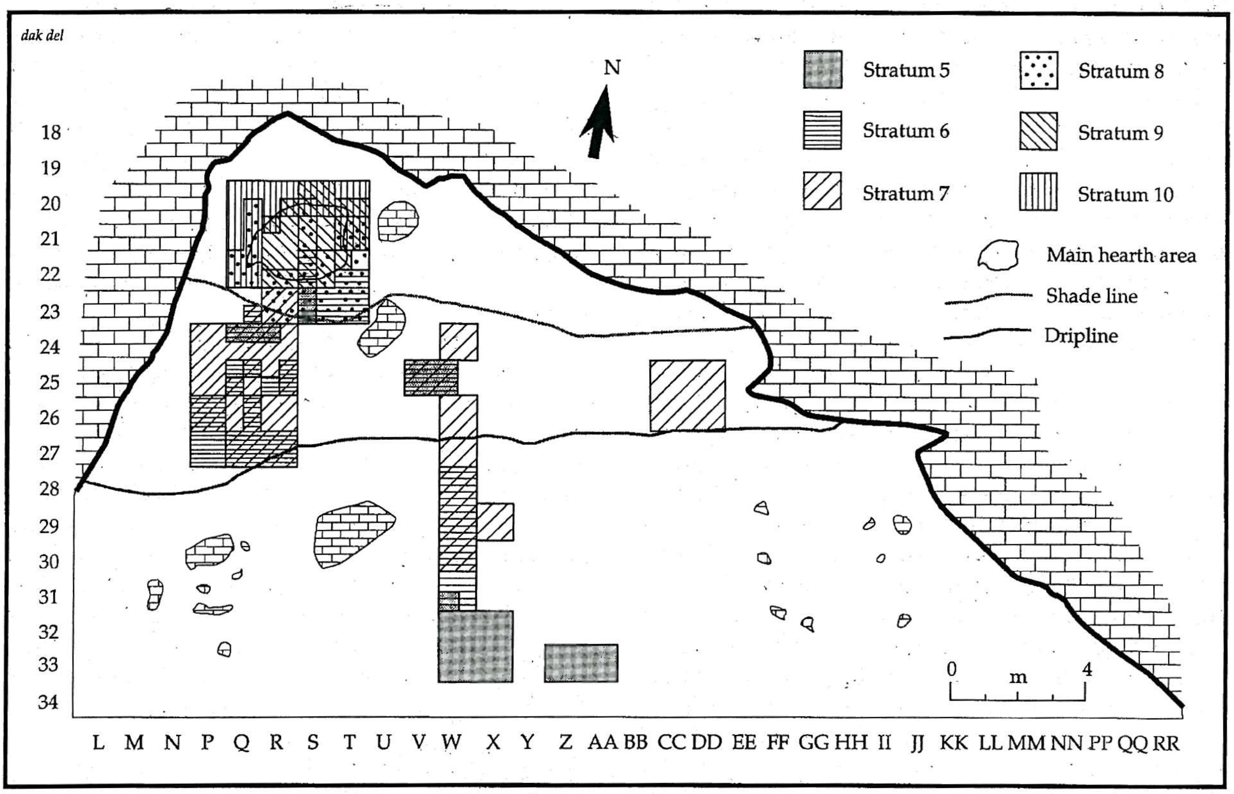


Figure 4.2. Plan of Klithi rockshelter showing the main hearth area, excavation trenches and drip and shade lines (from Galanidou 1997:279).

The burnt horizons yielded only low densities of material, as opposed to the surrounding drop and displacement zones (*sensu* Binford 1983). These were characterised by high densities of bone, knapping debris and stone tools. In addition, bone needles, incised bones and perforated objects were also found (Galanidou 1997:299-302). The possible location of an additional hearth was suggested in the centre of the rockshelter, 3m away from the major hearth complex, while the southern area of the shelter or talus was characterised by low densities of archaeological materials (*ibid.*).

4.3. The contexts studied

Examination of the lithic assemblage of Klithi was carried out during the summer of 1998 and 1999 in Aristi and Klidonia, two small villages within the Vikos National Park where the rockshelter itself is located. The samples recorded during the fieldwork are listed in table 4.1.

Table 4.1. The samples studied, their origin, bag reference numbers and associated dates.

Stratum	Years BP (uncal)	Samples defined by *bag numbers*
5	15,460-16,650	F4043
6	15,460-14,290	F4041, F4040, D4215, B4210, C4632, C4634, C4625, D0109, D0104
7	14,200-13,600	D4122, F4032, B4012, B4204, C4612, C4610
8	12,500	D4124, D4111, D4106, D4104, D0106, D0113, D0110
10	13,900-10,400	C2421, C2424, B2407
20	Contaminated	B4009, B4005, B4205, B4208, B4603, D0101, D0102, B2405, B2413

The sampling strategy was organised on the basis of the following prerequisites:

- The samples should cover as much of the chronological sequence as possible.
- The samples should be taken from focal areas. For this reason material was investigated from around the central hearth, interpreted as one of the main residential hubs of the site (Galanidou 1997:299-304). Samples from around the hearth were derived from quadrants R20, R23 and T23, and from slightly further away from quadrants R24, R25 and R27 (tbl.4.1, see also fig.4.2).
- Samples should be representative of the quantity of lithics excavated at the site. Since the total number of artefacts is not known (Bailey *pers. comm.),* a sampling strategy based on weight was adopted. Lithic material from the same quadrants and layers was weighed together and a random grab sample of one third of the total was extracted for study.

Analysis of the samples was undertaken along the lines of the original recording system employed during the excavation, which involved different levels of analysis of the stratigraphic sequence of the site. According to this, the first comprises individual levels or *Contexts* representing local units identified at the time of the excavation. The second level comprises *Strata*, where individual contexts were grouped together into larger synthetic units applicable across the whole area of excavation, as supported by radiocarbon dating (Bailey and Woodward 1997: 66-7). Each unique volume of deposit had its own *Bag number* or *Bagno*, referring to the three-dimensional coordinates of each, and also the layer or feature to which it was assigned. All the finds from a given volume of deposit so defined thus have the same *Bagno*, and this is all that is needed to define all the attributes of the provenance which the finds come from (Bailey 1997b:46-8).

4.4. Morphological characteristics of the lithic assemblage

4.4.1. Introduction

The lithic assemblage studied consisted of 8312 pieces. However, in the following analysis, only those pieces over 10mm were included, so excluding both chips and debris and reducing the total assemblage to 4344 pieces. The only exception to this were retouched tools and technical pieces less than 10mm, which were included. The main lithic units are listed in table 4.2 and illustrated in figure 4.3.

Table 4.2. The main lithic categories.

Lithic category	Number of pieces
Unworked raw materials (pebbles, nodules, tablets)	6 (0.07%)
Cores	106 (1.2%)
Debitage (flakes, blades, bladelets, atypical)	3140 (37.7%)
Tools	990 (11.9%)
Microburins	105 (1.2%)
Chips (≤ 1cm)	3824 (46.0%)
Debris (natural, knapped, burnt)	144 (1.7%)
Total	**8312**

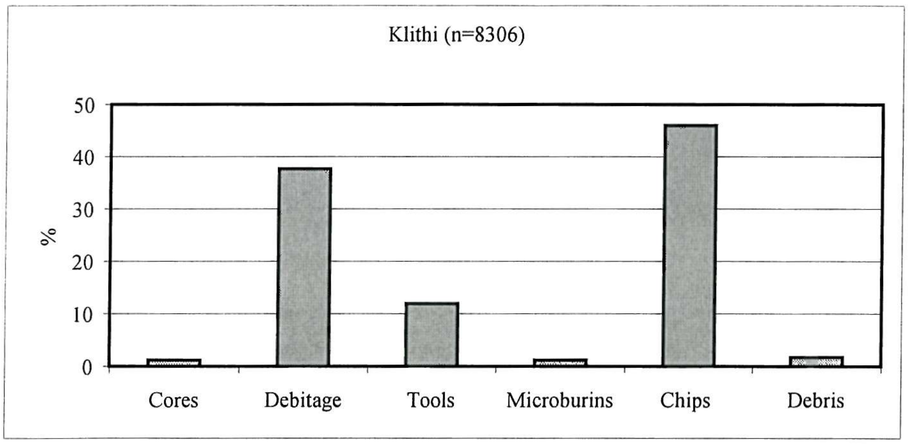


Figure 4.3. The main lithic categories from Klithi. Raw materials were omitted due to very small sample size.

Examination of the assemblage in terms of its main units suggested that all stages of lithic production were present including transport of pebbles into the site to tool discard. Debitage, chips and tools are the three main lithic categories in the assemblage, with chips being by far the most abundant group. A plausible explanation for this is the quality of the local flint employed at the site which, as will be discussed in the next section, tends to shatter to small fragments. In addition, as seen in table 4.3, the collection contained several categories of technical pieces (for definitions see chapter 3).

Table 4.3. Technical pieces.

Types of technical pieces	Number of pieces
Crested blanks	48 (18.7%)
Rejuvenation blanks	9 (3.5%)
Core tablets	39 (15.2%)
Burin spalls	55 (21.4%)
Microburins	105 (41.0%)
Total	**256**

Crested blanks were predominantly made on bladelets (n=20, 41.7%), followed by flakes (n=18, 37.5%), and then blades (n=9, 18.7%), while one piece (2.1%) was unidentifiable in terms of blank type. Cresting is usually applied at the beginning of the flaking process in order to create a guiding ridge along which the first removal can be struck. However as argued by Adam (1989:226), this would probably not have been necessary at Klithi since the natural edges of the river pebbles used would have provided the initial guiding ridge. Instead, cresting was probably more critical at the later stages of flaking in order to maintain the shape of cores, especially during blade production. That refreshing of core striking surfaces and platforms by removal of steps and hinge fractures occurred at Klithi is indicated by the presence of core tablets and rejuvenation blanks. Core tablets were usually made on flakes (n=18, 46.2%) or bladelets (n=17, 43.6%), and less commonly on blades (n=4, 10.2%). Rejuvenation blanks were predominantly on flakes (n=8, 88.8%), with a single blade (11.1%). Technical pieces including burin spalls and microburins were also present, and point to the manufacture of tools. Burin spalls occurred mainly as laminar pieces (n=48, 85.7%) and less often flakes (n=7, 12.5%). The majority of microburins (n=94, 89.5%) were classic but some Krukowski types were also present (n=11, 10.4%).

4.4.2. Raw materials

Lithic production at Klithi was based exclusively on the use of flint, which can be divided into local and exotic types (Roubet 1997a), as well as those for which provenance remained uncertain because of patination and burning. Local Voidomatis flint can be found in abundance as small pebbles along the banks of the river, and more rarely as in-situ layers within the limestone walls of the Vikos gorge (pl. 4.2.).

Plate 4.2. In-situ bands of Voidomatis flint within the limestone walls of the Vikos Gorge, photographed during fieldwork in 1998.

The origin of the exotic flint remains unknown, although some may have been transported over long distances, such as from the Drin valley in Albania or the Rhodope mountains near the Greek-Bulgarian border (Bailey 1997c:666, Galaty *pers.comm.*). On the basis of the classificatory schemes of Adam (1989), Roubet (1997a), Sinclair (1997) as well as my own observations, local raw materials can be divided into five subgroups on the basis of colour, texture and degree of patination as follows.

- Small nodules of black, semi- translucent flint of fine texture. In many cases there are small black inclusions in the body of the flint. The natural surface can be locally very smooth.
- Light grey, semi-translucent flint of fine texture, which may derive from the same source as the black nodules.
- Voidomatis flint, black and opaque with rough texture. It has no obvious colour patination or inclusions.
- Black flint of moderately rough texture with white patination stripes.
- Light grey-black flint, semi-translucent and of fine texture.

In general, Voidomatis flint is usually found in fresh condition and only very rarely patinated. When present, patination is creamy grey in colour, while thermal alteration, either intentional or accidental, produces an opaque blue surface (Roubet 1997a:146). Voidomatis flint is usually fine grained, although coarser examples do occur. The river nodules are rounded and less often tabular and almost entirely lacking limestone cortex due to water action. The ridges on the pebbles are rounded and battered and they are generally small in size (Adam 1989:228). Two samples collected by Adam (*ibid.*:240) and Shawcross and Winder (1997:191) consisting of seventy and thirteen pebbles respectively, showed that the average size of local flint is 58×38.5×26.5mm and 80×50×30mm. A small fairly representative collection of Voidomatis flint pebbles, which were assembled during fieldwork in 1998, is shown in plate 4.3.

Plate 4.3. A small selection of Voidomatis flint pebbles collected during fieldwork in 1998.

The non-Voidomatis flint varied considerably in terms of colour from dark chocolate brown, through creamy white and blue-grey to lilac. Patination was creamy white, either speckled or opaque, while its surfaces varied from translucent to semi-translucent and from smooth to rough in texture. From here on, this material is referred to as exotic.

4.4.3. Cores

The core sample of Klithi consisted of 106 pieces, of which seventeen were broken or heavily burnt. The basic parameters of the core collection are listed in table 4.4.

Table 4.4. Basic structure of the core collection. (Note that different numbers included in each descriptive category relate to breakage patterns).

Total	**106**
Condition	**n=106**
Complete	89 (84.0%)
Broken or burnt	17 (16.0%)
Raw material	**n=106**
Local	98 (92.5%)
Exotic	7 (6.6%)
Uncertain	1 (0.9%)

Core type	n=105
Flake	88 (83.8%)
Bladelet (or blade)	17 (16.2%)
Core shape	**n=104**
Amorphous	38 (36.5%)
Cores on flakes	9 (8.6%)
Conical/semi conical	38 (36.5%)
Cuboid/tabular	6 (5.8%)
Other (oval, sphere)	13 (12.5%)
Number of platforms	**n=105**
One	40 (38.1%)
Two	47 (44.8%)
Three	14 (13.3%)
Four	4 (3.8%)
Direction of removals	**n=104**
Longitudinal	90 (86.5%)
Multidirectional	14 (13.5%)
Platform preparation	**n=104**
Absent	30 (28.8%)
Trimming	64 (61.5%)
Facetting	4 (3.8%)
Multi	6 (5.7%)
Cortex proportions	**n=89**
0%	15 (16.8%)
0-50%	65 (73.0%)
50-100%	9 (10.1%)
Reasons for core discard	**n=104**
Size	73 (70.2%)
Raw material	22 (21.1%)
Uncertain	9 (8.7%)

Raw material use

Cores made on local Voidomatis flint accounted for 92.5% of the collection, as opposed to just seven pieces (6.6%) made on exotic raw materials (fig.4.4). This was slightly less than the contribution of exotic debitage, which was around 10%. One possible explanation for this may be that exotic cores were being introduced later in the knapping sequence, so producing relatively less waste.

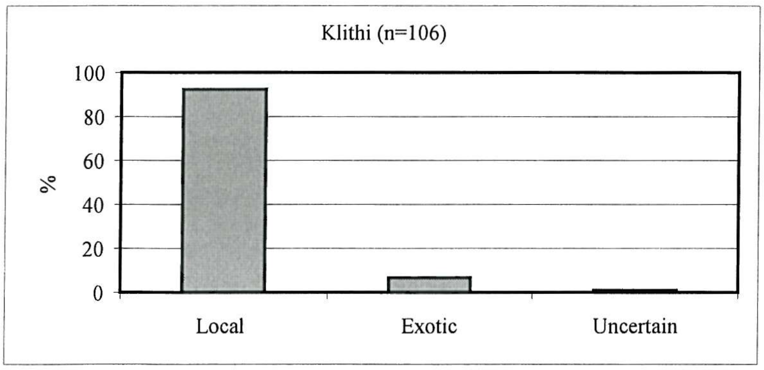


Figure 4.4. Raw material composition of the core assemblage.

Core type, flake versus blade/bladelet

The majority of cores retained only flake scars, whereas very few had clear evidence for bladelet or blade removals (fig.4.5). This was probably an underestimation of the numbers actually used to produce blades/bladelets, since cores were categorised on the basis of their final appearance. I erred on the side of caution when describing them, and only included those with complete laminar scars as blade/bladelet. In her study of the Klithi material, Adam (1989: 239) defined six (31.6%) out of 19 cores as blade/bladelet. The differences in proportions noted in Adam's work and my own probably relate to the way in which cores were classified. I suspect that in her classification those with incomplete but probable laminar scars were included, thus accounting for the higher proportions.

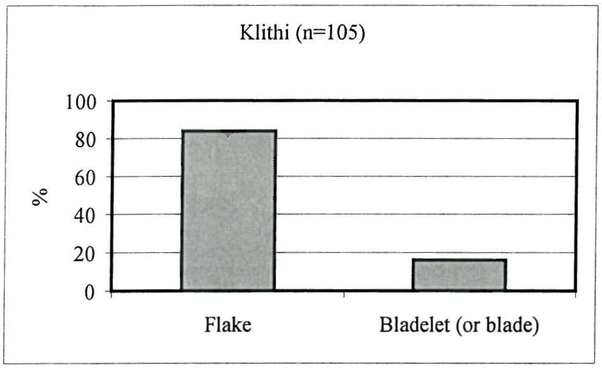


Figure 4.5. Core type, flake versus blade/bladelet.

Core shape

Amorphous and conical were equally as common core shapes (fig.4.6), although spherical and oval could probably be added to conical on the basis of similarity in shape and working. Conical shapes would therefore comprise 49% of all cores. Conical cores tend to be associated with blade production, their shape facilitating the maintenance of a ridge system around the platform and at the same time maintaining the length of the core and thus removals. Amorphous cores tend to be associated more with flake production, which by using several striking platforms allows the removal of greater quantities of more irregular flakes.

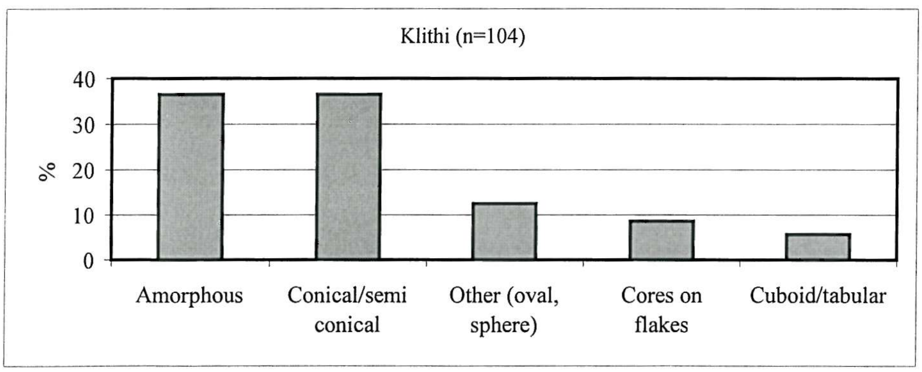


Figure 4.6. Core shapes.

Blade/bladelet and flake production would therefore appear to have been similarly important at Klithi However, it needs to be borne in mind that cores change shape and function during their lives, and so a single platform conical blade core may be transformed into a multi-platform amorphous flake core as working progresses. The opposite is unlikely to occur, that is, amorphous core transformed into a conical blade core. Therefore, many of the amorphous cores were probably previously blade/bladelet cores, which suggests that most knapping effort was expended towards blade/bladelet production, with flakes simply a by-product.

Number of platforms

Cores with up to two striking platforms dominated the sample (fig.4.7). Single or double platform cores tend to be conical in shape and are more often associated with blade production. Out of the seventeen blade/bladelet cores identified, eight (47%) had single platforms, eight (47%) had two, while just one (5.8%) had three platforms. In her analysis of cores from Klithi, Adam (1989:227,235) suggested that the use of opposing platforms was necessary in order to maintain the blade/bladelet producing potential of the core profile, by allowing the removal of opposing step or hinge terminations.

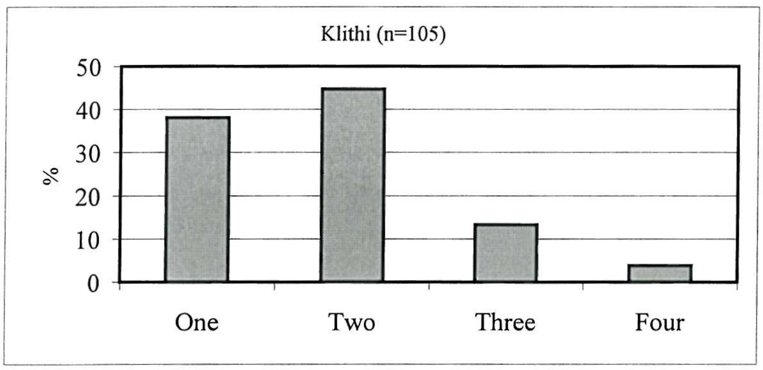


Figure 4.7. Number of platforms.

Platform preparation

A significant proportion of platforms had been modified through trimming, and to a lesser extent as facetting, or a conjunction of both (fig.4.8). Trimming consists of light chipping across the platform perimeter in order to remove acute brittle edges. This allows the hammer blow to be accurately placed further back from the platform edge, so limiting crushing and allowing the shock to be transmitted down the axis of the core. Trimming tends to be strongly associated with blade/bladelet core working (Whittaker 1997:223).

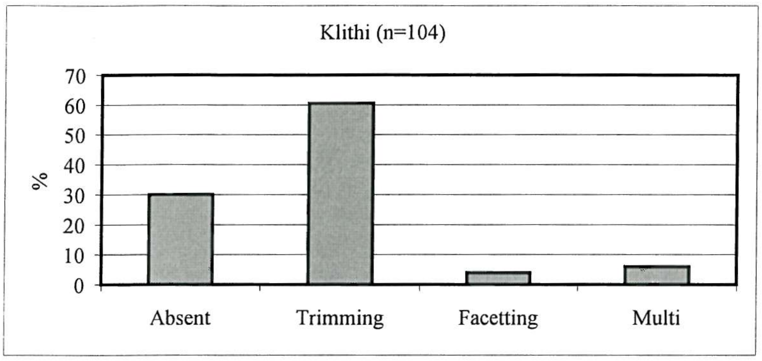


Figure 4.8. Types of platform maintenance.

Direction of flaking

The predominance of longitudinal removals suggests that once the main striking platform was set up, the most effective way in which to maintain the core was to continue working along the long axis (fig.4.9).

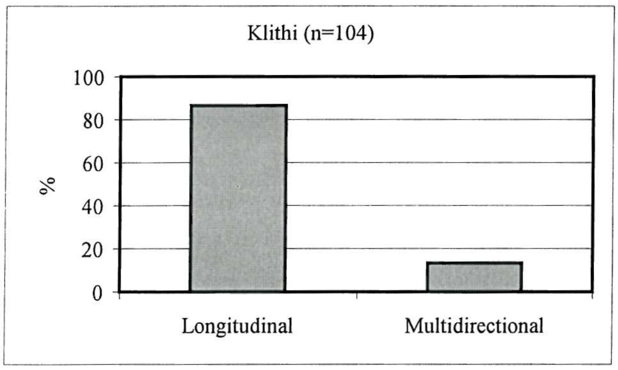


Figure 4.9. Flaking direction.

This again reflects the predominance of conical blade cores at Klithi, and the fact that the most efficient way to maintain core productivity is not the addition of more platforms and multiple removal directions, but through maintaining the original longitudinal set-up.

Cortex proportions

Most cores at Klithi had at least some remnant cortex (fig.4.10). The amount of cortex can be used to provide an index of working intensity. Less cortex would generally equate to more extensive use, and by implication, probably a greater interval between raw material collection and core discard. However, the proportions observed are difficult to interpret in isolation. In chapter 7, cores are compared between all three sites, and cortex proportions interpreted accordingly. However, it needs to be remembered that raw material starting configurations will play a part in determining how much cortex remains when the core is abandoned. Larger raw materials will have more cortex removed prior to the core being abandoned on the basis of size. At Klithi, the poor quality and small size of raw materials meant that relatively more cores retained cortex up until the point at which they were discarded on the basis of size.

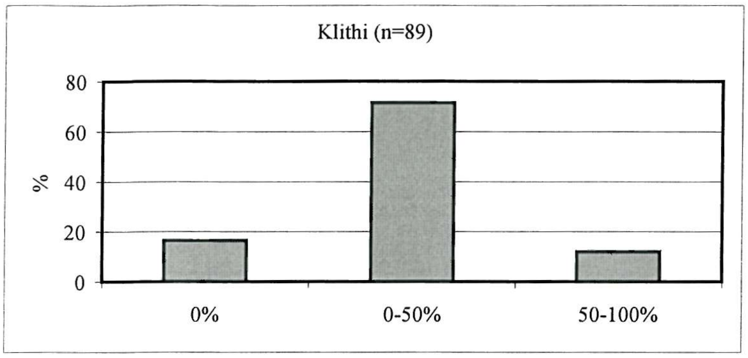


Figure 4.10. Cortex proportions.

Reasons for core discard

The majority of cores were abandoned at the point at which they became too small to hold. Also included in this category were those cores with step and hinge fractures, and which once rejuvenated would have been prohibitively small. In addition to size, cores were abandoned due to raw materials, in particular internal fractures. In a series of replication experiments, Adam (1989:226) found that the majority of cores failed very early in the knapping cycle due to internal flaws and shattering. A total of nine (8.6%) cores were abandoned for no apparent reason, whether cached or simply no longer needed.

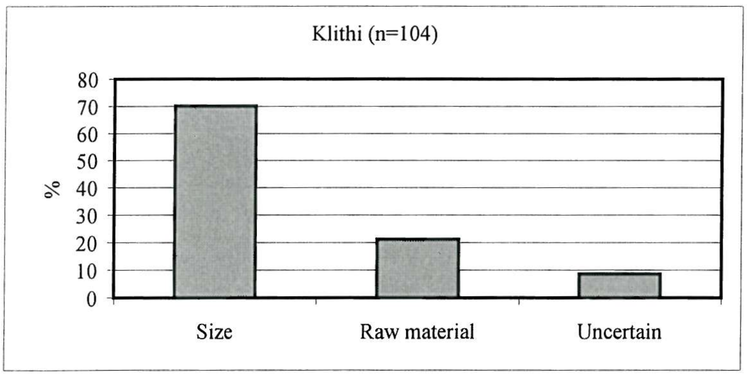


Figure 4.11. Reasons for core discard.

Amongst the small sample of cores made on raw materials other than those derived from the Voidomatis, there was some evidence for a different picture in terms of abandonment. Of the seven pieces identified, four (57.1%) were discarded because of size, and the remaining three (42.8%) for no apparent reason. Although a contradiction in terms of expectations as to how local and exotic raw materials were used, the effect of very small sample size must be considered, particularly since the collections collate many different parts of the site and an extensive chronology.

4.4.4. Primary, secondary and inner proportions

The proportions of primary, secondary and inner debitage and tools are listed in table 4.5 and illustrated in figure 4.12.

Table 4.5. Primary, secondary and inner proportions of debitage and tools.

Debitage and tools	Number (n=4130)
Primary	83 (2.0%)
Secondary	1789 (43.3%)
Inner	2258 (54.7%)

Key: Primary: the very first removal covered entirely by natural cortex.
Secondary: removals covered partly by natural cortex.
Inner: removals lacking natural cortex.

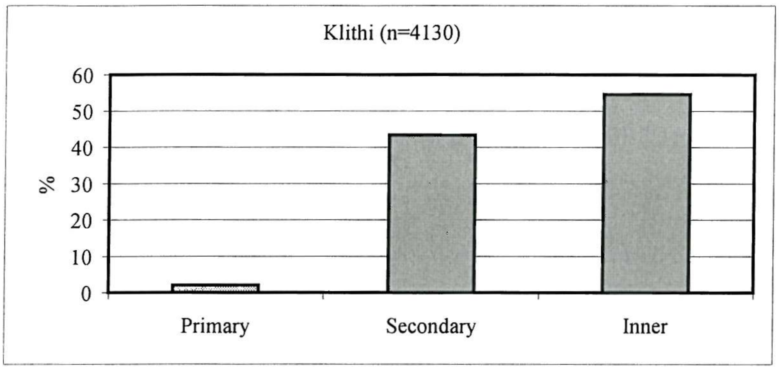


Figure 4.12. Primary, secondary and inner proportions of debitage and tools.

The relatively high proportion of secondary material suggests that both unworked nodules and minimally worked cores were being carried into the site. In a series of experimental assemblages based on rolled flint pebble raw materials, Marshall (1997) found that the proportions of primary, secondary and inner debitage followed, within reason, a broadly predictable pattern despite initial pebble size. He found that clearly identifiable primary flakes accounted for just 2% of debitage, and in most cases less, while secondary material comprised between 20% and 40%, and inner between 60% and 80%. At Klithi, secondary material comprised just over 43% of the collection. This relatively high secondary frequency suggests that raw materials were probably being introduced as minimally worked pebbles. The relatively small size of the nodules and poor quality thereof probably led to even higher secondary frequencies, while inner material is relatively more likely to have been removed from the site as tools and cores.

An alternative possibility is that this picture may be distorted by the fact that blanks of local and exotic raw materials were examined together. It is reasonable to assume that exotic raw materials, because they were transported over longer distances, are more likely to represent later stages of the core reduction sequence. In order to explore this possibility, the proportions of primary, secondary and inner made of local and non-local raw materials were investigated (tbl.4.6 and fig.4.13).

Table 4.6. Proportions of primary, secondary and inner blanks made of local and exotic raw materials.

Debitage and tools	Local (n=3598)	Exotic (n=402)
Primary	84 (2.3%)	1 (0.2%)
Secondary	1364 (38.0%)	119 (29.6%)
Inner	2150 (59.7%)	282 (70.1%)

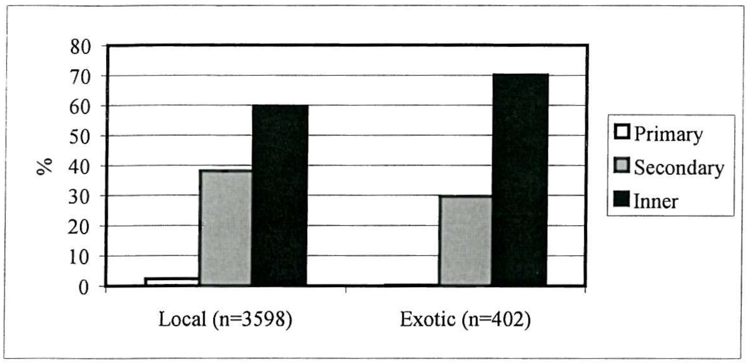


Figure 4.13. Proportions of primary, secondary and inner amongst local and exotic raw materials.

The proportions of primary, secondary and inner amongst local and exotic raw materials differed by approximately 10%, with as expected, more inner material made of non-local raw materials. The fact that the differences in secondary and inner proportions between local and exotic raw materials were not larger, suggests that the source of the latter may not be very far from the rockshelter, and so its collection and use could have been included in broadly the same range of provisioning strategies as Voidomatis flint. Only further survey in the region will provide an answer. An alternative and probably more likely explanation is that exotic raw materials were being introduced at later stages in the knapping sequence, but that the frequencies observed were biased by the fact that better quality inner exotic material is relatively more likely to have been carried out of the site again. Therefore, it is likely that the proportions of inner exotic material introduced into the site would have been relatively higher than the discarded residues would suggest.

4.4.5. Flake, blade and bladelet proportions

As discussed in section 4.4.3, the majority of cores from Klithi displayed flake scars which suggests that flakes rather than blades or bladelets were the primary knapping objective. This was also confirmed by the proportions of flakes identified in the assemblage, with 64% of recorded pieces (tbl.4.7 and fig.4.14).

Table 4.7. Proportions of flakes, blades and bladelets.

	Debitage (n=3140)	**Tools (n=990)**
Flakes	2008 (63.9%)	356 (36.0%)
Blades	280 (8.9%)	129 (13.0%)
Bladelets	809 (25.8%)	492 (49.7%)
Atypical	43 (1.4%)	13 (1.3%)

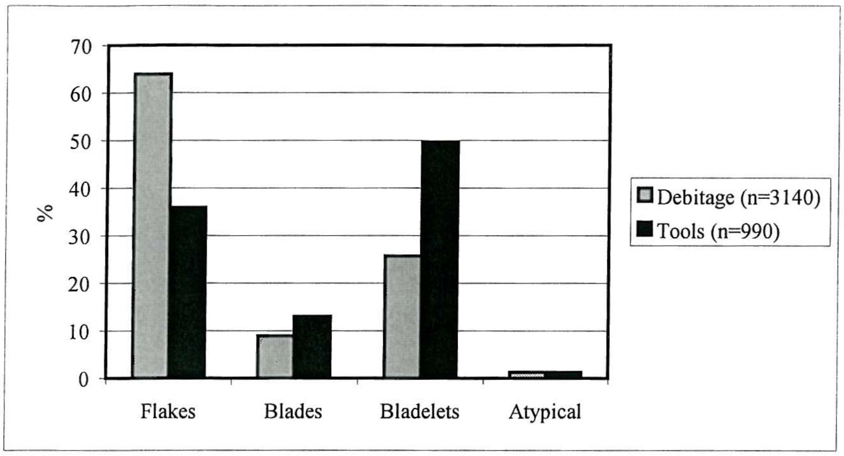


Figure 4.14. Proportions of flakes, blades and bladelets.

However, the picture was reversed amongst tools, where bladelets appear to have been the preferred blank. The reasons for this are self evident, bladelets and blades with linear sharp edges are much easier to transform into tools.

4.4.6. The tool inventory

The lithic assemblage contained eight tool categories, numbering a total of 990 artefacts (tbl.4.8 and fig.4.15). Of these, 835 (84.3%) were made on local flint, 120 (12.1%) of exotic flint and 35 (3.6%) had been patinated or altered due to thermal action to the extent that their origin was unclear. The typologies applied were based on schemes applied elsewhere on Upper Palaeolithic lithic technologies of the Eastern Mediterranean, for instance by Tixier (1963) and de Sonneville and Perrot (1954, 1955a,b, 1956).

Table 4.8. The tool inventory from Klithi.

Tool groups	Number of pieces
Artefacts with backed retouch (included shouldered bladelets and geometric microliths)	419 (42.3%)
Artefacts with linear retouch	156 (15.7%)
Atypical retouched artefacts	12 (1.2%)
Notches/Denticulates	125 (12.6%)
Truncations	33 (3.3%)
Scrapers/Composite tools	97 (9.8%)
Borers	33 (3.3%)
Burins	115 (11.6%)
Total	**990**

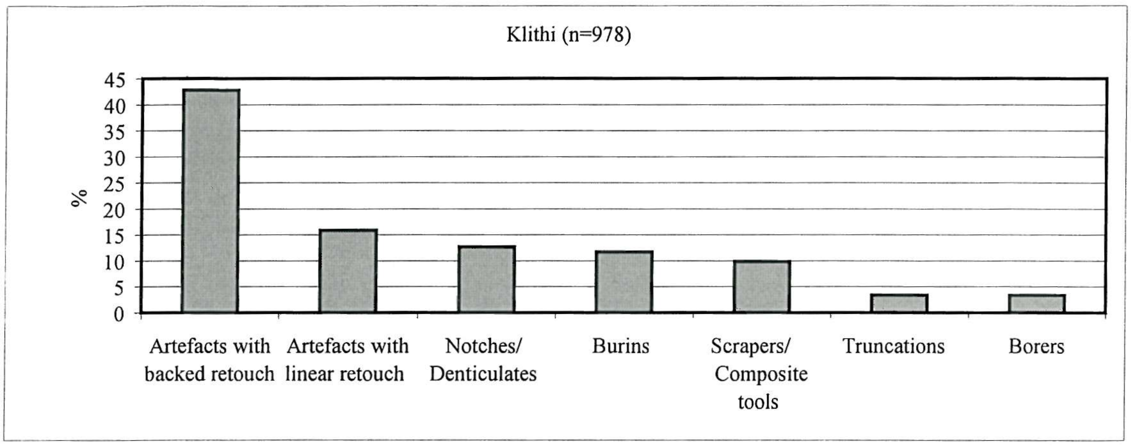


Figure 4.15. The tool inventory from Klithi.
Atypical pieces were omitted due to very small sample size.

In order to avoid large numbers of subgroups, tools with broadly similar morphological characteristics, for instance notches/denticulates or end and sidescrapers, were grouped together. Furthermore, those that could not be safely attributed to any one category were grouped as atypical. The largest tool category was backed artefacts, while all the others were present at very much lower frequencies. Despite generally lacking retouch, burins were included as tools since micro-wear analysis done on the Klithi artefacts as well as from other sites has suggested that they had a functional role (Ibáñez-Estévez and González-Urquijo 1996; Moss 1997). Of the 419 **backed artefacts**, 68 (16.2%) were made on flakes, 10 (1.2%) on blades, 338 (80.6%) on bladelets, while three (0.7%) were geometric microliths, two scalene and one rectangular (see Roubet 1997b:176 regarding the rarity of geometric microliths at the site). Three (0.8%) of the 338 backed bladelets were shouldered. Most had abrupt, crossed abrupt or semi-abrupt retouch along their lateral edges, proximal or distal ends. In the latter case, backed pieces were considered as truncated. Often, when one edge was covered by backed retouch, the other had inverse low angle retouch. As suggested by Adam (1989:239), this was used to remove the bulb of percussion. A small proportion of the backed pieces (20.5%, n=80) were pointed on one or on both ends. Out of 153 **artefacts with linear retouch**, 91 (58.3%) were on flakes, twenty-two (13.6%) on blades and forty-three (28.5%) on bladelets. Most displayed low angle retouch along their lateral sides, proximal or distal ends.

Out of **125 notches/denticulates**, 69 (55.2%) were made on flakes, and 56 (44,8%) on blades or bladelets. They were often found in conjunction with other tools such as artefacts with linear retouch, backed artefacts or burins. The location, direction and nature of retouch varied considerably, found on the edges or ends of the artefacts. The direction of retouch was direct, inverse or alternating, while it varied from abrupt to semi-abrupt and to a lesser extent, low angle. Of 33 **truncations**, 21 (63.6%) were made on flakes and twelve (36.6%) on blades or bladelets. As in the case of notches/denticulates, retouch varied in terms of location, direction and nature. Of 97 **scrapers**, 46 (47.4%) were made on flakes, 39 (40.2%) on blades and 11 (11.3%) on bladelets. A single scraper (1%) was made on a core. Scrapers were classified as single or double endscrapers, single or double sidescrapers, or end-side scrapers. They were rarely found in conjunction with other tool types, such as notches/denticulates, artefacts with linear or backed retouch or burins. According to Tixier (1963), scrapers in conjunction with burins comprise composite tools. The length of retouch varied between 0.8mm and 16.3mm, with a mean of 4.8mm (SD 2.7mm).

Of 33 **borers**, 23 (69.6%) were made on flakes, 21 (21.2%) on blades and three (9%) on bladelets. Retouch was mainly along the lateral or oblique edges, with less on either the distal or proximal ends. Retouch was mainly direct and to a lesser extent alternating or inverse. The nature of retouch was predominantly low angle, although with some abrupt and semi-abrupt. Out of the 33 borers, only two (6%) had retouched butts. Of 115 **burins**, 60 (52.1%) were made on flakes, twenty-three (20%) on blades, 32 (27.8%) on bladelets. They were simple, dihedral or on truncations.

4.5. Metric analysis of the lithic assemblage

4.5.1. Introduction

The lithic assemblage has up until now been examined simply on the basis of its composition. The discussion now shifts to an analysis of its metric character.

4.5.2. Cores

The analysis of metric characteristics of the core sample from Klithi included length, platform width and breadth, platform circumference and the proportion of the platform circumference worked. The aim of the analysis is to investigate the intensity of core use. A summary of the characteristics of the sample is presented in table 4.9, and includes only complete cores which constitute 84% (n=89) of the total sample. Given the presence of cores made from both local and non-local flint, an analysis of the ways in which these cores were treated would be of interest. Unfortunately however, the sample size of complete exotic cores was small, consisting of just five pieces, and therefore the analysis was considered unviable. Consequently, in the following analysis all cores were considered together.

Table 4.9. Metric characteristics of the complete core sample.

	Klithi (n=89, 84%)
Local raw materials	n=84 (94.4%)
Exotic raw materials	n=5 (5.6%)
Length (mm)	
Minimum/Maximum	11.7/65.8
Mean (SD)	32.7 (10.6)
Platform width (mm)	
Minimum/Maximum	4.3/45.6
Mean (SD)	21.1 (8.6)
Platform breadth (mm)	

Minimum/Maximum	0.2/27.7
Mean (SD)	11.0 (6.8)
Percentage of platform worked (%)	
Minimum/Maximum	9.2%/100%
Mean (SD)	68.2% (23.2%)

Length

Core length was measured perpendicularly from the primary platform to the base. As shown in figure 4.16, the majority of cores from Klithi were between 25mm and 45mm in length, with a mean of almost 33mm. This accords well with the study by Shawcross and Winder (1997:186) in which a sample of 123 cores produced a mean of approximately 34mm. The significant decline in frequency of those cores less than 25mm in length, points towards a lower cut-off. Below this point, cores became either too small to hold, or alternatively the bladelets produced were too short to be useful.

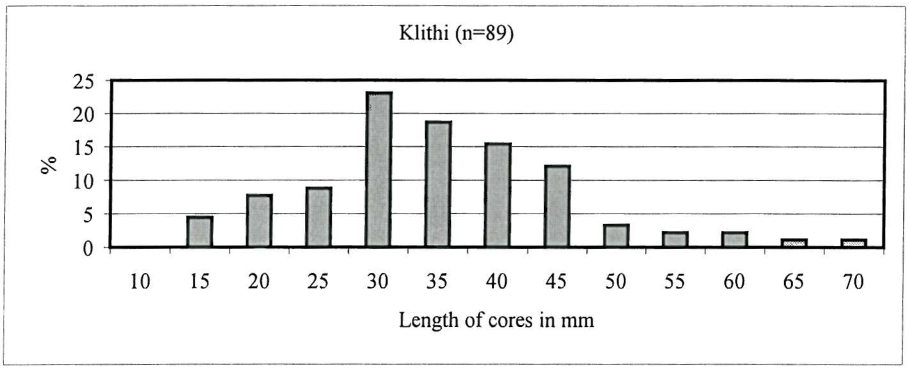


Figure 4.16. Length of all complete cores.

The presence of small numbers of cores of between 10mm and 25mm in length suggests that raw materials were being on occasion, quite extensively worked, although it is difficult to image what use the bladelets produced would have been. A small group of cores longer than 45mm had been discarded without having been exhausted. Two had been abandoned because of internal flaws, one because once rejuvenated, the core would have been prohibitively small, and one for no apparent functional reason.

Platform width

Width was measured across the longest diameter of the primary core. The main central tendency was between 15mm and 20mm, with a mean of just over 21mm (fig.4.17). The distribution was also suggestive of a bimodality, with a second peak in frequency at between 25mm and 30mm.

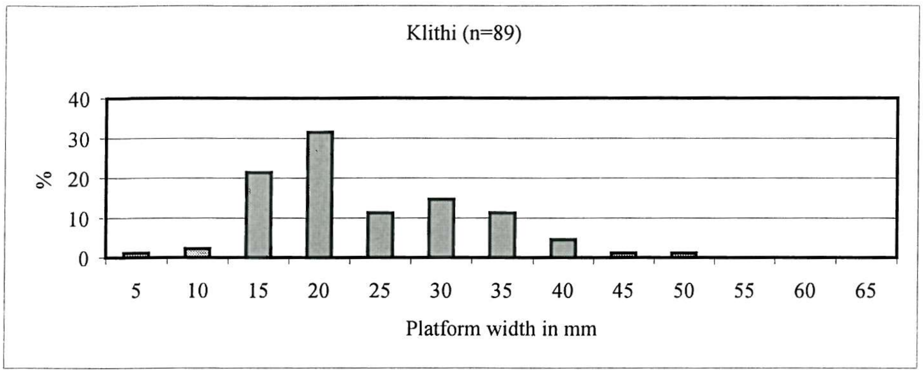


Figure 4.17. Width of all complete cores.

Platform breadth

Platform breadth was measured across the primary platform, perpendicular to platform width. Breadth was always the smaller dimension. The central tendency was between 10mm and 15mm with a mean of 11mm (fig.4.18). Unlike width there was no suggestion of a bimodality in the distribution.

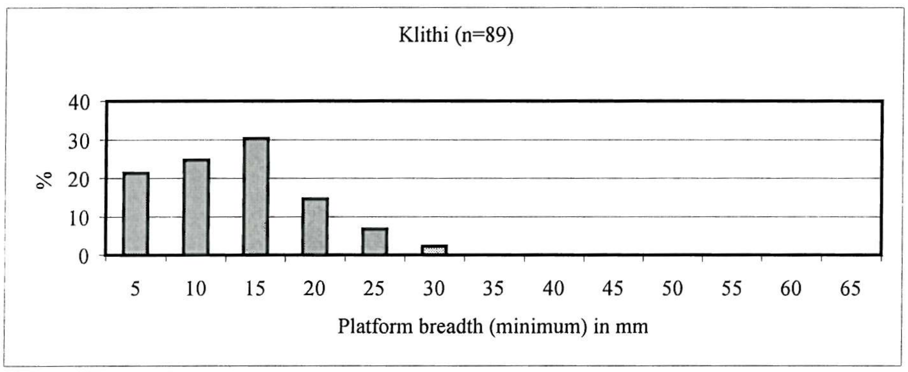


Figure 4.18. Breadth of all complete cores.

Two dimensional analysis, length against platform breadth

Plotting length against platform breadth in the scattergram (fig.4.19), the range of core sizes can be seen. Besides those with traditional platforms, an additional group of bifacial cores was also present. These tended to be larger overall, particularly longer than 35mm.

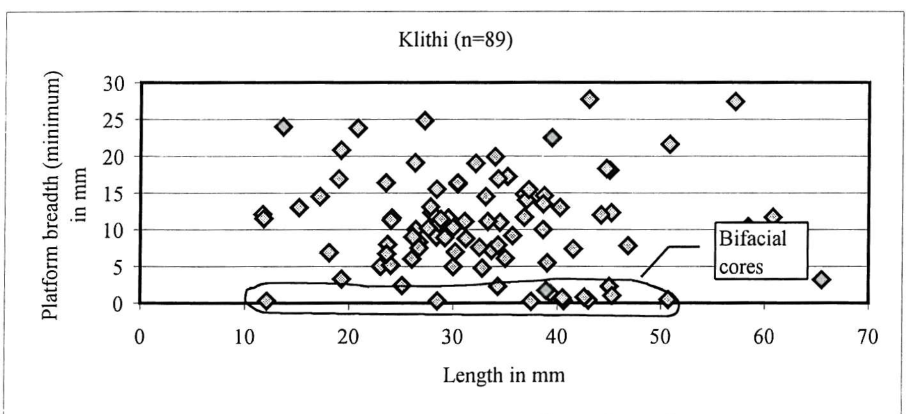


Figure 4.19. Length against platform breadth for all complete cores.

Two dimensional analysis, platform width against breadth

Platform width and breadth measure the broadest and narrowest axes across the platform respectively. As figure 4.20 suggests, cores from Klithi can be divided into three broad groups with regard to platform dimensions. The first group contains cores with the smallest platforms, many of which would have been very difficult to work effectively. The second group includes those with relatively large platforms, which probably could have been worked further. The final group includes what are referred to as bifacial cores. These have very narrow platforms, some less than one millimetre, consisting of an alternately worked sinuous edge.

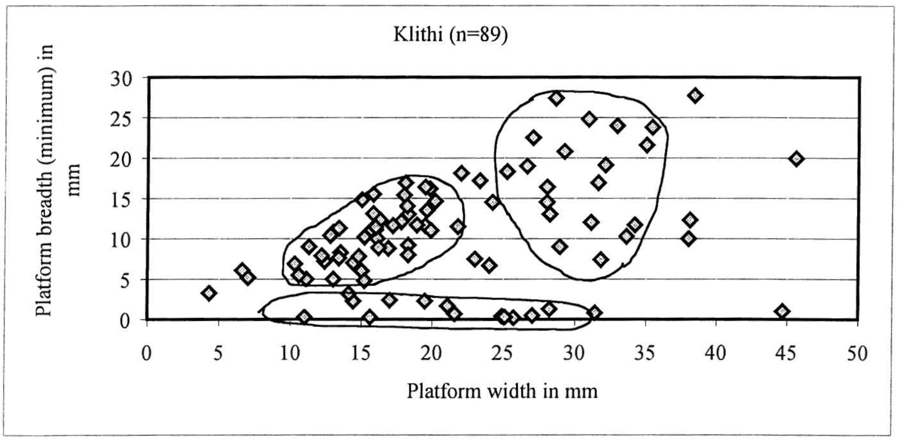


Figure 4.20. Platform width against breadth for all complete cores.

Platform working

Cores at Klithi (fig.4.21), tended to be less extensively worked, and in particular as will be seen in chapter 7, in comparison with both Franchthi and Kastritsa. On the face of it this suggests less extensive working of cores at Klithi, however it needs to be remembered that the raw materials used were small. The result of this was that less of the platform perimeter had been incorporated by the time the core had become too small to hold. On larger raw materials such as those used at the site of Kastritsa, more of the platform perimeter tended to be used prior to the core becoming too small to grasp.

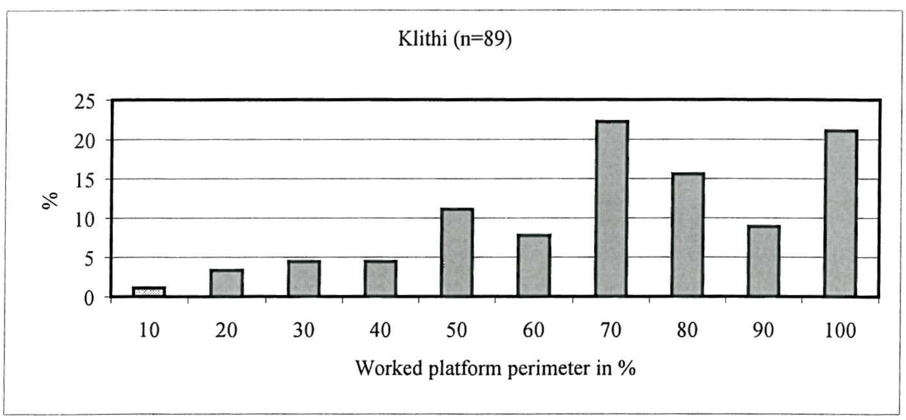


Figure 4.21. Proportions of platforms worked for all complete cores.

4.5.3. Debitage

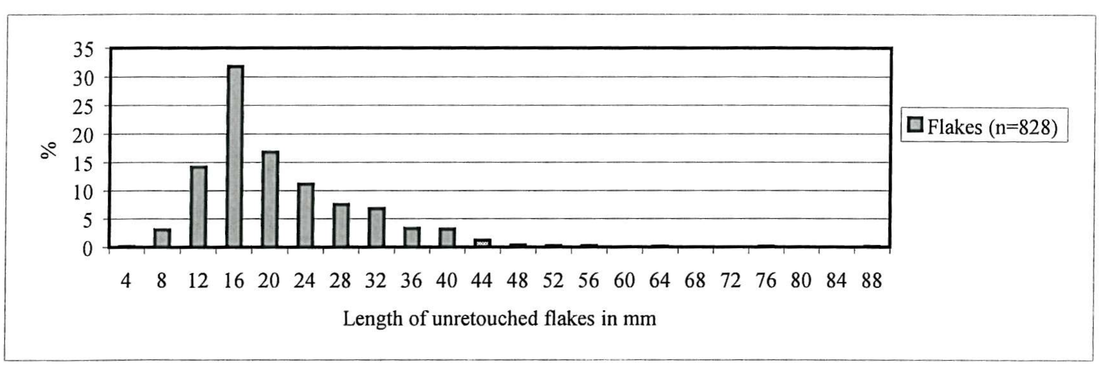
Debitage included all material over 10mm in minimum dimension, lacking any retouch, and which could be classified as flake, blade or bladelet based on the typological scheme applied in this research (see chapter 3). It should be noted that amongst a single class of material, for instance unretouched bladelets, the number of pieces included in the analysis of various dimensions will vary. This relates to the measurement of different dimensions depending on breakage patterns. For instance, blanks snapped midway can be used to provide measures for width and thickness but not for length. Basic dimensions including means, maximums and minimums (tbl.4.10), are used along with frequency histograms to discuss the metric character of the assemblage.

Table 4.10. Basic dimensions of unretouched debitage >10mm.

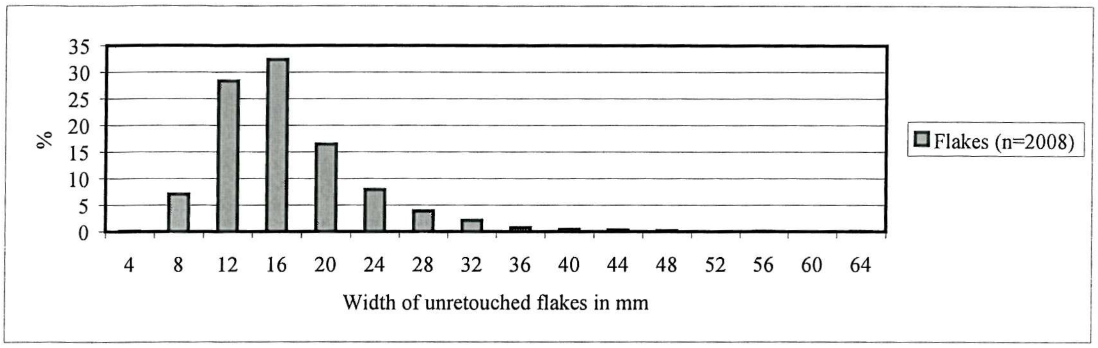
Dimensions in mm	**Length**	**Width**	**Thickness**
Flakes	**(n=828)**	**(n=2008)**	**(n=2008)**
Minimum/ Maximum	0.9/86.3	3.3/61.1	0.7/25.5
Mean (SD)	19.0 (9.0)	15.0 (6.1)	4.5 (3.0)
Bladelets	**(n=270)**	**(n=809)**	**(n=809)**
Minimum/ Maximum	10.1/47.6	2.1/12.0	0.8/12.4
Mean (SD)	20.6 (6.7)	8.0 (2.2)	3.3 (1.6)
Blades	**(n=80)**	**(n=280)**	**(n=280)**
Minimum/ Maximum	24.0/66.8	12.1/27.1	1.1/14.7
Mean (SD)	37.3 (8.1)	15.0 (2.5)	5.6 (2.7)

Flakes

The flake frequency distribution indicated a broadly normal distribution but with positive skewing for both length, width and thickness. Both length and width had similar central tendencies of between 12mm and 16mm, with a mean length of 19mm and width of 15mm. The longest flake was just over 86mm, and the shortest just less than one millimetre, in this case width was larger than 10mm, while the widest was just over 61mm.



a.



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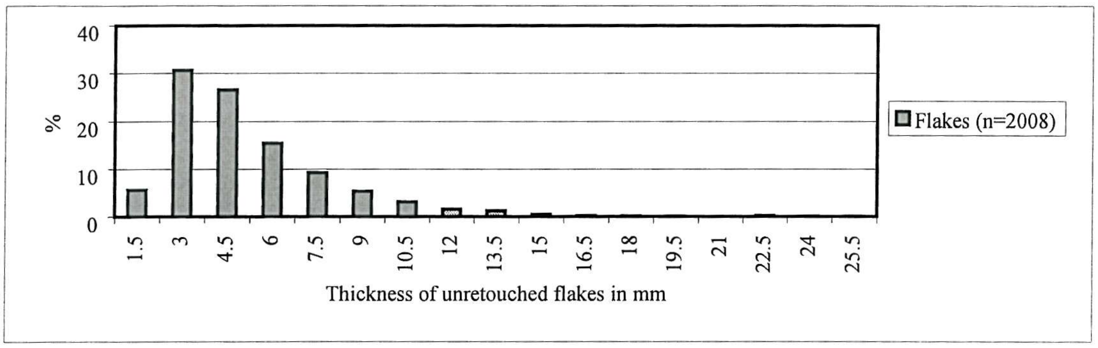


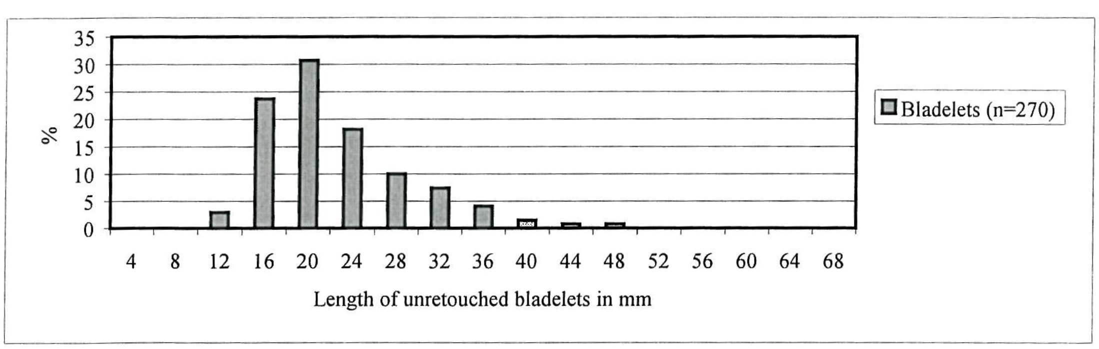
c.

Figure 4.22. Length (a), width (b) and thickness (c) of unretouched flakes.

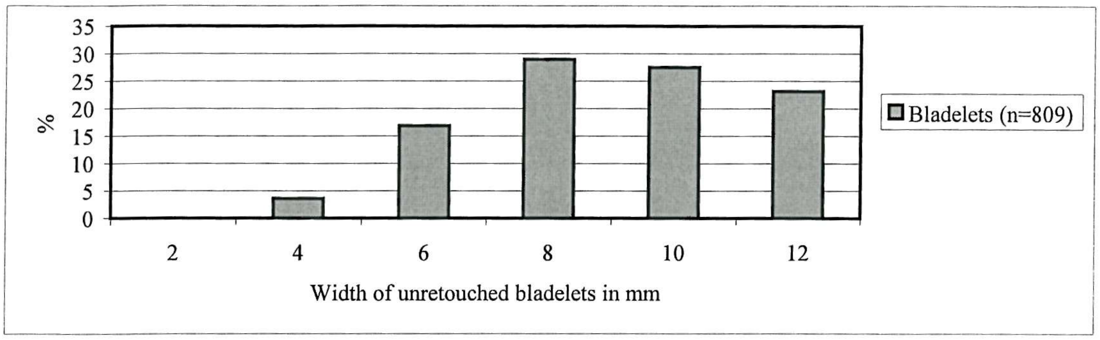
The thickness frequency histogram had a central tendency of between 1.5mm and 3mm and mean of 4.5mm. The significant jump in frequency of pieces thicker than 1.5mm is a result of the removal of flakes less than 10mm, which tended to be less than 1.5mm in thickness, so accounting for their apparent absence. A small number of primary flakes (12%, n=22) were present, all of which were over 30mm long. Primary flakes tend to be larger as they are removed early in the life of the core, often in order to create the initial striking platform (see for instance Adam 1989:226). As flaking continues, the size of core decreases, and so too will the flakes produced.

Bladelets

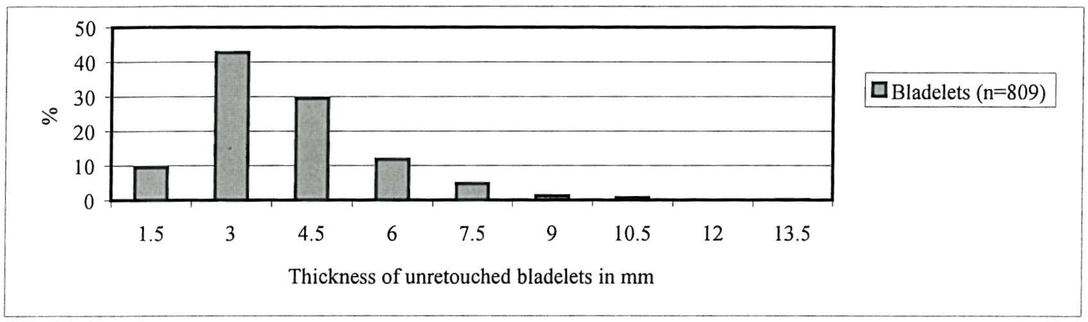
The bladelet length frequency distribution indicated a broadly normal distribution but with positive skewing. It had a central tendency between 16mm and 20mm, with a mean of 20.6mm. The longest bladelet was 47.6mm and the shortest just over 10mm.



a.



b.



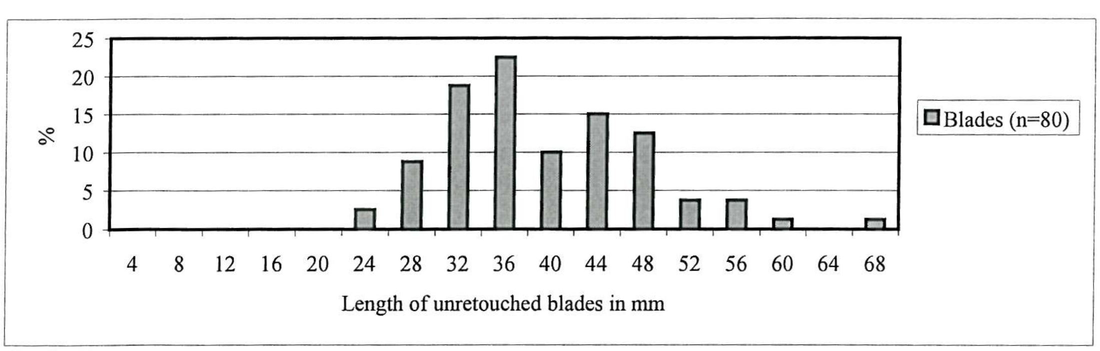
c.

Figure 4.23. Length (a), width (b) and thickness (c) of unretouched bladelets.

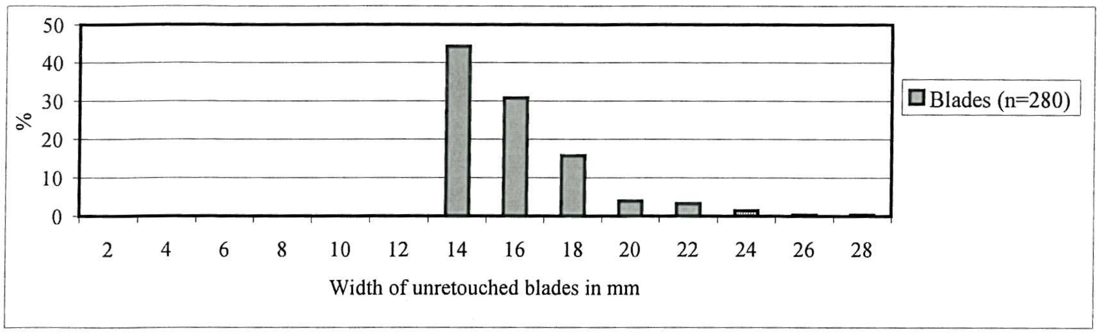
The frequency histogram for bladelet width was limited by the upper bladelet width cut-off of 12mm. There was a central tendency of between 6mm and 8mm, with a mean of 8mm, and a maximum and minimum of 12mm and 2.1mm respectively. Bladelet thickness had a central tendency of between 1.5mm and 3mm, with a mean of 3.3mm, and a maximum and minimum of 12.4mm and 0.8mm respectively. The significant decline of bladelets thinner than 1.5mm is again due to removal of smaller pieces less than 10mm, which are more likely to be less than 1.5mm thick.

Blades

The blade length frequency distribution indicated a broadly normal distribution but with a possible bimodality. The central tendency of the first mode was between 32mm and 36mm, and between 40mm and 44mm for the second. The overall mean was 37.3mm, while the maximum and minimum lengths were 66.8mm and just over 24mm respectively. The width frequency distribution was non-normal because of the 12mm cut-off.



a.



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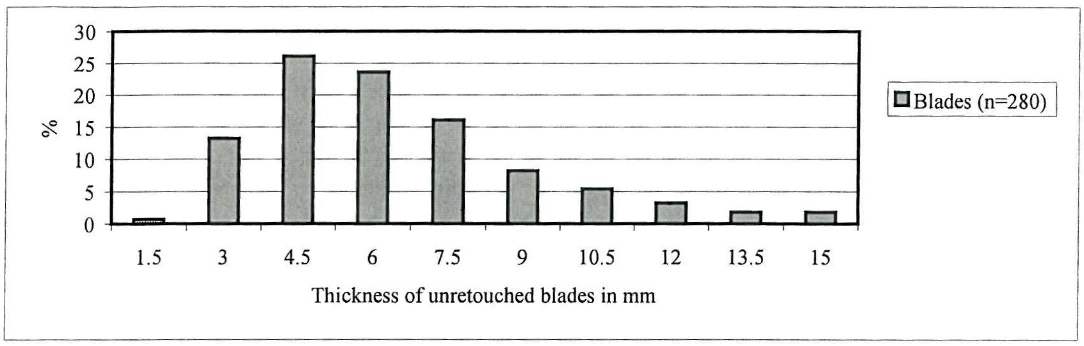


c.

Figure 4.24. Length (a), width (b) and thickness (c) of unretouched blades.

Blade thickness was normally distributed but positively skewed, with a central tendency of between 3mm and 4.5mm, with a mean of 5.6mm, and a maximum and minimum of 14.7mm and 1.1mm respectively.

Raw material use amongst debitage

Debitage was grouped on the basis of raw materials, as local or exotic, primarily on the basis of colour and texture. The aim was to identify any difference in their relative use for the manufacture of flakes, blades or bladelets, as well as in terms of dimensions. The proportions of both types are listed in table 4.11 and illustrated in figure 4.25. In this analysis, only debitage defined as local or exotic was included, irrespective of whether it was complete or broken. In the dimensional comparisons, only complete pieces were included.

Table 4.11. Debitage made on exotic and local raw materials (atypical excluded).

Debitage type	**Exotic**	**Local**	**Total**
Flakes	179 (9.2%)	1765 (90.8%)	1944
Blades	25 (9.2%)	246 (90.8)	271
Bladelets	85 (11%)	688 (89%)	773

All three debitage types showed a significant degree of similarity in terms of proportions of raw materials (fig.4.25). This indicates no obvious differentiation in terms of the range of blanks produced, despite that, as we saw earlier in figure 4.13 (section 4.4.4), exotic material had less cortex than local, suggesting that cores were being introduced in a more worked state.

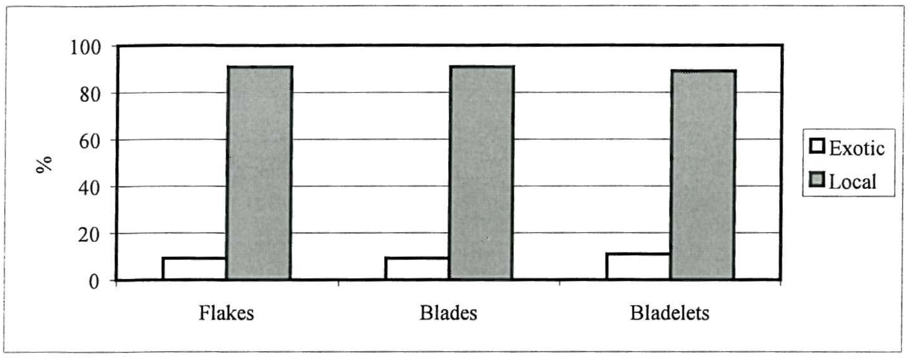


Figure 4.25. Proportions of unretouched flakes, blades and bladelets amongst exotic and local raw materials.

This lack of differentiation between local and exotic raw materials continued in the dimensional analysis of all three debitage types, although with some possible exceptions. For instance, exotic flakes tended to be slightly smaller than those made on local Voidomatis flint, in particular those less than 30mm in width and 35mm in length (fig.4.26). However in terms of length ($Dmax_{obs}=5.7<Dmax_{0.05}=16.1$) and width ($Dmax_{obs}=15.9<Dmax_{0.05}=16.1$), neither was significant.

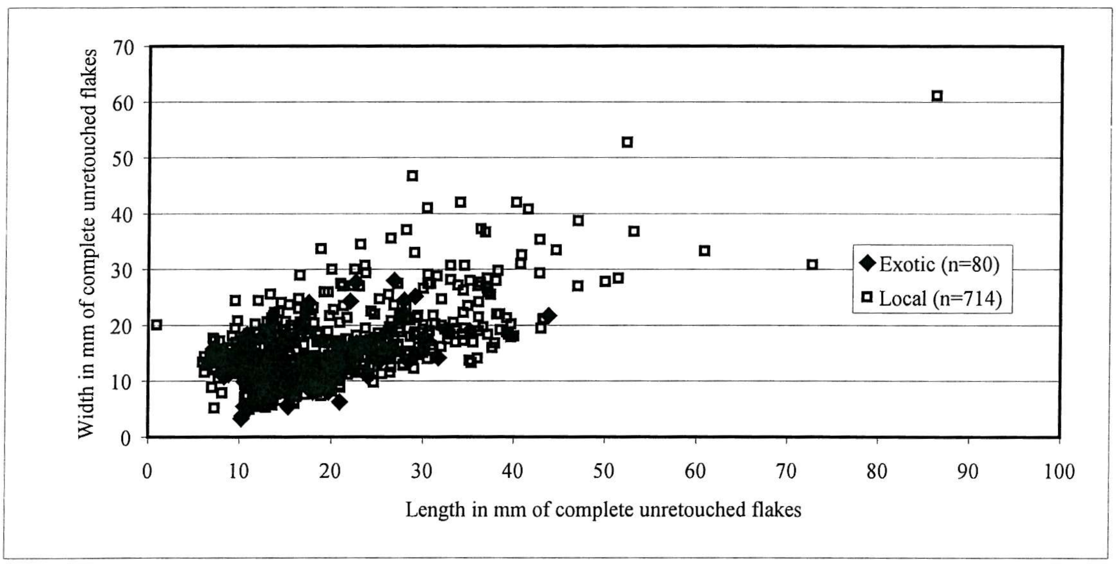


Figure 4.26. Length against width for complete flakes made of local and exotic flint.

Similarly, in the case of bladelets there was no obvious difference noted in the size distribution of exotic and local raw materials (fig.4.27), but bearing mind small sample size. Moreover, the KS test identified no significant difference in terms of length ($Dmax_{obs}=14.1<Dmax_{0.05}=28.1$) or width ($Dmax_{obs}=10.7<Dmax_{0.05}=28.1$).

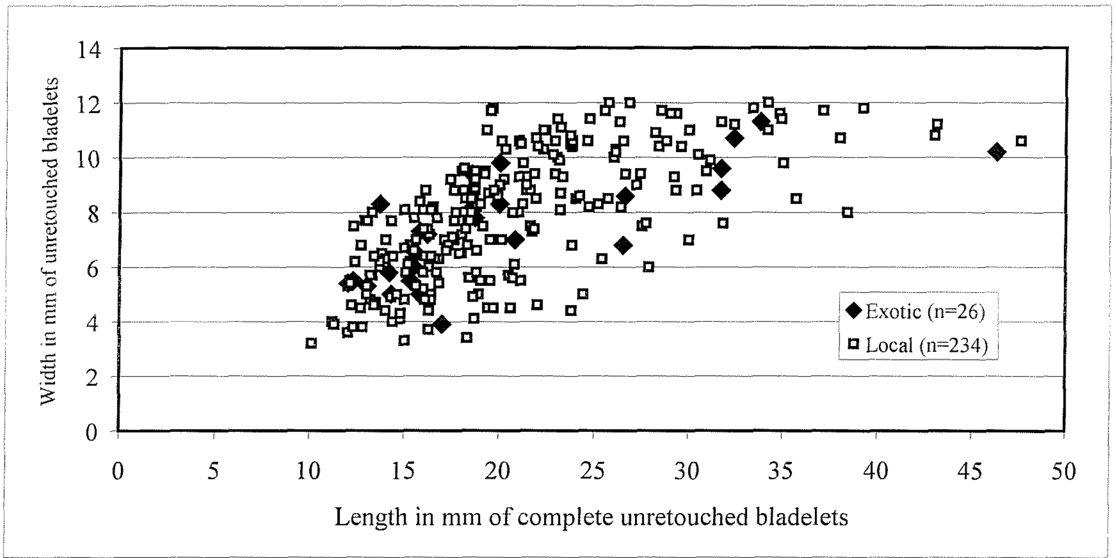


Figure 4.27. Length against width for complete bladelets made of local and exotic flint.

In the case of blades, and again bearing in mind small sample size, differences between local and exotic raw materials were minimal (fig.4.28). The KS test identified no significant difference in terms of length ($Dmax_{obs}=37.1<Dmax_{0.05}=50.8$) and width ($Dmax_{obs}=11.1<Dmax_{0.05}=50.8$). However, there was a slight suggestion, albeit based on a very small number of pieces, of a greater proportion of longer blades made of exotic raw materials, particularly those over approximately 42mm in length.

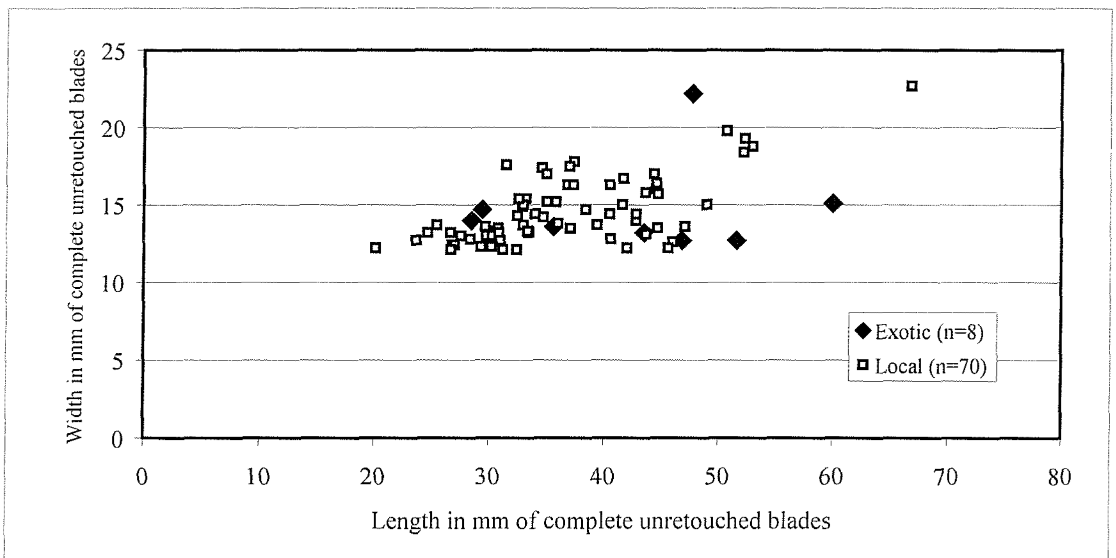


Figure 4.28. Length against width for complete blades made of local and exotic flint.

The analysis of raw material differences in the debitage assemblage pointed to only minimal variability in proportional use of either type. There was little obvious difference in dimensions, apart from the suggestion that exotic raw materials were being used to produce slightly narrower flakes and longer blades. However none of these differences were identified as significant by the KS test.

4.5.4. Tools

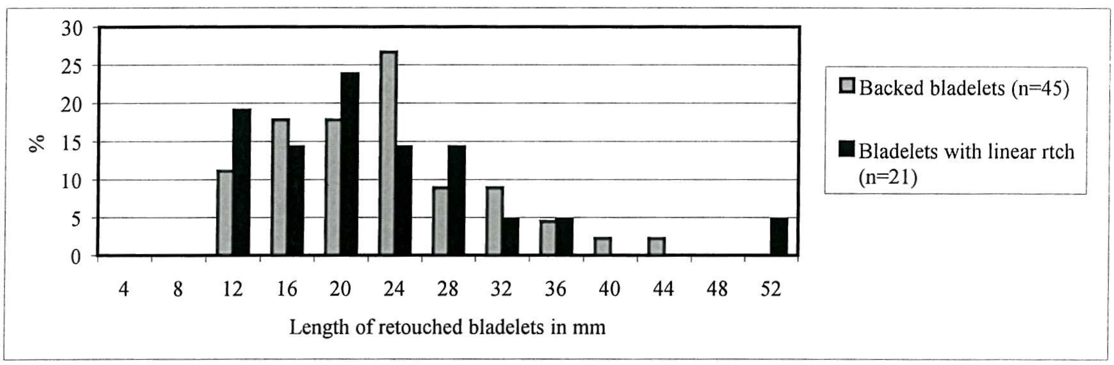
Tools included all retouched pieces as well as burins with or without secondary working. The approach used here was similar to that applied to debitage. In addition, the analysis including only those tools made on flake, blade or bladelet blanks, atypical artefacts were excluded. Dimensions measured on less than ten pieces, including geometric microliths and retouched blades in terms of length, were included in table 4.12, but not in the frequency histograms.

Table 4.12. Basic dimensions of tools.
(Different numbers of artefacts were used to measure the various dimensions depending on breakage patterns).

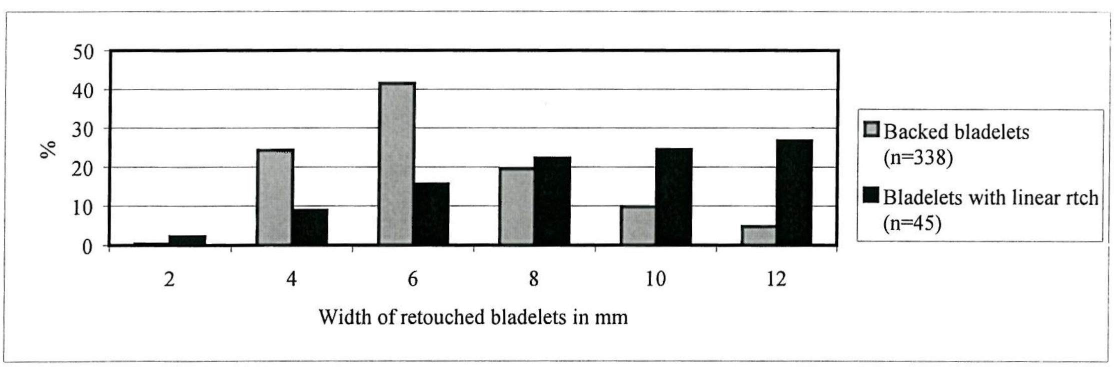
Dimensions in mm	**Length**	**Width**	**Thickness**
Backed flakes	**(n=34)**	**(n=68)**	**(n=68)**
Minimum/ Maximum	7.0/26.6	5.1/30.5	0.7/6.7
Mean (SD)	15.7(5.5)	12.0 (4.2)	3.1 (1.3)
Backed bladelets	**(n=45)**	**(n=338)**	**(n=338)**
Minimum/ Maximum	9.3/43.6	2.0/12.0	0.9/6.6
Mean (SD)	20.8 (7.4)	5.6 (2.0)	2.4 (1.0)
Backed blades	**(n=2)**	**(n=10)**	**(n=10)**
Minimum/ Maximum	27.0/38.7	12.2/19.0	2.3/9.3
Mean (SD)	32.8 (11.4)	15.1(2.8)	4.2 (2.1)
Geometric microliths	**(n=3)**	**(n=3)**	**(n=3)**
Minimum/ Maximum	9.6/23.5	6.6/8.3	1.9/5.5
Mean (SD)	17.8 (7.3)	7.5 (0.8)	3.5 (1.8)
Flakes with linear retouch	**(n=50)**	**(n=91)**	**(n=91)**
Minimum/ Maximum	3.2/62.8	3.5/42.1	1.1/14.4
Mean (SD)	19.1 (10.3)	14.1 (6.4)	4.4 (2.6)
Bladelets with linear retouch	**(n=21)**	**(n=45)**	**(n=45)**
Minimum/ Maximum	10.8/51.8	2.0/12.0	0.9/7.2
Mean (SD)	20.8 (9.5)	7.8 (2.8)	3.1 (1.4)
Blades with linear retouch	**(n=6)**	**(n=21)**	**(n=21)**
Minimum/ Maximum	27.1/44.4	12.2/22.6	1.8/8.5
Mean (SD)	37.3 (7.1)	16 (3.0)	5.5 (1.9)
Truncations	**(n=28)**	**(n=33)**	**(n=33)**
Minimum/ Maximum	6.6/51.5	4.2/21.8	1.1 /10.4
Mean (SD)	20.4 (10.8)	13.2 (4.2)	4.0 (1.8)
Notches/Denticulates	**(n=69)**	**(n=125)**	**(n=125)**
Minimum/ Maximum	10.6/56.8	4.0/45	1.3/13.4
Mean (SD)	28.2 (9.6)	15.8 (6.5)	4.6 (2.3)
Borers	**(n=26)**	**(n=33)**	**(n=33)**
Minimum/ Maximum	5.3/50.0	5.2/41.0	1.8/12.0
Mean (SD)	27.3 (10.5)	16.7 (7.8)	6.0 (2.6)
Burins	**(n=81)**	**(n=115)**	**(n=115)**
Minimum/ Maximum	8.4/61.3	4.1/35.5	1.1/16.1
Mean (SD)	27.0 (11.4)	14.1 (6.0)	5.0 (3.0)
Scrapers/Composite tools	**(n=39)**	**(n=97)**	**(n=97)**
Minimum/ Maximum	8.6/48.3	9.2/41.4	2.2/15.4
Mean (SD)	34.1 (8.5)	17.7 (5.0)	6.5 (2.3)

Blade/bladelet based tools (backed bladelets, bladelets with linear retouch, backed blades and blades with linear retouch)

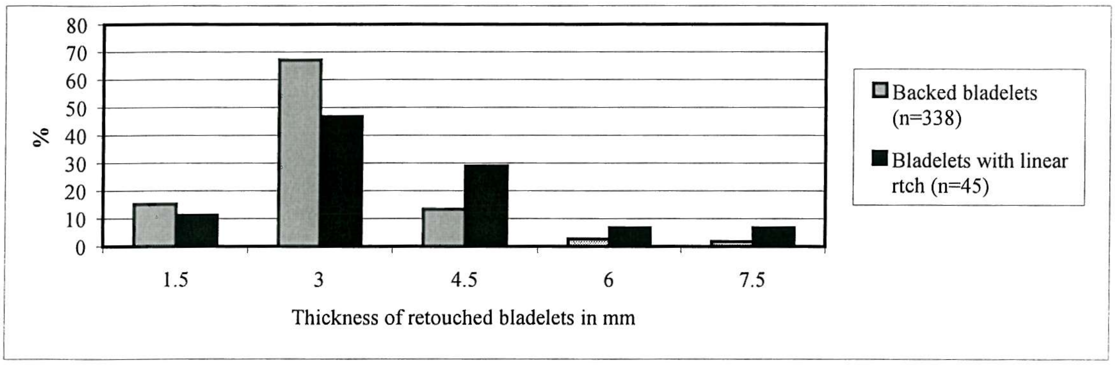
To reduce the numbers of graphs, the dimensions of bladelet or blade based tools were plotted on the same axes. The blade length frequency histogram was excluded due to small sample size. Backed bladelets had a length central tendency of between 20mm and 24mm, with a mean of 20.8mm and a maximum and minimum of 43.6mm and 9.3mm (fig.4.29). Bladelets with linear retouch had a central tendency of 16mm and 20mm, with a mean of 20.8mm, and a maximum and minimum of 51.8mm and 10.8mm. Amongst backed bladelets, there was a significant decline in frequency of pieces longer than 24mm suggesting either that this was an upper optimal length, or simply that this was as long as they could be made with the blanks available. There was an apparent although less spectacular decline in bladelets with linear retouch beyond 28mm, again suggesting either an upper usefulness limit or limitations imposed by raw materials. Both artefact types had a similar lower length cut-off of 8mm. This is unlikely to be a result of raw material limitations and probably represents a lower usefulness limit for both artefact types. This significant decline in frequency of backed bladelets longer than 24mm, compared to the more gradual decline noted for bladelets with linear retouch, suggests that length was more critical in the case of the former tools.



a.

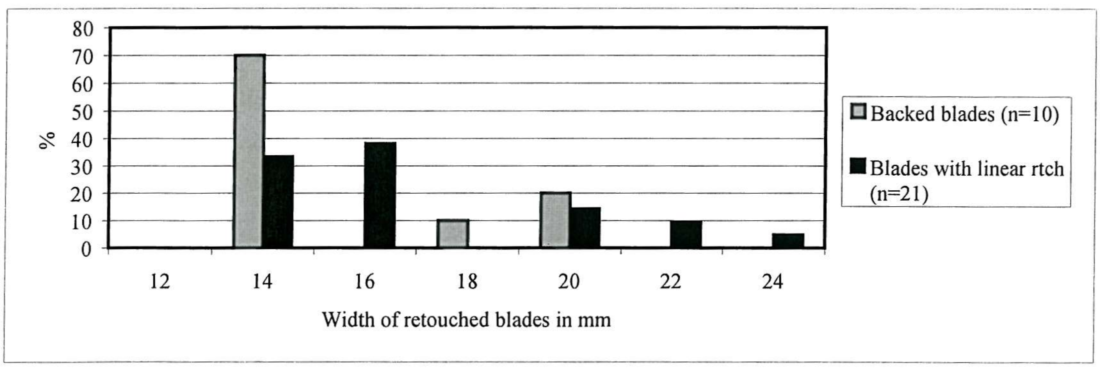


b.

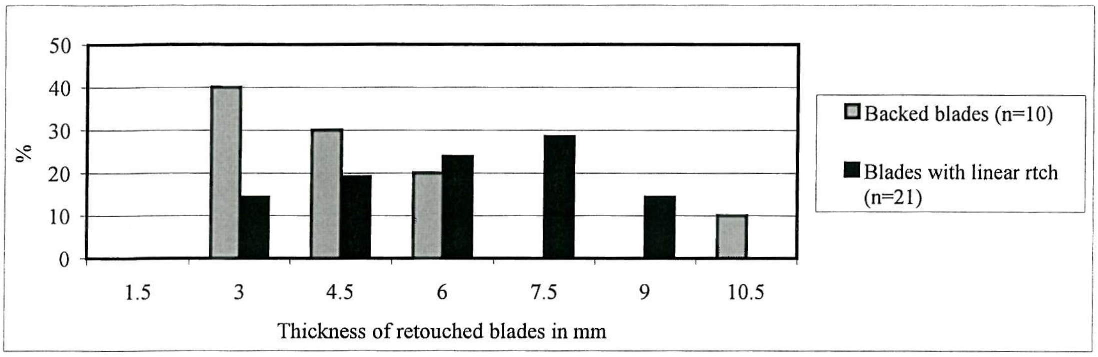


c.
Figure 4.29. Length (a), width (b) and thickness (c) of backed bladelets and bladelets with linear retouch.

Backed bladelets had a width central tendency of between 4mm and 6mm, with a mean of 5.6mm and a maximum and minimum of 12mm and 2mm. Bladelets with linear retouch had a central tendency of between 10mm and 12mm with a mean of 7.8mm and a maximum and minimum of 12mm and 2mm. The frequency histogram suggests that backed bladelets tended to be significantly narrower than bladelets with linear retouch, and also much less diffuse in terms of the range of widths present. The distribution suggested that the optimal backed bladelet width was between 2mm and 8mm. Backed bladelets had a thickness central tendency of between 1.5mm and 3mm, with a mean of 2.4mm and a maximum and minimum of 6.6mm and 0.9mm. Bladelets with linear retouch had a similar central tendency of between 1.5mm and 3mm with a mean of 3.1mm and a maximum and minimum of 7.2mm and 0.9mm. Both distributions were broadly similar although backed bladelets tended to be thinner than bladelets with linear retouch. Additionally, backed bladelets appeared more tightly clustered with 70% between 1.5mm and 3mm in thickness, compared to just over 45% of bladelets with linear retouch.



a.

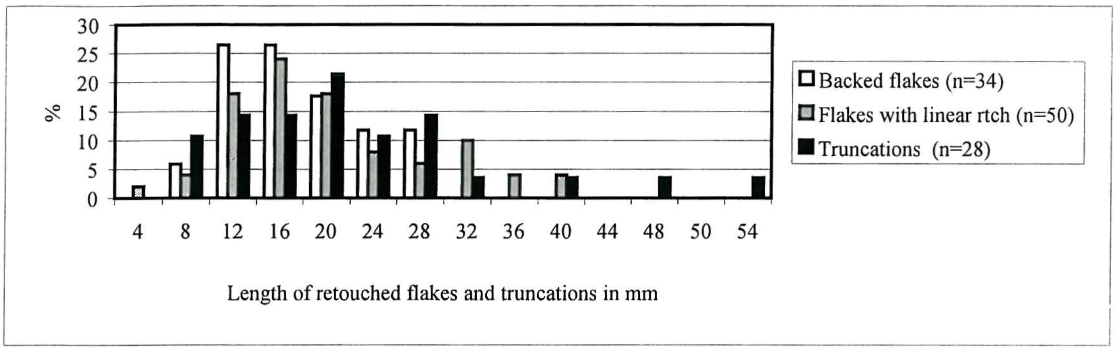


b.
Figure 4.30. Width (a) and thickness (b) of backed blades and blades with linear retouch.

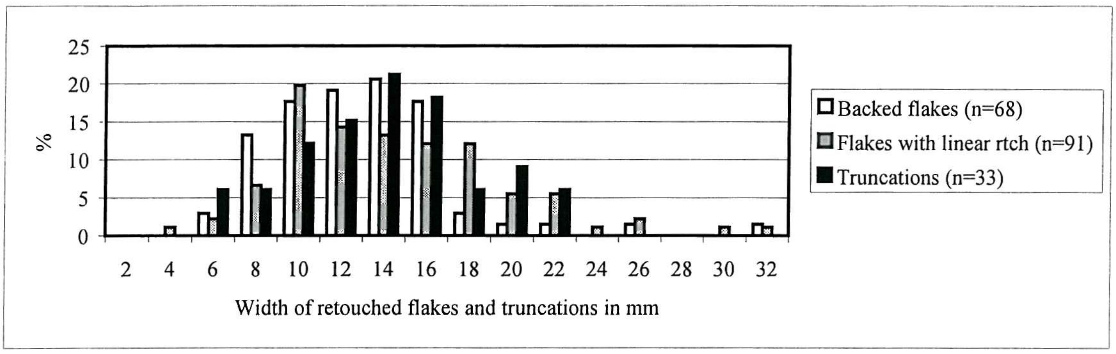
Blade based artefacts were not assessed in terms of length due to small sample size, and even in terms of width and thickness, assemblages remained small. The width distribution was irregular for both tool types, although with the suggestion that between 12mm and 16mm was the optimum or at least most common blade tool width (fig.4.30). Backed blades had a width central tendency of between 12mm and 14mm, with a mean of 15.1mm and a maximum and minimum of 19mm and 12.2mm. Blades with linear retouch had a central tendency of between 14mm and 16mm with a mean of 16mm, and a maximum and minimum of 22.6mm and 12.2mm. The presence of a small component of wider pieces was noted amongst blades with linear retouch. In terms of thickness, backed blades had a central tendency of between 1.5mm and 3mm, with a mean of 4.2mm and a maximum and minimum of 9.3mm and 2.3mm. Blades with linear retouch had a central tendency of between 6mm and 7.5mm with a mean of 5.5mm, and a maximum and minimum of 8.5mm and 1.8mm. Like backed bladelets, backed blades tended to be narrower and more tightly clustered than blades with linear retouch.

Flake based tools (backed flakes, flakes with linear retouch and truncations)

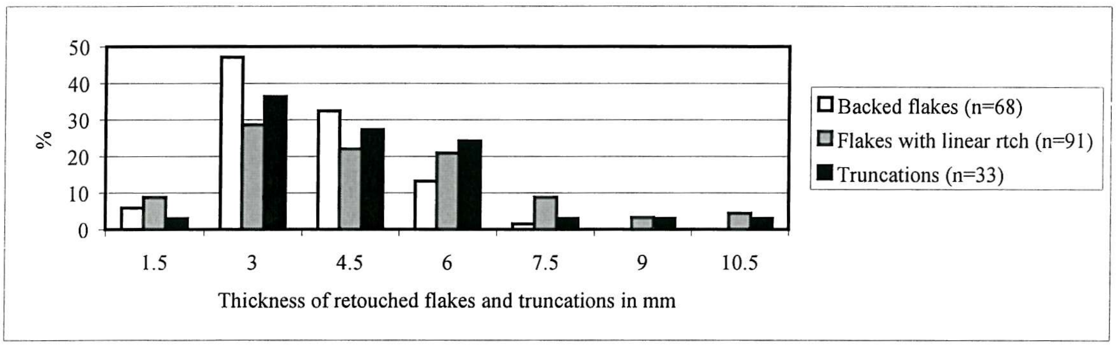
Backed flakes had a central tendency of between 8mm and 16mm, with a mean length of 15.7mm and a maximum and minimum of 26.6mm and 7mm (fig.4.31). The distribution was broadly normal in shape although with slight positive skewing. The complete lack of backed flakes longer than 28mm suggests an upper usefulness cut-off. Flakes with linear retouch had a similar central tendency of between 12mm and 16mm, with a mean of 19.1mm, and a maximum and minimum of 62.8mm and 3.2mm. The distribution was broadly normal in shape although again positively skewed. The significant drop-off in frequency beyond 20mm suggests an upper usefulness cut-off, although compared to backed flakes, flakes with linear retouch included some longer pieces, particularly those over 28mm and up to 40mm in length. This suggests tighter clustering for backed flakes. Truncations had a central tendency of between 16mm and 20mm, with a mean length of 20.4mm and a maximum and minimum of 51.5mm and 6.6mm. The distribution was positively skewed with some long pieces up to 56mm. The distribution appears to become more erratic beyond 24mm in particular. The possible bimodality at between 24mm and 28mm may suggest an additional component of longer pieces, however the effects of small sample size need to be taken into account here, with just 28 pieces measured in terms of length.



a.



b.



c.

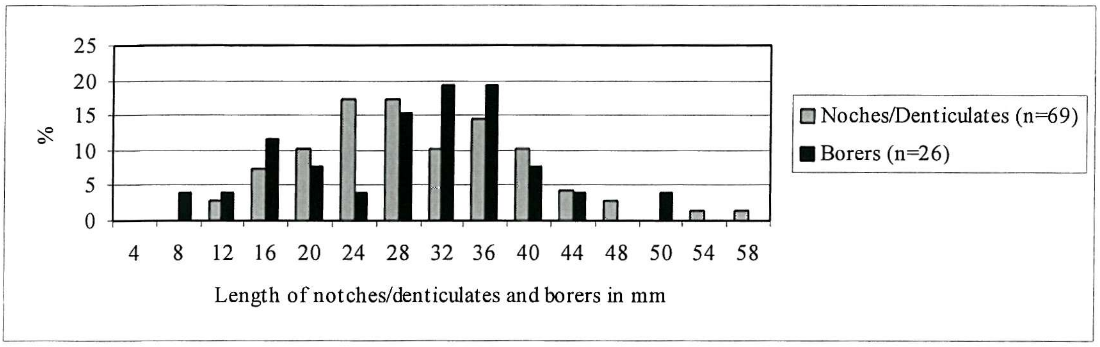
Figure 4.31. Length (a), width (b) and thickness (c) of backed flakes, flakes with linear retouch and truncations. Width outliers were omitted (see table 4.12).

Larger numbers of artefacts were measured in terms of width. Backed flakes had a central tendency of between 12mmmm and 14mm, with a mean of 12mm and a maximum and minimum of 30.5mm and 5.1mm. The distribution was broadly normal in shape, although with slight positive skewing with small proportions of wider pieces up to 32mm. The significant decline from approximately 17% to just 3% in backed flakes wider than 16mm suggests an upper usefulness cut-off. Flakes with linear retouch had a narrower central tendency of between 8mm and 10mm, with a mean of 14.1mm, and a maximum and minimum of 42.1mm and 3.5mm. The distribution was positively skewed and suggested that flakes with linear retouch were being made wider than backed flakes and in addition, were less tightly clustered. Truncations had a central tendency of between 12mm and 14mm, with a mean width of 13.2mm and a maximum and minimum of 21.8mm and 4.2mm. The distribution was broadly normal in shape although somewhat irregular in profile, probably because of the relatively small sample size, just 33 measures. Although truncations and backed flakes shared a similar central tendency, the distribution of the former tended to be wider, suggesting less clustering. The significant decline in frequency from 17% to 6% amongst truncations wider than 16mm may suggest an upper usefulness cut-off, similar to that observed amongst backed flakes.

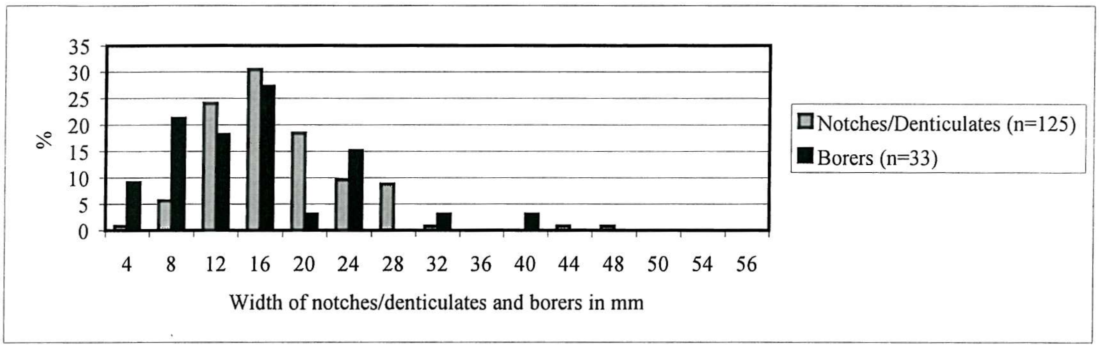
Backed flakes had a thickness central tendency of between 1.5mm and 3mm, with a mean of 3.1mm and a maximum and minimum of 6.7mm and 0.7mm. The distribution was positively skewed. Flakes with linear retouch had the same central tendency, with a mean of 4.4mm, and a maximum and minimum of 14.4mm and 1.1mm. Like backed flakes, the distribution was positively skewed. Truncations again had the same central tendency of between 1.5mm and 3mm, with a mean width of 4mm and a maximum and minimum of 10.4mm and 1.1mm. The significant decline in frequency of all three artefact classes for thickness of less than 1.5mm is probably due to functional reasons, with thinner too fragile to retouch and use. Additionally, there is an inter-relationship between surface area and thickness, with those less than 1.5mm thick also on the whole probably too small in plan. In effect, 1.5mm thickness represents a lower functional threshold in terms of the artefacts, as well as in relation to size interdependence. At the other end of the scale, backed flakes declined in frequency more rapidly beyond 4.5mm in thickness, suggesting that it was a more critical element in the manufacture of backed flakes than either flakes with linear retouch or truncations. However, all three declined significantly in frequency beyond 6mm, suggesting either that retouch was very much more difficult or the utility of these artefacts declined with thickness.

Notches/denticulates and borers

Notches/denticulates had a central tendency of between 20mm and 28mm, with a mean length of 28.2mm and a maximum and minimum of 56.8mm and 10.6mm (fig.4.32). There was a possible bimodality in the frequency distribution with a second peak at between 32mm and 36mm. Apart from this, the frequency distribution was fairly uniform without any significant jumps, suggesting a fairly broad spread of lengths amongst notches/denticulates, and therefore no real evidence for clustering. A similar bimodality was also suggested for borers, although the effects of smaller sample size need to be taken into account with only 26 pieces measured in terms of length. The central tendency was between 32mm and 36mm, with a mean of 27.3mm, and a maximum and minimum of 50mm and 5.3mm. Interestingly, this central tendency for borers corresponded with the apparent second peak for notches/denticulates. The first peak for borers was between 12mm and 16mm. These two peaks in frequency may simply represent an artefact of small sample size; alternatively they may suggest two groups of borers, the largest consisting of longer tools, along with a smaller group of shorter pieces. Although speculative, perhaps these reflect a hafted versus hand held dichotomy. As with notches/denticulates, the frequency distribution was fairly uniform without any significant jumps, suggesting a fairly broad spread of lengths amongst borers, and therefore no real evidence for clustering.



a.



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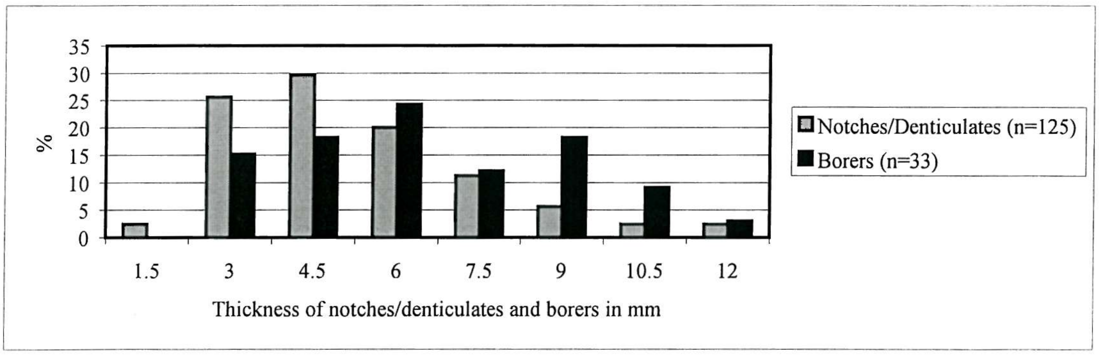


c.

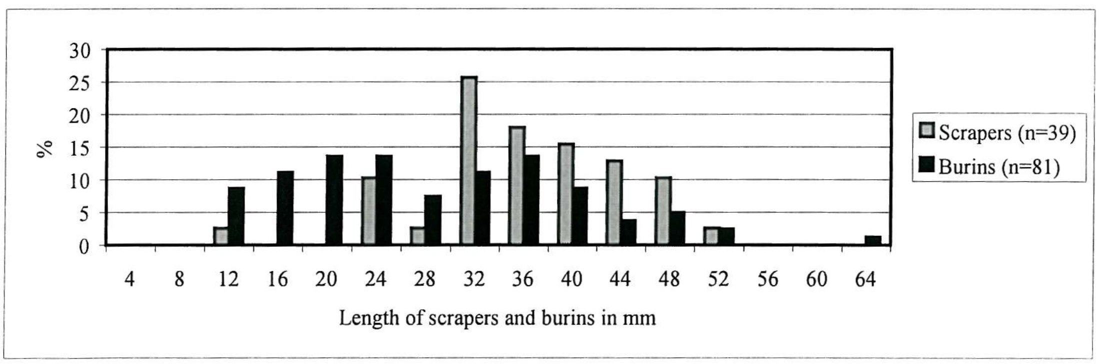
Figure 4.32. Length (a), width (b) and thickness (c) of notches/denticulates and borers.

Notches/denticulates had a width central tendency of between 12mm and 16mm, with a mean of 15.8mm and a maximum and minimum of 45mm and 4mm. The distribution was broadly normal in shape but with some limited positive skewing. The frequency distribution was fairly uniform without any significant jumps, suggesting a fairly broad spread of widths with no evidence for clustering. The central tendency for borers was between 12mm and 16mm, with a mean 16.7mm, and a maximum and minimum of 41mm and 5.2mm. The distribution was fairly irregular, probably reflecting relatively smaller sample size. The spread of the distribution suggested no real difference in terms of clustering.

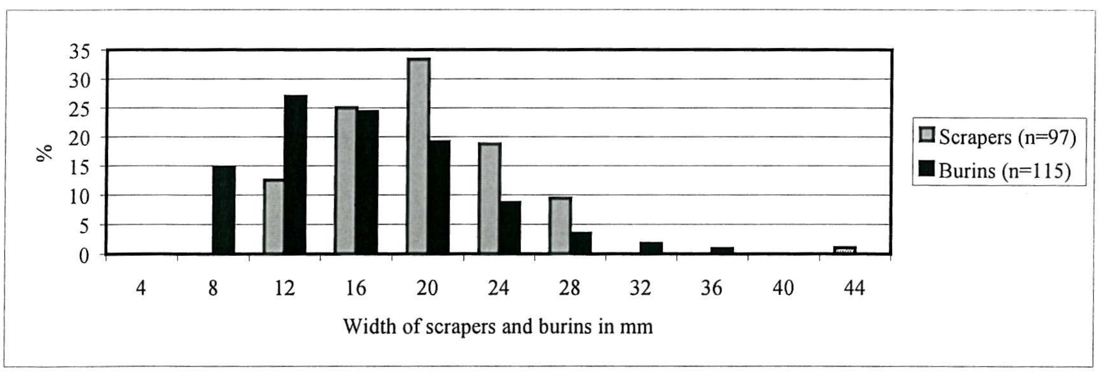
Notches/denticulates had a thickness central tendency of between 3mm and 4.5mm, with a mean of 4.6mm and a maximum and minimum of 13.4mm and 1.3mm. The distribution was positively skewed, but with most of the collection (70%) less than 6mm in thickness. The significant decline in frequency of notches/denticulates less than 1.5mm in thickness suggests a lower usefulness cut-off or simply that the blanks would have been too small overall. This lower cut-off was observed throughout the tool and debitage collections. The central tendency for borers was between 4.5mm and 6mm, with a mean of 6mm, and a maximum and minimum of 12mm and 1.8mm. Borers tended to be thicker than notches/denticulates, and also suggested a bimodality in the frequency distribution, the second peak centring on 7.5mm to 9mm. Borers declined to zero below 1.5mm in thickness. Despite borers being slightly thicker than notches/denticulates, there was no real evidence for differential clustering.

Scrapers and burins

Scrapers had a central tendency of between 28mm and 32mm, with a mean length of 34.1mm and a maximum and minimum of 48.3mm and 8.6mm. Apart from a small component between 20mm to 24mm, most of the scrapers were longer than 28mm. The significant increase in scraper frequencies beyond this point suggests a lower usefulness cut-off. In other words scrapers needed to be longer than this minimum to function effectively. This may represent a minimum length to which scrapers were made, or alternatively the point to which they were retouched and then discarded. The burin distribution was diffuse and appeared to be bimodal. The first peak was between 16mm and 24mm, and the second between 32mm and 36mm. The mean was 27mm, with a maximum and minimum of 61.3mm and 8.4mm. What this bimodality suggests is unclear, although again it may relate to a hafted hand held dichotomy. The distribution was diffuse compared to scrapers, which suggests less control of length.



a.



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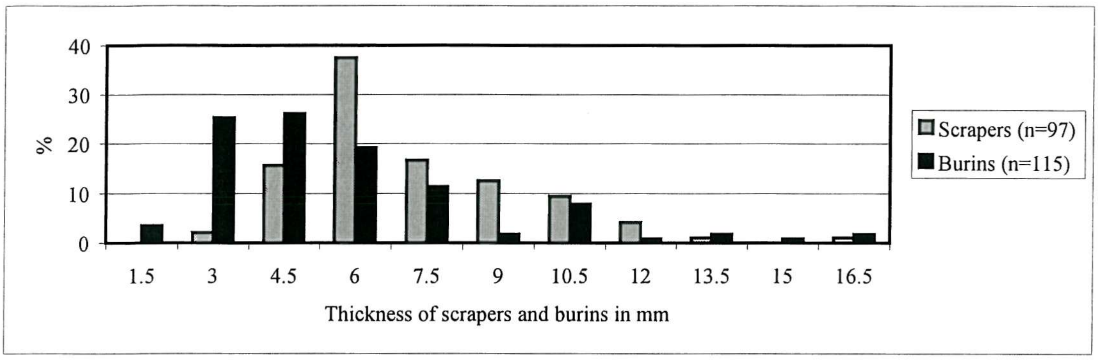


c.
Figure 4.33. Length (a), width (b) and thickness (c) of scrapers and burins.

Scrapers had a width central tendency of between 16mm and 20mm, with a mean width of 17.7mm and a maximum and minimum of 41.4mm and 9.2mm. Burins had a central tendency of between 8mm and 12mm, with a mean of 14.1mm, and a maximum and minimum of 35.5mm and 4.1mm. Both distributions were broadly normal, although burins were slightly more positively skewed. Burins also tended to be slightly narrower than scrapers, while also with a small component of wider outliers.
Scrapers had a thickness central tendency of between 4.5mm and 6mm, with a mean of 6.5mm and a maximum and minimum of 15.4mm and 2.2mm. Burins had a central tendency of between 1.5mm and 4.5mm, with a mean of 5mm, and a maximum and minimum of 16.1mm and 1.1mm. Both distributions were extensively positively skewed. Burins tended to be made on thinner blanks in particular those between 1.5mm and 4.5mm. Scrapers on the other hand were thicker, particularly over 3mm and 4.5mm. These differences may be explained in terms of potential differences in the use of these tools. Scrapers needed to be able to resist lateral pressure so needed to be thicker. Burins on the other hand as potential notching tools needed to be thin, with pressure distributed along the edge rather than across it.

Raw material use amongst tools

As with debitage, tools were grouped on the basis of raw materials, as either local or exotic. The aim was to assess whether there was any difference in their relative use for the manufacture of artefacts, as well as if any differences in dimensions could be identified. The proportions of both types are listed in table 4.13 and illustrated in figure 4.34. In this analysis, only tools attributed to local or exotic were included, irrespective of whether they were complete or broken. In the dimensional analysis, only complete pieces were included.

Table 4.13. Tools made on exotic and local raw materials.

Tool types	**Exotic (n=120)**	**Local (n=835)**	**Total (n=990)**
Atypical	0	12 (100%)	12
Blades with linear retouch	0	21 (100%)	21
Truncations	2 (6.3%)	30 (93.8%)	32
Burins	11 (9.8%)	101 (90.2%)	112

Notches/denticulates	12 (9.8%)	110 (90.2%)	122
Flakes with linear retouch	9 (10.1%)	80 (89.9%)	89
Backed blades	1 (11.1%)	8 (88.9%)	9
Scrapers	11 (12%)	81 (88%)	92
Backed flakes	9 (13.9%)	56 (86.2%)	65
Backed bladelets	49 (14.9%)	280 (85.1%)	329
Bladelets with linear retouch	7 (16.7%)	35 (83.3%)	42
Borers	9 (30%)	21 (70%)	30

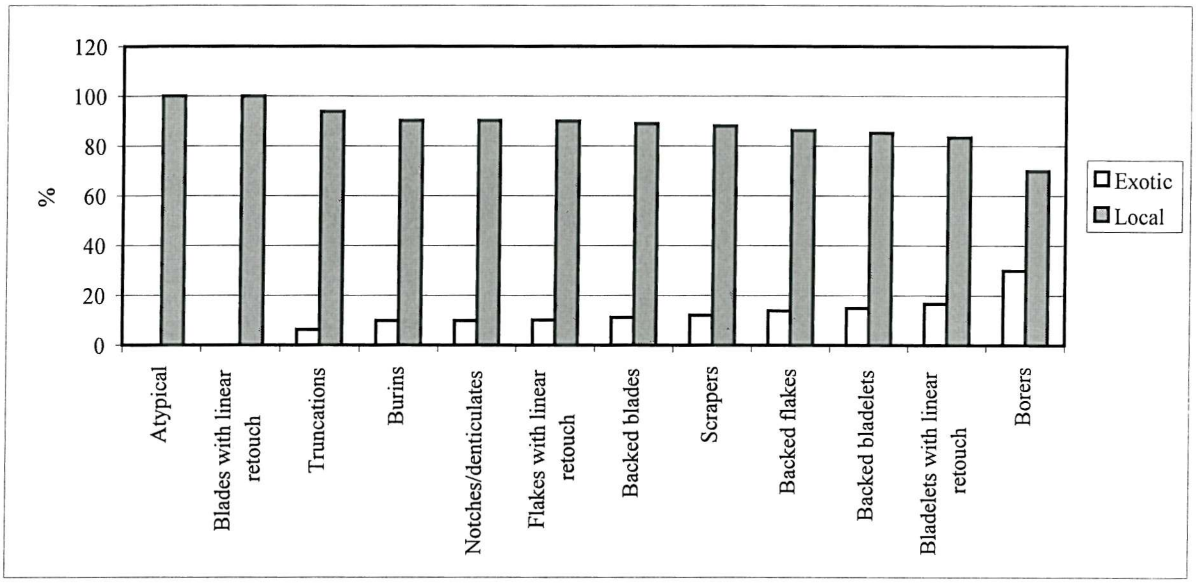


Figure 4.34. Proportions of local and exotic raw materials amongst tools, arranged from left to right with increasing exotic proportions

Proportions of exotic raw material amongst tools were less than 20% in all cases apart from borers. As to why borers were apparently relatively more commonly made on exotics is unclear. Perhaps they were not as expedient as its form or function would suggest, and in some cases were being curated as part of personal gear. After borers, those tools with the highest frequency of exotics were bladelets with linear retouch, backed bladelets and backed flakes, while those with the least exotics tended to be more expedient types such as truncations or burins. This suggests that the more formal tool categories, perhaps including borers, were relatively more commonly being carried into Klithi, from where they were also more likely to have been made on non-Voidomatis flint. This is not necessarily to argue that they were being differentially treated, but that as part of more formal composite artefacts, for instance projectiles, the rate at which they would be flushed from the system would be more gradual than expedient informal types (Marshall 1997:184).

In her analysis of the Klithi material, Roubet (1997a:150) argued for an association between larger tools and the use of exotic raw materials. However in my analysis this association was far from clear. In figure 4.35, the relationship between length and width for all complete tools from my sample of Klithi material is presented. Apart from a single large outlier, a flake with linear retouch of just over 62mm in length, there was little in the way of a clear association between larger tools and exotic raw materials. Moreover, the KS test identified no significant association between either length

($Dmax_{obs}$=8.8<$Dmax_{0.05}$=20.4) or width ($Dmax_{obs}$=12.2<$Dmax_{0.05}$=20.4) and the use of local versus exotic raw materials.

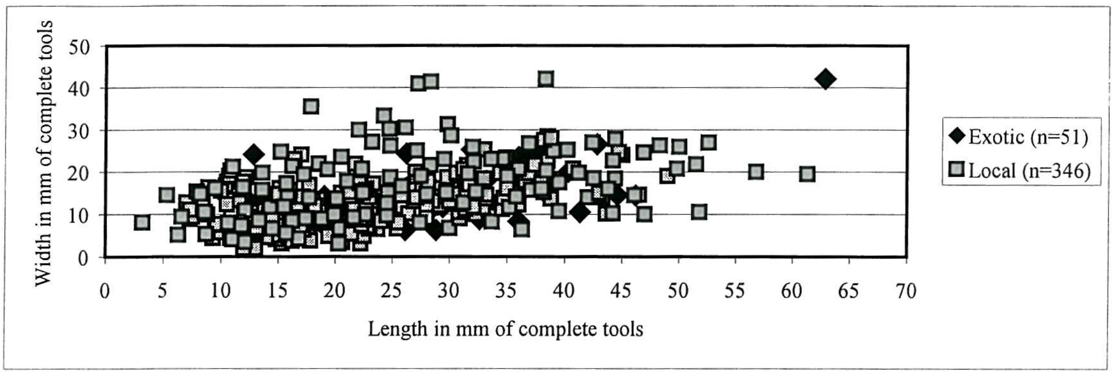


Figure 4.35. Length against width for all complete tools showing relative use of local and exotic raw materials.

Analysis of individual tool groups was difficult due to small sample sizes for definitely complete tools. However, two groups produced relatively larger numbers, backed bladelets and scrapers. In figure 4.36 no clear differences were observed between exotic and local raw material use for the manufacture of backed bladelets. In terms of scrapers (fig.4.37) there was a slight suggestion that those made of exotic raw materials were being discarded while still relatively long.

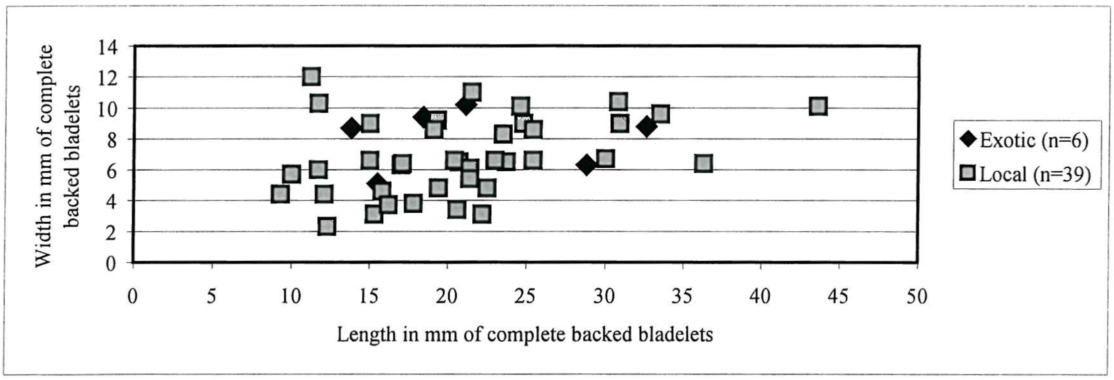


Figure 4.36. Length against width for complete backed bladelets showing relative use of local and exotic raw materials.

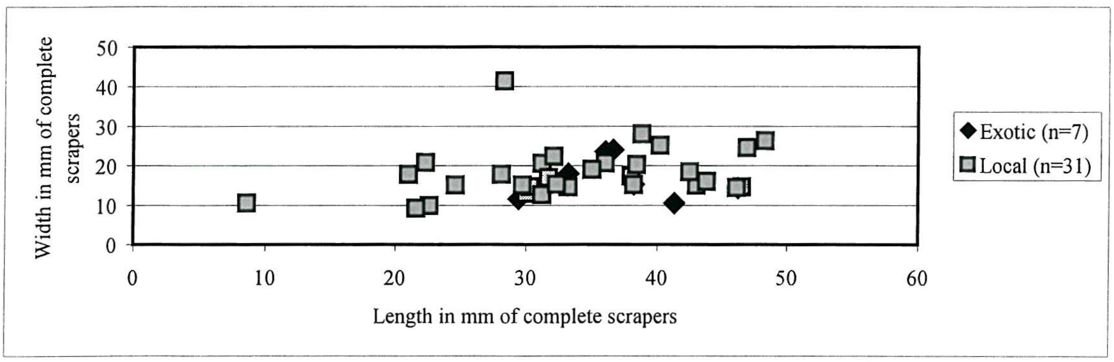


Figure 4.37. Length against width for complete scrapers showing relative use of local and exotic raw materials.

Overall, the metric analysis of the Klithi material sampled in this research did not support Roubet's (1997a.) suggestion that larger tools were being made more often on exotic raw materials. Rather, it pointed to a similarity between artefacts made of both types. Any differences in frequencies and dimensions can probably be explained more readily in terms of differing discard rates for composite and non-composite artefact components, and perhaps variations in raw material quality and sizes.

4.6. Assessment of standardisation in the lithic assemblage

4.6.1. Introduction

The lithic collection of Klithi has so far been examined in terms of overall assemblage composition as well as metric characteristics. The final part of the analysis involves an analysis of both debitage and tools in terms of metric standardisation. As discussed in chapter 2, standardisation has been used as an index for the degree of specialisation in lithic (Torrence 1986; Marks *et al.* 2001), ceramic (Arnold and Nieves 1992; Kvamme *et al.* 1996; Blackman *et al.* 1993) and craft production (Milliken 1998). Standardisation can be regarded as a means by which returns are maximised for a given investment in energy and time, by formalising and routinising aspects of tool manufacture and use. In terms of hunting, success rates can be improved by matching equipment with different prey species (Frison 1978:332), honing techniques and skills (Straus 1987b) and the provisioning of hunters with supplies of easily replaceable tools (Frison:*ibid.*). These objectives are best achieved through standardisation (Bleed 1986; Eerkens 1998; Bar-Yosef and Kuhn 1999:324).

With this as a working hypothesis, the aim of this chapter is to investigate whether any of the blank or tool categories for Klithi were more or less metrically standardised. The analysis is based on differences in the coefficient of variation (CV) and the *F* significance test, and a graphical presentation based on cumulative percentage difference between means and values. This is then assessed for significance using the KS test. In all cases the data used was $\log_{10}$ transformed in an attempt to account for non-normality. For a fuller description of the methods, including the value of log transformed data, see chapter 3.

4.6.2. Debitage

Debitage included all unretouched flakes, bladelets and blades, with a minimum dimension greater than 10mm. In the previous metric analysis, blades and bladelets were examined separately in order to follow the methods applied by other researchers in the region, namely the blade/bladelet division of 12mm in width. For the analysis of standardisation presented here, blades and bladelets were combined in order to avoid imposing an element of standardisation by using this cut-off. The CV results are listed in table 4.14 and illustrated in figure 4.38. Note that differences in numbers of pieces measured in terms of length and width or thickness were due to differential breakage.

Table 4.14. CV values for unretouched debitage.

Debitage type	Length	Width	Thickness
Flakes	15.3% (n=828)	14.3% (n=2008)	43.0% (n=2008)
Blades/Bladelets	12.4% (n=350)	18.0% (n=1089)	43.7% (n=1089)

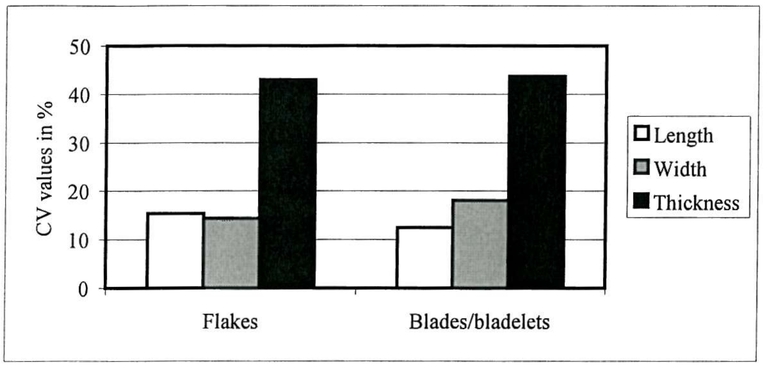
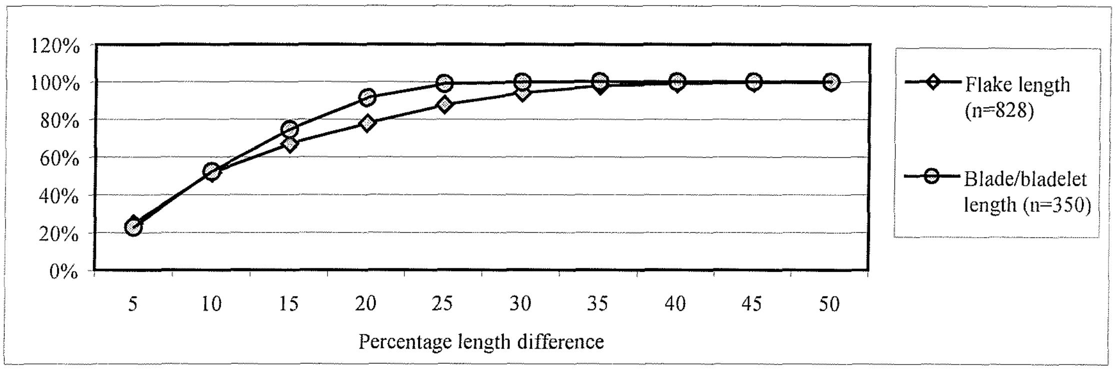


Figure 4.38. CV values for unretouched flakes and blades/bladelets.

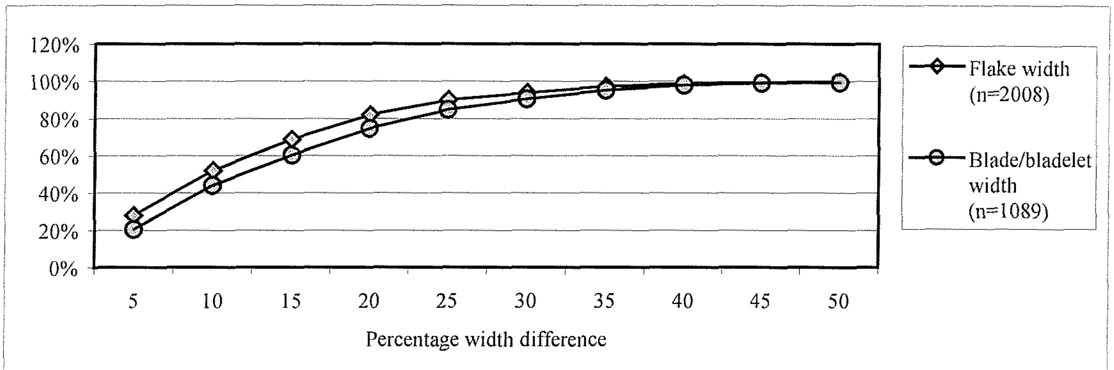
Thickness produced the largest CV values of all three dimensions, indicating that it also had the highest relative variance, in turn suggesting that it was the least standardised. Although this may appear intuitively wrong, it has been verified elsewhere and is a recurring pattern in all three collections. Amongst all debitage and artefact groups, thickness was the least standardised of the three dimensions. It must be remembered that variance is a relative measure of dispersion, not an absolute one. Therefore, although to the eye thickness may appear to vary less than either length or width, this analysis has shown that in relative terms, it is exactly the opposite. The reason for this is that thickness is the least controllable dimension. Whereas length and width can to some extent be determined by the knapper or influenced by raw materials, thickness is the result of a much wider range of factors such as platform angle, hammer size, raw material quality, or platform preparation. The similarity between the thickness CV values for flakes (43%) and blades/bladelets (43.7%) suggested a similar degree of standardisation, although the *F* test indicated that the difference was in fact significant. For a full listing of *F* test results for Klithi see Appendix I, table 1. The CV results for length pointed to significantly more standardisation than was present amongst thickness. Moreover, the results for blades/bladelets were lower (12.4%) than flakes (15.3%), suggesting the former were more standardised, and again the *F* test indicated that this difference was significant. The width CV values were similar to those obtained for length, but in this case blades/bladelets produced a higher CV value (18%) than flakes (14.3%), suggesting less standardisation amongst the former. Again the *F* test indicated that the difference was significant. The results pointed towards blades/bladelets as more standardised than flakes in terms of length, but less so in terms of width and thickness. Moreover, the *F* test identified the variance amongst all dimensions as significantly different.

These patterns are further verified in the following series of cumulative frequency histograms, based on the percentage difference between the mean of all dimensions, and the individual values. Again this was based on log transformed data. Presented in this way the effect of artefact size is eliminated and the success of the knapper in standardising over the full dimensional range is assessed.

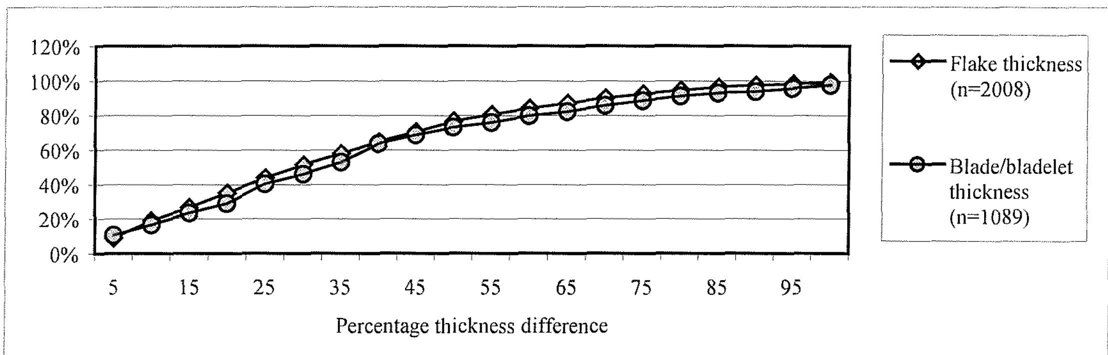
The length cumulative frequency histogram (fig.4.39a) pointed to less percentage difference overall amongst blades/bladelets than flakes, suggesting that the former were more standardised. Moreover, the KS test identified this difference as significant ($Dmax_{obs}=13.6>Dmax_{0.05}=8.7$). Conversely however, width percentage difference was lower amongst flakes (fig.4.39b), suggesting that they were more standardised. The KS test identified the difference as significant ($Dmax_{obs}=7.5>Dmax_{0.05}=5.1$).



a.



b.



c.

Figure 4.39. Flake and blade/bladelet cumulative percentage difference between the log transformed mean and values for length (a), width (b), and thickness (c).

In terms of thickness, the percentage difference was very similar amongst both flakes and blades/bladelets, although on balance was slightly lower for flakes, suggesting slightly more standardisation (fig.4.39c). Moreover, the KS test identified the difference as significant ($Dmax_{obs}=6.2>Dmax_{0.05}=5.1$).

The coefficient of variation and frequency distributions, along with the *F* and KS tests indicated a number of significant differences between flakes and blades/bladelets in terms of length, width and thickness. Blades/bladelets were significantly more standardised than flakes in terms of length, however they were apparently less so in terms of width and thickness. In purely metric terms then, although differences were observed, there was no convincing evidence for a consistent pattern of metric standardisation amongst these two components of the debitage assemblage. This suggests that apart from choosing to make either blades or flakes, which is assumed to have been a conscious decision, there was no significant effort being made to limit the amount of variability present in this first stage of the tool making process. If standardisation was to be identified within the end products of this process, the tools themselves, then it would have had to have been applied either during the blank selection or retouch phases.

4.6.3. Tools

Tools were investigated for size variance in the same way as debitage using CV and the *F* test, and cumulative percentage differences and the KS test, all on log transformed data. The CV results are listed in table 4.15 and illustrated in figure 4.40 for all tool groups with a minimum of ten pieces. The *F* significance test results can be found in Appendix I, table 2. In the cumulative percentage difference analysis, only those artefacts with more than 40 pieces measured in at least two dimensions were included. This reduced the total number of tool categories from eleven to seven, with those included highlighted below in table 4.15.

Table 4.15. CV values for tools.
(Highlighted categories indicate those used in the cumulative percentage difference analysis).

Tool type	**Length**	**Width**	**Thickness**
Backed flakes	13.3% (n=34)	13.8% (n=68)	41.3% (n=68)
Backed bladelets	11.8% (n=45)	21.3% (n=338)	45.2% (n=338)
Backed blades	NA (n=3)	6.5% (n=10)	33.8% (n=10)
Flakes with linear retouch	18.6% (n=50)	16.7% (n=91)	42.3% (n=91)
Bladelets with linear retouch	13.6% (n=21)	22.1% (n=45)	44.4% (n=45)
Blades with linear retouch	NA (n=6)	6.5% (n=21)	26.0% (n=21)
Truncations	18% (n=28)	14.4% (n=33)	36.0% (n=33)
Notches/Denticulates	11.0% (n=69)	15.0% (n=125)	34.4% (n=125)
Borers	15.4% (n=26)	17.4% (n=33)	28.9% (n=33)
Burins	14.3% (n=81)	16.5% (n=115)	40.3% (n=115)

Scrapers	9.0% (n=39)	9.7% (n=97)	19.1% (n=97)

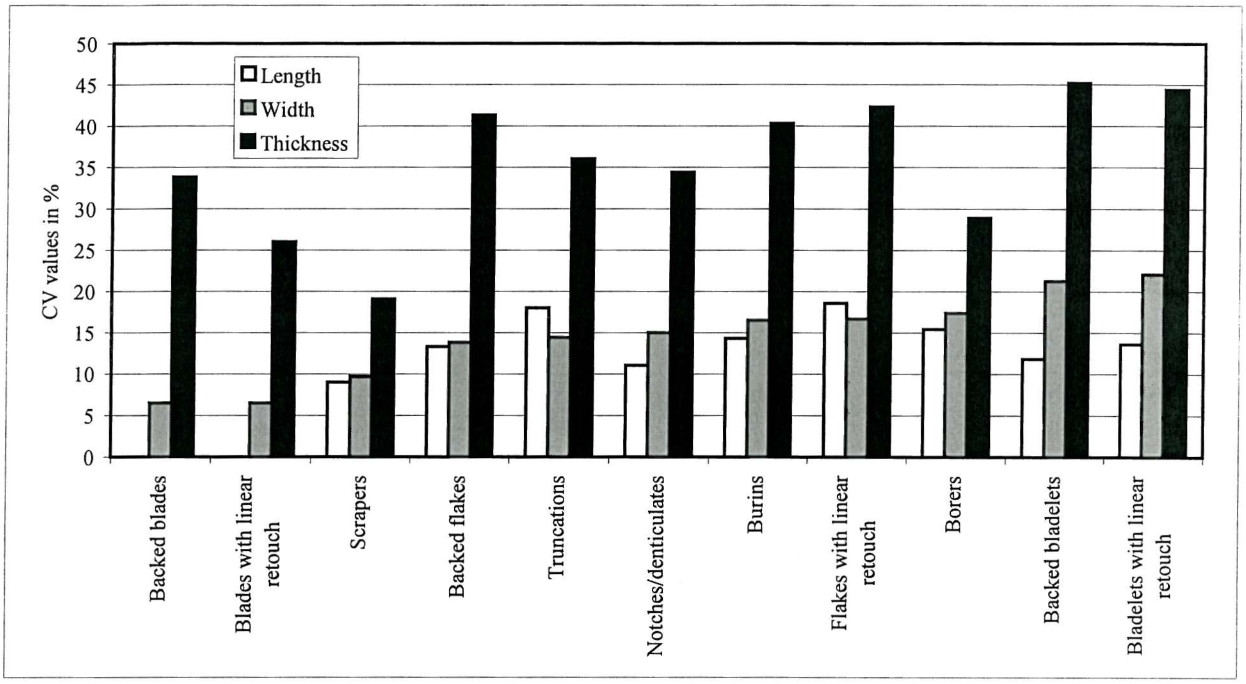
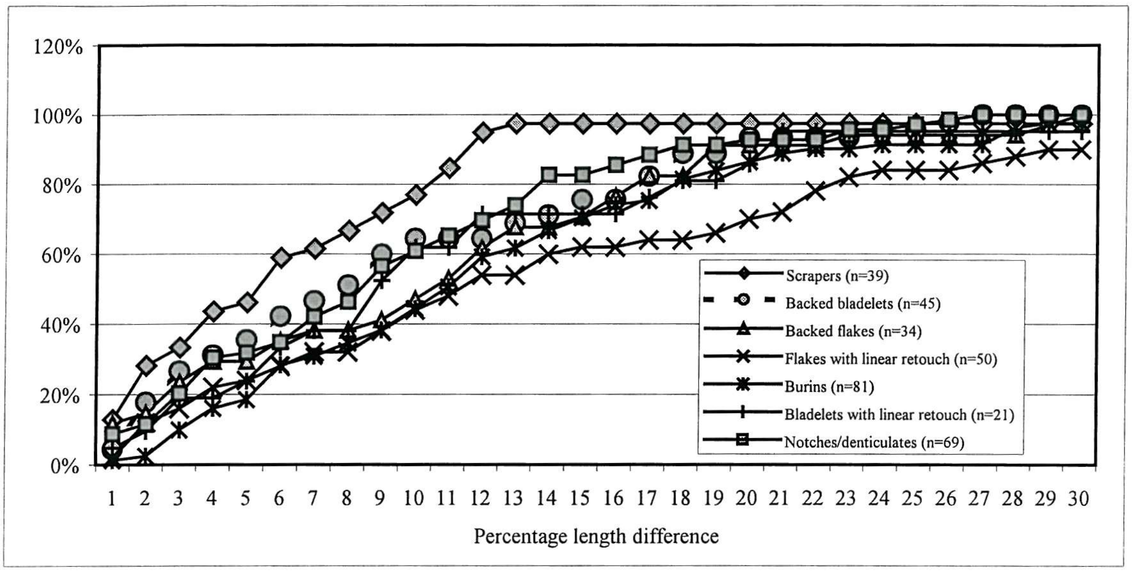


Figure 4.40. CV results for all eleven tool groups, arranged from left to right on the basis of increasing width values.

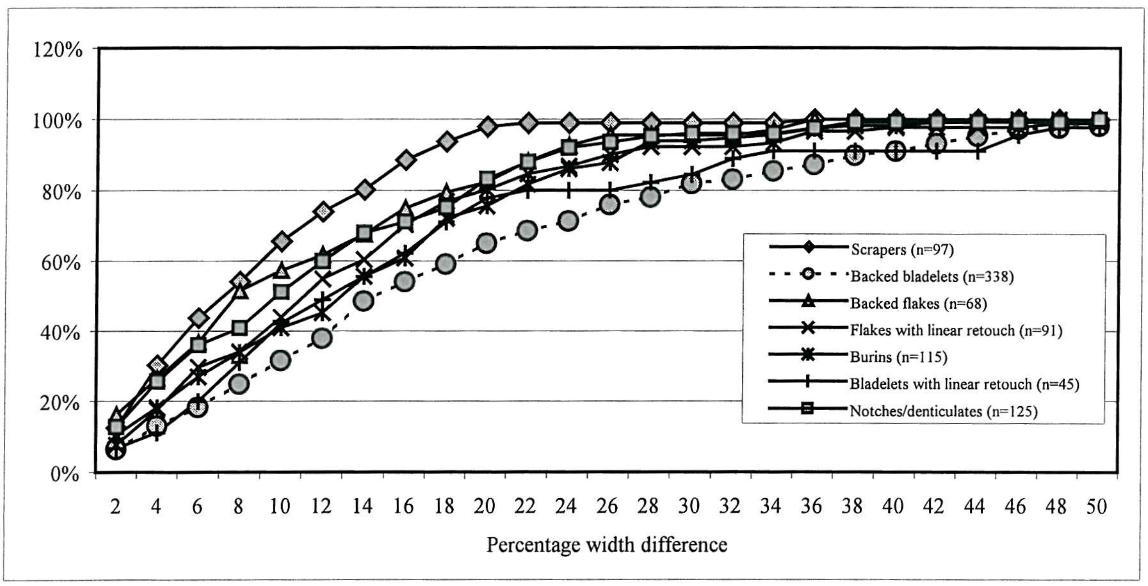
As with debitage, the CV results for thickness were in all cases much larger than those obtained for either length or width. Since thickness is unlikely to have been altered much during either the blank selection or retouch stages, the similarly high CV values amongst debitage and tools was not unexpected. As for length and width, the CV results produced a number of interesting "anomalies". Arranged from left to right on the basis of increasing width CV, we see in figure 4.40 that both backed blades and blades with linear retouch were apparently the most standardised of all artefact types in terms of width. However the relatively small sample sizes amongst blade based artefacts needs to be borne in mind. The next category of artefact with the lowest width, and for that matter length and thickness CV values were scrapers. A similar result was obtained at both Franchthi and Kastritsa (chapters 5 and 6). Excluding the small collection of blade based artefacts, this suggests that scrapers were the most metrically standardised artefact category at Klithi. Conversely, and as equally surprising, backed bladelets and bladelets with linear retouch produced the highest CV values in terms of width and thickness in particular. In terms of the location of retouch along the edges of this category of artefact, we would expect width to be the least variant of all dimensions, assuming that is, that they were being standardised. The fact that CV values for bladelets based artefacts were high, suggests that in purely metric terms, standardisation was not being applied. The rest of the artefact collection produced a range of CV values ranging between those of scrapers and bladelet tools. However there was no consistent pattern noted in terms of the implied degree of standardisation and tool groups.

Similarly, the *F* test results as listed in table 2, Appendix I, failed to identify any consistent patterns in variance.

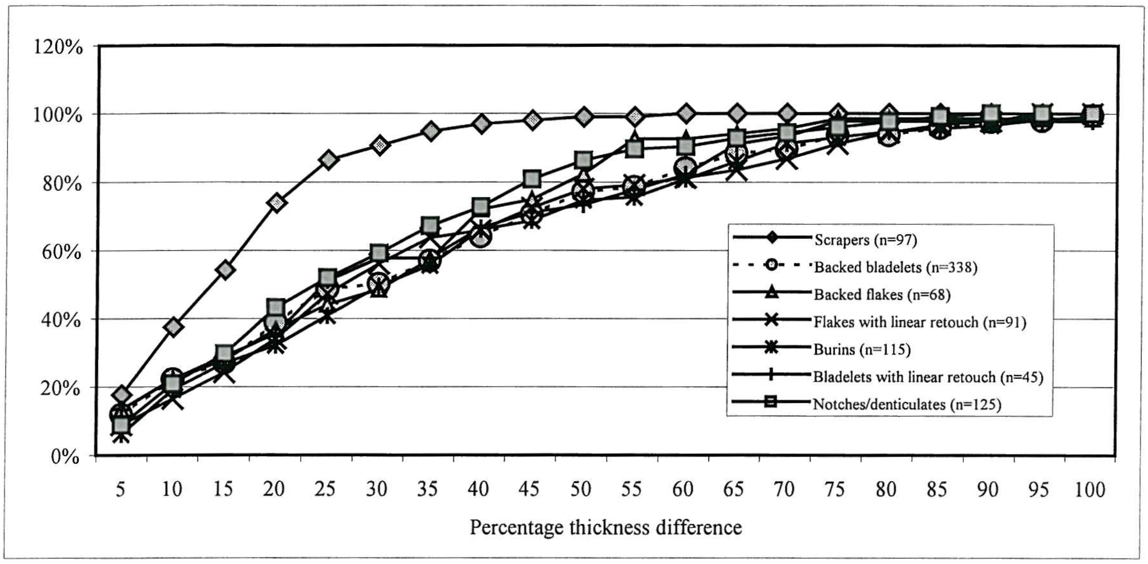
Differences between the tool categories are presented graphically in the following series of cumulative frequency histograms for length, width and thickness.



a.



b.



c.

Figure 4.41. Tools cumulative percentage difference between log transformed means and values for length (a), width (b) and thickness (c).

In terms of length, scrapers produced the lowest percentage difference, while flakes with linear retouched produced the highest (fig.4.41a). Scrapers were therefore the most standardised of all tool categories in terms of length. In terms of width, scrapers again produced the least percentage differences (fig.4.41b), whereas backed bladelets produced the most, while in terms of thickness (fig.4.41c), scrapers produced significantly less percentage difference compared to all other artefact categories.

The KS tests verified the differences observed, the results of which are listed in table 4.16. As can be seen highlighted, scrapers were identified as significantly more standardised in terms of length, width and thickness. In terms of width, backed bladelets were identified as significantly less standardised than all the other tool categories apart from bladelets with linear retouch.

Table 4.16. Results of the KS test.
They are based on cumulative percentage differences for tool length (a), width (b) and thickness (c). Significant differences are shown highlighted.

Length KS test results	Scrapers	Backed flakes	Backed bladelets	Flakes with linear retouch	Bladelets with linear retouch	Notches/ denticulates
Backed flakes	$Dmax_{obs}=33.1>$ $Dmax_{0.05}=31.9$					
Backed bladelets	$Dmax_{obs}=30.5>$ $Dmax_{0.05}=29.7$	$Dmax_{obs}=17.3<$ $Dmax_{0.05}=30.9$				
Flakes with linear retouch	$Dmax_{obs}=40.9>$ $Dmax_{0.05}=29.1$	$Dmax_{obs}=25.3<$ $Dmax_{0.05}=30.2$	$Dmax_{obs}=24.9<$ $Dmax_{0.05}=27.9$			
Bladelets with linear retouch	$Dmax_{obs}=28.6<$ $Dmax_{0.05}=36.8$	$Dmax_{obs}=14<$ $Dmax_{0.05}=37.8$	$Dmax_{obs}=13<$ $Dmax_{0.05}=35.9$	$Dmax_{obs}=23.2<$ $Dmax_{0.05}=35.4$		
Notches/ Denticulates	$Dmax_{obs}=25.3<$ $Dmax_{0.05}=27.2$	$Dmax_{obs}=13.8<$ $Dmax_{0.05}=28.5$	$Dmax_{obs}=9<$ $Dmax_{0.05}=26.1$	$Dmax_{obs}=27.3>$ $Dmax_{0.05}=25.3$	$Dmax_{obs}=14.1<$ $Dmax_{0.05}=33.9$	
Burins	$Dmax_{obs}=35.7>$ $Dmax_{0.05}=26.5$	$Dmax_{obs}=14.3<$ $Dmax_{0.05}=27.8$	$Dmax_{obs}=21.7<$ $Dmax_{0.05}=25.3$	$Dmax_{obs}=18<$ $Dmax_{0.05}=24.5$	$Dmax_{obs}=16.5<$ $Dmax_{0.05}=33.3$	$Dmax_{obs}=18.2<$ $Dmax_{0.05}=22.3$

a.

Width KS test results	Scrapers	Backed flakes	Backed bladelets	Flakes with linear retouch	Bladelets with linear retouch	Notches/ denticulates
Backed flakes	$Dmax_{obs}=15.5<$ $Dmax_{0.05}=21.5$					
Backed bladelets	$Dmax_{obs}=32.8>$ $Dmax_{0.05}=15.7$	$Dmax_{obs}=26.6>$ $Dmax_{0.05}=18.1$				
Flakes with linear retouch	$Dmax_{obs}=17.7<$ $Dmax_{0.05}=19.9$	$Dmax_{obs}=17.6<$ $Dmax_{0.05}=21.8$	$Dmax_{obs}=17.7>$ $Dmax_{0.05}=16.1$			
Bladelets with linear retouch	$Dmax_{obs}=26.3>$ $Dmax_{0.05}=24.5$	$Dmax_{obs}=20.4<$ $Dmax_{0.05}=26.1$	$Dmax_{obs}=12.7<$ $Dmax_{0.05}=21.6$	$Dmax_{obs}=11.7<$ $Dmax_{0.05}=24.8$		
Notches/ Denticulates	$Dmax_{obs}=18.6>$ $Dmax_{0.05}=18.4$	$Dmax_{obs}=10.7<$ $Dmax_{0.05}=20.5$	$Dmax_{obs}=20.7>$ $Dmax_{0.05}=14.2$	$Dmax_{obs}=7.6<$ $Dmax_{0.05}=18.7$	$Dmax_{obs}=13.6<$ $Dmax_{0.05}=23.6$	
Burins	$Dmax_{obs}=22.2>$ $Dmax_{0.05}=18.7$	$Dmax_{obs}=16.6<$ $Dmax_{0.05}=20.8$	$Dmax_{obs}=17.1>$ $Dmax_{0.05}=14.7$	$Dmax_{obs}=9.8<$ $Dmax_{0.05}=19.1$	$Dmax_{obs}=13<$ $Dmax_{0.05}=23.9$	$Dmax_{obs}=14.8<$ $Dmax_{0.05}=17.6$

b.

Thickness KS test results	Scrapers	Backed flakes	Backed bladelets	Flakes with linear retouch	Bladelets with linear retouch	Notches/ denticulates
Backed flakes	$Dmax_{obs}=42.1>$ $Dmax_{0.05}=21.5$					
Backed bladelets	$Dmax_{obs}=41>$ $Dmax_{0.05}=15.7$	$Dmax_{obs}=13.6<$ $Dmax_{0.05}=18.1$				
Flakes with linear retouch	$Dmax_{obs}=30.2>$ $Dmax_{0.05}=19.9$	$Dmax_{obs}=14.9<$ $Dmax_{0.05}=21.8$	$Dmax_{obs}=5.9<$ $Dmax_{0.05}=16.1$			
Bladelets with linear retouch	$Dmax_{obs}=37>$ $Dmax_{0.05}=24.5$	$Dmax_{obs}=14.8<$ $Dmax_{0.05}=26.1$	$Dmax_{obs}=9.6<$ $Dmax_{0.05}=21.6$	$Dmax_{obs}=7.6<$ $Dmax_{0.05}=24.8$		
Notches/ Denticulates	$Dmax_{obs}=34.5>$ $Dmax_{0.05}=18.4$	$Dmax_{obs}=10.7<$ $Dmax_{0.05}=20.5$	$Dmax_{obs}=10.5<$ $Dmax_{0.05}=14.2$	$Dmax_{obs}=10.5<$ $Dmax_{0.05}=18.7$	$Dmax_{obs}=13.6<$ $Dmax_{0.05}=23.6$	
Burins	$Dmax_{obs}=45.6>$ $Dmax_{0.05}=18.7$	$Dmax_{obs}=17<$ $Dmax_{0.05}=20.8$	$Dmax_{obs}=7.8<$ $Dmax_{0.05}=14.7$	$Dmax_{obs}=8<$ $Dmax_{0.05}=19.1$	$Dmax_{obs}=11.1<$ $Dmax_{0.05}=23.9$	$Dmax_{obs}=13.9<$ $Dmax_{0.05}=17.6$

c.

The picture at Klithi was of lower variance, and by implication, more standardisation amongst scrapers, while conversely, amongst more formal elements such as backed bladelets, there was significantly less evidence for standardisation. In fact, bladelet based tools were the least metrically standardised of all tool categories.

One possible explanation for the surprising degree of standardisation amongst scrapers may be to do with re-working. Continual re-sharpening would result in a tool which could no longer be either held or hafted, at which point it would be discarded. Scrapers were also remarkably standardised in terms of thickness. Since thickness is unlikely to be altered much during re-sharpening, this suggests a significant element of deliberate blank selection. If the piece chosen was too thin, then the tool would be likely to snap during use, while if too thick, re-sharpening would be difficult. In addition, hafting would probably have imposed its own size restrictions, at least in terms of width and thickness. As to why backed bladelets appeared so un-standardised will be discussed further in chapters 7 and 8. Perhaps metric standardisation was less important than simply having long, narrow and thin laminar pieces. If hafted, replacement of broken or missing elements would require considerable flexibility in dimensions, so that a replacement could be easily slotted in. In this case, relatively high variability may not necessarily be unexpected. An alternative possibility is that purely metric methods may not be the best way in which to assess standardisation between different tool categories. The ability of a knapper to standardise small tools would be significantly less than it would with larger tools, both in terms of judging sizes as well as modifying them through retouch.

Chapter 5. Franchthi cave

5.1. Introduction

Franchthi cave (pl.5.1) is located on a rocky limestone headland on the coast of the Argolid peninsula, in the north-eastern Peloponnese of southern Greece (fig.5.1). The site itself is approximately one hundred and fifty meters in length, with a commanding view over the bay of Koilada. The floor of the cave is currently only about fifteen meters above the shoreline, although during occupation of the site, lower sea levels would have seen the coastline approximately six kilometres away.

Plate 5.1. South facing view along the coast towards Franchthi cave, photographed during fieldwork in 2000.

The site was identified as potentially containing early deposits in 1967 by the "Argolid Exploration Project", under the direction of T. Jacobsen and M. Jameson from the Universities of Indiana and Pennsylvania respectively (Jacobsen and Farrand 1987:2). Research began the same year and continued until 1979, revealing a site unique in Greek prehistory (*ibid.*). Franchthi, along with Theopetra cave in central Greece (Kyparissi-Apostolika 1996), are the only sites so far which document a human presence from the Palaeolithic to the Neolithic (Jacobsen and Farrand 1987:2). Furthermore, due to the multidisciplinary nature of research carried out at the site, each occupation episode can be studied in the context of prevailing palaeoenvironmental conditions, as well as archaeological features such as site structures, technology and burial practices.

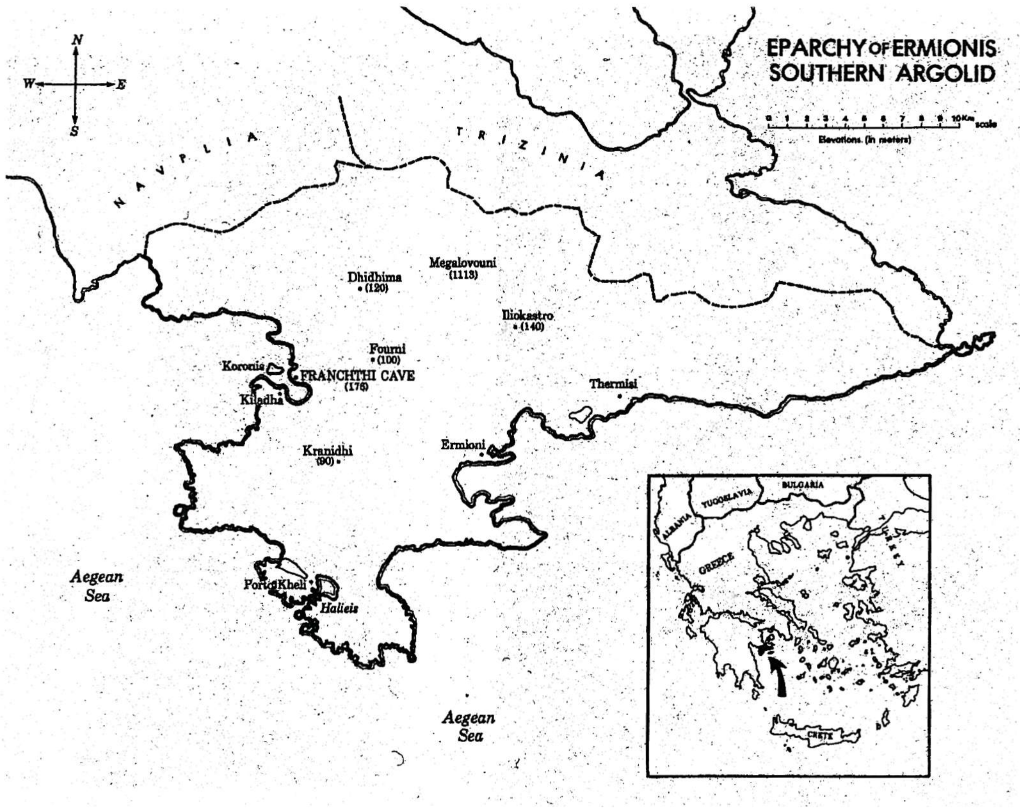


Figure 5.1. Site location plan (from Jacobsen and Farrand 1987:3).

In chapter one it was suggested that Franchthi was more likely to represent a site at which a wide range of more generalised tasks would be undertaken. Although presently within few meters of the sea, the site would have been located on the edge of an extended coastal plain during the last glacial, while to its rear are the hills and valleys of the north-eastern Argolid. Both these biotypes would have provided access to a range of environmental niches, many of which are reflected in the cave's faunal record (Payne 1975). There were animals typical of open plains, such as horses and deer, as well as those more likely to be found in the rugged broken interior, in particular ibex. Apart from herbivores, smaller animals as well as birds and fish would undoubtedly have supplemented the diet, along with fruits, nuts and roots. Moreover, the large size of the cave and its prominent position at the edge of the coastal plain would have in theory, provided an ideal residential focus, albeit with a slightly unstable roof. My working hypothesis that Franchthi was a generalised site is based on the presence of a wide range subsistence indicators, at least many more so than at Klithi, as well as the nature of the site itself.

However, this contradicts the early views expressed by Perlès (1987:307), in which she classified the site as geared towards specialised hunting prior to the Last Glacial Maximum. Her reasoning was based purely on technology, and in particular the predominance of backed artefacts, traditionally associated with hunting equipment. This thesis takes the view that to base the designation of any site purely on the basis of its technology is risky, particularly one for which we have very little functional understanding. The aim of this chapter is therefore to consider technology from Franchthi, and particular whether it could be considered as specialised. The chapter is divided into the following broad sections:

- An introduction to the occupational history of the site.
- Basic assemblage structure.
- Analysis of the assemblage in terms of metric characteristics.
- Analysis of the assemblage in terms of metric standardisation.

5.2. Quaternary history of human occupation at Franchthi

Franchthi has a long history of occupation extending from the Upper Palaeolithic, and possibly earlier, to the Neolithic. However, sedimentological studies have suggested that the use of the site was never continuous. There were at least three major hiatuses in the use of the cave, the first during the Upper Palaeolithic, the second during the Palaeolithic to Mesolithic transition, and the third from the Mesolithic to Neolithic, and all lasting several thousand years (Farrand 1988:314). The following are the main periods of occupation of the site.

Middle Palaeolithic

The only evidence for occupation during this period came from a small number of flakes and tools (Perlès 1987:49-51). The paucity of evidence may be due to excavations not having reached bedrock, rather than an absence of Middle Palaeolithic in the area, which has in fact been noted at several other locations across the peninsula (Jameson *et al.*1994:326, 329).

Upper Palaeolithic

The Upper Palaeolithic sequence at Franchthi is divided into two phases which are dated to between 25,000 to 17,000 and then 12,000 to 10,000 years ago. Between these two periods, namely from around 17,000 to 12,000, there was a hiatus in occupation (Farrand 1988:311; Hansen 1991:155). The first phase coincided with the LGM, a period during which the surroundings of the cave would have been significantly different to that present today. The bay of Koilada would have been a open marshy plain with a few low cliffs at its western extremity. The coastal plain in front of the cave would have been six to seven kilometres wide, traversed by a river and several ephemeral streams, while sea level would have been approximately 100m lower than at present (van Andel and Sutton 1987:38; Lambeck 1996:607). Botanical evidence from the cave has confirmed that the climate during this period would have been cold and dry, with sparse steppe-like vegetation (Hansen 1991:155). The fauna would have been dominated by equids and cervids, species typical of open dry environments (Payne 1975:122). Sediment deposition rates within the cave were low, at approximately 1-2cm per 100 years, indicating that human occupation was very limited (Farrand

1988:315; Perlès 1987, 1999). One possible explanation for the low intensity of use of the site may be the frequent roof collapses which appear in the sequence sometime before 21,500 years ago, and which might have simply made the site too dangerous for regular occupation (Farrand 1988:311,315). The second phase of major occupation coincided with climatic amelioration between 12,000 and 10,000 years ago, during which time sea level rose and the coastal plain was flooded. By around 10,000 years ago it had risen to approximately 50m below its present level, resulting in a reduction of the distance from the cave to the sea, now just 4km (van Andel and Sutton 1987:38). The climate continued to improve, leading to the development of a mosaic of micro-environments around the cave. These consisted of sagebrush and grass on the coastal plain and scattered oak and pine in the lowland and upland valleys (Jameson *et al.* 1994:334). Botanical evidence from the cave indicates the presence of pistachios, almonds, pears and a variety of legumes, such as bitter vetch, lentils, oats and barley. Since all of these are edible, it suggests that they were brought into the cave to be eaten (Hansen 1991:160). Changes in vegetation towards more open woodland had an effect on the faunal composition of the area, with *Equus* (ass), *Cervus* (red deer), large bovids (*Bos primigenius*) and *Capra* (ibex) (Payne 1975:122). In addition, the first evidence for small scale fishing occurred at this time (*ibid.*), as well as the collection of both marine and terrestrial molluscs, presumably a direct result of the cave now being closer to the shoreline (Jameson *et al.* 1994:334).

Based on the flowering and fruiting seasons of plants, it has been suggested that during the second phase, the cave was occupied mostly during the warmer months of the year, namely from April to October (Hansen 1991:160). Moreover, this occupation appears to have been more intensive, with a sedimentation rate of up to 6cm per 100 years, three times that of phase one (Farrand 1988:315). However, recent re-examination of the fauna has identified the remains of juvenile deer, including neonates, which suggests that the site had been used during winter and spring, and less frequently during summer and autumn (R. Redding, *pers. comm*). Completion of the faunal examination of the site will shed more light on this apparent contradiction between the botanical and faunal evidence. Nevertheless, the discovery of human remains including shed milk teeth and a single infant rib, indicates the presence of young individuals, perhaps suggesting that the cave was used as a home base (Cullen 1995:274).

Despite intensive archaeological survey in the Argolid (Jameson *et al.* 1994:335), the picture is of only ephemeral human presence during the Upper Palaeolithic. Apart from Franchthi, two small open sites have been discovered in the south of the peninsula (*ibid.*), as well as the caves of Kefalari near Nauplion and Kleisoura on the edge of the Argolid plain (Koumouzeli *et al.* 2001).

Mesolithic

The Mesolithic at Franchthi extends from approximately 9,500 to 8,200 years ago (Perlès 1999:316). During this period sea level continued to rise, reaching 38 metres below its present level by between 9,500 and 9,000 years ago, and 29 metres by about 8,500 years ago. The coast still consisted of high cliffs to the north and south, with a central inlet flanked by beaches, marshes and salt flats. This formed what is now the bay of Koilada. By about 9,000 years ago the distance between the shoreline and the cave had declined to two kilometers (van Andel and Sutton 1987:38-39). The botanical evidence suggests that the site was surrounded by mixed deciduous forest with some open areas (Hansen 1991:161). The loss of grazing due to sea level rise encouraged those animal species better adapted to the rugged interior rather than the rapidly disappearing coastal plain (Jacobsen 1981:308), and included *Cervus, Equus, Capra* and *Sus* (Payne 1975:122). The approach of the coastline also explains the shift towards the exploitation of marine resources such as tuna, which at the later stages of the Mesolithic dominated the fauna (*ibid.*). Evidence for sea-faring is also present in the increasing use of obsidian derived from the Aegean island of Melos, located 150km to the south-east of the Argolid peninsula (Jacobsen 1981:307, Jacobsen and van Horn 1974:307). Human skeletal remains representing 34 individuals of mixed age and sex, including neonates and infants were also found (Cullen 1995:270,274). What makes these remains so unique is that most were identified in a mortuary context, either inhumations or cremations (*ibid.*). Amongst the finest examples was that of a young man, about 25-29 years old, who had died from a violent blow to the forehead, and who was buried in a shallow pit near the entrance to the cave. The presence of a stone lining and ash deposits above and below the remains, as well as land snails on and around the skeleton, may suggest mortuary ritual (*ibid.*). Although the cave appears to have been used much more intensively during the Mesolithic than in previous periods (Hansen 1991:161), evidence from the rest of the southern peninsula was scarce (Jameson *et al.* 1994: 338).

Neolithic

Neolithic occupation at Franchthi extended from approximately 7,900 to 5,000 years ago (Hansen 1991:163-4). The faunal and botanical records along with evidence from the lithic assemblages suggested that subsistence had shifted from hunting and gathering to animal and plant husbandry (*ibid.*). It has been suggested that during this period, the cave was used as a winter camp by pastoral herders. The presence of neonates and young domestic animals of between one and two months old indicates that the cave was used during the lambing/kidding season, which extended from December to April. However, evidence from the cave also suggests that these were being supplemented by some hunting of deer and hare (R. Redding, *pers.comm.*). During the Neolithic, occupation had extended outside of the cave with rectangular stone structures along the shoreline. These settlements are referred to as *Paralia*, which in Greek means beach (Jacobsen 1981: 308-310).

5.3. The contexts studied

As outlined in the previous section, the Quaternary sequence of Franchthi is bracketed to between approximately 30,000 to 8,190±80 (uncal) years ago (Perlès 1987,1999:313,316). The lithic assemblage was assigned subsequent to excavations, to nine lithic phases on the basis of typology, from I to IX beginning from the bottom of the sequence. The first six phases were assigned to the Palaeolithic and the final three to the Mesolithic. This research focuses on phases II, III and IV. Phases II and III have been interpreted on the basis of their tool inventories as periods during which Franchthi was used specifically as a specialised hunting camp, and probably date from approximately 22,000 to 17,000 years ago (*ibid.*). Phase IV probably dates from around 12,000 years ago. As can be seen, phases III and IV are separated by an apparent hiatus of approximately 5,000 years.

The assemblage was examined during a single study season in early spring 2000 at the Archaeological Museum of Nauplion in the north-eastern Peloponnese. Table 5.1 lists the samples investigated, their dates if known, and their trench and unit references. For instance H1A 216 refers to trench H1A (main trench H, sub-trench 1, sub-sub trench A) and spit 216 (numbered from top to bottom), (Jacobsen and Farrand 1987:16). In addition, the total number of pieces recorded for each lithic phase is given.

Table 5.1. The recorded lithic samples.

Lithic phase	**Years BP (uncalibrated)**	**Samples identified by excavation trench and unit numbers**	**Total (n=3930)**
II	22,330±350 21,480±1270	H1A 216, 218, 219, 220 H1B 188, 196, 198, 200, 201, 203, 206 F/AS 215,216	**2172**
III	No radiocarbon dates available but culturally similar to the previous phase.	H1A 205, 206,207 H1B 171,172,174,181	**822**
IV	12,540±180	H1A 191, 192,197	**936**

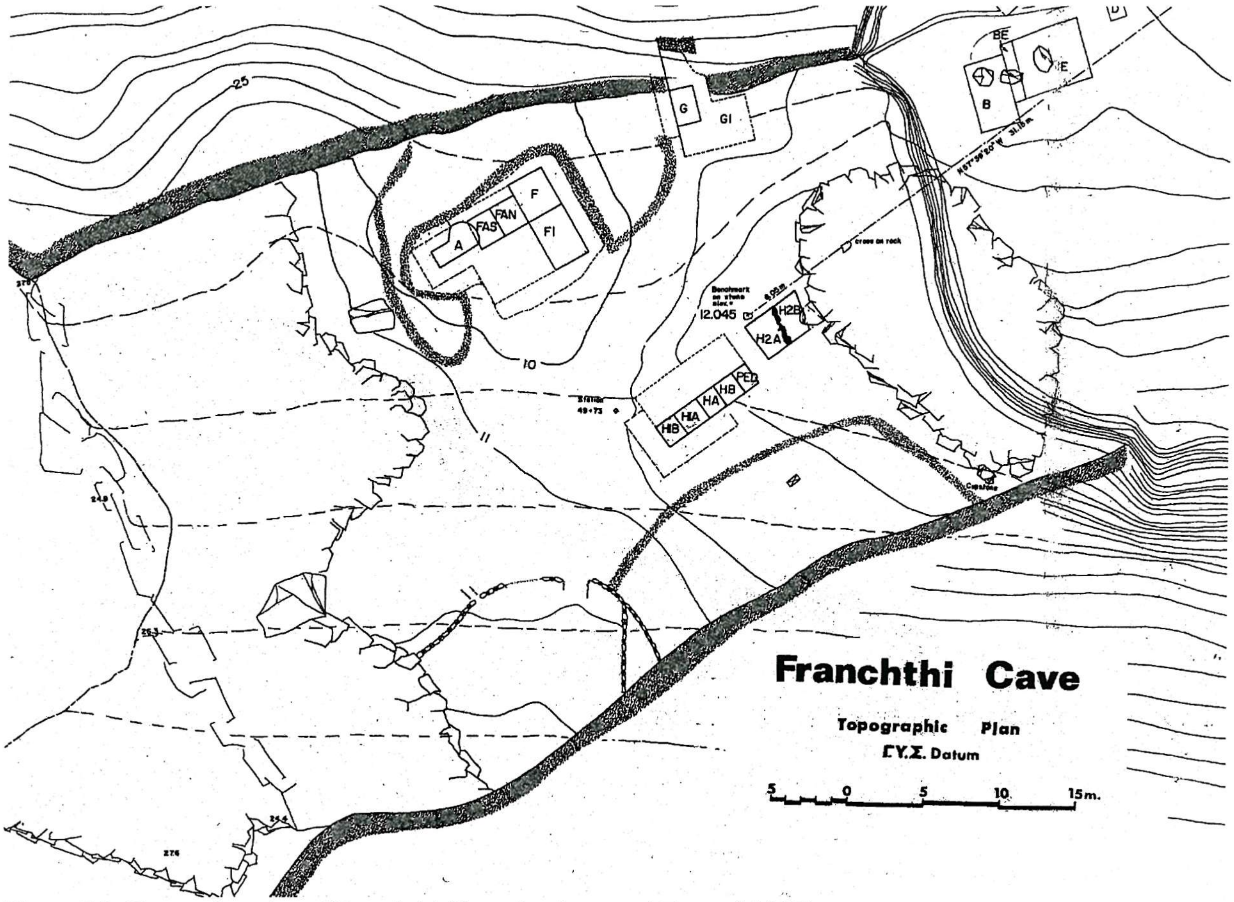


Figure 5.2. Excavation plan of Franchthi (from Jacobsen and Farrand 1987).

Analysis of the lithic assemblage was based on the same methodological principles followed at Klithi and Kastritsa, as described in detail in chapter 3. The main limitation at Franchthi was the small size of the lithic assemblage. The reasons for this were firstly that excavation was limited by massive rock falls and pools of water in the south and eastern parts of the cave, thankfully leaving almost two thirds unexplored (Jacobsen and Farrand 1987:2). Additionally, recovery strategies varied throughout the excavation and therefore not all the trenches were suitable for analysis. Those used included F/A, subdivided into south and north, and H1 further subdivided into A and B (fig.5.2), were regularly, although not consistently, water sieved (Perlès 1987:43-46). Additionally, and perhaps more importantly, occupation during the earlier phases II and III was ephemeral, producing only a small lithic assemblage.

To take account of this, the strategy was modified. Instead of sampling one third by weight from phases II and III, the sample was increased to one half. Unfortunately, this meant that time allocated for the study of phase IV was used up, and therefore only approximately one tenth of the available material from this phase could be investigated. In spite of these limitations, I am confident that the samples investigated are representative of the assemblage as a whole.

5.4. Morphological characteristics of the lithic assemblage

5.4.1. Introduction

The aim of this section is to present the morphological character of the sampled lithic assemblage. Table 5.2 lists the main lithic components of phases II, III and IV, which are illustrated in figure 5.3. The phase II samples were derived from trenches HIA, HIB and F/AS and amounted to a total of 2172 pieces. Of these, 1458 consisted of chips and amorphous debris, leaving debitage larger than 1cm and tools numbering 714 pieces. The lithic assemblage from phase III was poor in size and diversity, comprising only 822 pieces, of which 400 were larger than 1cm or tools. They were derived from trenches H1A and H1B. The sample from phase IV totalled 936 pieces of which those over 1cm or tools amounted to 587 pieces. They were derived from trench H1A.

Table 5.2. The main lithic groups from phases II, III and IV.

Lithic category	Phase II	Phase III	Phase IV	Total
Cores	61 (2.8%)	26 (3.1%)	54 (5.7%)	141
Unretouched debitage (flakes, blades, bladelets)	566 (26%)	339 (41.2%)	467 (50%)	1372
Tools	86 (4%)	35 (4.2%)	50 (5.3%)	171
Microburins	1 (0.04%)	0	16 (1.7%)	17
Chips (≤1cm)	987 (45.4%)	364 (44.2%)	309 (33.0%)	1660
Debris (natural, knapped, burnt)	471 (21.6%)	58 (7.0%)	40 (4.2%)	569
Total	**2172**	**822**	**936**	**3930**

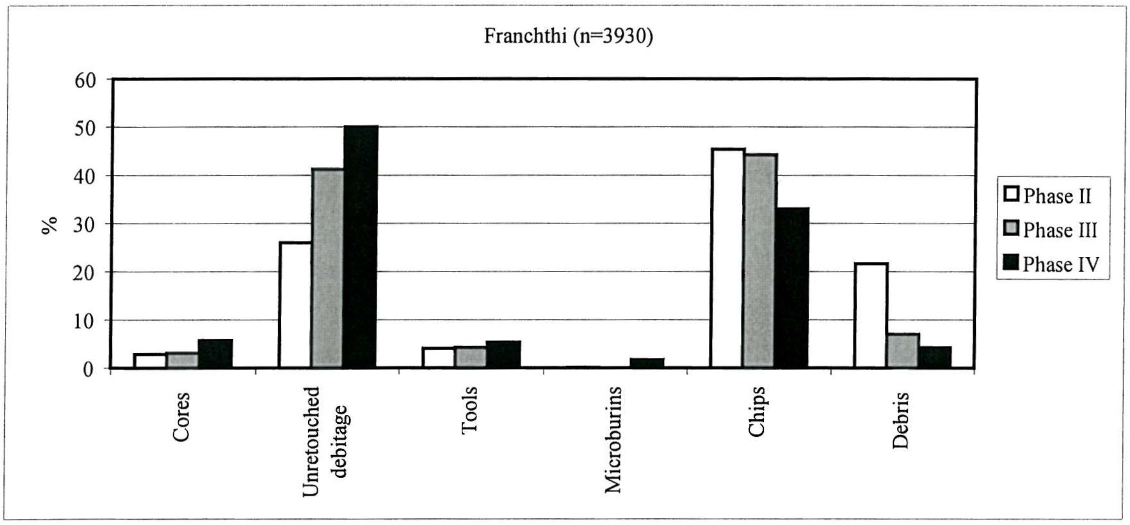


Figure 5.3. The main lithic groups from phases II, III and IV.

The decline in small chips and debris from phase II onwards suggests that artefact manufacture declined through time. Considering debitage, cores and tools on their own however, cores comprised 8.5%, 6.5% and 9.4% of phases II, III and IV respectively, debitage was 79.2%, 84.4% and 81.7% for the same phases while tools comprised 12%, 8.7% and 8.5%. This suggests that despite apparent changes in the small debitage components through time, the intensity of core working and tool manufacture remained fairly stable.

The significant differences in chip proportions between the earlier and the later part of the sequence, for instance around 45% in phases II and III and 33% in phase IV is unclear. One explanation may be that better quality raw materials, which did not shatter on impact, were being used during phase IV. It was noted during study of the collection that phase IV produced relatively more good quality reddish-brown flint than the other periods. An alternative explanation may be that wet sieving was not undertaken on the phase IV assemblage (Perlès 1987:118), so very small pieces were excluded. However this is unlikely as it was not undertaken for the samples from phase III either, (Perlès 1987:110), and they did produce more chips. The same problem applies to the relatively higher proportions of debris present in phase II. One possibility is that phase II contained more shattered burnt material. At present it is unclear which of the explanations fits best, a satisfactory answer will only be forthcoming with a re-examination of the assemblage.

The three phases also produced low frequencies of technical pieces (tbl.5.3).

Table 5.3. Technical pieces from the three samples.

Types of technical pieces	**Phase II**	**Phase III**	**Phase IV**	**Total**
Crested blanks	1 (6.7%)	2 (28.6%)	3 (14.3%)	6
Core rejuvenation blanks	3 (20.0%)	2 (28.6%)	1 (4.8%)	6
Core tablets	5 (33.3%)	1 (14.2%)	7 (33.3%)	13
Burin spalls	5 (33.3%)	2 (28.6%)	0	7
Microburins	1 (6.7%)	0	10 (47.6%)	11
Total	**15**	7	**21**	**43**

The low numbers of technical pieces might be related to overall small size of the lithic assemblage from these periods or alternatively to limited use of technical pieces. Cresting as a means of guiding core removals appears to have been rare, while very small numbers of spalls suggest that burins themselves were rarely used (Perlès 1987:106). The very small numbers of rejuvenation blanks and core tablets suggest that although some maintenance was taking place, this was rare. This may have been due to the nature of raw materials employed at the site, in particular small pieces of tabular flint, on which rejuvenation would have been difficult. The most significant difference between the three periods was the presence of microburins in the later phase IV, suggesting that this technique only appeared at Franchthi after the Last Glacial Maximum (*ibid.*:120). They numbered ten complete pieces of which three were classified as Krukowski.

5.4.2. Raw materials

Common to all three phases was an absence of unworked raw materials, which suggests that partially worked cores rather than pebbles or nodules were being introduced, probably as personal gear. This apparent lack of caching in the cave itself may have been due to sporadic use. If visits to the site were not regular or planned, there would have been little point to stocking the cave with raw materials. An alternative explanation may be that raw materials were being carried into the cave, but that the small volume so far excavated has failed to locate any of these. Lithic production at Franchthi was based on the use of a range of cryptocrystalline materials including chert, flint, radiolarite, chalcedony and jasper, while in phase IV, metamorphic schist and limestone were also used (Perlès 1987:118). These came in an array of colours including dark to light chocolate brown, light yellowish brown, brownish grey, reddish brown, grey, green and blue grey. Their texture and surface varied from fine to rough and from semi-transparent to opaque. Along with these, phase II also produced three flakes of obsidian from the island of Melos over 150km away. The presence of obsidian is problematic, and although frequently encountered in the Mesolithic horizons at Franchthi, is absent from the Upper Palaeolithic apart from these three in phase II. The most plausible explanation is that they are intrusive from more recent layers (Perlès 1987:99), perhaps through animal burrowing or simply mislabelling.

It has been suggested that the majority of raw materials used at Franchthi during the three phases studied were essentially local, and came from within a few kilometres of the cave (Perlès 1987:99), however their exact provenance remains unknown. The blue-grey flint outcrops approximately 2km to the north-east of Franchthi in an area called Paliokastro, near the village of Fournoi. Secondary river rolled deposits of this material can be found along the beach to the north of the cave, as the Fournoi valley drains westward towards the sea (Jacobsen and van Horn 1974:307-8). The region near Trachia, 30km to the north-east of Franchthi has been suggested as the source of reddish brown jasper (J. Newhard, *pers. comm.*).

Due to the lack of a systematic research on the distribution of raw materials used at Franchthi, information concerning nodule sizes and flaking characteristics is still lacking. However, to some extent these can be reconstructed by examining cores and debitage from the collections, which suggests that raw materials were collected as small river pebbles or tabular chunks. The pebbles have smooth exterior surfaces and are slightly battered, whereas the latter are angular with parallel surfaces. Both types were small in size and fairly poor in quality. The blue-grey flint that occurs in tabular form in local limestone outcrops provides a good example of the difficulties involved in working this material. Cleavage plains run perpendicular to that of tabular bedding, thus while of relatively good internal quality, it is difficult to produce large blanks (Jacobsen and van Horn 1974:306). In contrast, better quality reddish brown jasper can be found 30km away near Trachia as 40cm diameter pebbles, or as conglomerates with individual clasts of up to 10cm in diameter (J. Newhard, *pers. comm.*).

5.4.3. Cores

The core sample consisted of 141 pieces, of which 10 were fragments. Their morphological characteristics are listed in table 5.4.

Table 5.4. Morphological characteristics of cores.

	Phase II	Phase III	Phase IV	Total
Total number of cores	61	26	54	141
Complete cores	54	25	52	131
Core fragments	7	1	2	10
Core types	**n=61**	**n=26**	**n=54**	**n=141**
Flake	55 (90.2%)	21 (80.8%)	48 (88.9%)	124
Blade/bladelet	6 (9.8%)	5 (19.2%)	6 (11.1%)	17
Core shape	**n=59**	**n=25**	**n=54**	**n=138**
Amorphous	8 (13.6%)	8 (32.0%)	15 (27.7%)	31
Cores on blanks	11 (18.6%)	6 (24.0%)	11 (20.4%)	28
Conical/semi conical	16 (27.1%)	2 (8.0%)	10 (18.5%)	28
Cuboid/tabular	23 (39.0%)	9 (36.0%)	18 (33.3%)	50
Other (oval, sphere)	1 (1.7%)	0	0	1
Number of platforms	**n=61**	**n=26**	**n=54**	**n=141**
One	15 (24.6%)	5 (19.2%)	10 (18.5%)	30
Two	26 (42.6%)	18 (69.2%)	36 (66.7%)	80
Three	17 (27.9%)	3 (11.5%)	8 (14.8%)	28
Four	3 (4.9%)	0	0	3
Direction of removals	**n=59**	**n=25**	**n=54**	**n=138**
Longitudinal	35 (59.3%)	18 (72.0%)	36 (66.7%)	89
Multidirectional	24 (40.7%)	7 (28.0%)	18 (33.3%)	49
Platform preparation	**n=59**	**n=25**	**n=54**	**n=138**
Absent	42 (71.2%)	20 (80.0%)	38 (70.4%)	100
Trimming	17 (28.8%)	1 (4.0%)	15 (27.8%)	33
Facetting	0	4 (16.0%)	1 (1.8%)	5
Multi	0	0	0	0
Cortex	**n=57**	**n=25**	**n=53**	**n=135**
0 %	30 (52.6%)	8 (32.0%)	26 (49.0%)	64
0-50%	25 (43.8%)	17 (68.0%)	25 (47.1%)	67
50-100%	2 (3.5%)	0	2 (3.7 %)	4
Reasons for core discard	**n=59**	**n=25**	**n=54**	**n=138**
Size	39 (66.1%)	20 (80.0%)	41 (75.9%)	100
Raw material	9 (15.3%)	2 (8.0%)	11 (20.4%)	22
Uncertain	11 (18.6%)	3 (12.0%)	2 (3.7%)	16

Core type, flake or blade/bladelet

Flake cores dominated all three phases with between 80% and 90% of all pieces, while bladelet cores were poorly represented (see also Perlès 1987: 101-2, 110-11, 118).

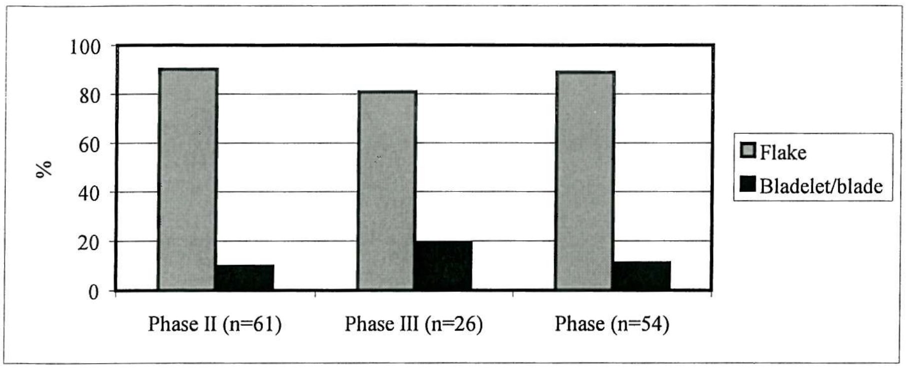


Figure 5.4. Core types.

Blade cores were very rare, with a single piece identified in phase II. It was combined with bladelet cores as blade/bladelet. They were probably scarce due to the small size of raw materials, although intensive working of cores up until discard will also tend to remove traces of blade removals.

Core shape

The most common core shape in all three phases was tabular/cuboid. Tabular cores were defined as having parallel sides longer than their width, and cuboid if they were short and thick. Tabular raw materials from which both these types were made, can be found in relatively close proximity to the cave.

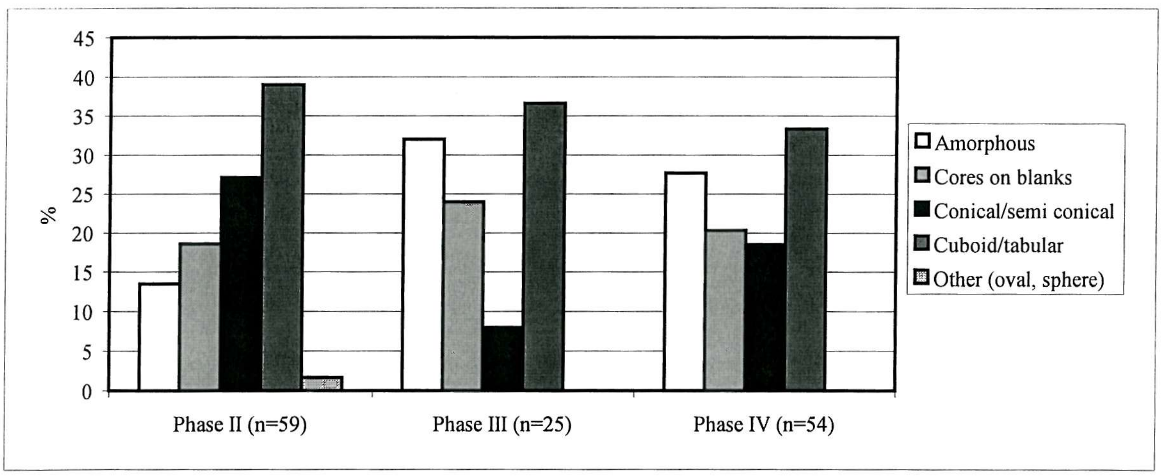


Figure 5.5. Core shapes.

Phase II contained a significant component of conical/semi conical cores which would be even higher if combined with oval or spherical types. Conical cores tend to be associated with blade production, suggesting greater emphasis on the manufacture of long and thin pieces. Conical cores declined in phase III and then increased in frequency in phase IV, although not to the same level as phase II. Amorphous cores increased in frequency from phase II to III, before declining again in phase IV, although not to the level seen in phase II. The third most common core shape in all three samples were cores on previously broken flakes, a strategy suggesting more extensive use of available raw materials. An increase was also noted through time from phase II onwards, in the use of pebble cores.

These appear to have been used directly without any preparation, and were classified as amorphous. In phase II only one such core was identified as opposed to three in phase III and four in phase IV. The increase in proportions of these cores may suggest that access to pebbles increased through time. Unfortunately, as very little is known about the distribution of raw materials around Franchthi, these suggestions must remain speculative.

Number of platforms

The majority of cores in all phases had up to two striking platforms, while those with three or more platforms were most common in phase II. In the case of those cores with two platforms, they were usually located opposite to each other (53.8% in phase II, 72.2% in phase III and 66.6% in phase IV) and less often adjacent (46.1%, 27.7% and 33.3% respectively).

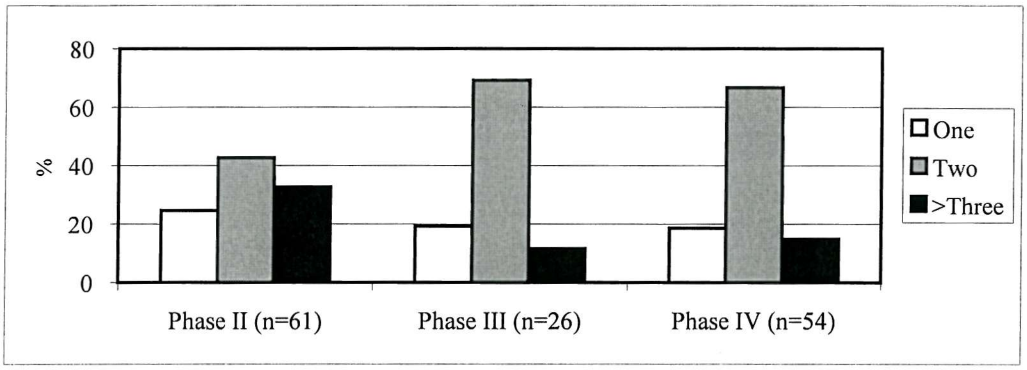


Figure 5.6. Number of platforms.

The slightly higher frequency of single platform cores in phase II probably relates to the greater incidence of conical/semi conical cores.

Removal direction

Flaking was usually along the longest axis, and less frequently multidirectional. The latter involved the removal of blanks perpendicular to the main striking platform (fig.5.7). This may reflect the intention of the knapper to exploit as much of the core as possible, particularly tabular ones, which tend to be wider than long. Phase II contained more of these types of core, suggesting more intensive use of available raw materials in the earlier phases. Phases III and IV were essentially the same.

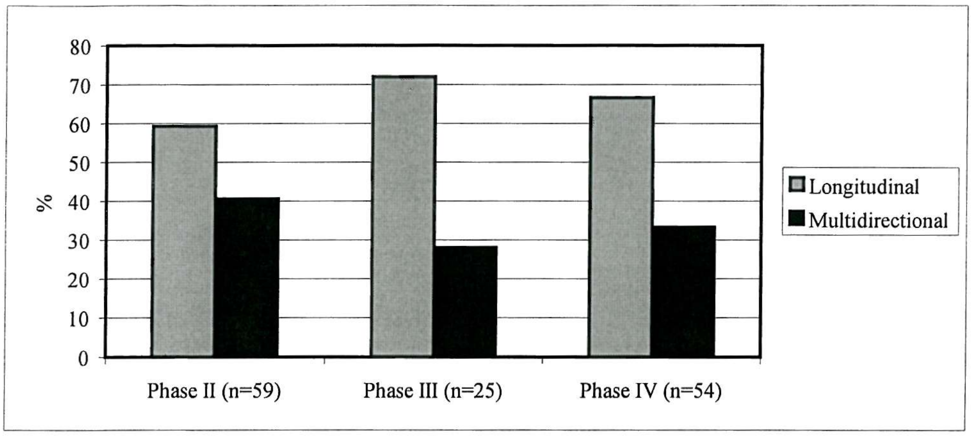


Figure 5.7. Direction of removal.

Platform preparation

Platform preparation was poorly represented at Franchthi, with no more than 30% of cores displaying one type or another in any of the three phases (fig.5.8). Trimming was most common in phases II and IV, whereas facetting dominated phase III. Platform preparation tended to be more common on conical/semi conical cores or those with blade/bladelet scars (60% in phases II and III and 40% in phase IV). Facetting was apparently more common in phase III, although consisted of just four pieces.

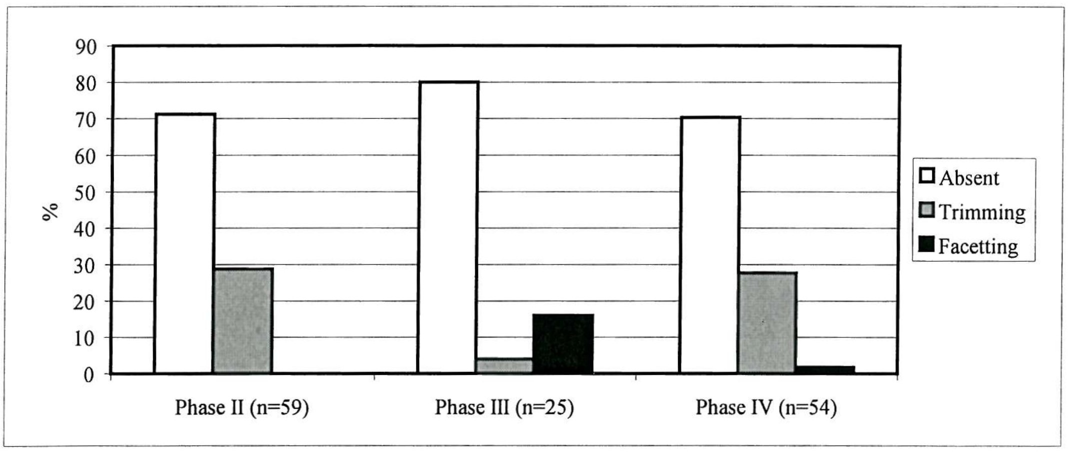


Figure 5.8. Core platform preparation.

Cortex

The frequency of cores with no cortex declined from phase II to III before increasing again in phase IV, although not to the same level as in phase II (fig.5.9). Conversely, those with up to 50% cortex increased from phase II to III, before declining again in phase IV.

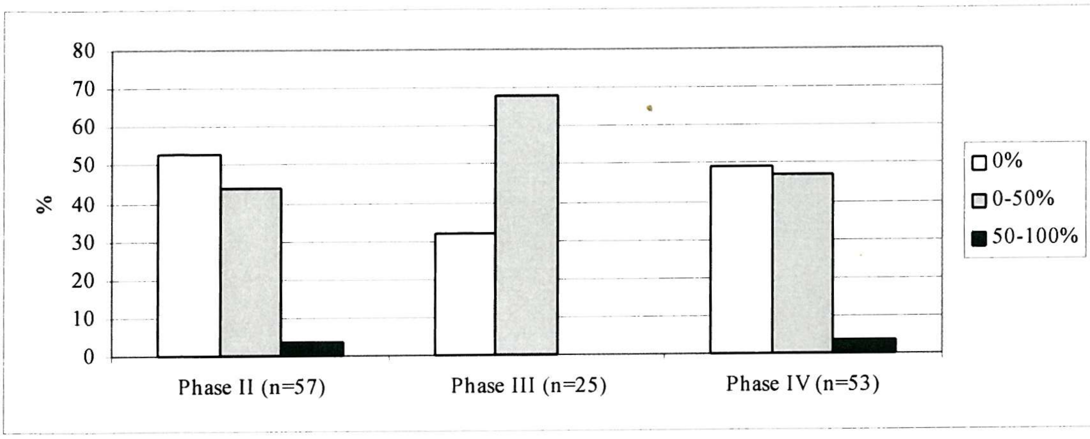


Figure 5.9. Proportion of cortex on cores.

Reasons for core discard

The main reason for core discard during all phases was size (pl.5.2). Included in this group were those cores covered by step and hinge fractures, which once rejuvenated would have been too small to work.

Plate 5.2. Selection of cores from Franchthi showing the ranges of shapes and overall small sizes, photographed during fieldwork in 2000.

The second most common reason for discard was the poor quality of the raw materials themselves, and in particular interior fractures (fig.5.10).

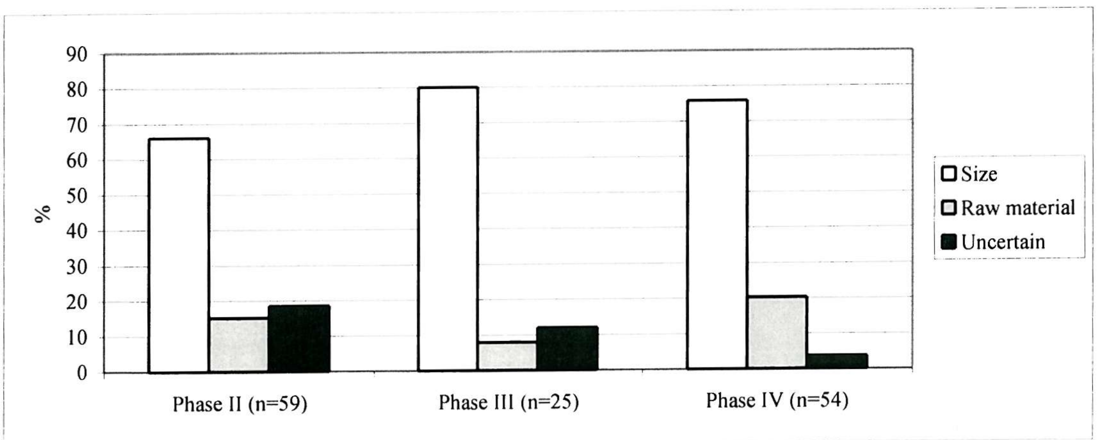


Figure 5.10. Probable reasons for core discard.

A small proportion of cores were discarded for no obvious functional reason, although the proportions of these declined from phase II through III to IV. This suggests that greater effort was being expended in later phases to extract as much as possible from the available raw materials.

5.4.4. Primary, secondary and inner proportions

The proportions of primary, secondary and inner debitage and tools are listed in table 5.5 and illustrated in figure 5.11.

Table 5.5. Primary, secondary and inner debitage >10mm and tool proportions.

Debitage and tools	Phase II (n=652)	Phase III (n=374)	Phase IV (n=517)	Total (n=1543)
Primary	0	3 (0.8%)	8 (1.6%)	11
Secondary	109 (16.7%)	104 (27.8%)	130 (25.1%)	343
Inner	543 (83.3%)	267 (71.4%)	379 (73.3%)	1189

Key : Primary: the very first core removal covered entirely by natural cortex.
Secondary: removals covered by natural cortex.
Inner: removals lacking cortex.

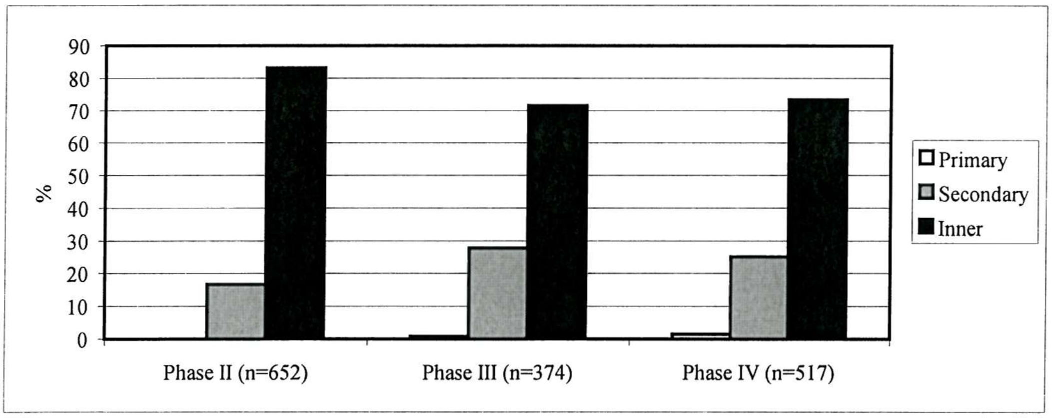


Figure 5.11. Primary, secondary and inner proportions for debitage >10mm and tools.

Primary debitage was rare in all three phases, although with such small sample sizes, its complete absence from phase II should not be seen as significant. The relatively low proportions of secondary material indicate that raw materials were entering the site as partially worked cores, suggesting individual rather than site provisioning (*sensu* Kuhn 1995:22).

In a series of experimental assemblages based on rolled flint pebble raw materials, Marshall (1997) found that the proportions of primary, secondary and inner debitage followed a broadly predictable pattern despite initial pebble size. He found that clearly identifiable primary flakes accounted for just 2% of debitage, and in most cases less, while secondary material comprised between 20% and 40%, and inner between 60% and 80%. At Franchthi, the highest frequency of secondary material was in phase III where it comprised almost 28% of debitage and tools. In phases II and IV it was towards the lower end of Marshall's (1997) experimental prediction. This suggests that partially worked cores, rather than unworked pebbles were being carried into the site. Although we have no idea as to the amount and nature of material carried away after use, and bearing in mind that these are more likely to have been in the form of partially worked cores, then we may expect inner proportions to have in reality been even higher. There does appear to have been an increase through time, albeit small, in the proportions of secondary material entering the site, particularly between phases II and III.

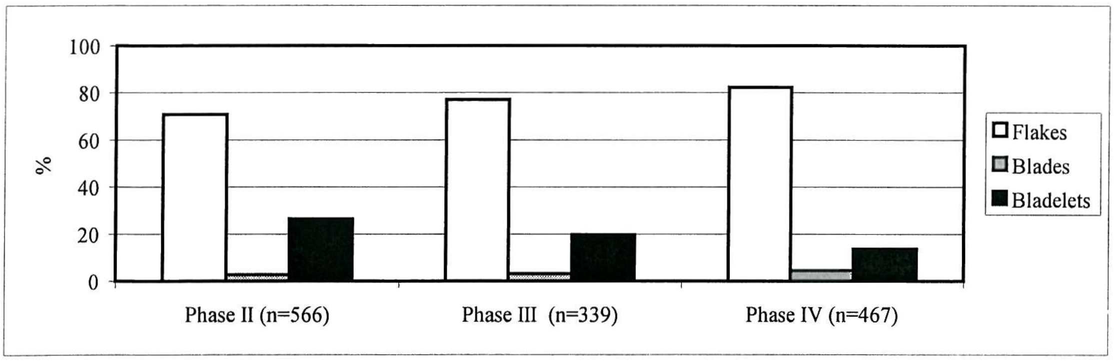
Based on the small size of the assemblage and the lack of unworked raw materials, Perlès (1987) suggested that the cave was probably only sporadically used during phase II. However, the increase in secondary proportions suggests that lithic production in phase III had shifted towards the use of cores earlier in the knapping sequence. Interpreting this in the context of provisioning strategies (*sensu* Kuhn 1995) it may be possible to argue that phase III documents a shift from individual to site provisioning, or at least raw materials exploited relatively closer to the cave. One possible explanation could be that the site was occupied for longer, or alternatively that short stays were characterised by more intense activity. Although the evidence from the site so far does not necessarily support this interpretation for phase III (see Perlès 1987), work being undertaken at present on the fauna should clarify the picture further (R. Redding *pers. comm.*).

5.4.5. Flake, blade and bladelet proportions

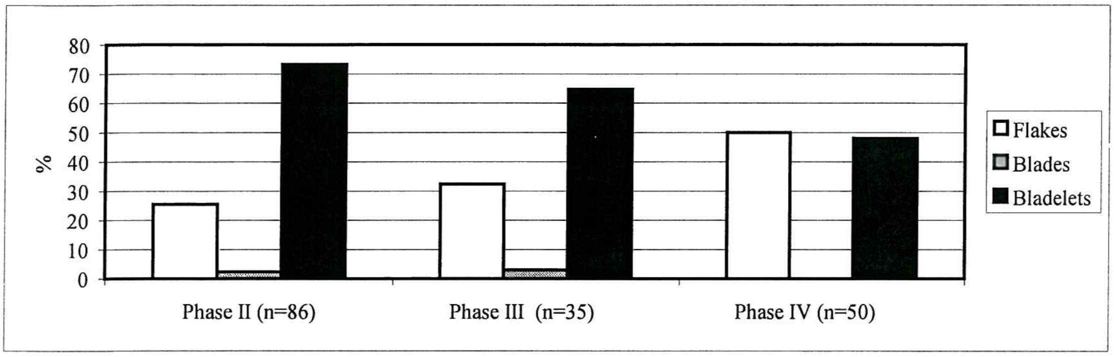
Flakes dominated unretouched debitage, whereas tools were more commonly made on bladelet blanks, at least in phases II and III, table 5.6 and figure 5.12.

Table 5.6. Proportions of flakes, blades and bladelets.

	Phase II (n=652)		**Phase III (n=374)**		**Phase IV (n=517)**	
	Debitage (n=566)	**Tools (n=86)**	**Debitage (n=339)**	**Tools (n=35)**	**Debitage (n=467)**	**Tools (n=50)**
Flakes	400 (70.7%)	20 (25.5%)	261 (77.0%)	11 (31.4%)	384 (82.2%)	25 (50.0%)
Blades	16 (2.8%)	2 (2.3%)	11 (3.2%)	1 (2.8%)	21 (4.5%)	0
Bladelets	149 (26.3%)	63 (73.2%)	67 (19.8%)	22 (62.8%)	62 (13.3%)	24 (48.0%)
Atypical	1 (0.1%)	1 (1.2%)	0	1 (2.8%)	0	1 (2.0%)



a.



b.
Figure 5.12. Proportions of flakes, blades and bladelets in debitage (a) and tools (b). Atypical were omitted.

Blade production remains low and at broadly the same rate in all three phases, however bladelets decline through time from phase III to IV. Similarly, tools made on bladelets declined through time until they were equalled by flakes in phase IV. Perlès (1987:119) suggests that aspects of blank production from this period, such as irregular blank edges and the lack of parallel ridges, indicates a decline in the quality of cores. In general, it would appear that both knapping and tool manufacture became more expedient in phase IV.

5.4.6. The tool inventory

Tools were poorly represented at Franchthi, both in terms of numbers and diversity. The collection consisted of 171 pieces from seven broad tool classes. These are listed in table 5.7 and illustrated in figure 5.13.

Table 5.7. The tool inventory.

Tool group	Phase II (n=86)	Phase III (n=35)	Phase IV (n=50)	Total (n=171)
Artefacts with backed retouch	66 (76.7%)	27 (77.1%)	39 (78.0%)	132
Artefacts with linear retouch	6 (7.0%)	0	0	6
Notches/denticulates	7 (8.1%)	4 (11.4%)	3 (6.0%)	14
Truncations	1 (1.2%)	0	2 (4.0%)	3
Scrapers	6 (7.0%)	4 (11.4%)	3 (6.0%)	13
Burins	0	0	2 (4.0%)	2
Geometric microliths	0	0	1 (2.0%)	1

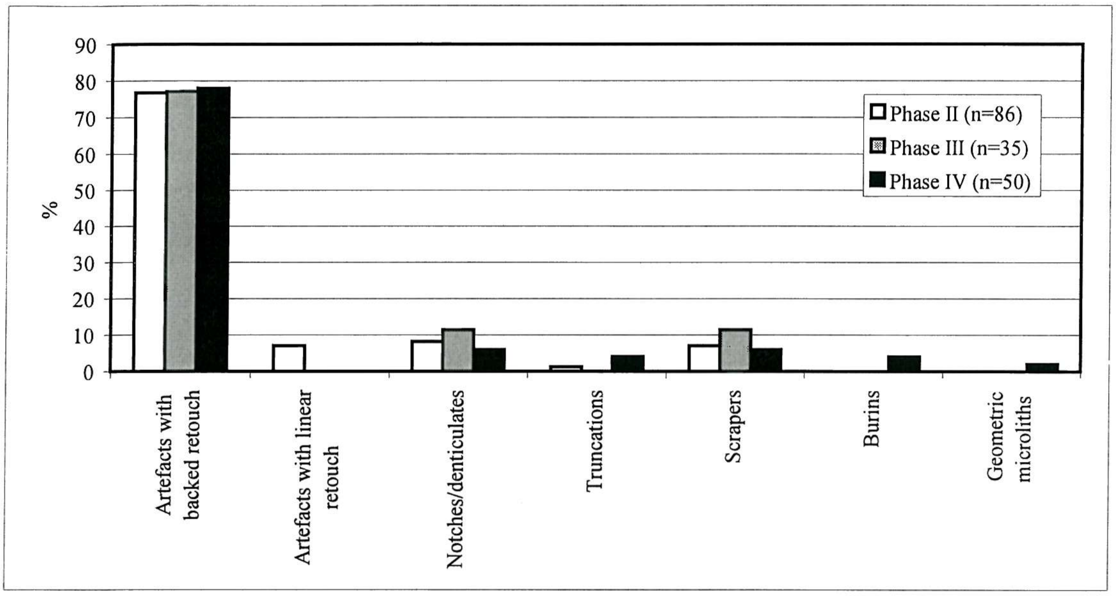


Figure 5.13. The tool inventory.

Phase II

Tools with **backed retouch** were the most common, comprising 76.1% (n=66) of the total inventory. Of these, 57 (86.3%) were made on bladelets, eight (12.1%) on flakes and only one (1.5%) on a blade. Most had direct (n=60, 91%) and abrupt (n= 61, 92.4%) retouch along one or both edges. Rarely, the direction and nature of retouch was inverse or alternating (n=6, 9.1%), or semi or crossed abrupt (n=5, 7.6%). Two backed bladelets (3%) were truncated at the distal end. A small proportion of backed pieces were pointed, five (71%) on bladelets and two (2.3%) on flakes. All had acute points estimated to be approximately 18 degrees. The ends of most of the pointed artefacts were not retouched, with the exception of one shouldered backed bladelet (lamelle à cran) (see Perlès 1987: 103, fig.21). Tools with **linear retouch** comprised just 7% (n=6) of the toolkit, equally divided between bladelets and flakes. Most artefacts displayed low angle, direct retouch along lateral edges. **Notches/denticulates** numbered just seven pieces, of which five (71.4%) were made on flakes and two (28.5%) on bladelets. They all displayed retouch along one or both edges, which was variable in direction and nature. A single **truncation** was made on a bladelet with crossed abrupt, alternating distal retouch. **Scrapers** consisted of six artefacts, of which four (66.6%) were made on flakes and one (16.6%) on a blade. In a single case (16.6%), a platform core was used as a scraper. Half of the collection were defined as endscrapers, one (16.6%) of which was made on a blade (see Perlès 1987:106, fig 23, no 10). The length of the retouched area varied between 1.8mm and 6mm with a mean of 3.5mm (SD=1.5mm).

Phase III

Tools with **backed retouch** comprised the largest group. Of the 27, a total of 22 (81.4%) were made on bladelets and five (18.5%) on flakes. Backed bladelets displayed abrupt (n=19, 90.4%) or crossed abrupt (n=3, 1.3%) retouch, which was usually direct (n=21, 95%) and less often alternating (n=1, 4.5%). Usually they were unilaterally retouched and only in eight cases (36.3%) bilaterally or retouched on proximal or distal ends. The direction of retouch was usually direct (n=7, 87%) and more rarely inverse (n=1, 12.5%). The nature of retouch was abrupt or semi-abrupt (n=6, 75%), and to a lesser extent, low angle (n=2, 25%). Nine bladelets (41%) were pointed, of which one was bi-truncated (11.1%) and one truncated. The points were always acute, approximately 18 degrees. Four flakes (80%) displayed retouch although their edges, with one (20%) on the distal end. Retouch was usually direct (n=4, 80%) and rarely inverse (n=1, 20%). There was only one (20%) example of bilaterally retouched flake. **Notches/denticulates** amounted to only four pieces, of which one (25%) was made on blade and three (75%) on flakes. One notch was particularly interesting, having been made on a core that had been exploited to the point of becoming a thin flake. Notches/denticulates usually displayed unilateral or bilateral, abrupt or semi abrupt retouch, while the direction of retouch was either alternating, direct or inverse. **Scrapers** were mainly made on flakes (n=3, 75%), and in a single case (15%) on a core. Three (75%) were classified as endscrapers and one (15%) as a sidescraper. The length of the retouched area varied between 3.6 and 9.3mm with mean 7.1mm (SD=2.4mm).

Phase IV

Tools with **backed retouch** constituted the majority of this assemblage. Of the 39, a total of 23 (59%) were made on bladelets and 16 (41%) on flakes. Backed bladelets displayed abrupt (n=20, 87%) and rarely crossed (n=1, 4.3%) or semi-abrupt retouch (n=2, 8.6%), which was usually direct (n=21, 91.3%) and less often alternating (n=1, 4.3%) or inverse (n=1, 4.3%). They were usually laterally retouched, although in five cases (26%) they were bilaterally retouched on the distal end. Retouch was direct in seven cases (30.4%) and inverse in two (8.6%). It was either abrupt or semi abrupt (n=6, 26%) and to a lesser extent low angle (n=2, 8.6%). Eleven bladelets (47.8%) were pointed, of which one (4.3%) was bi-pointed and one was truncated (4.3%). The point was always acute, approximately 18 degrees. Backed flakes were predominantly retouch on one side (n=13, 81.3%), while three (18.8%) were retouched along two sides, the proximal or distal end forming either a point or truncation. Retouch was usually direct (n=4, 25%) and rarely inverse or alternating (n=2 in each case, 6.2%). Overall, the nature of retouch was semi abrupt (n=8, 50%), abrupt (n=7, 43.7%) or crossed abrupt (n=1, 6.2%). **Notches/denticulates** accounted for only three pieces, all made on flakes. They were retouched laterally (n=2, 66.6%), or on the distal end (n=1, 33.3%) The retouch was usually inverse (n=2, 66%) or direct (n=1, 33%), while semi abrupt (n=2, 66%) or low angle (n=1, 33%). Two **truncations** were present, one made on a flake and the other on a bladelet. Both had distal, direct and abrupt retouch. **Scrapers** were mainly made on flakes (n=2, 66.7%), while one (33.3%) was made on core. Two (66.7%) were classified as endscrapers and one (33.3%) as a sidescraper. The latter was made on reddish brown fine-grained flint which was rare elsewhere in the collection. The length of the retouched area varied between 2.7 and 5.2 mm with a mean of 4.3mm.

(SD=1.4mm). Two **burins** were present, both made on flakes, along with a single **geometric microlith**. Triangular in shape, it had direct, abrupt retouch on both lateral and distal edges (see Perlès 1987:127, figure 28, no 12).

5.5. Metric analysis of the lithic assemblage

5.5.1. Introduction

The aim of this section is firstly to provide an overview to the dimensional character of the Franchthi collection, with particular emphasis placed on changes through time. The analysis was undertaken using the same methods as were applied at Klithi. The only difference being that the sample size cut-off for inclusion in the analysis was reduced to five pieces, compared to ten at Klithi. This was because of the much smaller sizes of the samples at Franchthi, and must be continually borne in mind.

5.5.2. Cores

Metric analysis of cores was based on length, platform width and breadth, and percentage of platform worked. The aim is to investigate the intensity of core use through time, and is based on complete cores only. They number 131 pieces in total. The basic characteristics of the core assemblage are listed in table 5.8.

Table 5.8. Metric characteristics of complete cores.

	Phase II	**Phase III**	**Phase IV**
Length (mm)	**(n=54)**	**(n=25)**	**(n=52)**
Minimum/ Maximum	10.8/50.0	14.0/48.0	10.1/42.3
Mean (SD)	26.8 (9.2)	26 (9.0)	26.5 (7.2)
Platform width (mm)	**(n=54)**	**(n=25)**	**(n=52)**
Minimum/Maximum	3.4/64.2	5.2/60.8	5.8/57.0
Mean (SD)	28.5 (15.0)	22.8 (12.4)	22.4 (9.1)
Platform breadth (mm)	**(n=54)**	**(n=25)**	**(n=52)**
Minimum/Maximum	0.2/51.1	0.1/44.8	0.3/31.5
Mean (SD)	19.0 (12.5)	14.3 (12.3)	15.0 (6.7)
Percentage platform worked (%)	**(n=54)**	**(n=25)**	**(n=52)**
Minimum/ Maximum	30.2%/100%	50%/100%	20.6%/100%
Mean (SD)	90.5% (18.5%)	87.5% (18.0%)	88.6 % (18.6%)

Length

Length was measured perpendicularly from the primary platform to the base of the core. Phases III and IV had a similar central tendency of between 25mm to 30mm; in addition, phase III was bimodal with a second peak at between 15mm and 20mm, which it shared with phase II, the primary central tendency for the latter (fig.5.14).

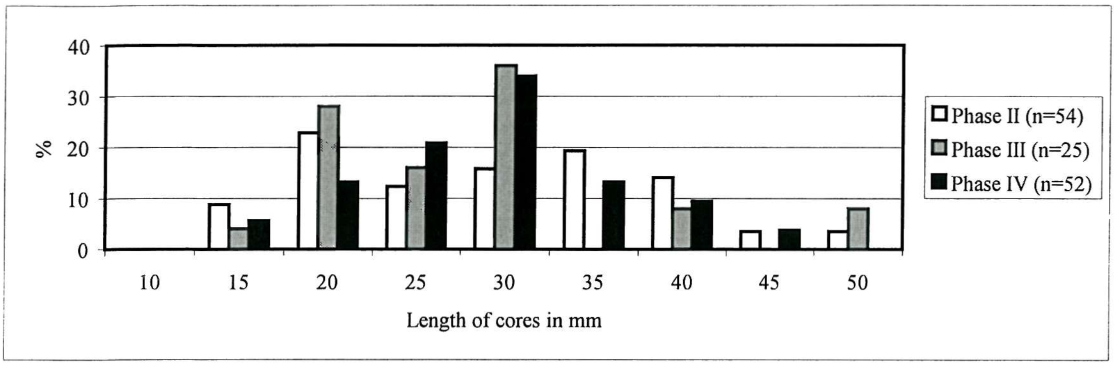


Figure 5.14. Length of all complete cores.

The principal central tendency, for phases III and IV in particular points to 25mm to 30mm as the minimum for core utility. The presence of shorter pieces in phases II and III in particular may suggest more extensive use of cores in earlier phases. Alternatively, the fact that cores in phase IV were being abandoned while still relatively long may suggest that blank length had become an important contributory factor in terms of discard. Despite the observed differences, none were identified as significant by the KS test, phases II and III ($Dmax_{obs}=24.3<Dmax_{0.05}=32.6$), phases II and IV ($Dmax_{obs}=13.9<Dmax_{0.05}=26$) and phases III and IV ($Dmax_{obs}=13.1<Dmax_{0.05}=33$).

Platform width

Platform width was measured across the widest portion of the primary platform. The phase II frequency histogram suggested a bimodality, with central tendencies centring on 15mm to 20mm and then 30mm to 35mm. Phase III and IV were unimodal, but with quite different central tendencies of between 10mm to 15mm and 25mm to 30mm respectively (fig.5.15).

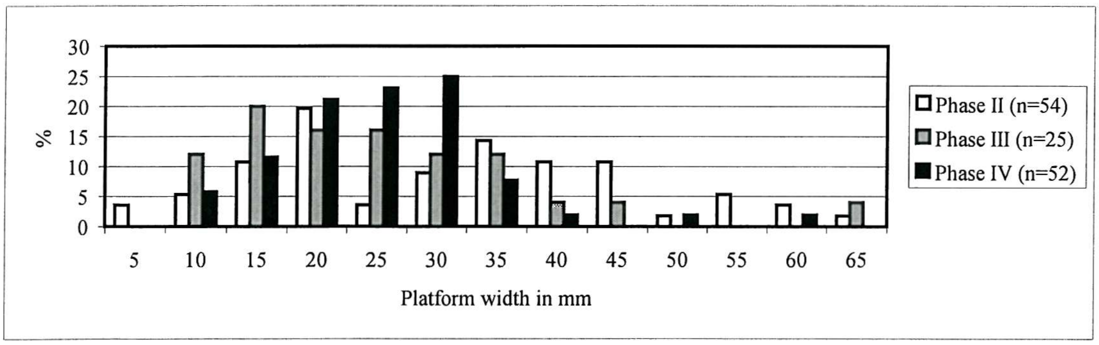


Figure 5.15. Platform width of all complete cores.

This suggests that earlier phase II cores comprised a small and large platform element, while in phase III, cores with wider platforms declined in frequency suggesting more extensive use of raw materials. However, after the 5,000 year hiatus, platform widths increased again in phase IV, although interestingly they declined significantly in frequency beyond 30mm. Compared to the earlier two phases where cores with wider platforms were more common, the decline in wider cores in phase IV suggests a more rigorous adherence to a lower usefulness cut-off. The KS test identified the frequency differences between phases II and III ($Dmax_{obs}=24.2<Dmax_{0.05}=32.7$), phases III and IV ($Dmax_{obs}=14.1<Dmax_{0.05}=33.1$) as not significant, but significant between phases II and IV ($Dmax_{obs}=34.7>Dmax_{0.05}=26.2$).

Platform breadth

Breadth was measured perpendicular to the width axis, and was always the smaller value. The bimodalities observed amongst platform width were not as apparent in terms of breadth. In fact all three phases had the same central tendency of between 10mm and 15mm (fig.5.16). There was some suggestion of bimodality amongst phase III with an initial peak in frequency with those cores with platforms less than 5mm in breadth, referred to as bifacial cores. They were characterised by alternate removals along a sinuous edge, and tended to be less than 3mm in breadth.

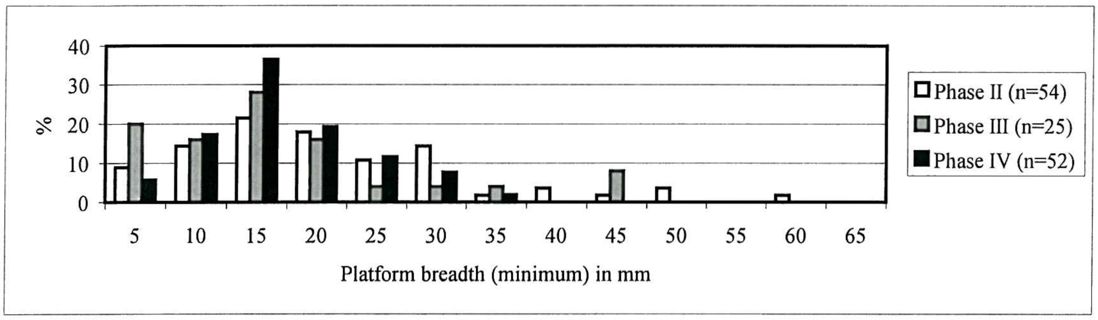


Figure 5.16. Platform breadth of all complete cores.

Bifacial cores tended to be more common in phase III, where of the total 25 cores in the sample, they accounted for 20% (n=5), compared to 5.3% (n=3) in the earlier phase II and 1.9% (n=1) in phase IV. Along with platform width, the picture which emerged was of cores in phase II with the largest platforms overall, however they declined in phase III along with an increase in bifacial cores which suggests an increase in the intensity of raw material use. This pattern appears to have been largely reversed in phase IV with apparently less intensive use of platforms and fewer bifacial cores. However, phase IV was poorly represented in terms of both wider and broader cores. As with width, this suggests that cores from phase IV tended to be more effectively worked down to a lower usefulness cut-off. However, the KS test identified no significant differences between phases II and III ($Dmax_{obs}=16<Dmax_{0.05}=32.7$), phases II and IV ($Dmax_{obs}=17.2<Dmax_{0.05}=26.7$) and phases III and IV ($Dmax_{obs}=14.2<Dmax_{0.05}=33.1$).

Two dimensional analysis, length against platform breadth

The differences observed between the three phases in the frequency histogram are further illustrated in the scattergram (fig.5.17). Cores from phase II appeared more widely distributed than in phases III or IV, suggesting a wider range of sizes, including longer and broader pieces.

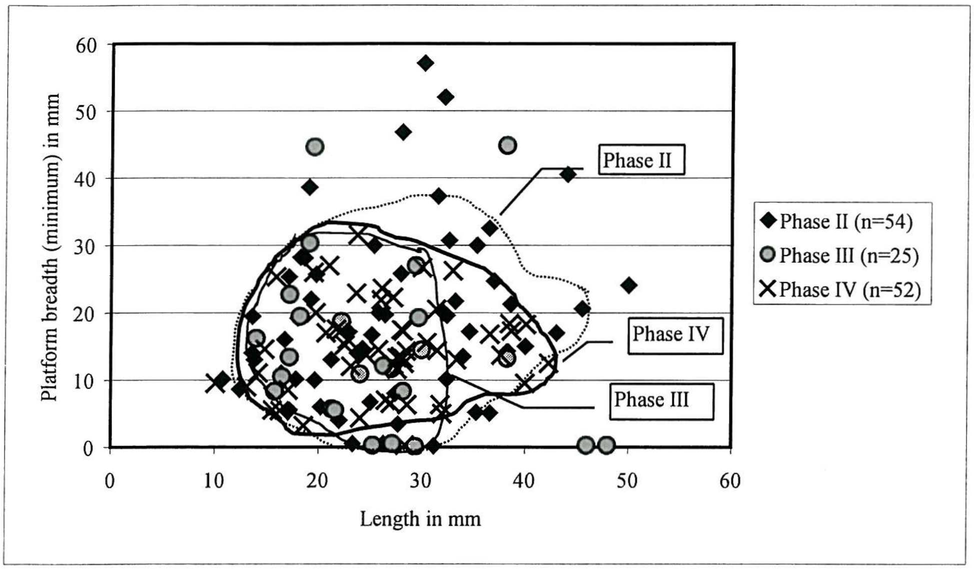


Figure 5.17. Length against platform breadth for all complete cores.

They also tended to have platforms broader than 30mm, which were rare in phase III and absent in phase IV. In phase III, although there were a few longer examples, cores on the whole tended to be shorter than in the other two, particularly those less than 30mm. However, the tendency was of similar platform breadths in phases III and IV. In addition, bifacial cores appeared relatively more common in phase III, which suggests more intensive use. Overall, cores appear to have declined in size from phase II to III with more intensive working and reduction in the range of sizes present. In phase IV, after the 5,000 year hiatus, cores increased in length to pre-hiatus lengths, while platform breadth remained broadly the same. In addition, there was little change in the range of sizes present between phases III and IV.

Two dimensional analysis, platform width against breadth

Phase II produced a significant component of cores with wider and broader platforms than either of the other two phases (fig.5.18). Although sample sizes declined in phase III, so too did platform dimensions, while at the same time the frequency of bifacial cores increased.

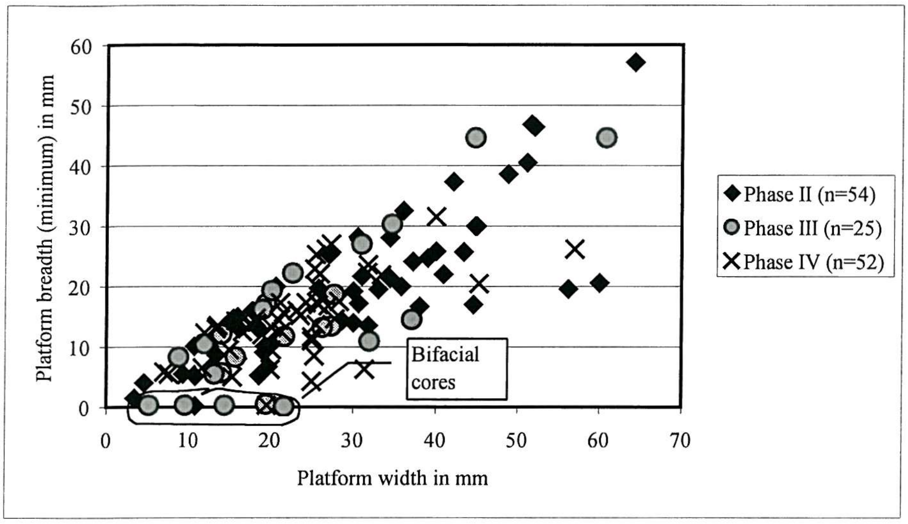


Figure 5.18. Core platform width against breadth for all complete cores.

In phase IV, platform size remained broadly the same although bifacial cores declined in frequency. This suggests that the extent of platform use increased through time between phases II and III, but that there was little change between phases III and IV despite the lengthy hiatus between them. In fact in terms of core use, phases III and IV at Franchthi appear quite similar to one another.

Percentage of platform worked

There was a decline in frequency of cores with completely worked platforms after phase II (fig.5.19). This suggests that although cores appear to have been discarded in a more extensively worked state in phases III and IV, this was not accompanied by an increase in the extent of platform perimeter use. One reason for this apparent lack of platform use despite a decline in size at discard may be that working around the platform was not necessarily the most efficient way in which to utilise the specific raw materials encountered at Franchthi. Working across rather than around the platform appears to have been a more efficient way of working the small raw materials available. Some support for this may be found in terms of platform breadth, where a decline was noted, particularly from phase II to III, but also into phase IV.

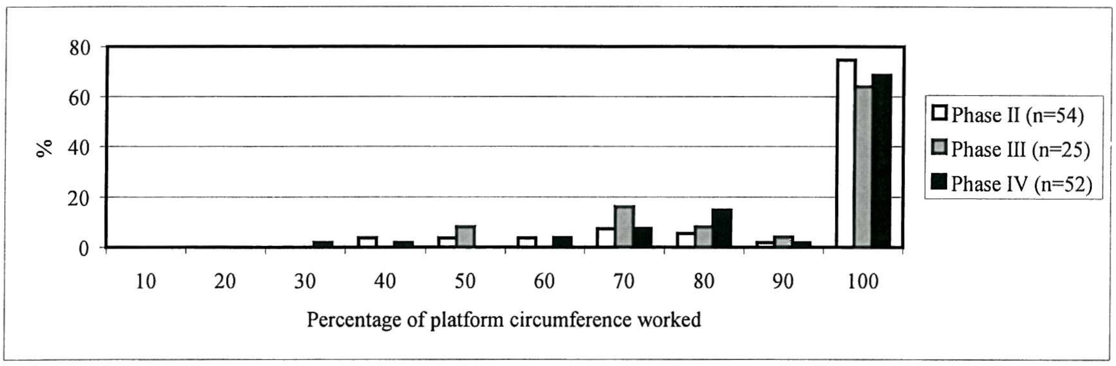


Figure 5.19. Percentage of platform circumference worked for all complete cores.

Despite this, the differences were small, and the KS test failed to identify any significant changes in percentage platform working between phases II and III ($Dmax_{obs}=10.5<Dmax_{0.05}=32.8$), phases II and IV ($Dmax_{obs}=6<Dmax_{0.05}=26.1$), or phases III and IV ($Dmax_{obs}=9.2<Dmax_{0.05}=32.9$).

5.5.3. Debitage

Debitage refers to all unretouched pieces larger than 10mm. Table 5.9 lists the total numbers sampled for each unretouched category and phase, as well as their basic dimensions. As will be noted, the total number of pieces measured in terms of length, width and breadth for each debitage category will vary due to the differential breakage patterns. So for instance, a snapped bladelet could be used to measure width and thickness, but not length. In this way more of what are in many cases very small collections, could be included in the analysis.

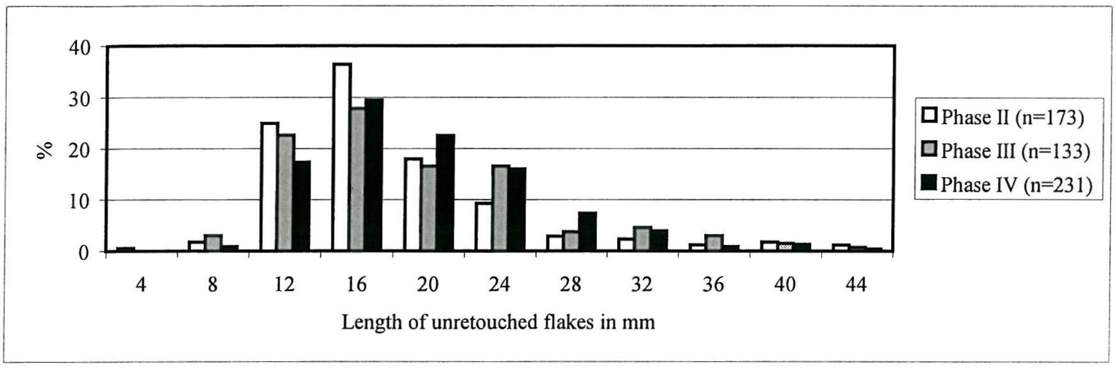
Table 5.9. Maximum, minimum and mean dimensions for debitage >10mm.

Dimensions in mm	Phase II	Phase III	Phase IV
	Length		
Flakes	**(n=173)**	**(n= 133)**	**(n= 231)**
Minimum /Maximum	4.0/42.4	6.0/41.8	7.1/44.0
Mean (SD)	16.0 (6.3)	17.1 (7.1)	17.4 (6.2)
Bladelets	**(n=76)**	**(n=29)**	**(n=42)**
Minimum /Maximum	10.5/32.8	11.6/26.5	11.0/33.8
Mean (SD)	17.3 (5.3)	17.1 (4.0)	17.5 (5.3)
Blades	**(n=9)**	**(n=8)**	**(n=9)**
Minimum / Maximum	26.5/43.2	26.1/52	25.1/43.2
Mean (SD)	31.7 (5.0)	36.2 (8.1)	34.0 (7.0)
	Width		
Flakes	**(n=400)**	**(n=261)**	**(n=384)**
Minimum /Maximum	5.5/ 38.8	6.0/40	1.4/36.1
Mean (SD)	14.4 (5.6)	14.3 (6.1)	14.0 (5.1)
Bladelets	**(n=149)**	**(n=67)**	**(n=62)**
Minimum / Maximum	2.3/12	3.8/ 11.7	4.1/11.0
Mean (SD)	7.4 (2.2)	7.0 (1.7)	7.3 (1.8)
Blades	**(n=16)**	**(n=11)**	**(n=21)**
Minimum / Maximum	12.3/21.1	13.0/19.2	12.1/20.0
Mean (SD)	14 (2.1)	14.3 (1.8)	14.1 (1.9)
	Thickness		
Flakes	**(n=400)**	**(n=261)**	**(n=384)**
Minimum / Maximum	1.0/16.3	1.0/15.1	1.0/16.5
Mean (SD)	4.5 (2.7)	4.7 (2.8)	5.1 (3.0)
Bladelets	**(n=149)**	**(n=67)**	**(n=62)**
Minimum / Maximum	0.6/8.1	1.2/7.4	1.4/9.1
Mean (SD)	3.0 (1.4)	3.2 (1.3)	3.5 (1.6)
Blades	**(n=16)**	**(n=11)**	**(n=21)**
Minimum / Maximum	3.0/10.3	3.1/10.7	3.8/11.7
Mean (SD)	5.5 (2.0)	4.5 (1.8)	6.7 (2.0)

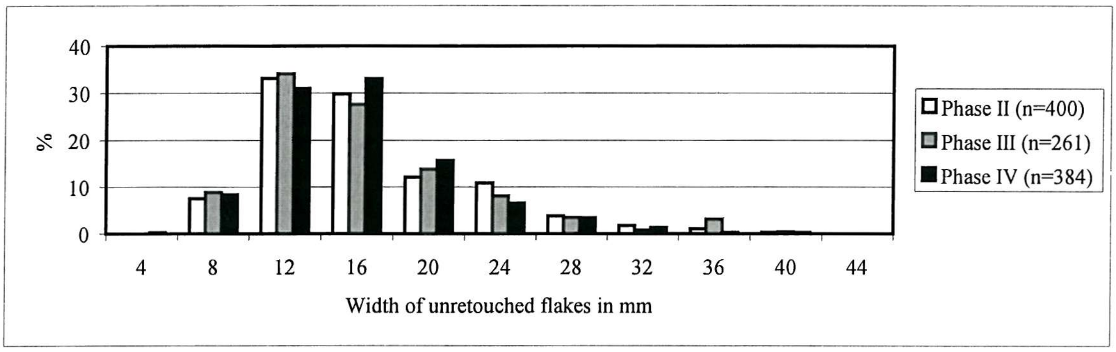
Flakes

Unretouched flakes from all three phases shared a similar central tendency of between 12mm and 16mm (fig.5.20a). Phase II produced the shortest flakes overall, followed by phase III and then phase

IV. This supported the results of the core analysis in which length appeared to increase in phase IV. However, the KS test indicated no significant difference between phases II and III ($Dmax_{obs}=11.6<Dmax_{0.05}=15.7$), phases II and IV ($Dmax_{obs}=11.4<Dmax_{0.05}=13.7$), or phases III and IV ($Dmax_{obs}=6.0<Dmax_{0.05}=15.0$).



a.



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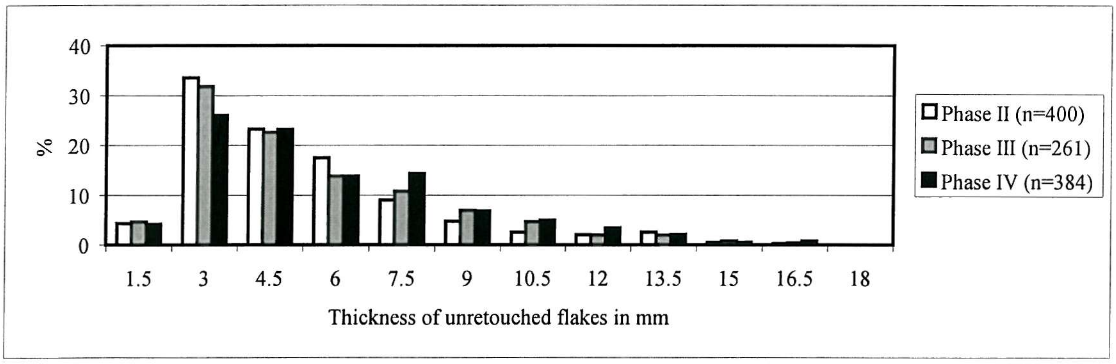


c.

Figure 5.20. Length (a), width (b) and thickness (c) of unretouched flakes.

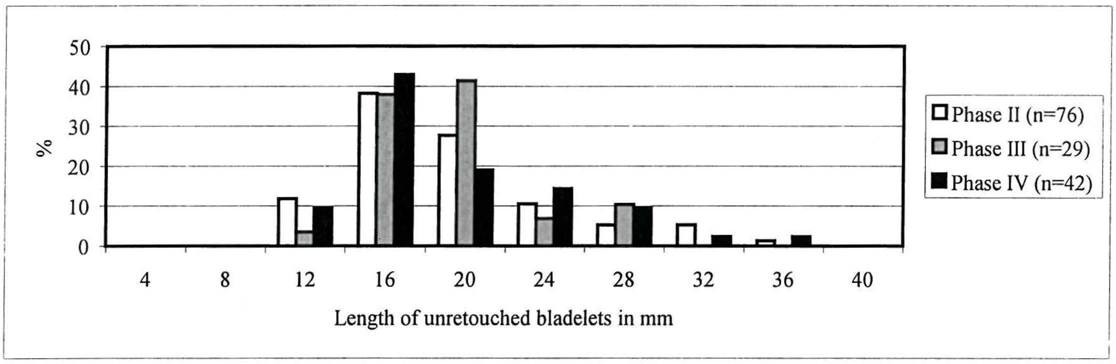
Unretouched flakes had a width central tendency of between 8mm and 12mm for phases II and III, however this increased to between 12mm and 16mm for phase IV (fig.5.20b). There were few obvious differences between the phases apart from a higher frequency of wider flakes from between 12mm and 20mm in phase IV. However, the KS test indicated no significant difference between phases II and III ($Dmax_{obs}=2.31<Dmax_{0.05}=10.8$), phases II and IV, ($Dmax_{obs}=5.8<Dmax_{0.05}=9.7$) or phases III and IV ($Dmax_{obs}=3.4<Dmax_{0.05}=10.9$).

All three phases shared the same thickness central tendency of between 1.5mm and 3mm (fig.5.20c). The distribution was positively skewed with a significant jump in frequency of flakes thicker than

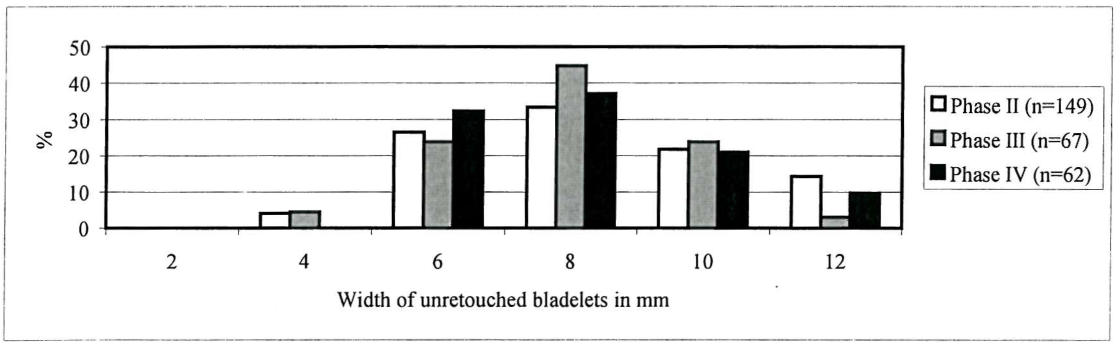
1.5mm. As argued previously for Klithi, this reflects the removal from the assemblages of pieces less than 10mm, the effect being also to remove thinner pieces. Overall, flakes tended to be thinnest in phase II, followed by phase III and then phase IV. However, the KS test indicated no significant difference between phases II and III ($Dmax_{obs}=5.70<Dmax_{0.05}=10.8$), phases II and IV, ($Dmax_{obs}=7.6<Dmax_{0.05}=9.7$), or phases III and IV ($Dmax_{obs}=6.2<Dmax_{0.05}=10.9$).

Bladelets

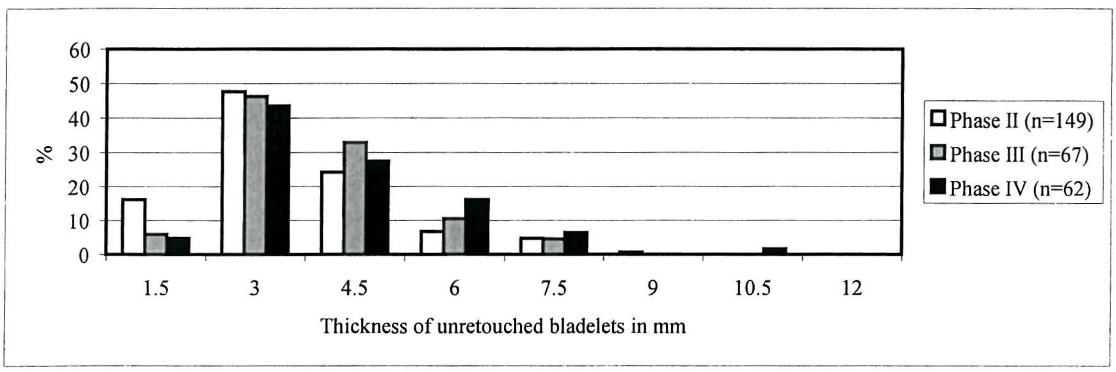
Unretouched bladelets from phases II and IV shared the same central tendency for length of between 12mm and 16mm, whereas it was between 16mm and 20mm in phase III (fig.5.21a). On balance phase IV produced slightly higher frequencies of longer bladelets. However, the KS test did not indicate any significant difference in length frequencies between phases II and III ($Dmax_{obs}=8.6<Dmax_{0.05}=30.0$), phases II and IV ($Dmax_{obs}=6.2<Dmax_{0.05}=26.1$), or phases III and IV ($Dmax_{obs}=11.3<Dmax_{0.05}=32.8$).



a.



b.



c.

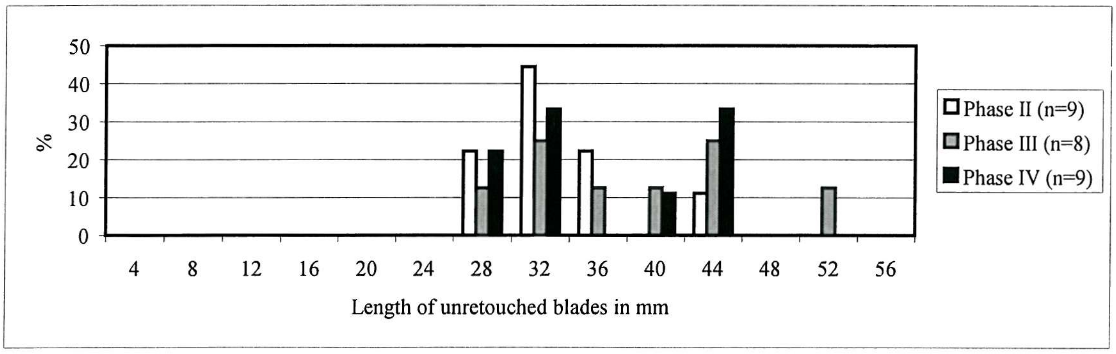
Figure 5.21. Length (a), width (b) and thickness (c) of unretouched bladelets.

All three phases shared a similar width central tendency of between 6mm and 8mm (fig.5.21b). Overall, phase II produced slightly higher frequencies of wider bladelets followed by phase IV and then phase III. However, the KS test identified no significant difference between phases II and III ($Dmax_{obs}$=11.3 <$Dmax_{0.05}$=29.7), phases II and IV ($Dmax_{obs}$=5.4<$Dmax_{0.05}$=26.1), or phases III and IV ($Dmax_{obs}$=6.7<$Dmax_{0.05}$=32.8). Unretouched bladelets shared the same thickness central tendency of between 1.5mm and 3mm (fig.5.21c). The distribution was positively skewed with a significant jump in the frequencies of pieces thicker than 1.5mm. Overall, phase IV produced slightly higher frequencies of thicker bladelets followed by phase III and then phase II. However, the KS test indicated no significant difference in the thickness between phases II and III ($Dmax_{obs}$=11.5<$Dmax_{0.05}$=29.7), phases II and IV, ($Dmax_{obs}$=15.3<$Dmax_{0.05}$=26.1), or phases III and IV ($Dmax_{obs}$=9.3<$Dmax_{0.05}$=32.8).

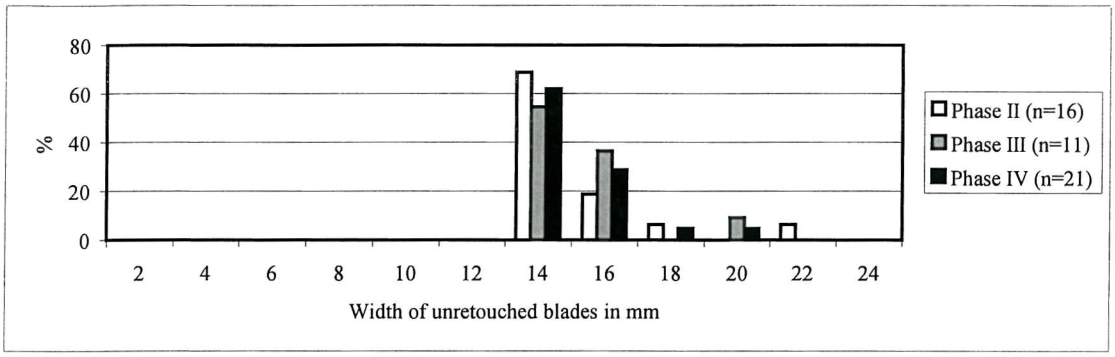
Like unretouched flakes, there was some evidence to suggest that bladelets increased through time in terms of both length and thickness from phase II to phase IV.

Blades

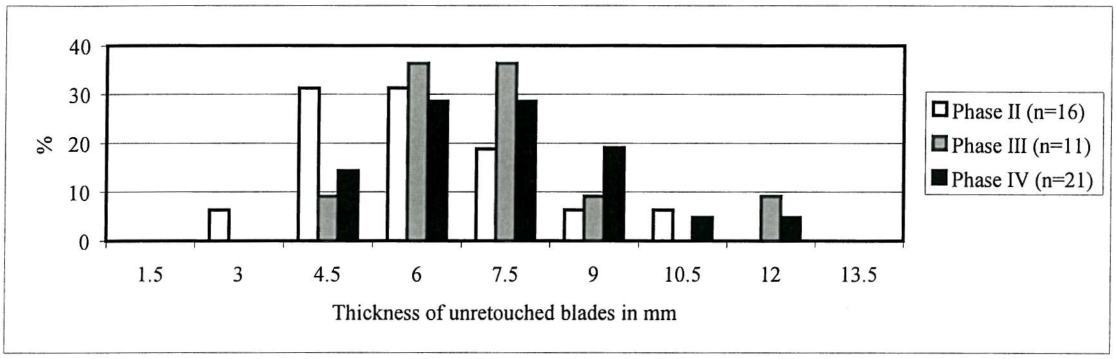
Given the small size of the blade samples, any conclusions must be viewed with caution. All three phases shared an initial central tendency of between 28mm and 32mm in length (fig 5.22a). However, phases III and IV were bimodal, with a second peak at between 40mm and 44mm. Whether a result of shifts in raw material provisioning or knapping strategy, the later phases III and IV appear to suggest the presence of an additional longer blade component. The KS test failed to identify any significant difference in length between phases II and III ($Dmax_{obs}$=38.9<$Dmax_{0.05}$=66.0), phases II and IV ($Dmax_{obs}$=33.3<$Dmax_{0.05}$=64.1), or phases III and IV ($Dmax_{obs}$=18.0<$Dmax_{0.05}$=66.0).



a.



b.



c.

Figure 5.22. Length (a), width (b) and thickness (c) of unretouched blades.

Similarly, phases III and IV appear to suggest an increase in blade width through time (fig.5.22b). Although all three phases shared the same central tendency, wider blades were slightly more common in phases III and IV. However, the KS test identified no significant difference between the width frequency distribution for phases II and III ($Dmax_{obs}=14.2<Dmax_{0.05}=53.2$), phases II and IV ($Dmax_{obs}=6.85<Dmax_{0.05}=45.1$) or phases III and IV ($Dmax_{obs}=7.36<Dmax_{0.05}=50.6$). Blades were thicker in phases III and IV, particularly those over 6mm, however all shared broadly the same central tendency of between 4.5mm and 7.5mm (fig.5.22c). The KS test identified no significant difference between phases II and III ($Dmax_{obs}=28.4<Dmax_{0.05}=53.2$), phases II and IV ($Dmax_{obs}=25.9<Dmax_{0.05}=45.1$), or phases III and IV ($Dmax_{obs}=10.3<Dmax_{0.05}=50.6$).

Like flakes and bladelets, blades suggested an increase in dimensions through time from phase II, through phase III to phase IV. On balance, and although none of the significance test results proved positive, phases III and IV were more similar to one another than phases II and III. Despite the 5,000 year hiatus in occupation of the cave between phases III and IV, there appears to have been less change in technology than between the previous consecutive phases II and III.

5.5.4. Tools

Table 5.10 presents the dimensional attributes of the tools from phases II, III and IV. Unfortunately, most of the tool collections were small in number, and could therefore not be included in the metric comparisons. In fact, the only groups that could be used were backed flakes, backed bladelets, notches/denticulates and scrapers.

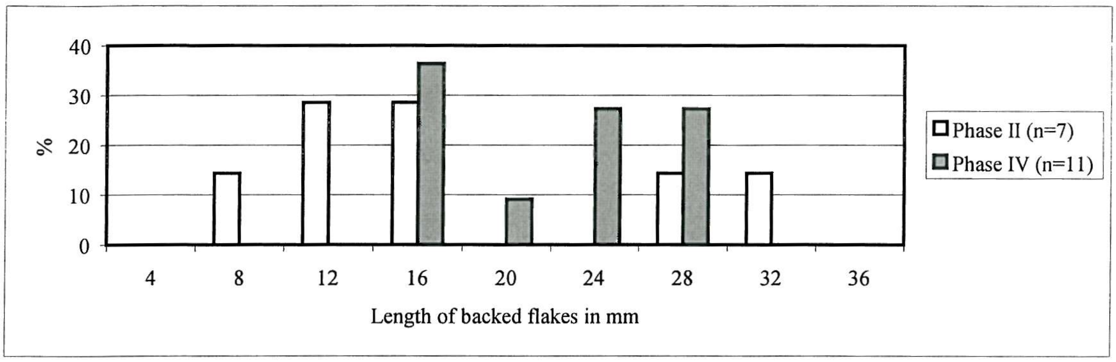
Table 5.10. Maximum, minimum and mean dimensions of tools.
Key:
N/A : tool groups with single pieces.
None found: none of this type of tool found.
None complete: although present, the dimension could not be measured due to breakage patterns.

Dimensions in mm	**Phase II**	**Phase III**	**Phase IV**
		Length	
Backed flakes	**(n=7)**	**(n=2)**	**(n=11)**
Minimum / Maximum	7.7/30.8	9.1/10.2	12.2/28.0
Mean (SD)	15.8 (9.5)	9.6 (0.7)	20.0 (5.4)
Backed bladelets	**(n=13)**	**(n=10)**	**(n=13)**
Minimum /Maximum	10.6/40.0	13.5/25.2	13.5/28.0
Mean (SD)	19.3 (8.4)	20.0 (3.3)	19.2 (5.2)
Backed blades	**(n=1)**	None found	None found
Minimum /Maximum	N/A	-	-
Mean (SD)	N/A	-	-
Geometric microliths	None found	None found	**(n=1)**
Minimum /Maximum	-	-	N/A
Mean (SD)	-	-	N/A
Flakes with linear retouch	None complete	None found	None found
Minimum / Maximum	-	-	-
Mean (SD)	-	-	-
Bladelets with linear retouch	None complete	None found	None found
Minimum / Maximum	-	-	-
Mean (SD)	-	-	-
Notches/Denticulates	**(n=3)**	**(n=2)**	**(n=1)**
Minimum / Maximum	13.8 /24.5	40.5/42.8	N/A
Mean (SD)	20.8 (6.1)	41.5 (1.6)	N/A
Scrapers	**(n=3)**	**(n=1)**	**(n=3)**
Minimum / Maximum	19.7/60.0	N/A	26.5/43.2
Mean (SD)	34.5 (22.1)	N/A	32.6 (9.2)
Burins	None found	None found	**(n=2)**
Minimum / Maximum	-	-	144.3/18.1
Mean (SD)	-	-	16.2 (2.6)
Truncations	**(n=1)**	None found	**(n=1)**
Minimum / Maximum	N/A	-	N/A
Mean (SD)	N/A	-	N/A
		Width	
Backed flakes	**(n=8)**	**(n=5)**	**(n=16)**
Minimum / Maximum	5.6/34.6	6.2/12.2	6.5/21.0
Mean (SD)	13.0 (10.0)	9.7 (2.6)	11.4 (4.6)
Backed bladelets	**(n=57)**	**(n=22)**	**(n=23)**
Minimum /Maximum	4.0/10.0	4.8/10.2	4.3/8.7
Mean (SD)	5.8 (1.2)	6.5 (1.4)	7.0 (1.2)
Flakes with linear retouch	**(n=3)**	None found	None found
Minimum / Maximum	9.6/17.7	-	-
Mean (SD)	12.5 (4.4)	-	-
Bladelets with linear retouch	**(n=3)**	None found	None found
Minimum / Maximum	5.5/6.1	-	-
Mean (SD)	5.7(0.3)	-	-
Backed blades	**(n=1)**	None found	None found
Minimum /Maximum	N/A	-	-

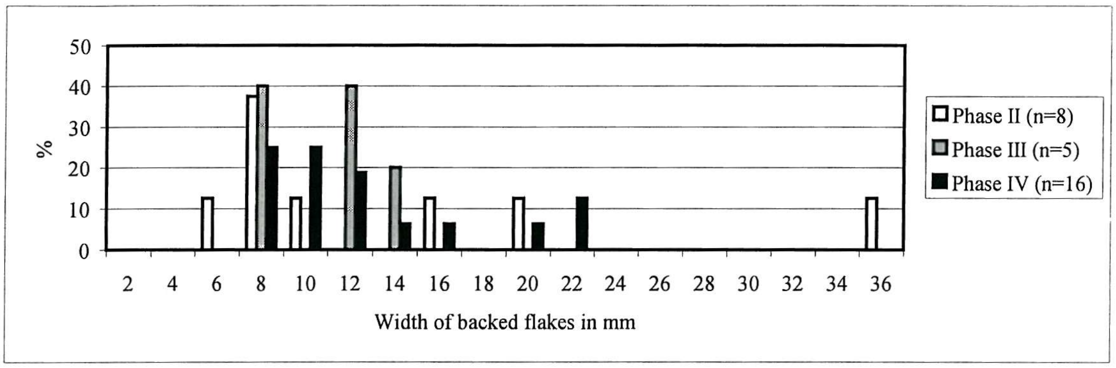
Mean (SD)	N/A	-	-
Geometric microliths	None found	None found	**(n=1)**
Minimum /Maximum	-	-	N/A
Mean (SD)	-	-	N/A
Notches/Denticulates	**(n=7)**	**(n=4)**	**(n=3)**
Minimum / Maximum	10.0/16.0	16.0/27.7	14.1/19.5
Mean (SD)	12.2 (2.5)	21 (5.7)	17.2 (2.8)
Scrapers	**(n=6)**	**(n=4)**	**(n=3)**
Minimum / Maximum	12.7/25.4	19.7/23.7	12.6/26.5
Mean (SD)	19.1 (4.1)	21.1 (1.7)	20.4 (7.1)
Burins	None found	None found	**(n=2)**
Minimum / Maximum	-	-	9.0/9.5
Mean (SD)	-	-	9.2 (0.3)
Truncations	**(n=1)**	None found	**(n=2)**
Minimum / Maximum	N/A	-	10.0/11.1
Mean (SD)	N/A	-	10.5 (0.7)
		Thickness	
Backed flakes	**(n=8)**	**(n=5)**	**(n=16)**
Minimum / Maximum	1.1/9.5	1.8/4.1	1.7/7.5
Mean (SD)	3.6 (3.0)	3.3 (0.9)	3.7 (1.7)
Backed bladelets	**(n=57)**	**(n=22)**	**(n=23)**
Minimum /Maximum	1.1/3.8	1.7/4.7	1.5/4.5
Mean (SD)	2.2 (0.7)	2.8 (0.9)	2.6 (1.0)
Backed blades	**(n=1)**	None found	None found
Minimum /Maximum	N/A	-	-
Mean (SD)	N/A	-	-
Geometric microliths	None found	None found	**(n=1)**
Minimum /Maximum	-	-	N/A
Mean (SD)	-	-	N/A
Flakes with linear retouch	**(n=3)**	None found	None found
Minimum / Maximum	1.6/3.6	-	-
Mean (SD)	2.3 (1.1)	-	-
Bladelets with linear retouch	**(n=3)**	None found	None found
Minimum / Maximum	1.4/1.8	-	-
Mean (SD)	1.5 (0.2)	-	-
Notches/Denticulates	**(n=7)**	**(n=4)**	**(n=3)**
Minimum / Maximum	2.1/5.0	2.5/11.7	4.6/10.0
Mean (SD)	3.6 (1.0)	7.0 (4.0)	7.5 (2.7)
Scrapers	**(n=6)**	**(n=4)**	**(n=3)**
Minimum / Maximum	5.0/9.5	9.2/14.2	10.1/16.1
Mean (SD)	7.7 (1.6)	10.0 (2.3)	12.9 (3.0)
Burins	None found	None found	**(n=2)**
Minimum / Maximum	-	-	3.4/4.4
Mean (SD)	-	-	3.9 (0.7)
Truncations	**(n=1)**	None found	**(n=2)**
Minimum / Maximum	N/A	-	1.8/4.4
Mean (SD)	N/A	-	3.1 (1.80)

Backed flakes

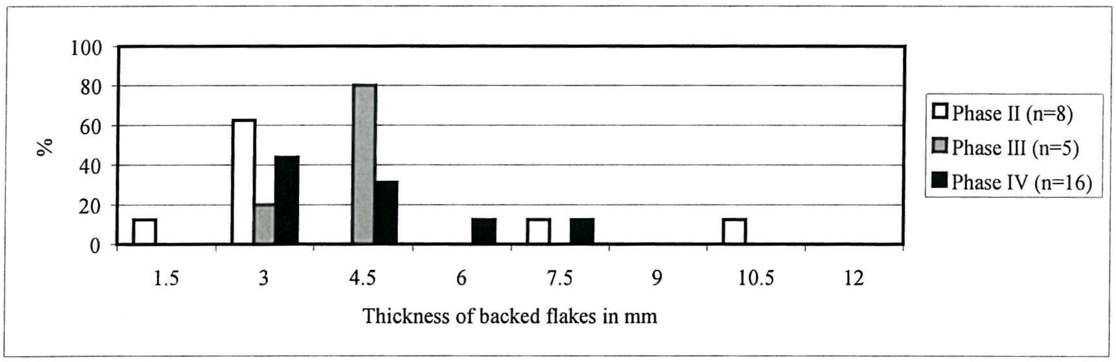
Backed flakes could only be compared in terms of length for phases II and IV, and even then for only seven and eleven pieces respectively. All that can be said is that there was some suggestion that backed flakes from phase IV tended to be longer than those from phase II (fig.5.23a). The KS test identified no significant difference between phases II and IV ($Dmax_{obs}=43.0<Dmax_{0.05}=65.7$).



a.



b.



c.

Figure 5.23. Length (a), width (b) and thickness (c) of backed flakes.

The width sample was better with all three phases included, although no consistent patterns were noted. Similarly with thickness, with such small sample sizes little more can be said. Needless to say, the KS test failed to identify any significant differences between any of the phases in terms of width or thickness.

Backed bladelets

Although sample sizes of backed bladelets were slightly larger than amongst backed flakes, they were still small with just 13 measured in terms of length. With such small samples all that can be said is that phases II and IV had a slightly higher frequency of short backed bladelets, compared to phase III (fig.5.24a). However, both phases II and IV also produced a small component of longer pieces as well. On the basis of the frequency distribution there appeared no clear evidence for any discernable pattern in backed bladelet length. Moreover, the KS test identified no significant difference between phases II and III ($Dmax_{obs}$=24.8<$Dmax_{0.05}$=57.2), phases II and IV ($Dmax_{obs}$=15.4< $Dmax_{0.05}$=53.3), or phases III and IV ($Dmax_{obs}$=36.1<$Dmax_{0.05}$=57.2).

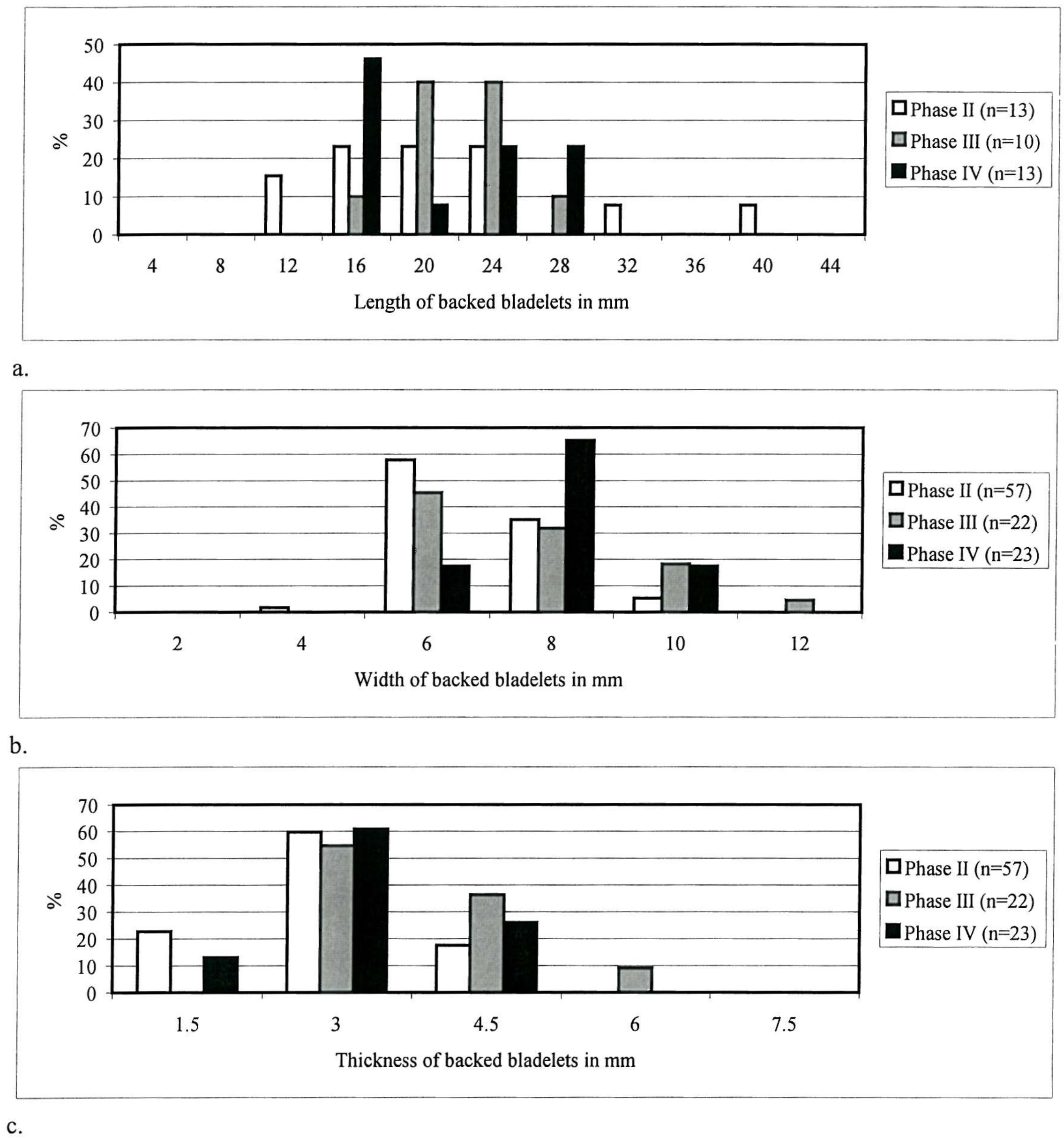
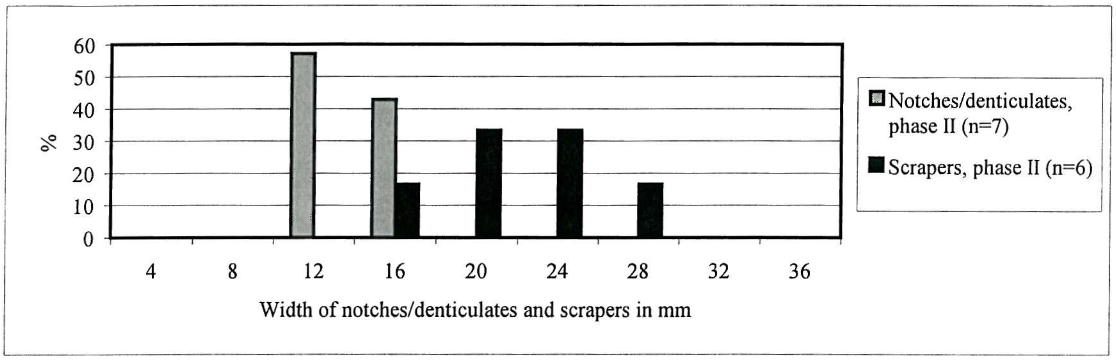


Figure 5.24. Length (a), width (b) and thickness (c) of backed bladelets.

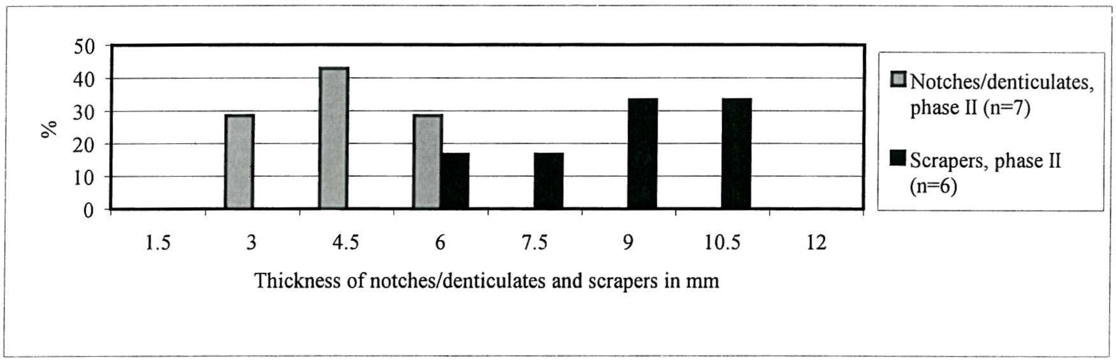
Sample sizes were larger for backed bladelets measured in terms of width and thickness. Phase II and III had a similar width central tendency of between 4mm and 6mm, while for phase IV it was between 6mm and 8mm (fig.5.24b). Overall, phase II produced the narrowest backed bladelets, followed by phase III and then phase IV. Phase IV also produced the most limited width distribution, with almost 65% of between 6mm and 8mm in width. The KS test indicated a significant difference between the width distribution of phases II and IV ($Dmax_{obs}$=42.2>$Dmax_{0.05}$=33.6), but not between phases II and III ($Dmax_{obs}$=17.4<$Dmax_{0.05}$=34.1), or phases III and IV ($Dmax_{obs}$=28.0<$Dmax_{0.05}$=40.5). All three phases had a similar thickness central tendency of between 1.5mm and 3mm (fig.5.24c). Overall, phase II produced the thinnest backed bladelets, followed by phase IV and then phase III, however the KS test identified no significant difference between phases II and III ($Dmax_{obs}$=28.0<$Dmax_{0.05}$=43.1), phases II and IV ($Dmax_{obs}$=9.76<$Dmax_{0.05}$=33.6), or phases III and IV ($Dmax_{obs}$=19.3<$Dmax_{0.05}$=40.5).

Notches/denticulates and scrapers

A small collection of notches/denticulates and scrapers were measured, but only phase II produced more than five pieces and then only measurable in terms of width and thickness.



a.



b.

Figure 5.25. Width (a) and thickness (b) of notches/denticulates and scrapers.

With so few pieces from a single phase, little can be said beyond that scrapers tended to be both wider and thicker than notches/denticulates (fig.5.25a,b).

5.6. Assessment of standardisation in the lithic assemblage

5.6.1. Introduction

The aim of this section was to undertake an assessment of extent of metric standardisation at Franchthi. This is done using the coefficient of variation (CV) as an index of size variance amongst length, width and thickness, and checked for significance using the *F* test. Variance was also presented graphically using cumulative percentage difference frequency histograms, which were then checked using the KS significance test. All were undertaken using log transformed data. The structure of this section is similar to that followed previously for the site of Klithi. For both debitage and tools, the collections from phases II, III and IV were combined in order to produce reasonably sized samples. In addition, blades and bladelets were combined in order to avoid imposing an element of typological standardisation either side of the 12mm width division.

5.6.2. Debitage

The CV results for debitage are listed in table 5.11 and illustrated in figure 5.26. The results of the *F* significance tests are given in Appendix II, table 1.

Table 5.11. CV values for debitage.

Debitage type	Length	Width	Thickness
Flakes	13.1% (n=537)	14.5% (n=1045)	42.3% (n=1045)
Blades/Bladelets	12.2% (n=173)	18.1% (n=326)	44.8% (n=326)

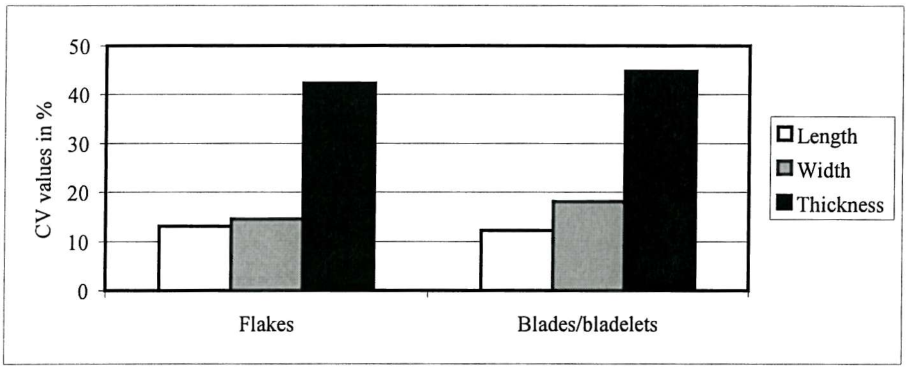
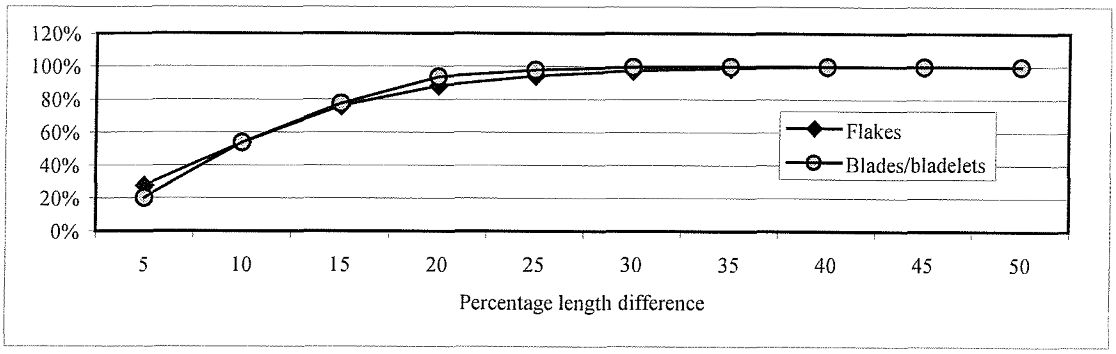


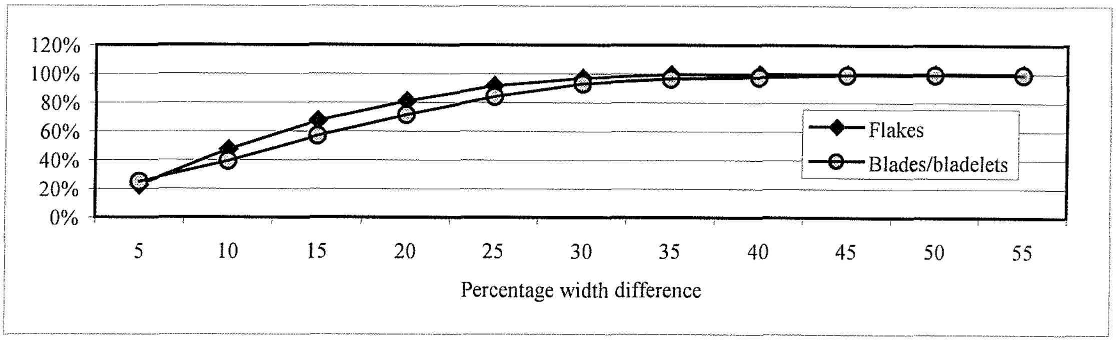
Figure 5.26. CV results for unretouched flakes and blades/bladelets.

Thickness CV values were by far the largest amongst both flakes and blades/bladelets, indicating much greater variance and by implication, less standardisation. Although intuitively unexpected, this result was repeated within the three collections and amongst both debitage and tools. The reason for this apparent lack of standardisation is the fact that of all three dimensions, thickness was the least controllable. It needs to be remembered that CV results refer to relative variance around the mean rather than absolute differences. The *F* test indicated that the difference in variance between flakes and blades/bladelets in terms of thickness was significant. The CV values for length were similar amongst flakes and blades/bladelets, and were overall the lowest, suggesting that of all three dimensions, length was the most standardised. The width CV for blades/bladelets was higher than for flakes, suggesting less standardisation amongst the former. However, the *F* tests indicated no significant difference in variance in terms of length and width between flakes and blades/bladelets.

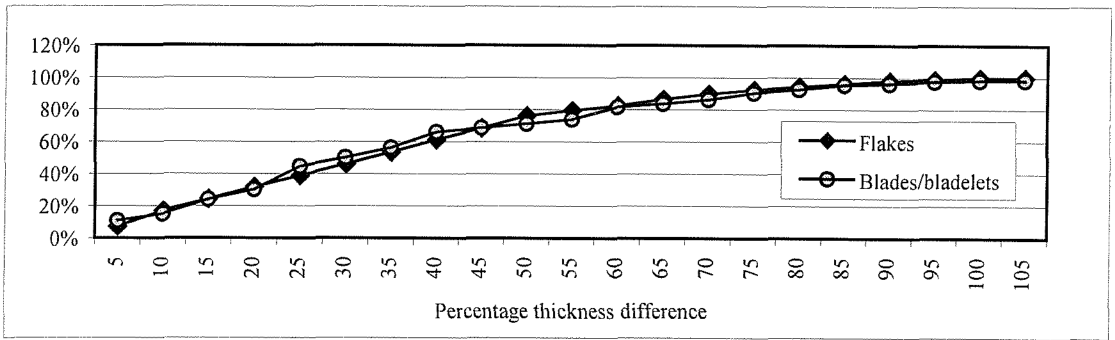
This pattern of variance was further illustrated using the cumulative frequency histograms of percentage difference (fig.5.27a-c). In terms of length it suggested that overall, the percentage difference for blades/bladelets was slightly less than for flakes, and by implication that the former were more standardised. In terms of width and thickness however, blades/bladelets percentage difference was greater than flakes, suggesting that in this case flakes were more standardised. The KS test indicated no significant difference between flakes and blades/bladelets in terms of length ($Dmax_{obs}=7.4<Dmax_{0.05}=11.9$) or thickness ($Dmax_{obs}=5.8<Dmax_{0.05}=8.6$), but that that they were significantly different in terms of width ($Dmax_{obs}=10.5>Dmax_{0.05}=8.6$).



a.



b.



c.

Figure 5.27. Flake and blade/bladelet cumulative percentage differences between log transformed means and values for length (a), width (b) and thickness (c).

Differential standardisation amongst flakes and blades/bladelets was not at all obvious and although the results of the CV values and cumulative percentage differences supported one another, the significance tests in general did not suggest any clear and consistent patterns. The *F* test suggested thickness as significantly different whereas the KS test identified width. On balance, the analysis pointed to little difference in standardisation of length, but that flakes were more so than blades/bladelets in terms of width and thickness. This suggests that apart from the apparent deliberate manufacture of blades/bladelets as opposed to flakes, there appears to have been no extra effort made on the part of the knappers at Franchthi to pre-standardise blade/bladelet blank production. If standardisation is found to be present amongst tools, then it will have been imposed during the retouch stage.

5.6.3. Tools

Retouched artefacts were assessed for size variance using CV and the *F* significance test, and graphically using cumulative percentage difference and the KS test. Listed in table 5.12 are those tool groups with more than five or more pieces, along with their CV results.

Table 5.12. CV values for tools.

Tool type	Length	Width	Thickness
Backed flakes	15.8% (n=20)	18.5% (n=29)	42.1% (n=29)
Backed bladelets	10.0% (n=36)	11.4% (n=102)	42.4% (n=102)
Notches/denticulates	12.8% (n=6)	11.5% (n=14)	33.5% (n=14)
Scrapers	12.3% (n=7)	7.6% (n=13)	13.4% (n=13)

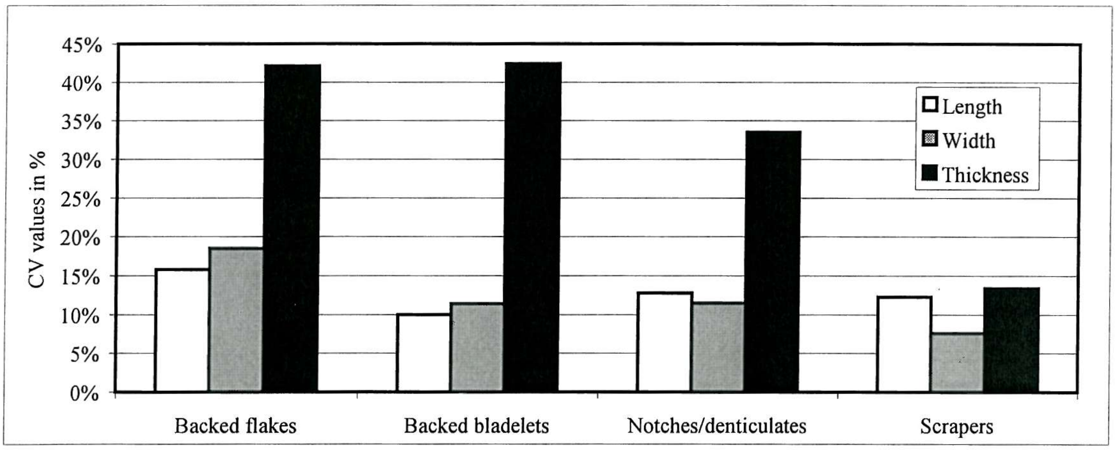
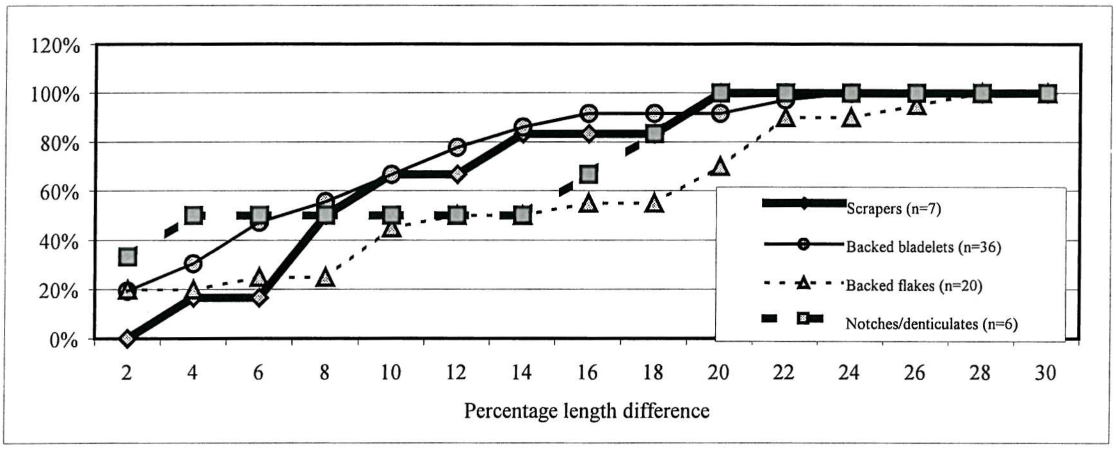


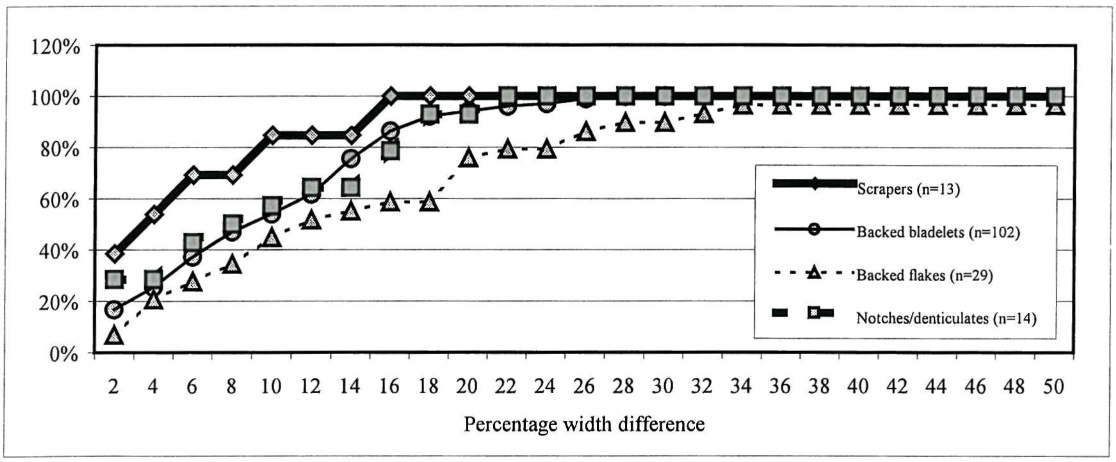
Figure 5.28. CV values for tools.

Thickness produced the highest CV values in all cases, and therefore by implication that was the least standardised of all three dimensions. This was not unexpected considering the high CV values obtained for unretouched flakes and blades/bladelets. Interestingly however, thickness CV values were significantly lower amongst notches/denticulates and scrapers in particular. Altering thickness through retouch is very difficult, strongly suggesting that the apparent standardisation of scraper-based artefacts was the result of deliberate blank selection. In terms of length, backed bladelets had the lowest CV, followed by scrapers, notches/denticulates and then backed flakes. In terms of width, scrapers produced the lowest CV, followed by backed bladelets, notches/denticulates and finally backed flakes. The *F* test identified only length of backed flakes and backed bladelets as significantly different. In terms of width, backed bladelets were significantly different to backed flakes and notches/denticulates, while backed flakes were significantly different to scrapers (see Appendix II, table 2, for *F* test results). In terms of thickness, the *F* test identified backed flakes as having a significantly different variance to backed bladelets and scrapers, and notches/denticulates compared to backed bladelets and scrapers.

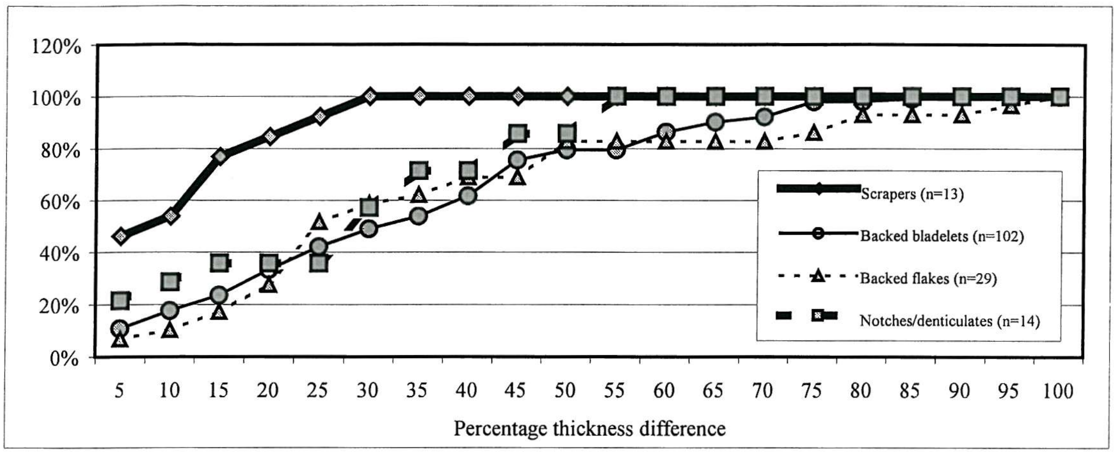
The differences in variance between the artefact groups are presented graphically in the following series of cumulative frequency histograms of percentage difference. The results of the KS significance test are presented in tabular form at the end of the section. In terms of length, backed bladelets appeared the most standardised overall, although closely followed by scrapers and then notches/denticulates (fig.5.29a). Backed flakes appeared the least standardised artefact group in terms of length. However, none of these differences were identified as significant by the KS test (tbl.5.13a). It needs to be noted however that with such small sample sizes, $Dmax_{0.05}$ values were very large and therefore even quite large observed differences were not significant.



a.



b.



c.

Figure 5.29. Cumulative percentage differences between log transformed means and values of length (a), width (b) and thickness (c) of tools.

Sample size increased in terms of those pieces measured in terms of width and thickness, in particular backed bladelets. In the case of width the cumulative frequency histogram pointed to scrapers as the most standardised artefact group, followed by backed bladelets and notches/denticulates, and lastly backed flakes (fig.5.29b). Despite the observed differences, only backed bladelets and backed flakes were identified by the KS test as significantly different (tbl.5.13b). In terms of thickness, the cumulative frequency histogram again pointed to scrapers as the most standardised artefact group, followed by backed bladelets, notches/denticulates, and backed flakes (fig.5.29c). This time the KS test identified the difference between scraper thickness and the other three artefacts groups as significant (tbl.5.13c).

Table 5.13. Results of the KS test. They are based on cumulative percentage differences for tool length (a), width (b), and thickness (c). Significant differences are shown highlighted.

Length KS test results	**Scrapers**	**Backed bladelets**	**Backed flakes**
Backed bladelets	($Dmax_{obs}$=30.6< $Dmax_{0.05}$=64.9)		
Backed flakes	($Dmax_{obs}$=33.3< $Dmax_{0.05}$=68)	($Dmax_{obs}$=33.7< $Dmax_{0.05}$=37.9)	
Notches/Denticulates	($Dmax_{obs}$=33.3< $Dmax_{0.05}$=82.4)	($Dmax_{obs}$=36.1< $Dmax_{0.05}$=60)	($Dmax_{obs}$=30< $Dmax_{0.05}$=63.3)

a.

Width KS test results	**Scrapers**	**Backed bladelets**	**Backed flakes**
Backed bladelets	($Dmax_{obs}$=30.7< $Dmax_{0.05}$=40.1)		
Backed flakes	($Dmax_{obs}$=41.4< $Dmax_{0.05}$=45.4)	($Dmax_{obs}$=33.6> $Dmax_{0.05}$=28.6)	
Notches/Denticulates	($Dmax_{obs}$=26.3< $Dmax_{0.05}$=52.4)	($Dmax_{obs}$=11.2< $Dmax_{0.05}$=38.8)	($Dmax_{obs}$=34.3< $Dmax_{0.05}$=44.3)

b.

Thickness KS test results	Scrapers	Backed bladelets	Backed flakes
Backed bladelets	($Dmax_{obs}$=51> $Dmax_{0.05}$=40.1)		
Backed flakes	($Dmax_{obs}$=59.7> $Dmax_{0.05}$=45.4)	($Dmax_{obs}$=11.8< $Dmax_{0.05}$=28.6)	
Notches/Denticulates	($Dmax_{obs}$=56.6> $Dmax_{0.05}$=52.4)	($Dmax_{obs}$=20.6< $Dmax_{0.05}$=38.8)	($Dmax_{obs}$=17.2< $Dmax_{0.05}$=44.3)

c.

The analysis of standardisation amongst tools at Franchthi was hampered by small sample size, which in turn limited the value of the significance tests. Both CV's and cumulative percentage differences pointed towards backed bladelets as the most standardised artefact type in terms of length, but only just. Amongst width and thickness, scrapers were by far the most standardised, again bearing in mind small sample size. Overall, backed flakes were the least standardised of the four artefact types at Franchthi. The status of scrapers as one of the most standardised artefact type remains an enigma, and although it could be argued that the analysis at Franchthi was limited by small sample size, the larger collection of scraper at Klithi produced the same pattern (see section 4.6.3). Whether in terms of blank selection or deliberate shaping through retouch, scrapers were apparently being made more regularly and to a definite set of size parameters. This will be discussed further in relation to Kastritsa cave, where we must wait to see if a similar pattern existed.

5.6.4. Changes in standardisation through time, phases II, III and IV

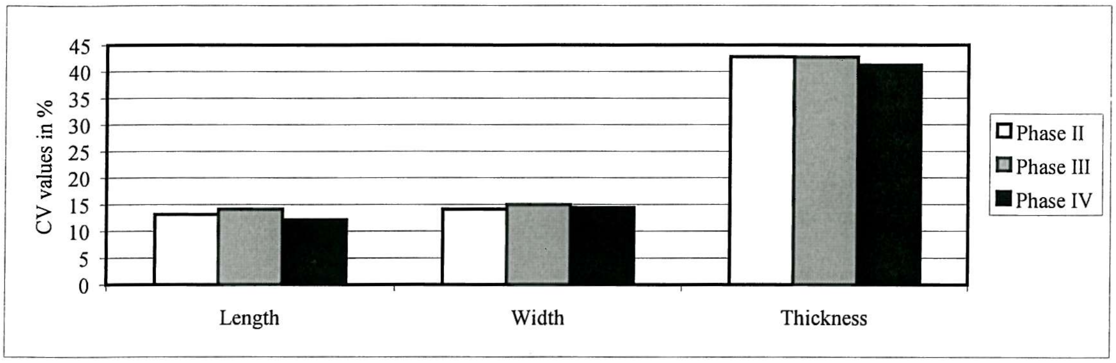
Standardisation was also investigated through time by comparing unretouched flakes, blades/bladelets and backed bladelets between phases II, III and IV. These groups were chosen simply on the basis of sample size, and again, blades and bladelets were grouped in order to avoid imposing standardisation on the collection.

Flakes and blades/bladelets

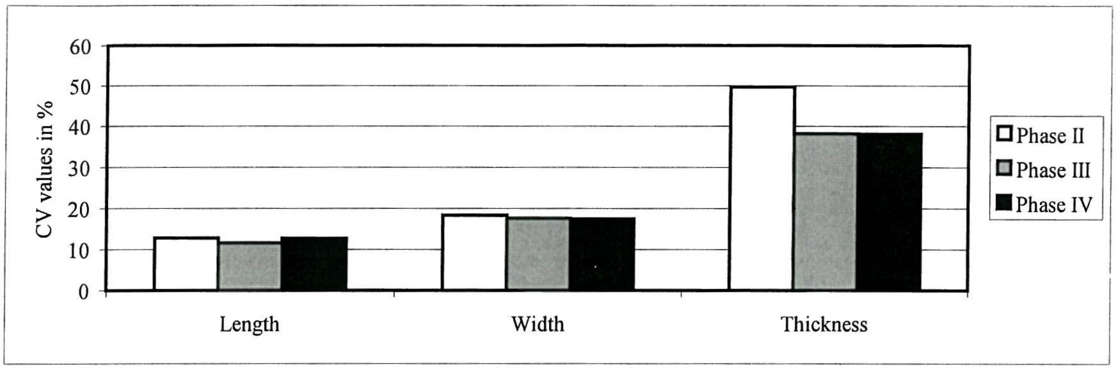
The CV results for unretouched flakes and blades/bladelets are listed in table 5.14 and illustrated in figure 5.30a,b.

Table 5.14. CV values for debitage from phases II, III and IV.

	Flakes (n=1045)			Blades/bladelets (n=326)		
	Length	Width	Thickness	Length	Width	Thickness
Phase II	13.1% (n=173)	14.1% (n=400)	42.8% (n=400)	12.8% (n=85)	18.3% (n=165)	49.7% (n=165)
Phase III	14.1% (n=133)	14.9% (n=261)	42.7% (n=261)	11.6% (n=37)	17.6% (n=78)	38.2% (n=78)
Phase IV	12.1% (n=231)	14.4% (n=384)	41.2% (n=384)	12.7% (n=51)	17.4% (n=83)	38.1% (n=83)



a.



b.

Figure 5.30. CV values for flakes (a) and blades/bladelets (b).

The CV values for unretouched flakes were similar from all three phases (fig.5.30a), although the *F* test did identify the difference in length variance between phases III and IV as significant (see Appendix II, table 3, for *F* test results). In terms of blades/bladelets there was little change in CV values for length or width, however in terms of thickness there was a decline between phases II and III (fig.5.30b). However, this was not identified by the *F* test as significant. This apparent discrepancy between CV and *F* test results provides an illustration of the difficulties encountered when using the two methods. In the calculation of CV, artefact size is normalised by dividing the standard deviation by the mean. However, the *F* test is based purely on the variance, which like standard deviation, varies according to absolute size. In the case of phase III and IV thickness, the difference in variance was minimal so producing a negative *F* test result, however once the standard deviation was divided by the slightly thicker means for phases III and IV, the CV values obtained were lower.

The results of the analysis of standardisation through time for unretouched flakes and blades/bladelets resulted in no obvious, and more importantly, consistent patterns. This suggests that despite the elapse of a considerable length of time, probably over ten thousand years, knapping was being carried out in broadly the same ways at Franchthi, with little evidence for any shift in standardisation of blank production.

Backed bladelets

Variance amongst backed bladelets was compared in the same way using CV values and the *F* test. This was the only tool class in which sample sizes were sufficiently large. The results are listed in table 5.15 and illustrated in figure 5.31.

Table 5.15. CV values for backed bladelets, phases II, III and IV.

	Length	Width	Thickness
Phase II	13.6% (n=13)	11.1% (n=57)	46.4% (n=57)
Phase III	5.8% (n=10)	11.1% (n=22)	31.7% (n=22)
Phase IV	8.9% (n=13)	9.4% (n=23)	38.0% (n=23)

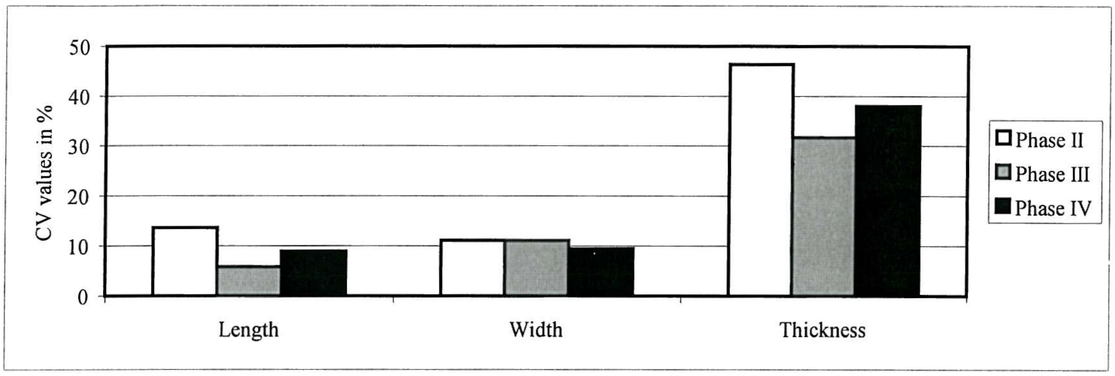


Figure 5.31. CV values for backed bladelets from phases II, III and IV.

Bearing in mind the relatively small sample sizes, particularly in terms of length, the results of the CV analysis pointed towards a decline in variance from phase II to phase III in terms of length and thickness. Although both increase again in phase IV, the levels are still slightly lower than they were originally in phase II. This suggests an overall increase in standardisation through time amongst backed bladelets. However, the only difference in variance identified by the *F* test as significant were amongst lengths between phases II and III.

Chapter 6. Kastritsa cave

6.1. Introduction

Kastritsa is a small Upper Palaeolithic cave site located within the Ioannina basin (pl.6.1). Although now a few kilometres from Pamvotis lake, deliberate drainage only took place in the 1940s and 50s, before which the site would have been significantly closer to the water. In fact during the last glacial, the cave would have been located at the edge of the lake. Kastritsa played host to a broad range of subsistence activities, while its location and distinctive character would have made it an obvious focus for activity in the Pamvotis lake area.

Plate 6.1. South-southeast facing view towards the mouth of Kastritsa cave, photographed during fieldwork in 2000.

The aim of my study of the lithic assemblage is to provide evidence as to the nature of tool use at Kastritsa, and in particular whether any differences between the sites of Franchthi and Klithi can be identified. For this reason the analysis presented here focuses on the final part of the Upper

Palaeolithic sequence of Kastritsa, which is regarded as broadly contemporary with occupation at Klithi, from around or just after the LGM to about 13,000 years ago. As with Klithi and Franchthi, the analysis of the assemblage from Kastritsa was organised around four themes:

- An introduction to the environment and archaeology of Kastritsa.
- An analysis of basic assemblage structure and in particular the proportions of the various debitage and artefact categories.
- A metric analysis of the lithic assemblage with comparison in particular focusing on chronological changes in debitage and artefact dimensions.
- An analysis of the nature and extent of metric standardisation both between debitage and artefact categories, as well as through time.

The study is based exclusively on samples generated as part of this research, but has also drawn on the work of others, most notably Adam (1989).

6.2. The site

Location and chronology

Kastritsa cave is a small cleft in a Senonian limestone hill located on the southeastern shore of Pamvotis lake in the Ioannina basin of eastern Epirus (fig.6.1). The site faces north-northwest towards the lake, part of which was artificially drained in the decades after the second world war, in order to be used as farmed land. That the lake had previously extended up to the cave, is supported by the presence of water worn pebbles and fine-grained lake sediments resting immediately above the bedrock of the cave (Bailey *et al.* 1983:26). The discovery of the site resulted from a survey undertaken by a team of Greek and British archaeologists in the early 1960's. Their aim was to explore the Early Stone Age of Greece which, according to Dakaris *et al.* (1964:199), had until then remained a blank on the Palaeolithic map of Europe. The research focused on northern Greece including the districts of western Macedonia and Epirus. Macedonia was abandoned as it yielded few artefacts or sites (*ibid.*:199-204), and all the effort was concentrated on Epirus, which by contrast produced significant evidence for human presence throughout the Palaeolithic. This was confirmed not only by scattered artefacts, but also by a range of open air sites and shelters such as Kokkinopilos, Asprochaliko and Kastritsa.

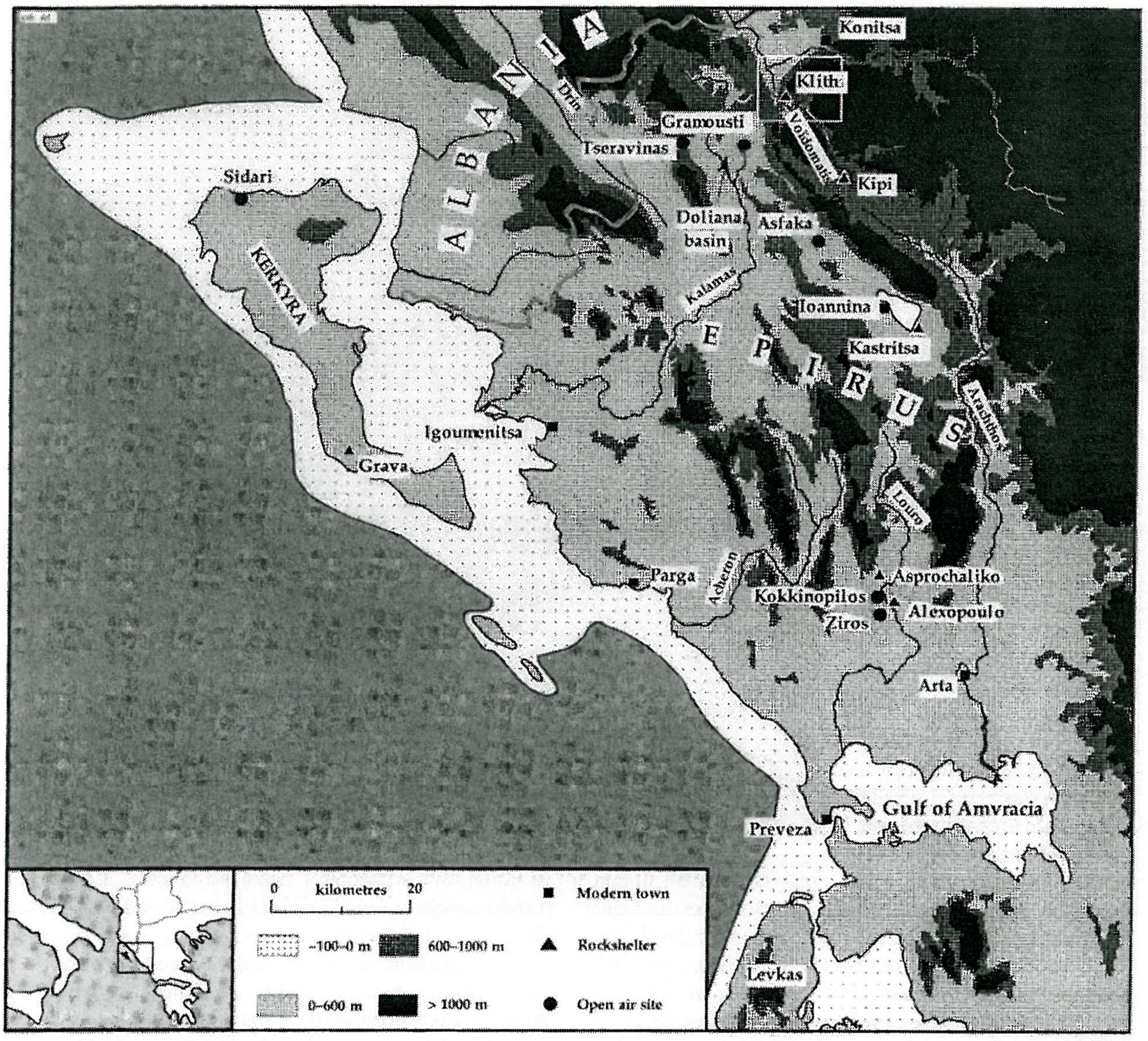


Figure 6.1. Location of Kastritsa cave (from Bailey 1997a:6).

The sites were studied more systematically towards the end of the same decade (Higgs *et al.* 1966, 1967), with excavations at Kastritsa carried out during two fieldwork seasons in 1966 and 1967, under the supervision of Eric Higgs. The site yielded a rich Upper Palaeolithic sequence which was subsequently bracketed by radiocarbon to between 21,800±470 and 13,400±210 BP (Bailey *et al.* 1983:24-25). Recent AMS dates have confirmed the chronological sequence of the site, although they indicate earlier initial use of the shelter from 23,880±100 BP (Galanidou *et al.* 2000:351-2).

The stratigraphy

The sequence at Kastritsa consisted of thirty-two layers (Y1-32) which were grouped into strata. In total five strata were identified, designated numbers 9, 7, 5, 3, and 1, the oldest being number 9 and the youngest the number 1 (Bailey *et al.* 1983:25-6). In general, the sediments at Kastritsa consisted of compacted and cemented soils with angular limestone fragments interpreted as the result of frost shattering of the walls and roof of the cave (fig.6.2). The bottom of the sequence (Y27-32) contained waterlogged deposits mixed with lake clays, rounded pebbles and fresh water shells, and represent a period during which changes in either the climatic or tectonic regime of the area resulted in fluctuations in lake level. The middle (Y16-26) layers of the sequence were characterised by terrestrial/anthropogenic deposits interspersed with sandy lake shore deposits, whereas the upper layers (Y1-15) contained pure terrestrial/anthropogenic sediments (Galanidou 1997:102). The upper layers of the sequence were the richest in terms of archaeological materials (Bailey *et al.* 1983:25-6).

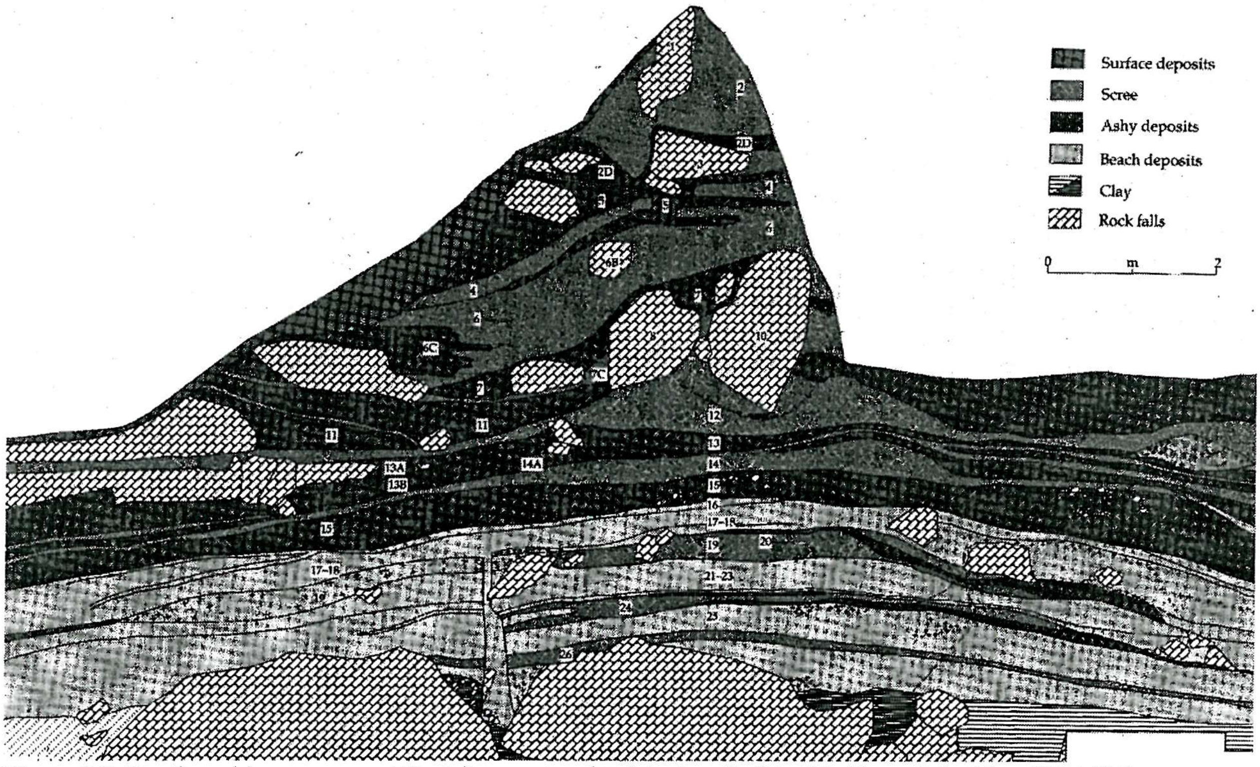


Figure 6.2. Stratigraphic sequence at Kastritsa, rectangles 2 to 6, spits 0 to 88 (from Galanidou 1997:499).

Strata 1 and 3 are of particular interest to this research and will be focused upon in the rest of the discussion. The remaining strata have been discussed by Bailey *et al.* (1983), Galanidou (1997) and Kotjabopoulou (2001). Available dating evidence indicates that the two strata were deposited between roughly 20,000 and 13,000 years ago, in other words with a significantly overlap with the LGM. Two layers, Y11 and Y7 were assigned to stratum 3. They consisted of ashy deposits and extended from the mouth of the cave into the interior. As can be seen in figure 6.2, layer Y11 had been disturbed by rock falls, although it still remains unclear whether its formation pre or post-dated these (Kotjabopoulou 2001:52). Layer Y7 rests at a significant angle, dipping from south east to north west on top of rocks 8 and 10, suggesting that it probably formed after the collapse (*ibid.*:52). Stratum 1 comprised layers Y6-Y1, and consisted of clast-supported scree with patches of ashy deposits, dipping towards the northwest like the underlying layers of stratum 3. The extent of this unit is restricted to the inside of the cave, roughly below the present entrance (*ibid.*).

Climatic and environmental setting

The dating evidence established by the old (Bailey *et al.* 1983) and new (Galanidou *et al.* 2000) radiocarbon chronologies shows that Kastritsa was used frequently within the last glacial and that the first occupation began in a period that predated the extreme environmental conditions of the Last Glacial Maximum. Pollen samples and ostracods extracted from Pamvotis lake sediments in the proximity of the site indicate that the first human presence in the cave coincided with mild climatic conditions with moderate moisture levels. This environment favoured the growth of Mediterranean tree species such as olives and evergreen oaks (Galanidou *et al.* 2000:353-4). In contrast, reconstruction of the environmental conditions which prevailed during the main period of occupation of the cave is still problematic. Based on pollen samples extracted from the lake (Bottema 1974), it has been suggested that the conditions in the area were marked by increased precipitation or alternatively reduced evaporation due to colder temperatures (Bailey *et al.* 1983:29). Initially this argument found support in evidence suggesting that the lake had reached its maximum level around 20,000 years ago, namely before the peak of the last glacial (*ibid.*). However, the picture is far from straightforward as the higher lake levels may not relate to glacial conditions during the Last Glacial Maximum, but to an earlier intermediate milder period, or even to the influence of tectonic activity in the region (Galanidou *et al.* 2000:352). Recent pollen evidence from the Ziros and Tseravinas lakes in southern and northern Epirus respectively, has indicated that during the last glacial, the region was like the rest of the Mediterranean basin, covered by open-steppe vegetation (Turner and Sánchez Goñi 1997:562), presumably as a result of the arid climate (Tzedakis 1993:438). However, whether the increase in aridity was a consequence of declining rainfall or increasing seasonality remains a subject of debate (Turner and Sánchez Goñi 1997:564). Definite changes in the climate of the area occurred after 15,000 years ago when exclusive steppe vegetation gave way to a mosaic of forest and steppe with local scale oscillations between the two. The expansion of woodland was halted at some stage prior to 13,000 years ago due to a short term deterioration of the climate (*ibid.*:584).

Fauna and subsistence

Palaeoecological studies have revealed a strong link between the topography of the site and seasonal movements of large herbivores such as red deer, cattle, and horse (Sturdy *et al.* 1997:587, 611). Kastritsa is located close to a limestone plateaux near the Ioannina basin, which provided the most accessible route for red deer and other large herbivores during the early summer while on their way to higher ground to the north of Epirus, and then back south to the lowlands during the colder months (*ibid.*). In addition, Kastritsa would have been on the shores of Pamvotis lake, the largest aquatic feature in the Ioannina basin. The association of the shelter with these topographic features is clearly reflected in the fauna present at the site, which persisted unchanged throughout the entire sequence. Large ungulates, primarily red deer (*Cervus elaphus*) dominated the fauna of the site, followed by steppe ass (*Equus hydruntinus*), bovids (*Bos primigenius*) and small sized mammals such as, ibex

(*Capra ibex*), chamois (*Rupicapra rupicapra*) and roe deer (*Capreolus capreolus*) (Kotjabopoulou 2001; Bailey *et al.* 1983:34-5). Alongside these herbivores, water birds of several kinds were identified, highlighting the significance of the lake to the inhabitants of Kastritsa, not only in terms of water but also food resources. Finally, frogs, rodents, and small carnivores complete the list of fauna recorded at the site. Fish bones were absent despite the presence of fish-eating birds (*ibid.*).

The faunal patterns at Kastritsa suggest that the site provided its inhabitants with access to a wide range of terrestrial and aquatic resources. From this perspective, Kastritsa could be regarded as different to Klithi, where only a very restricted range of resources were available. Like the species hunted, animal exploitation strategies at Kastritsa appear to continue broadly unchanged throughout the whole sequence. Based on the absence from the faunal record of anatomical parts of low food value, such as heads and hooves, it has been suggested that animals were hunted and butchered at some distance from the site, with the best parts carried back. The carcasses were then intensively processed for the maximum possible extraction of meat, fat and marrow. Traces of processing were also identified on the bones of smaller animals such as badgers and foxes, suggesting that these animals were targeted for their pelts as much as meat (Kotjabopoulou 2001:101-5). Based on the age profiles of red deer in particular, it appears as though the site was preferentially occupied during the summer (*ibid.*), potentially by large groups of people, as suggested by the numbers of animals and their food value (Sturdy *et al.* 1997:612).

Spatial features of the site

Estimates of potential living space at Kastritsa suggest that approximately 75m^2 was available, divided into three broad areas; the interior of the cave, its entrance and the talus deposits fanning out away from the entrance (Bailey *et al.* 1983:36). Extensive rock falls found in rectangles R2 to R6 (fig.6.3) indicate that at some stage during the site's use, the roof would have extended further out probably as an overhang, therefore providing more shelter (Bailey *et al.* 1983; Galanidou 1997:102; Kotjabopoulou 2000:53). Similarly, it is possible that the back wall of the cave is a large rock fall, behind which could be further space.

Insights as to how the living area at Kastritsa was internally organised are gained through the study of the distribution of archaeological features on the site, including bones, stone artefacts, hearths and postholes. Unfortunately, the analysis done was focused on strata 5 and 9 and not on those studied here, namely 1 and 3, but this might not be such a problem as basic spatial features of the site were probably repeated throughout its occupation (Galanidou 1997:115-6). Based on the distribution of debris as well as the presence of hearths, it seems that human activity took place at the entrance to the cave. The areas to the north and west appear to have been equally intensively used, while to the south and east there appear to have been less occupied (Galanidou 1997:117).

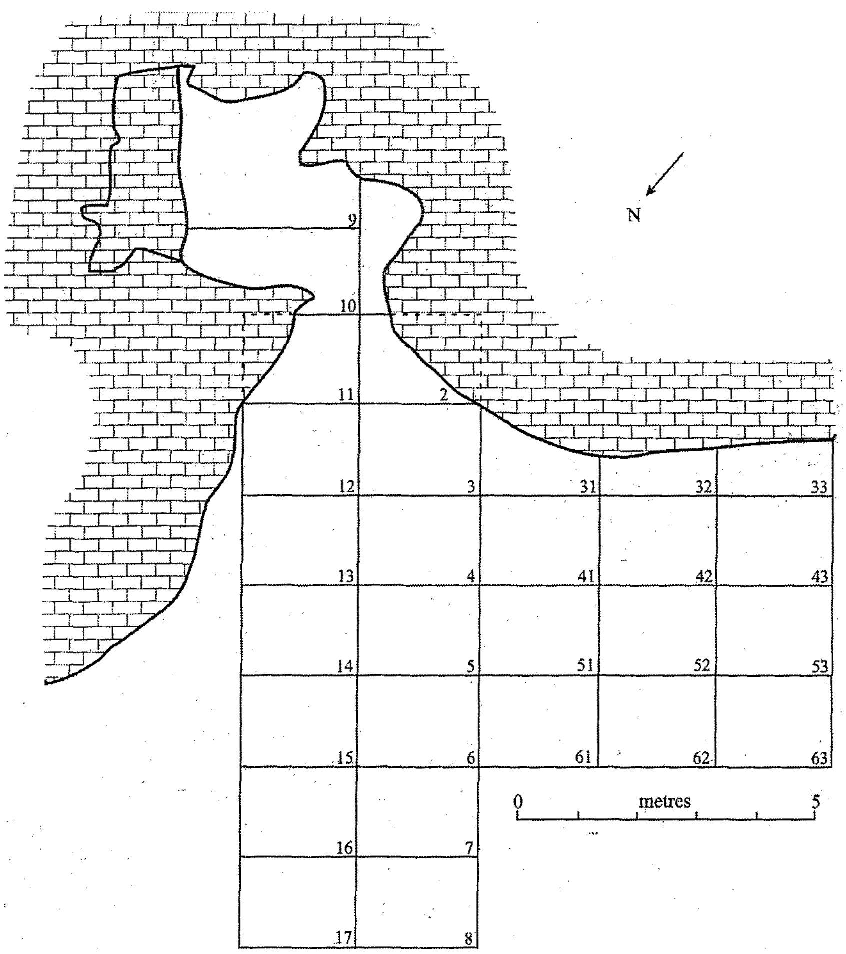


Figure 6.3. Trench plan of Kastritsa (from Bailey *et al.* 1983:25)

In stratum 5, at the entrance to the cave as well as in the western area, a series of stake holes, often associated with hearths, were discovered. These may indicate the presence of some sort of structure (Galanidou 1997:117). During stratum 9, the site appears to have been used only sporadically, as indicated by the small numbers of lithics as well by the fact that little energy appears to have been invested in arranging the living space (*ibid.*:115-6).

6.3. The samples investigated

Aims and design of the sampling strategy

The suggestion that Kastritsa may represent a generalised site in contrast to Klithi requires that any comparison between their technological traditions should be made on the basis of broadly contemporaneous samples. For this reason the analysis of the lithic assemblage at Kastritsa focuses exclusively on strata 1 and 3, which based on available evidence, have been assigned to the upper part of the chronological sequence of the site, estimated to date between 20,000 and 13,000 years ago (Bailey *et al.* 1983; Galanidou *et al.* 2000). The samples were derived from rectangles 2 and 3 (fig.6.3), which were chosen for the following reasons. They were two of the few rectangles where strata 1 and 3 were both identified, as well as having sufficient contextual information about the exact provenance of the samples, including spits, layers and bag numbers. These records were generated in the early 1980's by Bailey and his team from Cambridge University as part of a re-examination of the stratigraphy of the site, and are currently kept in the archives of the Archaeological Museum of Ioannina. The second and more important reason for the selection of rectangles 2 and 3 was that they were located at the entrance to the cave. Analysis of features and debris has indicated that it was an intensely used area, and included stone tools, bones and spatial features such as hearths, which all suggest that it was a primary focus for human activity (Galanidou 1997:115-6). As discussed in section 6.2, examination of the spatial arrangement at Kastritsa did not include strata 1 or 3, however there is no reason to believe that this location, well sheltered by the extended roof and cave walls, would not have continued to provide an attractive living area as it had during earlier periods.

Constraints to the sampling strategy

The examination of the lithic assemblage of Kastritsa was undertaken at the Archaeological Museum of Ioannina during 1998 and 2000. Its main objective was to collect data from strata 1 and 3, with a primary concern being to include as many as possible of the spits and layers from each rectangle. Like Klithi and Franchthi, the sampling strategy was organised on the basis of one third of the total weight of each stratum. One drawback of this method at Kastritsa was that the units were not bagged together. Isolating all the samples was difficult, and as a result, the time scheduled for analysis was reduced. The samples included in this study are listed in table 6.1, in which the minimum unit of reference was the bag number. This refers to single volumes of deposit defined in terms of the rectangle, spit, layer and stratum from where they were derived. However, the relation was not always one to one, so for instance bag number KC1209 derived from spit numbers 43-45. However, this was rarely a problem in my analysis as the sampling strategy was focused on the strata (1 and 3), and therefore inconsistencies at the level of spit or layer were irrelevant.

Table 6.1. The samples recorded.

Rectangle	Bag number	Spit	Layer	Stratum
2	KC147	18	1-2	1
2	KC 196	19	1-2	1
2	KC611	26	3	1
2	KC352	26	3	1
2	KC882	29	5	1
2	KC361	30	4	1
2	KC712	32	4-5	1
2	KC728	33	4	1
2	KC718	34	6	1
2	KC542	35	6	1
2	KC94	38	6	1
2	KC2609	39	6	1
2	KC1214	39	6	3
2	KC1425	43	7	3
2	KC1006	43	7	3

2	KC1209	43-45	7	3
2	KC1412	44	7	3
2	KC1048	45	7	3
2	KC1468	47	7-11	3
2	KC1462	48	7-11	3
2	KC1478	50	7-11-12	3
2	KC1490	52	7-11-12	3
3	KC871	36	4-5	1
3	KC897	37	5	1
3	KC892	37	5	1
3	KC532	39	6	1
3	KC639	42	6	1
3	KC667	43	6	1
3	KC1109	49	11	3
3	KC1140	49	11	3
3	KC1120	49	11	3
Total = 2954				

Key: R= rectangular, KC= Kastritsa cave.

The only potential sampling problem is the debate concerning the position of layer 12. Bailey *et al.* consider it as part of stratum 5 (1983), whereas Adam (1989:105-6) and Galanidou (1997:106) argue that it may in fact be part of stratum 3. However, as only two of the bags sampled in this study contained material from layer 12, whether from strata 3 or 5, it is unlikely to have much impact on the results.

6.4. Morphological characteristics of the lithic assemblage

6.4.1. Introduction

The aim of this section is to explore the nature of the structure of the lithic assemblage in terms of raw materials, cores, debitage and tools. This does not include technological aspects of lithic production, which has already been undertaken by Adam (1989). Instead, it looks at the assemblage in terms of what it tells us about the role of the site within the regional context. The analysis also investigates whether any changes occurred in the organisation of lithic production through time, between strata 3 and 1. The basic structure of the assemblage is listed in table 6.2, and illustrated in figure 6.4.

Table 6.2. The main lithic categories from strata 1 and 3.

Lithic category	Stratum 1	Stratum 3	Total
Unworked raw materials (pebbles, nodules, tablets)	1 (0.05%)	2 (0.2%)	3 (0.1%)
Cores	56 (2.8%)	46 (4.6%)	102 (3.5%)
Debitage (flakes, blades, bladelets, atypical)	1332 (68.1%)	685 (68.5%)	2017 (68.3%)
Tools	235 (12.0%)	82 (8.2%)	317 (10.7%)
Microburins	19 (1.0%)	5 (0.5%)	24 (0.8%)
Chips (≤1cm)	218 (11.1%)	141 (14.1%)	359 (12.2%)
Debris (natural, knapped, burnt)	94 (4.8%)	38 (3.8%)	132 (4.5%)
Total	**1955**	**999**	**2954**

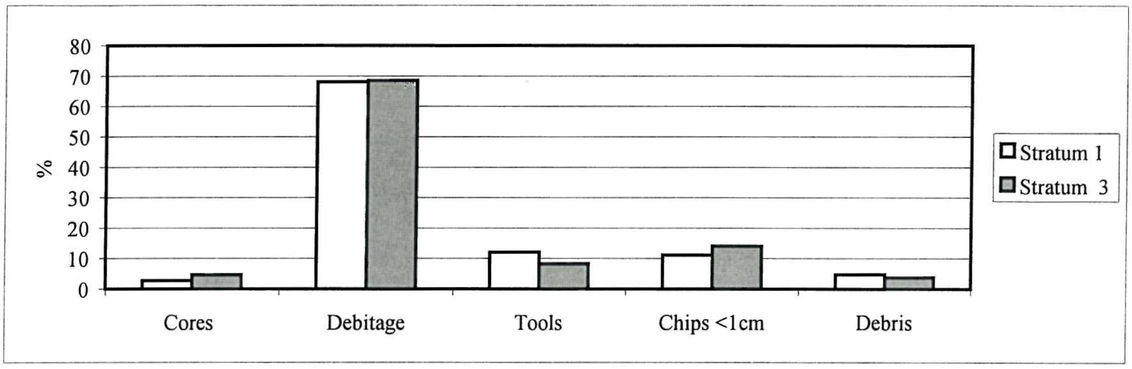


Figure 6.4. The main lithic categories from strata 1 and 3. Raw materials and microburins were omitted due to small sample sizes.

The assemblage sampled numbered 2954 pieces, of which debitage larger than 1cm and tools and tool waste irrespective of size, accounted for 2463. Initial analysis of the lithic assemblage and its main units, suggested that all the major steps of the knapping sequence, from cores to debitage and tools were present in both periods. On the basis of this it can be suggested that on-site manufacture and discard of tools was commonly practised at Kastritsa. That this was an involved process is supported by the significant quantity and range of technical pieces identified in both samples (tbl.6.3).

Table 6.3. Technical pieces.

Types of technical pieces	Stratum 1	Stratum 3	Total
Crested blanks	5 (5.0%)	6 (17.1%)	11
Core rejuvenation blanks	24 (24.0%)	6 (17.1%)	30
Core tablets	32 (32.0%)	11 (31.4%)	43
Burin spalls	20 (20.0%)	7 (20.0%)	27
Microburins	19 (19.0%)	5 (14.3%)	24
Total	**100**	**35**	**135**

The quantity and diversity of technical pieces identified in the lithic assemblage suggest more extensive flint-work at the site, and by implication, intensive and/or longer term occupation. Technical pieces to do with core set-up and maintenance were relatively common in both strata. In stratum 1, three (60%) out of five crested pieces were made on blades and two (40%) on bladelets, while in stratum 3, three each (50%) were made on blades and bladelets. As noted by Adam

(1989:170-1), cresting could also be found on flakes, but was extremely rare. In terms of core maintenance, sixteen (66.6%) core rejuvenation flakes were found, six blades (25%) and two bladelets (8.3%) in stratum 1. Amongst core tablets in stratum 1, twelve (37.5%) were made on blades, thirteen (40.6%) on flakes and seven (21.8%) on bladelets. In stratum 3, all rejuvenation blanks were on flakes, while five (45.4%) core tablets were made on bladelets, three (27.2%) on flakes and three (27.2%) on blades.

The majority of burin spalls in stratum 1 were made on bladelets (n=19, 95%), with one (5%) made on a blade. In stratum 3, all seven burin spalls were made on bladelets. Four (19%) microburins from stratum 1 and four (80%) from stratum 3 were defined as Krukowski.

6.4.2. Raw materials

Flint was the only raw material used at Kastritsa, and appears to have been collected in the form of river pebbles and nodules of different colours, usually variations of black and brown (see also Adam 1989).

Plate 6.2. Unworked pebble and some larger pieces of debitage as indicators of the range of dimensions of raw materials exploited at Kastritsa. Photographed during fieldwork in 2000.

It is opaque to semi-translucent, fine-grained and of good internal quality. Its origin remains unknown, however it is likely to have been collected from secondary deposits (Adam 1997:483), some of which may be located outside of the Ioannina basin (Kotjambopoulou *pers.comm.*). Since the sources are unknown, we have little direct evidence as to their size. However, clues can be gained from the rare pebbles found in the site, as well as debitage (pl. 6.2), from which it would appear that raw materials were up to 80mm in length. Less ambiguous in terms of size and morphology is Voidomatis flint (see chapter 4), which was also present at Kastritsa. Its presence may imply direct procurement from the area nearby Klithi rockshelter, although the possibility of secondary distribution along river systems apart from the Voidomatis cannot be ruled out (Adam 1997: 484).

6.4.3. Cores

The core sample consisted of 102 pieces, of which 21 were fragments. The aim of the analysis is to present the general trends in core working in strata 1 and 3, by placing particular emphasis on its intensity. The basic parameters of the core collection are listed in table 6.4.

Table 6.4. Morphological characteristics of the core sample.
(Note that different numbers included in each descriptive category relate to breakage patterns).

	Stratum 1	**Stratum 3**	**Total**
Cores complete	**46**	**35**	**81**
Cores fragmented	**10**	**11**	**21**
Total number of cores	**56**	**46**	**102**
Core type	**n=56**	**n=46**	**n=102**
Flake	40 (71.4%)	33 (71.7%)	73
Bladelet (blade)	16 (28.6%)	13 (28.3%)	29
Core shape	**n=56**	**n=46**	**n=102**
Amorphous	18 (32.1%)	26 (56.5%)	44
Cores on blanks	18 (32.1%)	14 (30.4%)	32
Conical/semi conical	17 (30.3%)	3 (6.5%)	20
Cuboid/tabular	1 (1.78%)	3 (6.5%)	4
Other (oval, sphere)	2 (3.57%)	0	2
Number of platforms	**n=56**	**n=45**	**n=101**
One	9 (16.0%)	5 (11.1%)	14
Two	29 (51.7%)	23 (51.1%)	52
Three	16 (28.5%)	15 (33.3%)	31
Four	2 (3.5%)	2 (4.4%)	4
Direction of removal	**n=56**	**n=45**	**n=101**
Longitudinal	34 (60.7%)	28 (62.2%)	62
Multidirectional	22 (39.3%)	17 (37.8%)	39
Platform maintenance	**n=56**	**n=44**	**n=100**
Absent	25 (44.6%)	25 (56.8%)	50
Trimming	13 (23.2%)	5 (11.3%)	18
Facetting	15 (26.7%)	12 (27.2%)	27
Multi	3 (5.3%)	2 (4.5%)	5
Cortex proportions	**n=47**	**n=36**	**n=83**
0%	21 (44.7%)	13 (36.1%)	34
0-50%	25 (53.2%)	22 (61.1%)	47
50%-100%	1 (2.1%)	1 (2.8%)	2
Reasons for core discard	**n=56**	**n=46**	**n=102**
Size	51 (91.1%)	32 (69.6%)	84
Raw material	2 (3.6%)	2 (4.3%)	3
Uncertain	3 (5.3%)	12 (26.1%)	15

Core type, flake versus blade/bladelet

Flake cores dominated the samples from strata 1 and 3, although bladelet types were present in significant quantities (fig.6.5). Cores with blade scars were rare, in fact only two were recorded in stratum 1. The results pointed to no obvious change in core use and by implication, debitage production between strata 3 and 1.

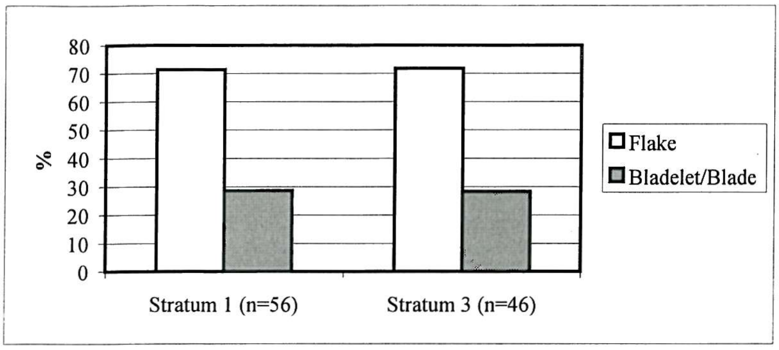


Figure 6.5. Core type, flake versus bladelet/blade.

These results were at odds with those of Adam (1989) who identified many more bladelet cores in both strata. This discrepancy has been discussed in relation to Klithi and Franchthi and has to do with the way in which cores were classified. I erred on the cautious side, only attributing blade/bladelet production to those cores with complete laminar scars.

Core shape

In stratum 1, amorphous, conical/semi-conical and cores on blanks were equally as common (fig.6.6). In stratum 3, amorphous cores were more common. Cores on blanks were equally as common as in stratum 1, while conical/semi-conical cores were much less common. As conical/semi-conical cores tend to be associated more with blade/bladelet production, the results were considered anomalous since the proportions of blade/bladelet cores did not decline in stratum 3 (see also Adam 1989). However, as will be seen in section 6.4.5 further below, blade/bladelet debitage proportions were lower by approximately 5% in stratum 3.

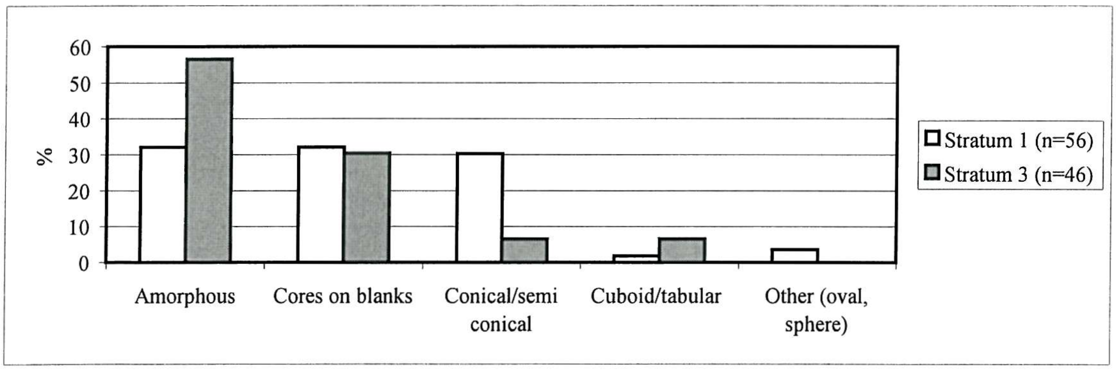


Figure 6.6. Core shape.

Number of platforms

Both strata produced similar proportions of cores with two platforms (see also Adam 1989:206), while stratum 3 produced relatively more with three or more, and stratum 1 with more single platform (fig.6.7). The slightly higher frequency of cores with three or more platforms in stratum 3 relates to the higher proportions of amorphous cores present.

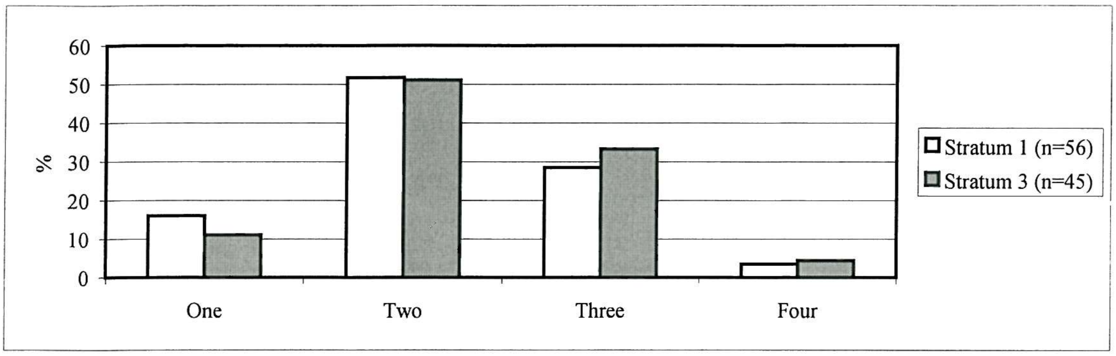


Figure 6.7. Number of core striking platforms on the examined samples from Kastritsa.

Direction of flaking

There appears to have been little change in the direction of flaking between strata 3 and 1 (fig.6.8).

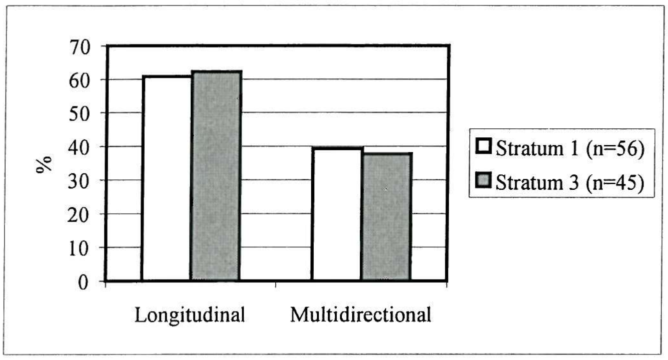


Figure 6.8. Direction of core removals.

Platform maintenance

Evidence for platform maintenance appears to increase through time from strata 3 to 1, in particular in terms of trimming (fig.6.9). This may relate to the greater use of amorphous cores in stratum 3, which tend to have less regular platform maintenance than conical/semi-conical types.

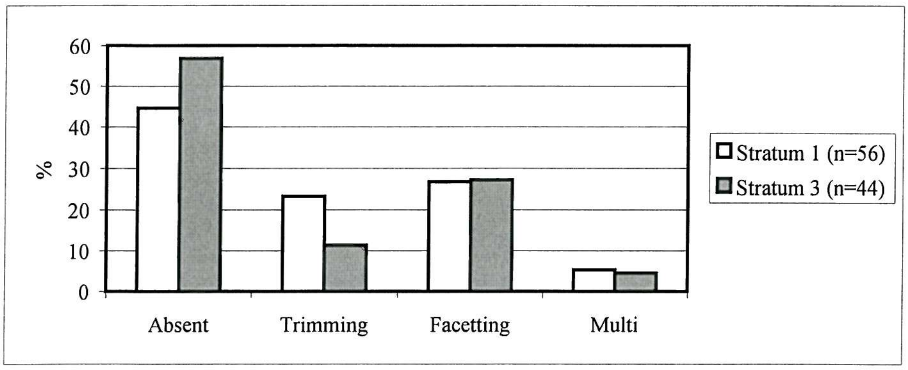


Figure 6.9. Platform maintenance.

Cortex

More cores in the earlier stratum 3 contained less than 50% cortex, while a very small number contained more than between 50% and 100%. Conversely, stratum 1 produced more cores with no cortex. Along with core size this supports the interpretation that cores were being introduced at larger sizes in stratum 3.

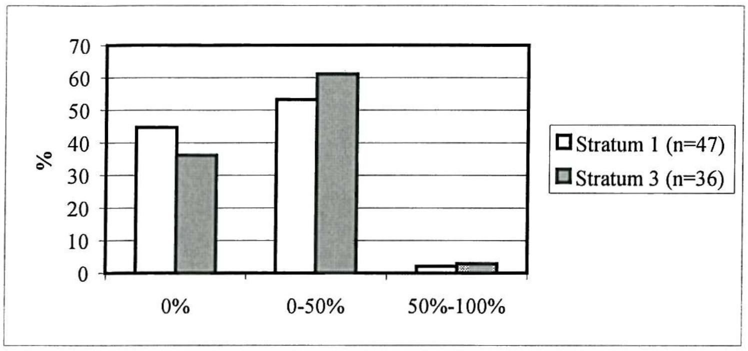


Figure 6.10. Cortex proportions.

Reasons for core discard

Cores from both strata were abandoned primarily on the basis of size (fig.6.11), suggesting that most cores were being worked down to a finite point at which stage they became difficult to hold. The fact that more were being abandoned in the later stratum 1 because of size, suggests that cores were being more intensively worked.

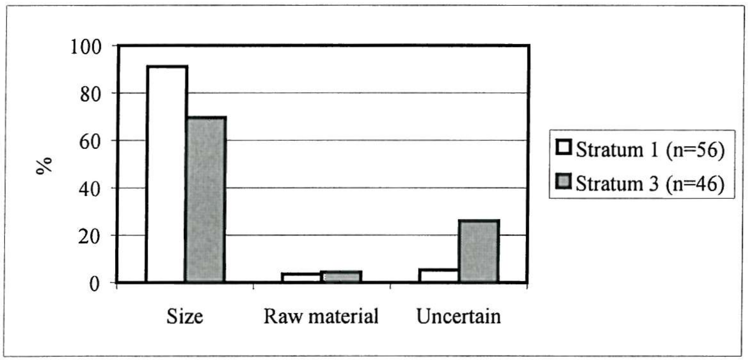


Figure 6.11. Reasons for core discard.

Conversely, those discarded for no obvious functional reason were more common in stratum 3, while there was little change in the very small proportion abandoned due to raw materials.

6.4.4. Primary, secondary and inner proportions

The proportions of primary, secondary and inner amongst debitage and tools are listed in table 6.5 and illustrated in figure 6.12. Primary debitage represents the very first removal, with the dorsal surface completely covered in cortex. Secondary debitage or tools are those pieces with some dorsal cortex. Inner debitage or tools lack any cortex.

Table 6.5. Primary, secondary and inner debitage >10mm and tools.

Debitage and tools	Stratum 1 (n=1567)	Stratum 3 (n=767)	Total (n=2334)
Primary	8 (0.5%)	5 (0.7%)	13
Secondary	309 (19.7%)	223 (29.0%)	532
Inner	1250 (79.8%)	539 (70.3%)	1789

Key : Primary: the very first core removal covered entirely by natural cortex.
Secondary: removals covered partly by natural cortex.
Inner: removals lacking natural cortex.

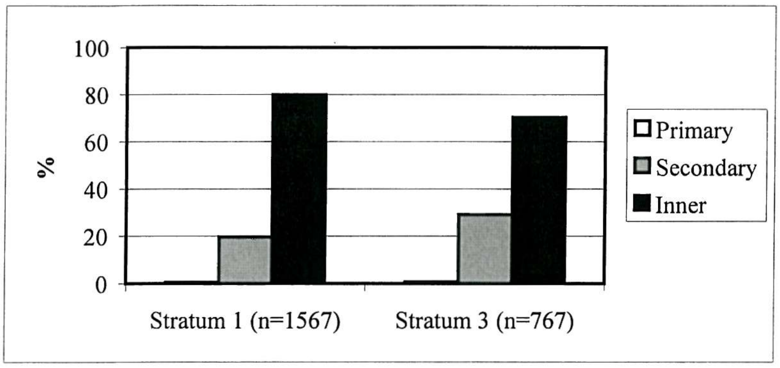


Figure 6.12. Primary, secondary and inner proportions for debitage >10mm and tools.

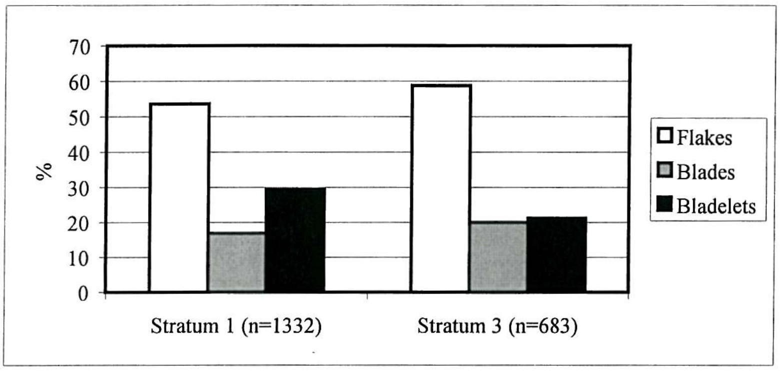
Inner material was present in greater proportions in stratum 1, which supports the previous interpretation that raw materials were being introduced in stratum 3 at an earlier stage in the life of the core. By implication, and assuming that the same range of raw materials were being exploited, this suggests that they were also entering the site in larger sizes. However, both fall within Marshall's (1997) experimental predictions for secondary proportions of 20% to 40%, which suggests that the raw material sources may not be that far from the site. As to why there was an apparently higher rate of introduction of secondary materials in the earlier stratum 3 is unclear. It may indicate less intensive working of cores between raw material source and site, suggesting that people were moving between rather than around focal points in the landscape such as Kastritsa. Alternatively, higher rates of mobility overall may have decreased the time interval between raw material collection and discard on site, so relatively enhancing remnant cortex proportions. Both scenarios would fit with the observed pattern at Kastritsa, which was of higher density and diversity of cultural material in stratum 3, suggesting more regular and intense occupation during the earlier phase (see Adam 1989:206, but also Kotjabopoulou 2001:104 for different suggestion).

6.4.5. Flake, blade and bladelet proportions

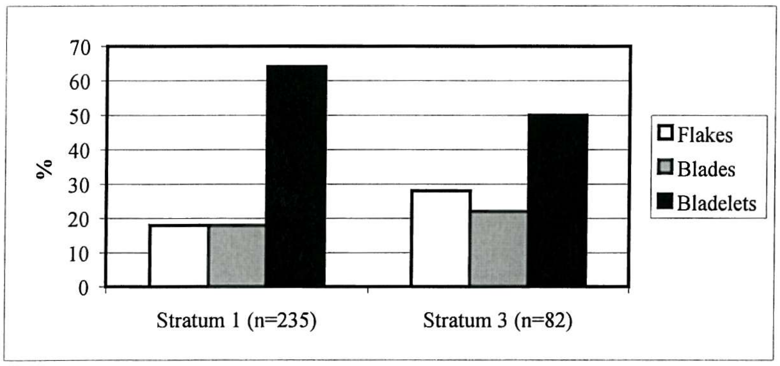
The proportions of debitage and tools made on flakes, blades and bladelets are listed in table 6.6 and illustrated in figure 6.13a,b. Flakes were the dominant blank form amongst debitage, followed by bladelets and blades (fig.6.13a). Overall, there was a slight decline in flake and blade blank proportions amongst debitage from stratum 3 to 1, with a corresponding increase in bladelets, suggesting that more success was in producing bladelets in the later stratum 1. The knappers at Kastritsa were having a significant degree of success in producing blades/bladelets, even more so if we consider that these are more likely to have been selectively removed from the debitage assemblage by retouch. In his series of experimental assemblages using beach pebble flint, Marshall (1997:131) achieved only a 5% to 20% success rate in blade/bladelet production, whereas at Kastritsa the figure was around 45%. This level of blade/bladelet success at Kastritsa in both strata is a reflection of the quality of the raw materials, as well as significant proficiency in stone working.

Table 6.6. Proportions of flakes, blades and bladelets amongst debitage and tools.

	Stratum 1 (n=1567)		**Stratum 3 (n=767)**	
	Debitage (n=1332)	**Tools (n=235)**	**Debitage (n=685)**	**Tools (n=82)**
Flakes	714 (53.6%)	42 (17.9%)	401 (58.7%)	23 (28.0%)
Blades	226 (16.9%)	42 (17.9%)	137 (20.0%)	18 (22.0%)
Bladelets	392 (29.4%)	150 (64.1%)	145 (21.2%)	41 (50.0%)
Atypical	0	1 (0.4%)	2 (0.3%)	0



a.



b.

Figure 6.13. Proportions of flakes, blades and bladelets amongst debitage (a), and tools (b). Atypical pieces were omitted.

Tools were most commonly made on bladelets, although blade and flake use was also significant. Interestingly, blade tools occurred at more or less the same frequency as blade blanks. Moreover, bladelet use for tool manufacture increased from stratum 3 to 1 by an amount similar to that noted amongst bladelet blanks.

6.4.6. The tool inventory

The samples from strata 1 and 3 produced a total of 317 tools as listed in table 6.7 and illustrated in figure 6.14. Tools with broadly the same morphological characteristics (e.g. backed bladelets) were grouped together despite some differences in stylistic features (for instance whether pointed, unilaterally or bilaterally retouched). As discussed in the previous chapters, the aim of this was to avoid large numbers of categories with small numbers of artefacts in each.

Table 6.7. The tool inventory from Kastritsa.

Tool type	Stratum 1 (n=235)	Stratum 3 (n=82)	Total (n=317)
Artefacts with backed retouch	128 (54.4%)	40 (48.8%)	168 (53%)
Artefacts with linear retouch	18 (7.7%)	9 (11.0%)	27 (8.5%)
Atypical retouched artefacts	2 (0.9%)	0	2 (0.6%)
Shouldered bladelets	2 (0.9%)	0	2 (0.6%)
Microgravettes	7 (3.0%)	0	7 (2.2%)
Aurignacian blades	0	1 (1.2%)	1 (0.3%)
Notches/denticulates	15 (6.4%)	5 (6.1%)	20 (6.3%)
Truncations	3 (1.3%)	2 (2.4%)	5 (1.6%)
Scrapers/composite tools	29 (12.3%)	16 (19.5%)	45 (14.2%)
Borers	8 (3.4%)	2 (2.4%)	10 (3.2%)
Burins	23 (9.8%)	7 (8.5%)	30 (9.5%)

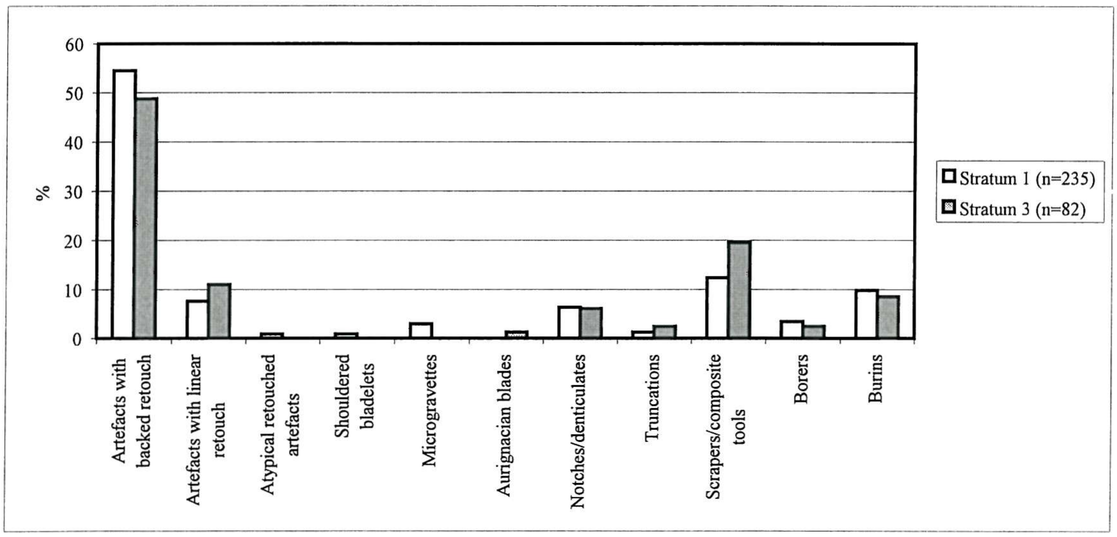


Figure 6.14. The tool inventory.

The most common tool group was artefacts with backed retouch. Tools such as microgravettes and Aurignacian blades were present in very small numbers, however they were absent at Klithi and Franchthi. A description of the morphological characteristics of the tools is given below for each stratum (see also Adam 1989).

Stratum 1

Artefacts with backed retouch (n=128) consisted of 119 (93%) bladelets, eight (6.2%) blades and only one (0.7%) flake. All backed bladelets were laterally retouched, which in most cases was direct (n=104, 87.3%), abrupt (n=110, 92.4%), and rarely inverse, alternating (n=15, 12.6%), or semi or crossed-abrupt (n=9, 7.5%). Thirty-one backed bladelets (26.1%) were bilaterally retouched, 16 (13.4%) truncated on the proximal and/or distal end, and 18 (15.1%) pointed on one or both ends. Similarly to bladelets, all backed blades were laterally retouched (n=8, 100%), most direct (n=7, 87.5%) and abrupt (n=6, 75%). More rarely the retouch was inverse (n=1, 12.5%) or semi abrupt (n=1, 12.5%). One (12,5%) backed blade was retouched on both lateral sides and was also truncated on the distal end, while a single case (12.5%) was just truncated. The single backed flake was partially retouched along one lateral edge with direct semi-abrupt retouch.

Artefacts with linear retouch consisted of six (33.3%) flakes, eight (44.4%) blades and four (22.2%) bladelets. All the flakes displayed low angle retouch, which in five cases (83.3%) was lateral and in four (66.6%) direct. In one case (16.6%), retouch was distal but not truncated, and in two (33.3%) the direction was inverse. All bladelets displayed lateral low angle retouch, either direct (n=2, 50%) or indirect (n=2, 50%). All the blades displayed lateral retouch, usually direct (n=6, 75%) and low angle (n=2, 25%). More rarely the direction of retouch was inverse (n=1, 12.5%), or alternate (n=1, 12.5%), abrupt (n=1, 12.5%), or semi abrupt (n=1, 12.5%).

Shouldered bladelets and **microgravettes** comprised a small but distinct group. The two shouldered bladelets displayed lateral, direct and abrupt retouch and were all bilaterally retouched. Out of seven microgravettes, six (85.7%) were made on bladelets and one (14.2%) on a narrow blade, 14.1mm in width. All but one was single pointed. One (14.2%) was truncated on the butt, and two (28.5%) were retouched. All had lateral retouch, usually direct and abrupt (n=6, 85.7% in both cases). Less often retouch was alternating or crossed abrupt (n=1, 14.2% in both cases). Finally three microgravettes (42.8%) were bilaterally retouched.

The truncations consisted of two flakes (66.6%) and one bladelet (33.3%), all of which displayed direct and abrupt retouch. Two (66.6%) were truncated on the proximal end and one (33.3%) on the distal. One piece was also laterally retouched.

Notches/denticulates constituted a relatively large group, with flakes, blades and bladelets contributing five pieces each. The notch (or notches) was always on the side of the tool and was formed in most cases by direct (n=9, 60%), abrupt or semi abrupt retouch (n=11, 73.3%). One notched tool displayed denticulate retouch on its side and another two were made on retouched blanks.

Borers comprised six (75%) pieces made on flakes and two (25%) on blades. All displayed abrupt, direct retouch usually on the side (n=5, 62.5%). In four cases (50%) they had a second retouched side.

Scrapers and **burins** comprised two of the largest groups after backed artefacts. Fifteen (51.7%) scrapers were made on flakes, eleven (38%) on blades, two (6.9%) on bladelets and one (3.4%) on a core fragment. Eighteen (62%) were end scrapers of which one (5.5%) was probably used as borer on the opposite end. Two (11.1%) were made on core rejuvenation flakes and four (22.2%) displayed burin facets and were thus defined as composite tools (see Tixier 1963; Adam 1989). Seven (24.1%) were defined as side scrapers with retouch on one or both sides, and four (13.7%) combined retouch on ends and sides. The length of the retouched area varied between 2.1mm and 16.2mm, with a mean of 7.2mm (SD=4mm).

Burins consisted of nine (39.1%) pieces made on bladelets, and seven (30.4%) each on flakes and blades A few were made on retouched blanks, notches and cores.

Atypical retouched artefacts consisted of two pieces that could not be formally categorised.

Stratum 3

Artefacts with backed retouch consisted of 40 pieces of which 37 (92.5%) were made on bladelets and three (7.5%) on blades. All backed bladelets had lateral retouch, either direct (n=21, 56.7%), inverse or alternating (n=16, 43.2%). A few pieces (n=10, 27%) displayed retouch along both edges. Retouch was predominantly abrupt (n=28, 75.6%) and rarely semi or crossed abrupt (n=9, 25%). A small number of backed bladelets had one (n=2, 5.4%) or both ends (n=1, 2.7%) pointed, while four (10.8%) were truncated at the distal end. Similarly to bladelets, all blades were retouched along the side, while one (33.3%) was also truncated at the proximal end. Retouch was abrupt, either alternate or direct.

Artefacts with linear retouch consisted of five flakes (55.5%), two (22.2%) bladelets and two (22.2%) blades. The majority of the pieces (n=8, 88/8%) were laterally retouched and only one preserved secondary working on the distal end. They all had low angle retouch which was either inverse or direct.

Truncated tools, Aurignacian blades, notches/denticulates and **borers** constituted a group of retouched artefacts with very few pieces. One of the truncated tools was made on flake and the other on a blade. They were truncated at the distal end, by abrupt or semi abrupt retouch. The single Aurignacian blade had abrupt/scalar retouch on one side and inverse, low angle retouch on the other. The two borers, one made on a flake and the other on a blade, were both pointed at the distal end by direct abrupt retouch. Out of the five notches, four (80%) were made on flakes and only one (20%) on a blade. The type, direction and the angle of their retouch varied.

Burins comprised the third largest tool group of the sample (see also Adam 1989:206-7). Out of sixteen pieces, eight (50%) were made on flakes, six (37.5%) on blades and two (12.5%) on bladelets.

Scrapers consisted of 7 pieces, of which four were made on flakes (25%) and three (18.8%) on blades. Out of seven, four (57.1%) were endscrapers and three (42.8%) side scrapers. The length of the retouch varied between 2.9mm and 8.8mm with a mean of 5mm (SD 2.1mm).

6.5. Metric analysis of the lithic assemblage

6.5.1. Introduction

In this analysis, cores and core removals from Kastritsa were examined in terms of their overall dimensions. The core study was based on complete pieces only, whereas for debitage and tools the lower limit for inclusion was five pieces.

6.5.2. Cores

Metric analysis of cores was based on length, platform width and breadth and the proportions of platform working. Its primary aim was to investigate how intensively cores were being utilised, and was based on complete cores only. A summary of basic core dimensions is given in table 6.8.

Table 6.8. Basic metric characteristics of complete cores.

	Stratum 1 (n=46)	**Stratum 3 (n=35)**	**Total (n=81)**
Length			
Minimum/Maximum	13.8/100	12.8/76.6	12.8/100
Mean (SD)	36 (14.1)	40.6 (14.3)	38.0 (14.3)
Platform width (mm)			
Minimum/Maximum	2.5/53.2	7.2/62.3	2.5/62.3
Mean (SD)	24.4 (11.6)	32.5 (14)	27.9 (13.2)
Platform breadth (mm)			
Minimum/Maximum	0.3/34.3	0.2/45.8	0.2/45.8
Mean (SD)	14.7 (7.4)	17.7 (10.6)	16 (9.0)
Percentage of platform worked (%)			
Minimum/Maximum	22.6%/100%	13.0%/100%	13.0%/100%
Mean (SD)	79.5% (23.4%)	80.2% (27.8%)	79.8% (25.3%)

Length

Length was measured perpendicularly from the primary platform to the base of the core. Stratum 3 produced slightly more longer cores than stratum 1, particularly those over 40mm (fig.6.15). However, the KS test identified no significant difference between the two strata ($Dmax_{obs}=25.8<Dmax_{0.05}=30.1$).

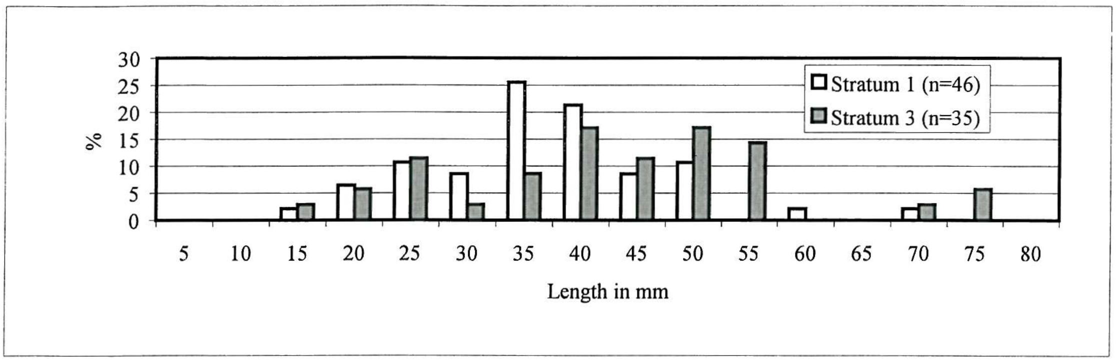


Figure 6.15. Length of all complete cores.

Platform width

Platform width was measured across the largest diameter of the primary platform. Stratum 3 produced cores with wider platforms, particularly those over 30mm (fig.6.16). However, the KS test identified no significant difference between the strata ($Dmax_{obs}$=25.9<$Dmax_{0.05}$=30.1).

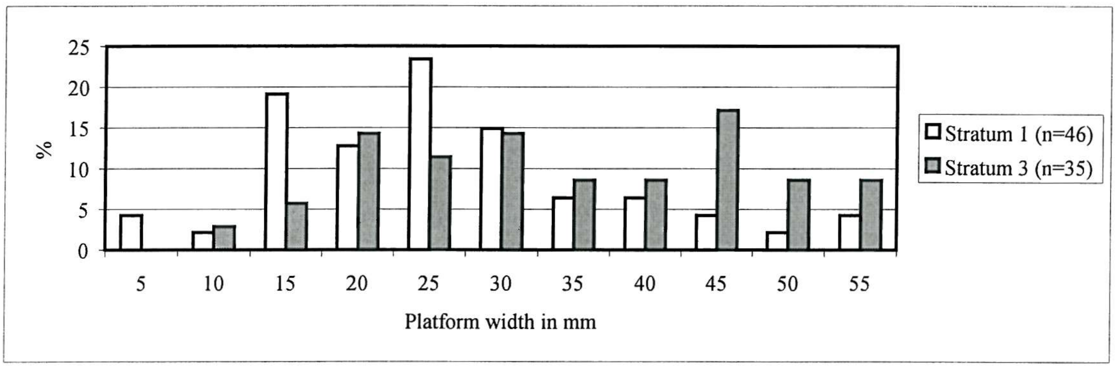


Figure 6.16. Platform width of all complete cores.

Platform breadth

Platform breadth was measured across the core perpendicular to the width axis. Although not as clear as in the case of width, stratum 3 produced slightly more cores with broader platforms (fig.6.17). However, the KS test identified no significant difference between the strata ($Dmax_{obs}$=18<$Dmax_{0.05}$=30.1).

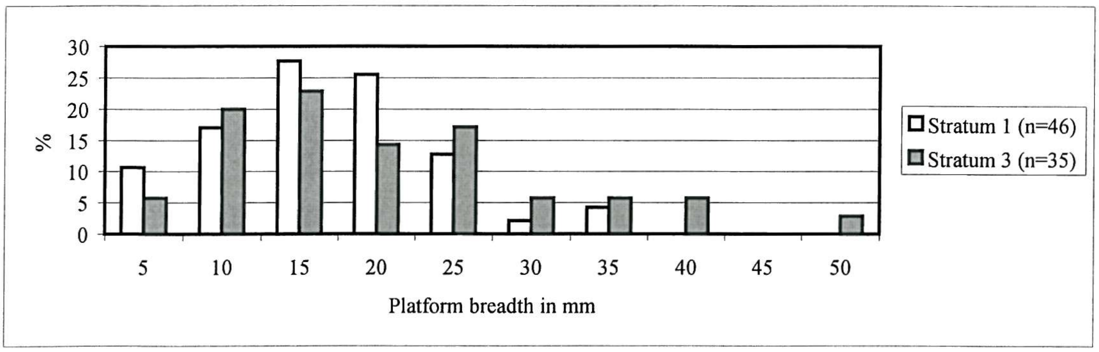


Figure 6.17. Platform breadth of all complete cores.

Two dimensional analysis, length against platform breadth

The slightly larger size of cores in stratum 3 is illustrated in the scattergram below (fig.6.18). This included a component of cores longer than 50mm, and those with platform breadth over 25mm.

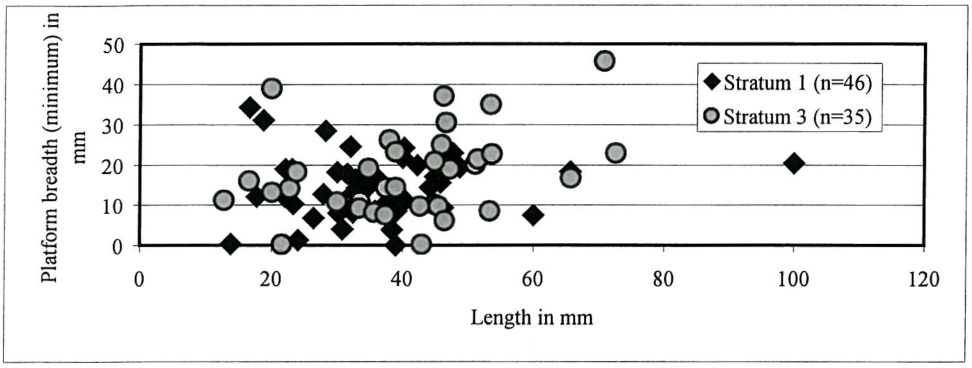


Figure 6.18. Core length plotted against platform breadth.

The reasons for this apparent tendency to abandon larger cores during the earlier phase are unclear. There was no change in the type of raw materials being used; however there was some suggestion that cores in stratum 3 were being introduced in a less extensively worked state, than in stratum 1. Secondary material in the latter accounted for 20%, while in the earlier stratum 3 it was 30% (see tbl.6.5, section 6.4.4). Assuming the range of sizes available for collection was comparable between strata 1 and 3, it can be suggested that cores were being introduced earlier and by implication in larger sizes during the earlier phase of occupation. Despite this, the fact that cores were also being discarded slightly larger suggests intensive use of raw materials.

Two dimensional analysis, platform width against breadth

The larger size of platforms in the earlier strata 3 can be seen in figure 6.19, particularly those over around 35mm in width.

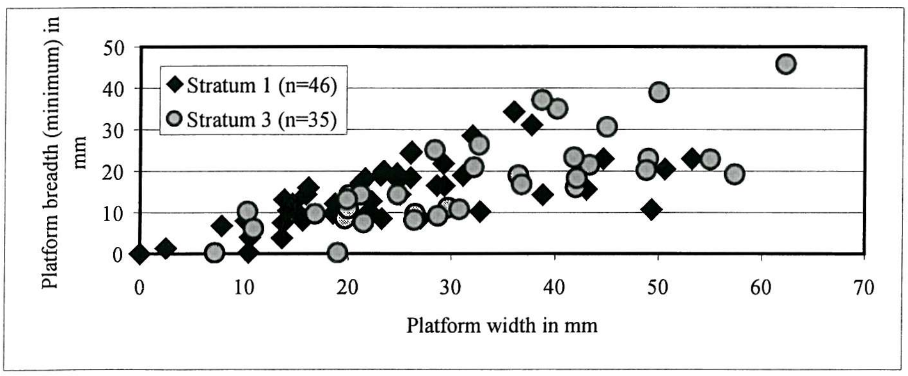


Figure 6.19. Core platform width plotted against platform breadth.

Platform working

In conjunction with the apparent decline in core size from stratum 3 to 1, there was an apparent decrease in the numbers of completely worked cores (fig.6.20). However, the KS test failed to identify any significant difference in platform working between the two strata ($Dmax_{obs}=12.5<Dmax_{0.05}=30.1$).

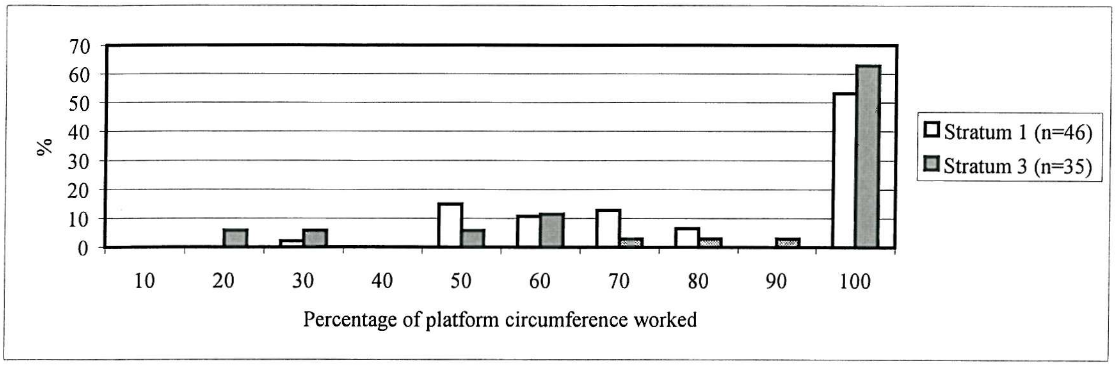


Figure 6.20. Percentage of platform circumference actively worked.

6.5.3. Debitage

Basic dimensions including means, maximums and minimums are given in table 6.9.

Table 6.9. Basic dimensions of debitage >10mm.

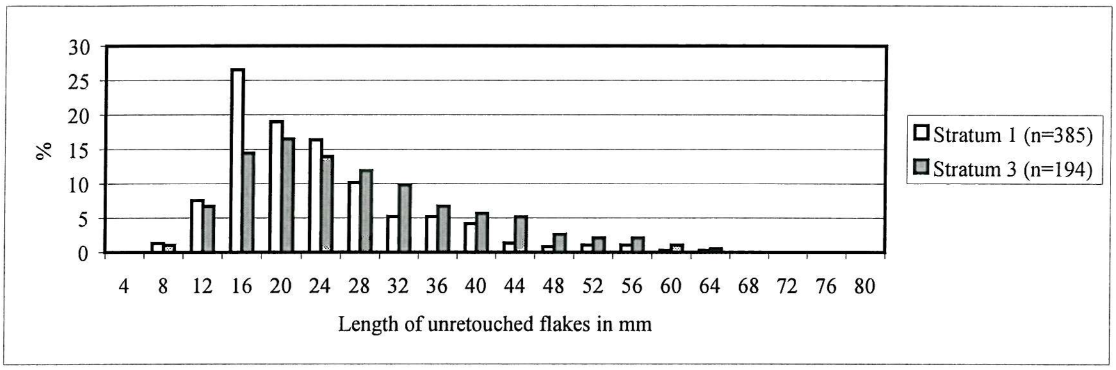
Dimensions in mm	**Stratum 1**	**Stratum 3**
	Length	
Flakes	**(n=385)**	**(n=194)**
Minimum / Maximum	6.1/62.8	7.4/60.5
Mean (SD)	21.4 (9.6)	25.7 (11.6)
Bladelets	**(n=191)**	**(n=64)**
Minimum / Maximum	11.8/56.1	11.7/79.0
Mean (SD)	24.3 (8.2)	27.8 (10.8)
Blades	**(n=91)**	**(n=61)**
Minimum / Maximum	20.3/77.4	25.5/75.0
Mean (SD)	41.5 (11.1)	46.5 (13.6)
	Width	
Flakes	**(n=714)**	**(n=401)**
Minimum / Maximum	5.0/57.7	3.5/72.5
Mean (SD)	17.3 (7.2)	18.9 (8.2)
Bladelets	**(n=392)**	**(n=145)**
Minimum / Maximum	2.1/12.0	3.7/12.0
Mean (SD)	8.6 (2.0)	8.8 (2.1)
Blades	**(n=226)**	**(n=137)**
Minimum / Maximum	12.1/37.2	12.1/29.6
Mean (SD)	15.7 (3.5)	17.0 (4.0)
	Thickness	
Flakes	**(n=714)**	**(n=401)**
Minimum / Maximum	0.6/22.4	0.8/20.9
Mean (SD)	4.6 (3.0)	4.9 (3.2)
Bladelets	**(n=392)**	**(n=145)**
Minimum / Maximum	0.7/11.7	0.8/12.2

Mean (SD)	3.2 (1.5)	3.7 (2.0)
Blades	**(n=226)**	**(n=137)**
Minimum / Maximum	1.0/16.8	1.8/21.1
Mean (SD)	5.7 (2.6)	6.0 (3.3)

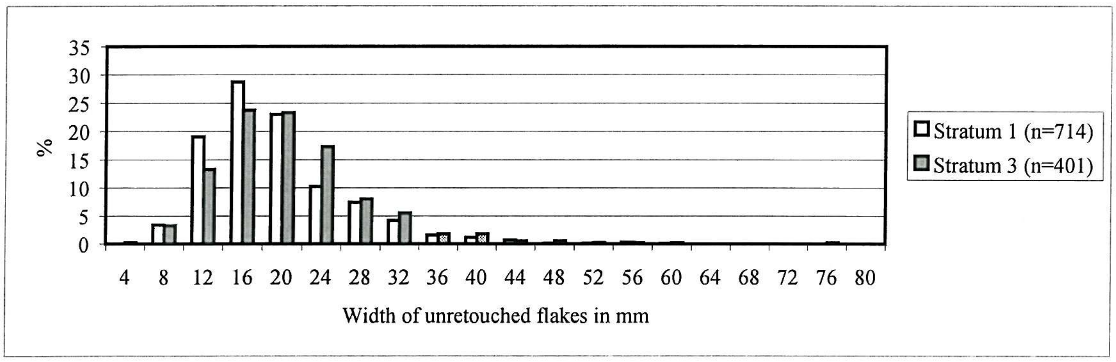
A description of the size distribution of each debitage group from strata 1 and 3 is given below. Frequency histograms are used in order to present any differences between the two strata, while the Kolmogorov-Smirnov (KS) test is used to test for significance.

Flakes

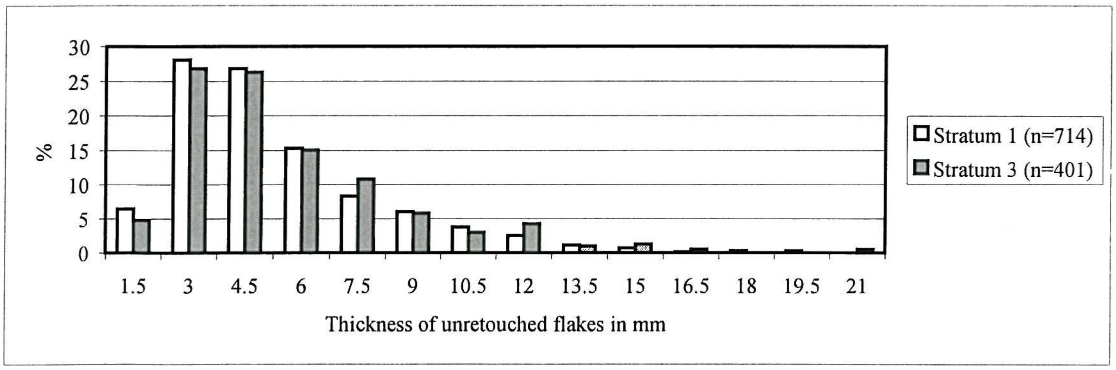
The length frequency distribution for flakes (fig.6.21a), pointed to a significant component of longer pieces in stratum 3, in particular those over 24mm, and visa versa in stratum 1. Moreover, the results of the KS test ($Dmax_{obs}$=18.0>$Dmax_{0.05}$=11.9) indicated that this difference was significant.



a.



b.



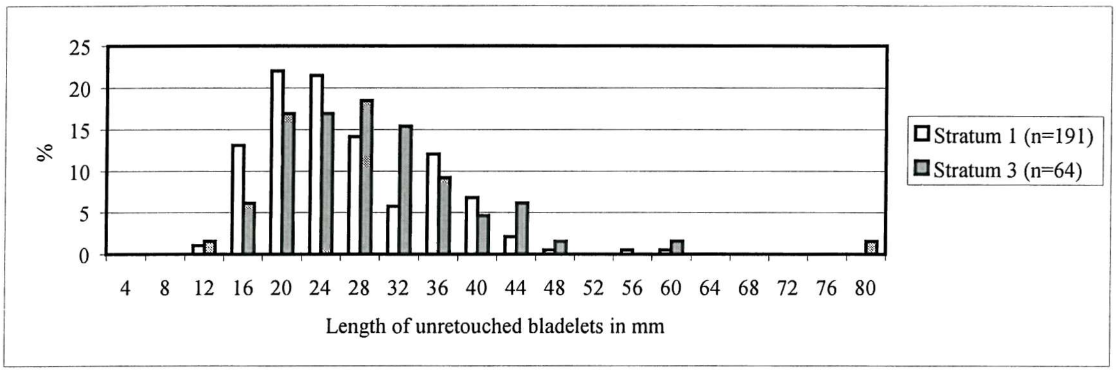
c.

Figure 6.21. Length (a), width (b) and thickness (c) of unretouched flakes.

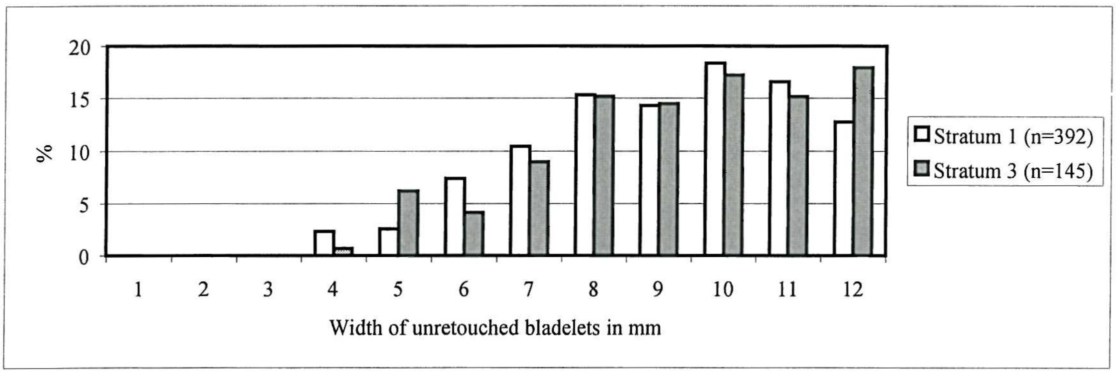
Similarly, stratum 3 produced a component of wider flakes, particularly those over 20mm (fig.6.21b), which the KS test identified as significant ($Dmax_{obs}=10.6>Dmax_{0.05}=8.5$). Stratum 3 also produced slightly thicker flakes, particularly those over 6mm. However the differences were less marked (6.21c), and the KS test indicated no significant difference ($Dmax_{obs}=3.76<Dmax_{0.05}=8.5$). As with both the sites of Franchthi and Klithi (see sections 4.5.3 and 5.5.3), the significant decline in flakes less than 1.5mm in thickness probably relates to the removal of small debitage less than 10mm, which also tend to be thinner.

Bladelets

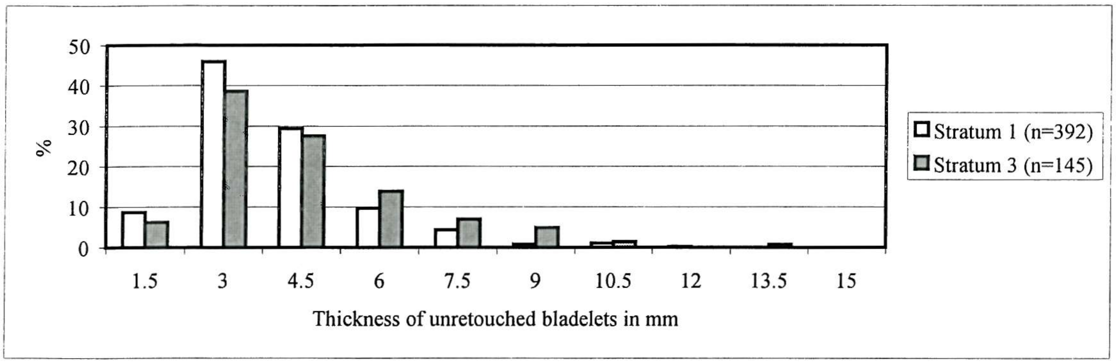
The length frequency histogram for bladelets pointed to the presence of longer pieces in stratum 3, particularly those over 24mm (fig.6.22a). The stratum 1 distribution appeared bimodal, suggesting a predominance of shorter pieces, as well as a small number over 32mm in length. Despite the variations in length frequencies, the KS test identified no significant difference between strata 1 and 3 ($Dmax_{obs}=17.0<Dmax_{0.05}=19.5$).



a.



b.

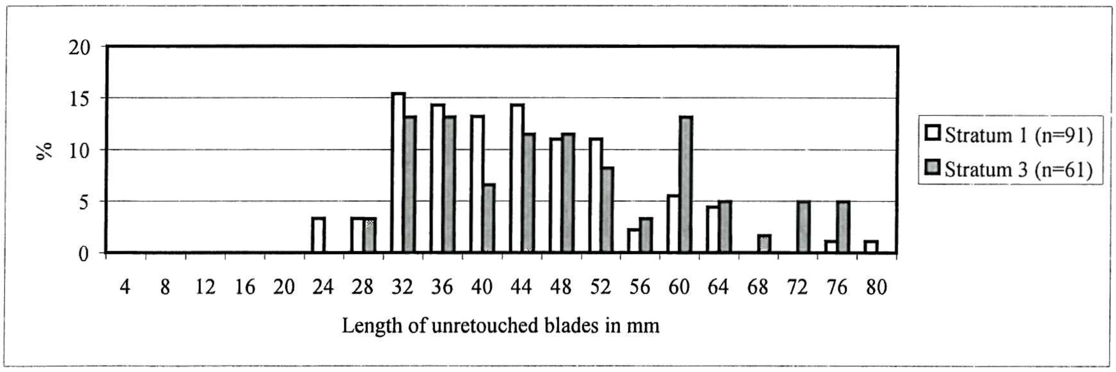


c.
Figure 6.22. Length (a), width (b) and thickness (c) of unretouched bladelets.

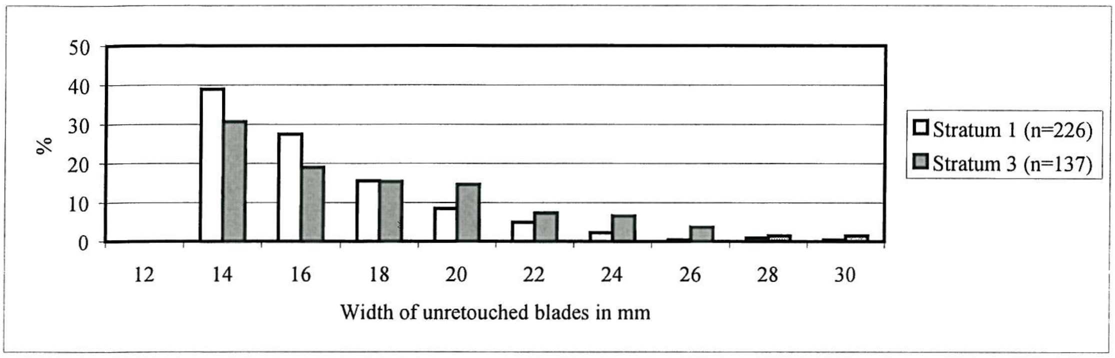
The width frequency distribution also pointed towards a tendency for wider bladelets in stratum 3, particularly those over 10mm (fig.6.22b), although the KS test did not identify this as significant ($Dmax_{obs}=3.7<Dmax_{0.05}=13.2$). In terms of thickness, bladelets once again tended to be thicker in stratum 3, particularly those over 4.5mm (fig.6.22c), although the KS test did not identify this as significant ($Dmax_{obs}=11.5<Dmax_{0.05}=13.2$).

Blades

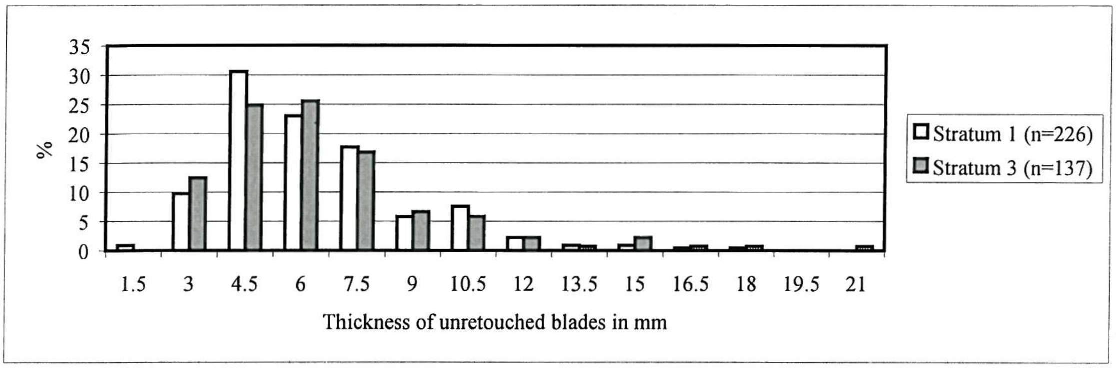
Blades from stratum 3 tended to be longer than those from stratum 1, particularly those over 52mm. Blades longer than this declined in frequency amongst both strata (fig.6.23a). The increase in frequency of pieces longer than 28mm is a result of the 12mm width blade/bladelet division rather than a deliberate lower length cut-off. The KS test identified no significant difference between the two strata in terms of length ($Dmax_{obs}=18.5<Dmax_{0.05}=22.5$).



a.



b.



c.

Figure 6.23. Length (a), width (b) and thickness (c) of unretouched blades.

The width frequency distribution was clearly affected by the 12mm blade/bladelet division, although as with all other debitage categories, stratum 3 produced wider pieces, particularly those over 18mm (fig.6.23b). In this case, the KS test identified this as significant ($Dmax_{obs}=16.9>Dmax_{0.05}=14.7$). There was little apparent difference in thickness between strata (fig.6.23c), and the KS test identified no significant difference ($Dmax_{obs}=4.0<Dmax_{0.05}=14.7$).

6.5.3. Tools

Table 6.10 lists the basic dimensions of tool categories identified at Kastritsa. Miscellaneous pieces were excluded, while only those with more than a single artefact were measured.

Table 6.10. Basic dimensions of tools.
Key:
N/A: tool groups with single pieces.
None found: none of this type of tool found.
None complete: although present, the dimension could not be measured due to breakage patterns.

Dimensions in mm	**Stratum 1**	**Stratum 3**
	Length	
Backed bladelets	**(n=40)**	**(n=13)**
Minimum / Maximum	16.5/43.6	13.0/31.3
Mean (SD)	25.5 (5.6)	24.3 (4.7)
Backed blades	**(n=2)**	**(n=1)**
Minimum / Maximum	41.1/55.0	N/A
Mean (SD)	48.0 (9.8)	N/A

Backed flakes	**(n=1)**	None found
Minimum / Maximum	N/A	-
Mean (SD)	N/A	-
Microgravettes	**(n=4)**	None found
Minimum / Maximum	34.2/51.0	-
Mean (SD)	44.0 (7.4)	-
Shouldered bladelets	**(n=2)**	None found
Minimum / Maximum	24.5/43.1	-
Mean (SD)	33.8 (13.1)	-
Flakes with linear retouch	**(n=3)**	**(n=4)**
Minimum / Maximum	3.8/46.2	7.3/31.2
Mean (SD)	38.3 (6.5)	34.1 (18.0)
Bladelets with linear retouch	**(n=2)**	**(n=1)**
Minimum / Maximum	22.7/37.4	N/A
Mean (SD)	30.0 (10.3)	NA
Blades with linear retouch	**(n=2)**	**(n=1)**
Minimum / Maximum	41.0/71.4	N/A
Mean (SD)	56.2 (21.5)	N/A
Truncations	**(n=3)**	**(n=2)**
Minimum / Maximum	14.5/27.3	24.0/25.0
Mean (SD)	20.9 (9.0)	24.5 (0.7)
Notches/Denticulates	**(n=9)**	**(n=2)**
Minimum / Maximum	16.3/64.1	19.6/33.2
Mean (SD)	39.1 (15.4)	26.4 (9.6)
Borers	**(n=6)**	**(n=2)**
Minimum / Maximum	23.8/51.2	40.5/92.0
Mean (SD)	37.5 (9.9)	66.2 (36.4)
Burins	**(n=16)**	**(n=7)**
Minimum / Maximum	6.8/77.6	12.8/59.2
Mean (SD)	36.6 (17.0)	34.1 (18.0)
Scrapers	**(n=18)**	**(n=3)**
Minimum / Maximum	35.1/86.3	31.0/56.0
Mean (SD)	55.3 (14.4)	42.4 (12.6)
Aurignacian blades	None found	**(n=1)**
Minimum / Maximum	-	N/A
Mean (SD)	-	N/A
	Width	
Backed bladelets	**(n=119)**	**(n=37)**
Minimum / Maximum	3.8/11.2	3.6/11.6
Mean (SD)	6.3 (1.7)	6.7 (2.0)
Backed blades	**(n=8)**	**(n=3)**
Minimum / Maximum	12.2/14.8	17.3/21.3
Mean (SD)	13.3 (1.0)	18.6 (2.2)
Backed flakes	**(n=1)**	None found
Minimum / Maximum	N/A	-
Mean (SD)	N/A	-
Microgravettes	**(n=6)**	None found
Minimum / Maximum	5.3/11.7	-
Mean (SD)	8.7 (2.1)	-
Shouldered bladelets	**(n=2)**	None found
Minimum / Maximum	6.8/8.8	-
Mean (SD)	7.8 (1.4)	-
Flakes with linear retouch	**(n=6)**	**(n=5)**
Minimum / Maximum	15.5/36.4	8.0/20.4
Mean (SD)	25.7 (8.7)	13.3 (4.6)
Bladelets with linear retouch	**(n=4)**	**(n=2)**
Minimum / Maximum	8.6/11.5	5.3/6.4

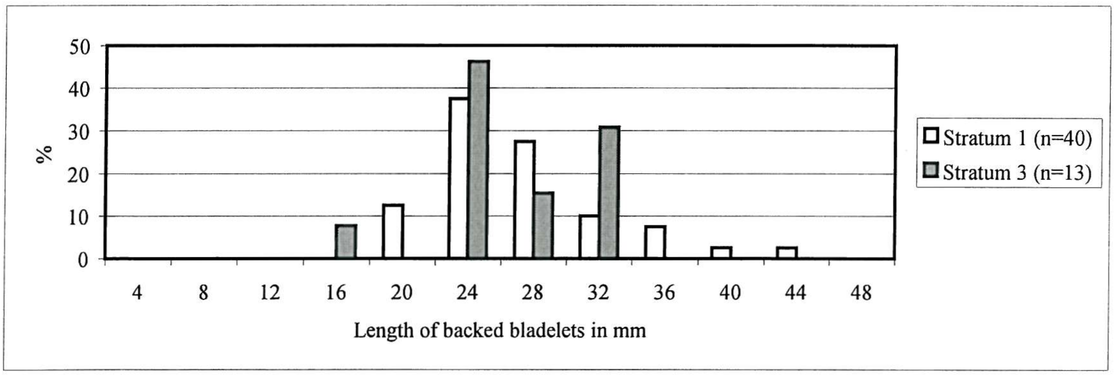
Mean (SD)	10.1 (1.4)	5.8 (0.7)
Blades with linear retouch	**(n=8)**	**(n=2)**
Minimum / Maximum	12.3/30.0	12.4/19.7
Mean (SD)	21.9 (6.8)	16.0 (5.1)
Truncations	**(n=3)**	**(n=2)**
Minimum / Maximum	10.4/14.7	12.1/30.0
Mean (SD)	12.1 (2.2)	21.0 (12.6)
Notches/Denticulates	**(n=15)**	**(n=5)**
Minimum / Maximum	9.0/31.4	13.2/21.7
Mean (SD)	14.2 (6.0)	16.5 (3.5)
Borers	**(n=8)**	**(n=2)**
Minimum / Maximum	14.1/32.6	17.8/23.2
Mean (SD)	20.4 (5.5)	20.5 (3.8)
Burins	**(n=23)**	**(n=16)**
Minimum / Maximum	7.2/40.0	7.8/23.0
Mean (SD)	14.4 (7.3)	15.8 (5.0)
Scrapers	**(n=28)**	**(n=7)**
Minimum / Maximum	10.4/42.3	17.3/31.8
Mean (SD)	25.0 (8.8)	24.8 (4.2)
Aurignacian blades	None found	**(n=1)**
Minimum / Maximum	-	N/A
Mean (SD)	-	N/A
	Thickness	
Backed bladelets	**(n=119)**	**(n=37)**
Minimum / Maximum	1.2/5.2	1.5/5.1
Mean (SD)	2.6 (0.8)	2.7 (0.8)
Backed blades	**(n=8)**	**(n=3)**
Minimum / Maximum	2.5/6.8	3.4/5.9
Mean (SD)	4.5 (1.7)	4.5 (1.2)
Backed flakes	**(n=1)**	None found
Minimum / Maximum	N/A	-
Mean (SD)	N/A	-
Notches/Denticulates	**(n=15)**	**(n=5)**
Minimum / Maximum	1.8/7.6	2.5/5.4
Mean (SD)	4.0 (1.6)	4.2 (1.1)
Microgravettes	**(n=6)**	None found
Minimum / Maximum	2.2/5.0	-
Mean (SD)	3.7 (1.0)	-
Shouldered bladelets	**(n=2)**	None found
Minimum / Maximum	2.6/3.2	-
Mean (SD)	2.9 (0.4)	-
Flakes with linear retouch	**(n=6)**	**(n=5)**
Minimum / Maximum	5.0/12.3	2.7/4.0
Mean (SD)	7.3 (2.8)	3.3 (0.5)
Bladelets with linear retouch	**(n=4)**	**(n=2)**
Minimum / Maximum	1.9/3.0	1.5/2.6
Mean (SD)	2.6 (0.5)	2.0 (0.7)
Blades with linear retouch	**(n=8)**	**(n=2)**
Minimum / Maximum	2.4/11.6	2.2/8.2
Mean (SD)	5.7 (2.7)	5.2 (4.2)
Truncations	**(n=3)**	**(n=2)**
Minimum / Maximum	1.6/4.0	3.1/6.3
Mean (SD)	2.8 (1.2)	4.7 (2.2)
Notches/Denticulates	**(n=15)**	**(n=5)**
Minimum / Maximum	1.8/7.6	2.5/5.4
Mean (SD)	4.0 (1.6)	4.2 (1.1)
Borers	**(n=8)**	**(n=2)**

Minimum / Maximum	4.3/8.8	4.3/6.1
Mean (SD)	5.8 (1.7)	5.2 (1.2)
Burins	**(n=23)**	**(n=16)**
Minimum / Maximum	2.7/20.7	1.7/9.2
Mean (SD)	5.5 (4.0)	5.0 (2.3)
Scrapers	**(n=28)**	**(n=7)**
Minimum / Maximum	3.6/22.4	4.0/16.0
Mean (SD)	9.5 (4.5)	9.0 (3.6)
Aurignacian blades	None found	**(n=1)**
Minimum / Maximum	-	N/A
Mean (SD)	-	N/A

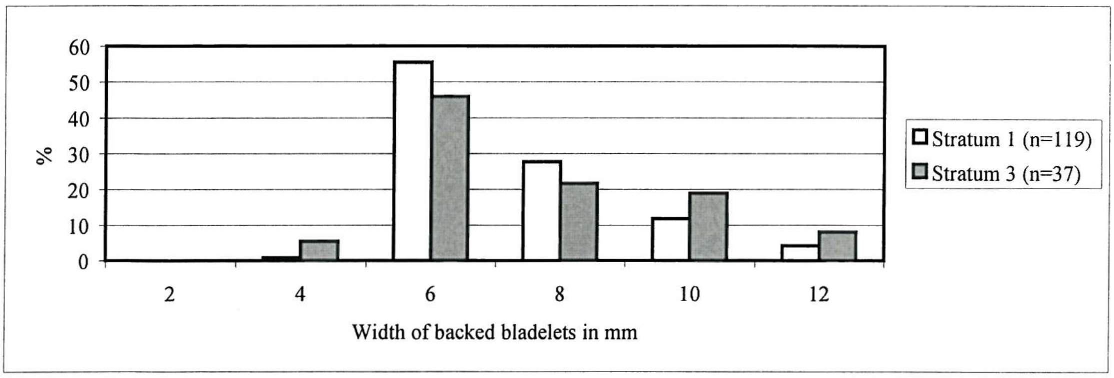
In the analysis below, the size frequency distributions for artefacts from strata 1 and 3 are presented graphically and tested for significance using the KS test. Only those categories with five or more pieces in both strata were included. This reduced the number of tool categories to five, and included backed bladelets, notches/denticulates, flakes with linear retouch, burins and scrapers.

Backed bladelets

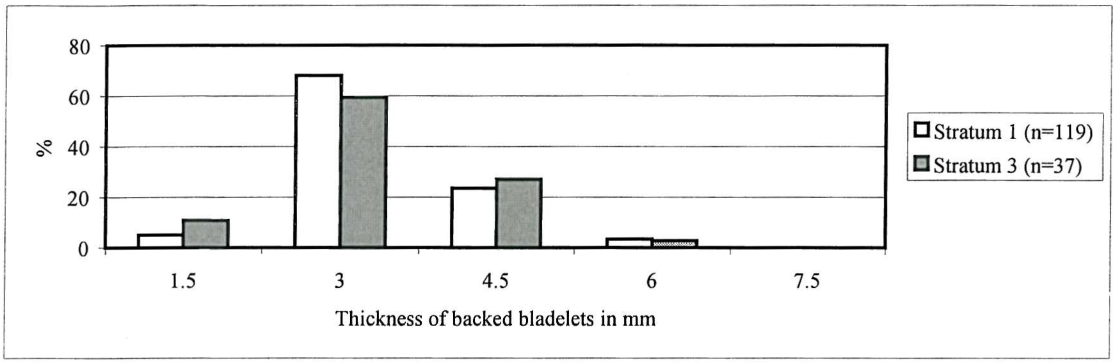
The pattern of larger pieces in stratum 3 compared to 1 continued amongst tools. Bearing in mind relatively small sample sizes, backed bladelets from stratum 3 tended to be longer, particularly those over 28mm (fig.6.24). The significant decline in frequency of backed bladelets less than 20mm in length suggests that 20mm was probably a lower usefulness cut-off. However, the KS test identified no significant difference between strata 1 and 3 ($Dmax_{obs}=12.5<Dmax_{0.05}=43.4$) in terms of length.



a.



b.



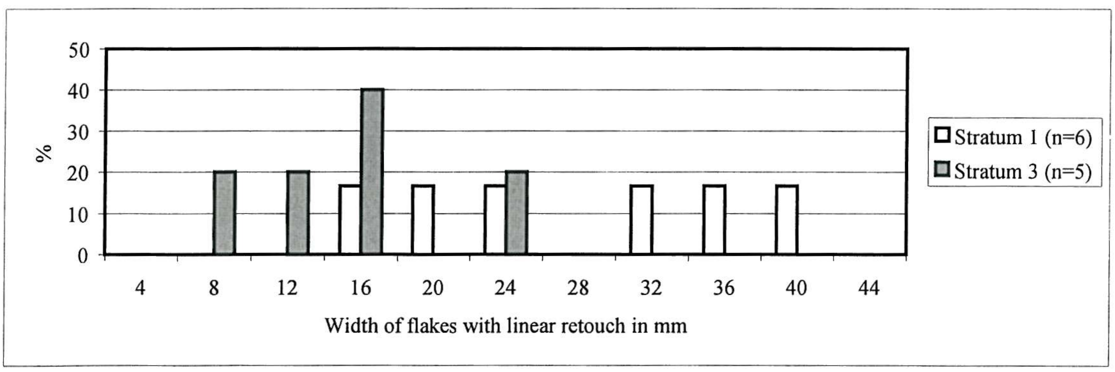
c.

Figure 6.24. Length (a), width (b) and thickness (c) of backed bladelets.

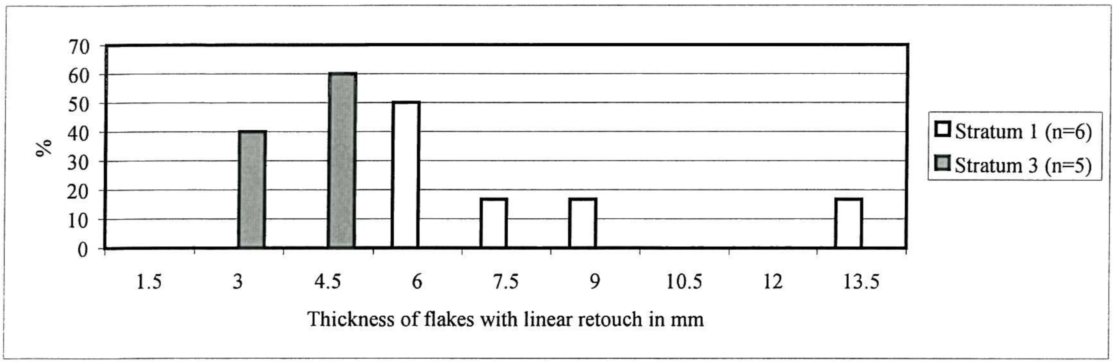
Backed bladelets from stratum 3 also tended to be slightly wider than those from stratum 1, particularly those over 8mm (fig.6.24b). The significant decline in frequency of pieces less than 4mm in width probably points to a lower usefulness cut-off, however the KS test identified no significant difference between the two strata ($Dmax_{obs}$=12.5<$Dmax_{0.05}$=43.4) in terms of width. Similarly, stratum 3 also produced a small number of thicker backed bladelets, particularly those over 3mm, although the KS test did not identify the two strata as significantly different ($Dmax_{obs}$=5.7<$Dmax_{0.05}$=25.6).

Flakes with linear retouch

Length was excluded due to the small numbers of artefacts measured, while width and thickness faired little better with just six and five from stratum 1 and 3 respectively. Taken at face value, the frequency distributions suggested that flakes with linear retouch included a component of wider and thicker pieces in stratum 1, which were not present in stratum 3 (fig.6.25a,b). The KS tests identified no significant differences, however with such small samples sizes it is of little value. Considering the small size of the samples, it would probably be safer to assume these results as spurious.



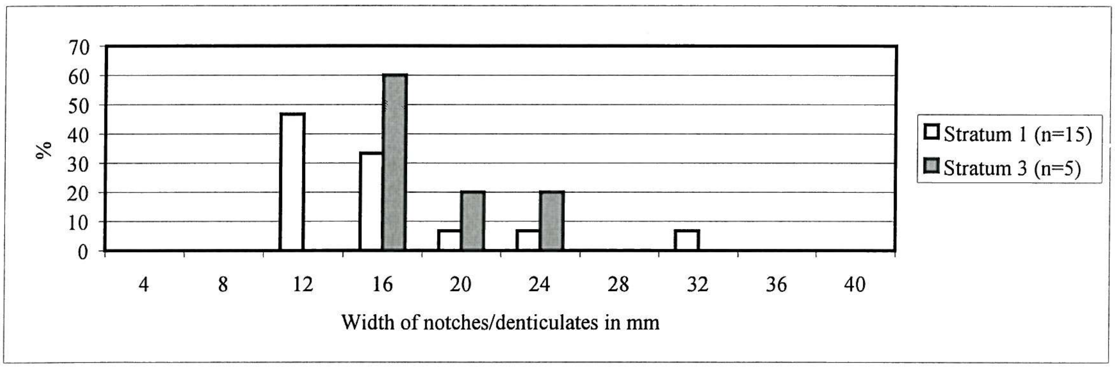
a.



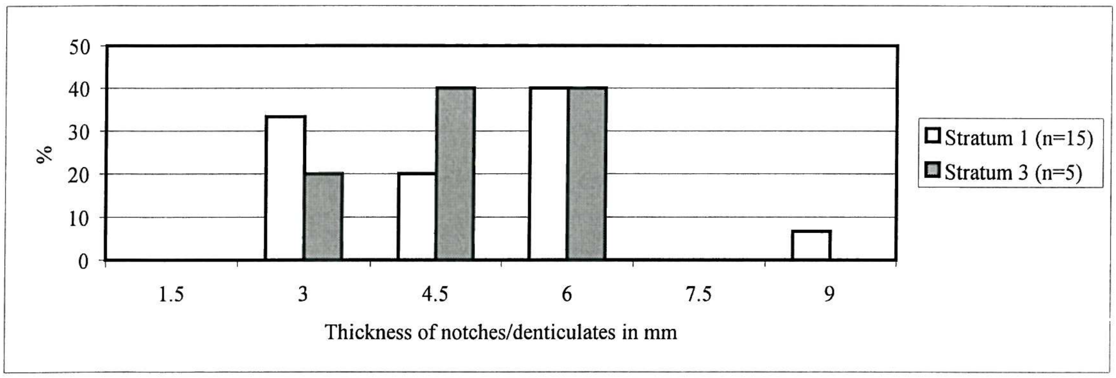
b.
Figure 6.25. Width (a) and thickness (b) of flakes with linear retouch.

Notches/Denticulates

Although nine notches/denticulates were recovered from stratum 1, only two were present in stratum 3, and therefore length was excluded. However, in the case of width and thickness, the value of comparison was limited by just five pieces in stratum 3. There was a slight suggestion that earlier stratum 3 notches/denticulates were both wider and thicker than those from stratum 1 (fig.6.26a,b). However the KS test identified no significant differences; they were of no use anyway because of the small sample sizes.



a.



b.
Figure 6.26. Width (a) and thickness (b) of notches/denticulates.

Burins

Despite a larger sample size, the length frequency distribution for burins was irregular and impossible to interpret (fig.6.27a). The KS test indicated no significant difference between the two strata ($Dmax_{obs}$=30.6<$Dmax_{0.05}$=61.6) in terms of length.

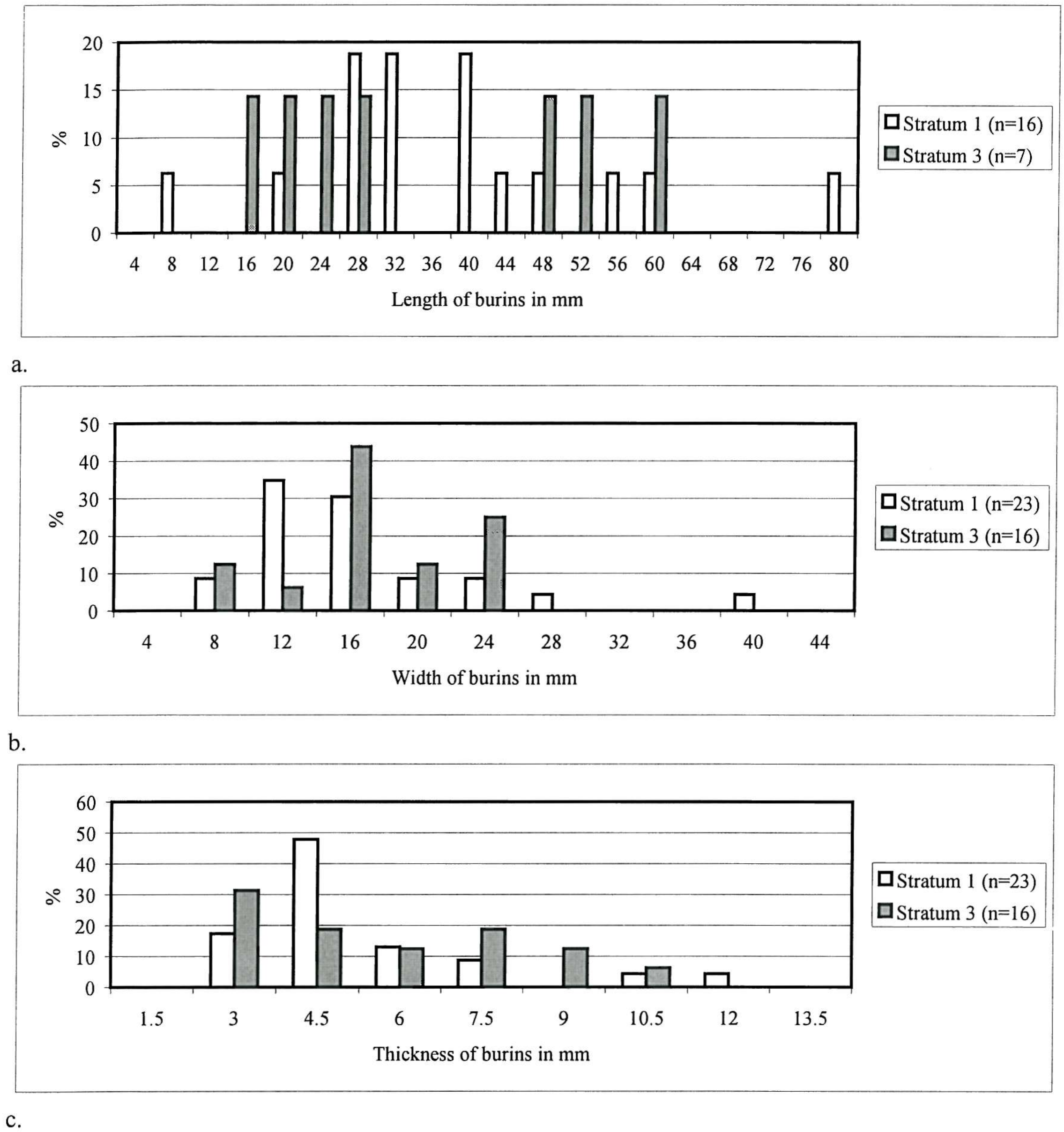
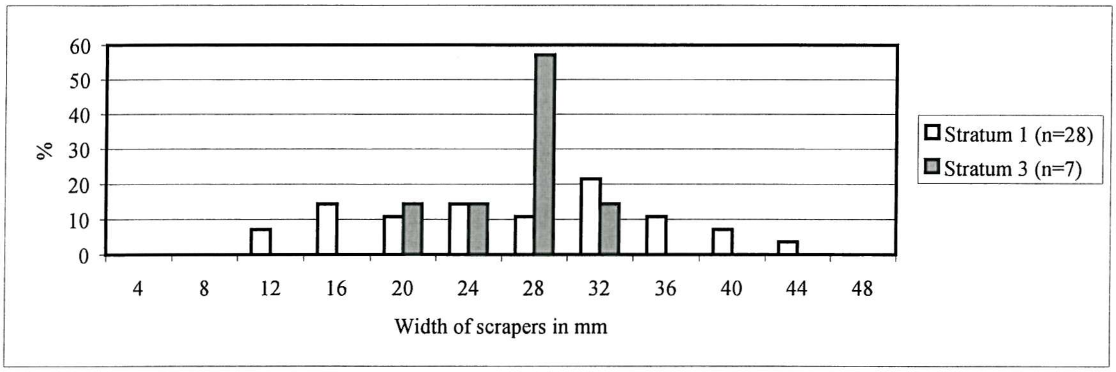


Figure 6.27. Length (a), width (b) and thickness (c) of burins.

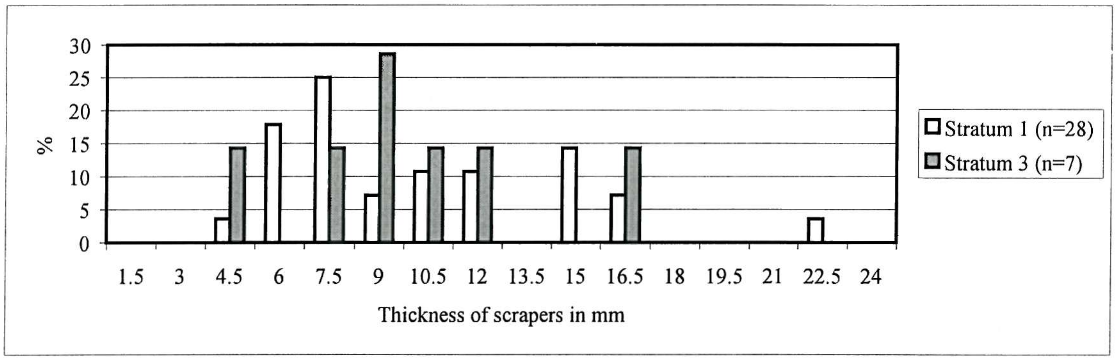
In terms of width, the larger sample of 23 and 16 burins from strata 1 and 3 respectively produced a more regular distribution (fig.6.27b). This suggested that burins from the earlier stratum 3 were wider than those from stratum 1, particularly in terms of those over 12mm. However, the KS test identified no significant difference between them ($Dmax_{obs}$=24.7<$Dmax_{0.05}$=44.2). Similarly, stratum 3 produced slightly thicker burins than stratum 1. However, the KS test identified no significant difference in burin thickness between strata 1 and 3 ($Dmax_{obs}$=15.7<$Dmax_{0.05}$=44.2).

Scrapers

Although stratum 1 produced 17 scrapers measurable in terms of length, there were none in stratum 3 and therefore length was excluded. Stratum 1 produced a broad range of scraper widths from 8mm to 44mm, whereas the range of widths from stratum 3 tended to be more constrained (fig.6.28a). In fact just over 57% of stratum 3 scrapers were between 24mm and 28mm in width. Overall, scrapers from stratum 1 tended to be both wider and narrower than those from stratum 3. However, the KS test identified no significant difference between the two strata ($Dmax_{obs}=28.6<Dmax_{0.05}=57.5$).



a.



b.

Figure 6.28. Width (a) and thickness (b) of scrapers.

Despite a rather irregular frequency distribution, there was some suggestion that some scrapers in stratum 3 were thicker than those from the overlying stratum 1 (fig.6.28b), particularly those thicker than 7.5mm. However, the KS test identified no significant difference between the two strata ($Dmax_{obs}=17.8<Dmax_{0.05}=57.5$).

6.6. Assessment of standardisation in the lithic assemblage

6.6.1. Introduction

In this section, metric standardisation is investigated using CV values and cumulative percentage difference. These are then tested for significance using the *F* and KS tests. All analysis was done on log transformed data. As with Franchthi cave (see section 5.6.4), standardisation through time was investigated at Kastritsa, by comparing both debitage and tools from strata 1 and 3.

6.6.2. Debitage

All debitage was grouped by category and bulked from strata 1 and 3. Blades and bladelets were combined in order to avoid imposing standardisation either side of the 12mm width divide. The results of the CV analysis are listed in table 6.11 and illustrated in figure 6.29, while the results of the *F* test are listed in Appendix III, table 1.

Table 6.11. CV values for debitage.

	Length	Width	Thickness
Flakes	14.4% (n=579)	14.1% (n=1115)	44.3% (n=1115)
Blades/bladelets	12.4% (n=407)	16.4% (n=900)	41.0% (n=900)

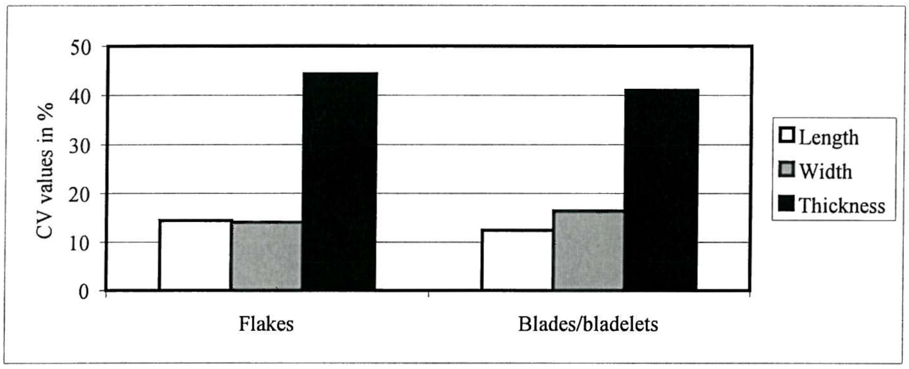
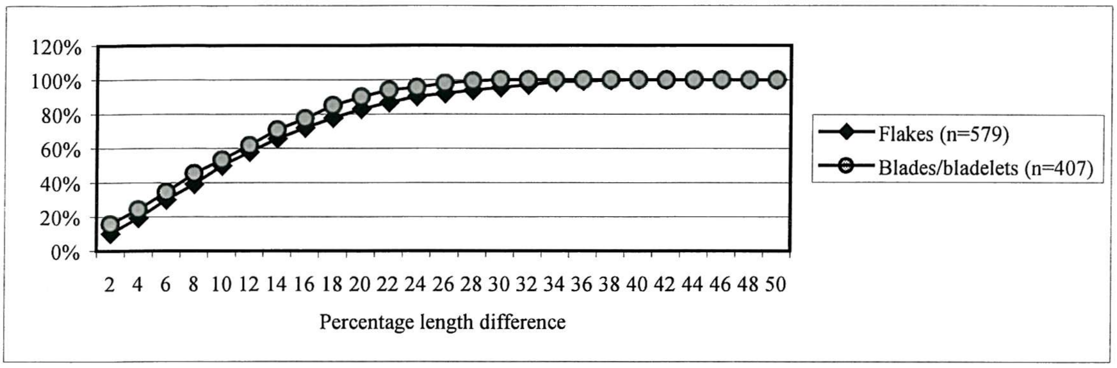


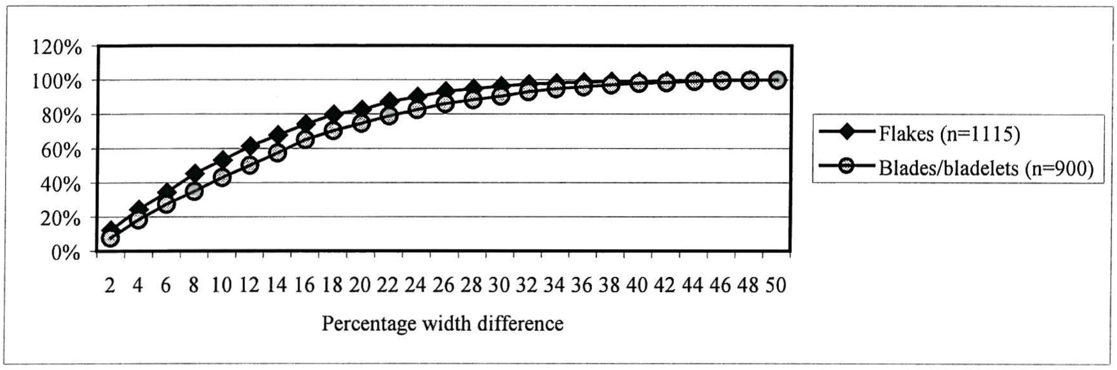
Figure 6.29. CV values for flakes and blades/bladelets.

The CV results pointed to thickness as having significantly higher variance than either length or width (fig.6.29). As argued in previous chapters this reflects that of all three dimensions, thickness would have been the least controllable. Also, despite thickness all appearing very similar, in purely metric terms they were anything but. The slightly lower CV value obtained for blades/bladelets suggested that the latter were more standardised, and the *F* test confirmed that this difference was significant. Length and width produced much lower CV values, suggesting a greater emphasis on metric standardisation. There was no difference between the length CV values, suggesting that both flakes and blades/bladelets were similarly standardised. In terms of width, blades/bladelets produced a higher CV, therefore appearing less standardised than flakes. The *F* test indicated that neither of these differences was significant.

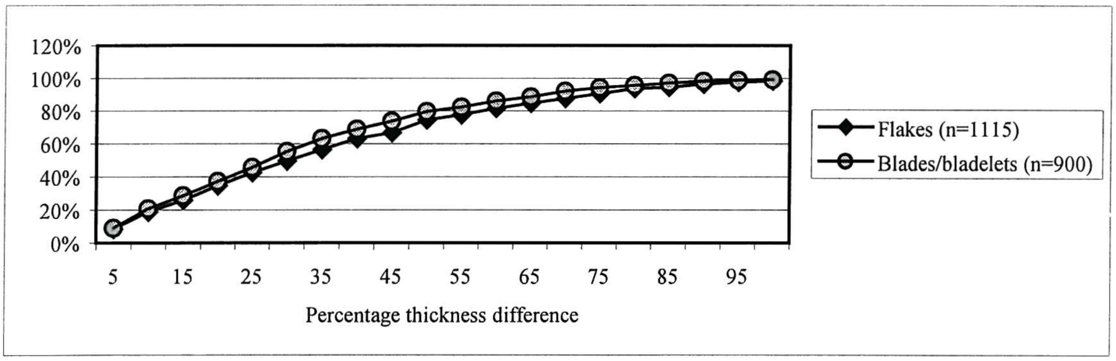
The overall similarity in variance between flakes and blades/bladelets is illustrated in the following series of cumulative frequency histograms in which the percentage differences between mean and values are presented.



a.



b.



c.

Figure 6.30. Flake and blade/bladelet cumulative percentage difference between log transformed means and values for length (a), width (b), and thickness (c).

The cumulative frequency distributions were all very similar and supported the conclusions of the CV results. In terms of length, backed bladelets appeared more standardised (fig.6.30a), whereas in terms of width, flakes appeared slightly more standardised (fig.6.30b). However, the KS test indicated that there was no significant difference between flakes and blades/bladelets in terms of length ($Dmax_{obs}=7.4<Dmax_{0.05}=8.8$), or width ($Dmax_{obs}=11<Dmax_{0.05}=6.1$). Backed bladelets were slightly more standardised in terms of thickness (fig.6.30c), the difference identified as significant by the KS test ($Dmax_{obs}=6.90>Dmax_{0.05}=6.1$). The CV results, cumulative percentage difference and the *F* and KS tests identified no clear or consistent evidence for differential standardisation between flakes and blades/bladelets. This suggests that beyond simply producing blades/bladelets as opposed to flakes, no obvious effort was being expended on standardising blank production at Kastritsa.

6.6.3. Tools

Analysis of artefact variance was based on CV values, cumulative percentage differences and the *F* and KS significance tests, and was applied to tool categories derived from the combined assemblages from strata 1 and 3. Despite grouping both strata, artefact categories such as flakes with linear retouch, borers and backed blades remained small in number and were excluded from the analysis. Because of their overall similarity, the small sample of microgravettes and shouldered bladelets were grouped together with backed bladelets. The results of the CV analysis are listed in table 6.12 and illustrated in figure 6.31.

Table 6.12. CV values for tools.

	Length	Width	Thickness
Backed bladelets, microgravettes and shouldered bladelets	8.0% (n=59)	14.6% (n=164)	32.6% (n=164)
Notches/Denticulates	12.3% (n=11)	12.4% (n=20)	29.0% (n=20)
Burins	15.8% (n=23)	15.0% (n=39)	33.3% (n=39)
Scrapers	7.4% (n=21)	11.4% (n=36)	20.3% (n=36)

As with debitage, thickness CV values were the highest, suggesting relatively less metric standardisation than either length or width. However, with a very much lower CV, scraper thickness appeared significantly more standardised than any of the other artefact categories, while backed bladelets and burins appeared the least standardised. Scrapers also produced the lowest length and width CV values. Backed bladelets produced a similarly low length CV as scrapers. In terms of width however, backed bladelets and burins were apparently the least standardised. The *F* test results pointed towards a significant difference in variance amongst backed bladelets and burins, in terms of length, width and thickness.

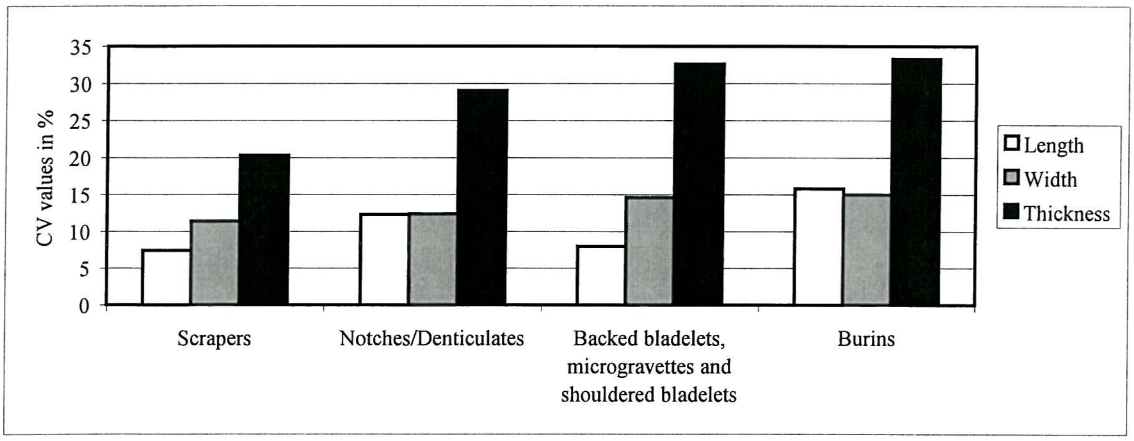
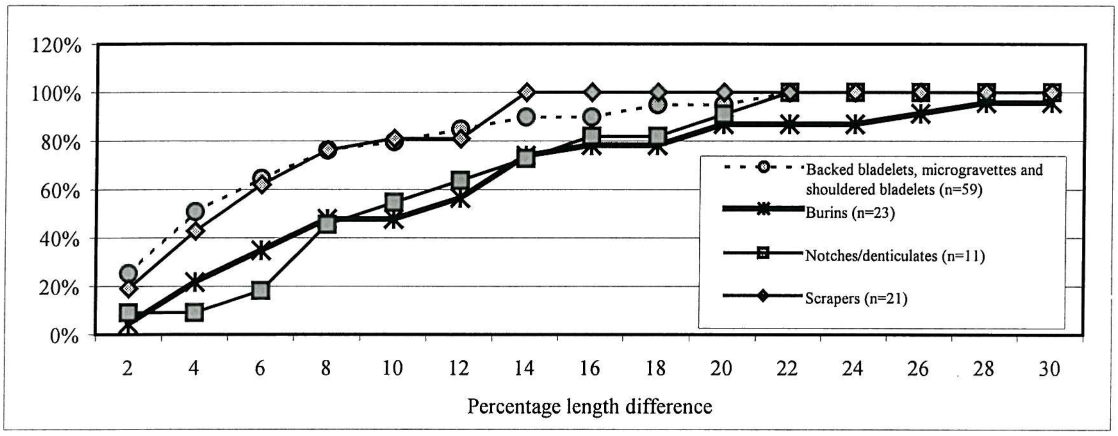
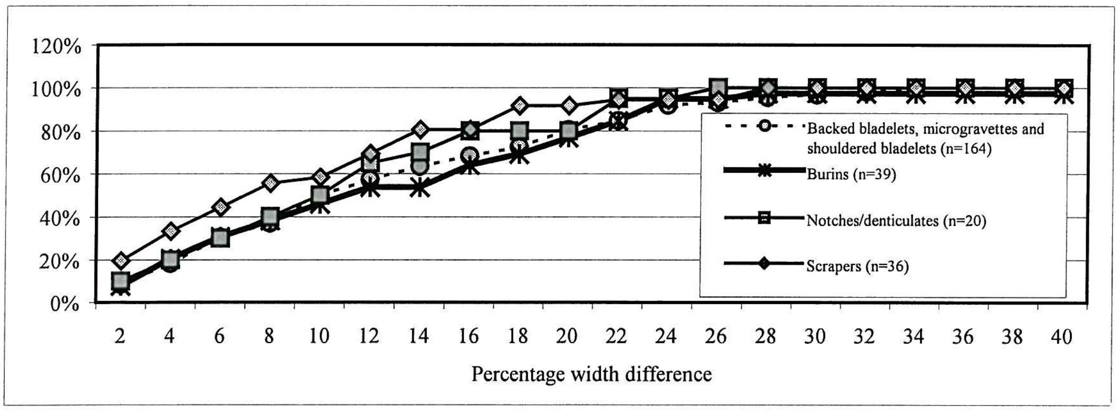


Figure 6.31. CV values for tools.

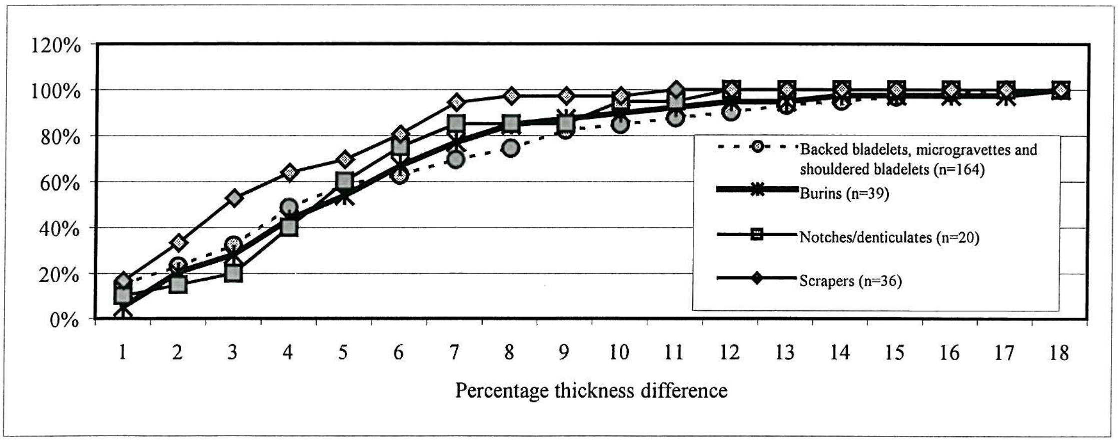
The patterns observed amongst the CV values are illustrated in the following series of cumulative frequency histograms for percentage difference between means and measures. The results of the KS significance tests are listed in the series of tables (tbl.6.12a,b,c) which follow the cumulative frequency histograms. Scrapers and backed bladelets produced lowest length percentage difference (fig.6.32a), and were therefore by implication, the most standardised artefacts in terms of length. Conversely, burins and notches/denticulates produced the highest overall percentage difference in terms of length, therefore interpreted as the least standardised.



a.



b.



c.

Figure 6.32. Tools cumulative percentage difference between log transformed means and values for length (a), width (b), and thickness (c).

In terms of width, differences were less marked although again, scrapers produced the lowest overall parentage difference, therefore the most metrically standardised (fig.6.32b). The least standardised in terms of width were burins and backed bladelets. Scrapers also produced the least percentage difference overall in terms of thickness, therefore the most standardised, whereas burins and backed bladelets appeared the least standardised. Of all the cumulative percentage differences, the only one identified by the KS test as significant was length of notches/denticulates and backed bladelets (tbl.6.13a).

Table 6.13. Results of the KS test.
They are based on cumulative percentage differences for tool length (a), width (b) and thickness (c).
Significant differences are shown highlighted.

Length KS test results	**Scrapers**	**Backed bladelets**	**Notches/ Denticulates**
Backed bladelets	(Dmaxobs=10.2< Dmax0.05=34.6)		
Notches/ Denticulates	(Dmaxobs=43.7< Dmax0.05=50.6)	(Dmaxobs=45.6> Dmax0.05=44.7)	
Burins	(Dmaxobs=33.2< Dmax0.05=41)	(Dmaxobs=33.2< Dmax0.05=33.4)	(Dmaxobs=13< Dmax0.05=49.9)

a.

Width KS test results	**Scrapers**	**Backed bladelets**	**Notches/ Denticulates**
Backed bladelets	(Dmaxobs=19.1< Dmax0.05=25)		
Notches/ Denticulates	(Dmaxobs=15.6< Dmax0.05=37.9)	(Dmaxobs=12.3< Dmax0.05=32.2)	
Burins	(Dmaxobs=26.7< Dmax0.05=31.4)	(Dmaxobs=9.5< Dmax0.05=24.2)	(Dmaxobs=16.5< Dmax0.05=37.4)

b.

Thickness KS test results	**Scrapers**	**Backed bladelets**	**Notches/ Denticulates**
Backed bladelets	(Dmaxobs=24.9< Dmax0.05=25)		
Notches/ denticulates	(Dmaxobs=32.8< Dmax0.05=37.9)	(Dmaxobs=15.5< Dmax0.05=32.2)	
Burins	(Dmaxobs=24.6< Dmax0.05=31.4)	(Dmaxobs=10.6< Dmax0.05=24.2)	(Dmaxobs=8.1< Dmax0.05=37.4)

c.

As with the sites of Klithi and Franchthi (see section 4.6.3 and 5.6.3), the evidence at Kastritsa pointed towards scrapers as the most standardised artefact type. Conversely, backed bladelets were in all cases less standardised, and were in fact in the majority of dimensions, the least standardised artefact category.

6.6.4. Changes in standardisation through time

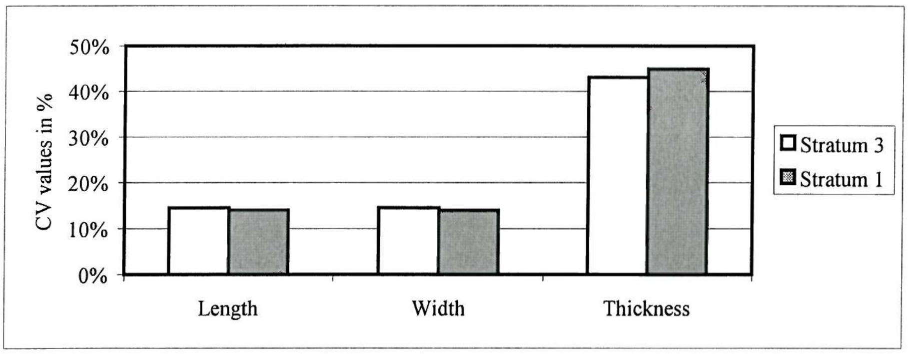
Standardisation through time is investigated by comparing unretouched flakes, blades/bladelets and retouched backed bladelets from strata 3 and 1. These groups were chosen simply on the basis of having sufficiently large sample sizes. Again, blades and bladelets were grouped together in order to avoid imposing any standardisation on the collections.

Flakes and blades/bladelets

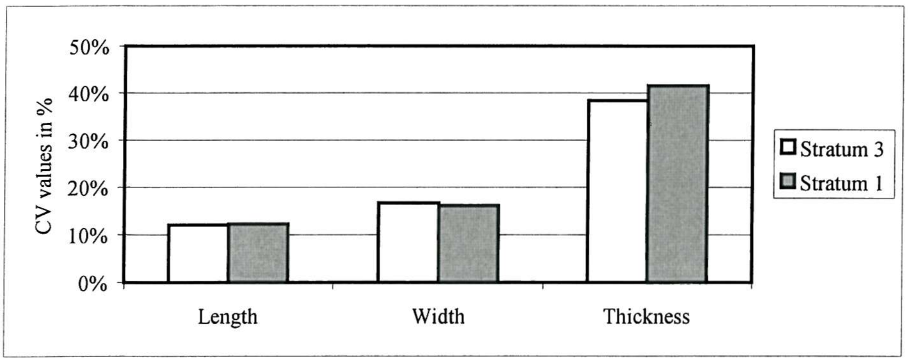
The results of the CV analysis for unretouched flakes and blades/bladelets are presented in table 6.14 and illustrated in figure 6.33a,b.

Table 6.14. CV values for debitage from strata 1 and 3.

	Flakes			**Blades/bladelets**		
	Length	**Width**	**Thickness**	**Length**	**Width**	**Thickness**
Stratum 1	14% (n=385)	13.9% (n=714)	44.9% (n=714)	12.2% (n=282)	16.1% (n=618)	41.5% (n=618)
Stratum 3	14.5% (n=194)	14.5% (n=401)	43.1% (n=401)	12% (n=125)	16.7% (n=282)	38.4% (n=282)



a.



b.

Figure 6.33. CV values for flakes (a) and blades/bladelets (b).

The CV values for unretouched flakes were very similar from both strata, although there appears to have been a slight increase in variance in thickness in the later stratum 1. However the *F* test identified no significant difference in variance between length, width or thickness and the two strata. Blades/bladelets were also very similar, with no significant difference in the CV values for length and width, but again with a slight increase in thickness in the later stratum 1. However, none of these differences were identified as significant by the *F* test. For a full listing of the *F* test results see table 3, Appendix III. The results of the analysis of standardisation through time for unretouched flakes and blades/bladelets identified no obvious and consistent changes.

Backed bladelets

Variance amongst backed bladelets was compared using CV values and the *F* test. This was the only tool class in which sample sizes were sufficiently large to attempt the analysis, the results of which are listed in table 6.15 and illustrated in figure 6.34.

Table 6.15. CV values for backed bladelets from strata 1 and 3.

	Length	Width	Thickness
Stratum 1	6.6% (n=40)	13.9% (n=119)	32.2% (n=119)
Stratum 3	7.1% (n=13)	15.9% (n=37)	34.7% (n=37)

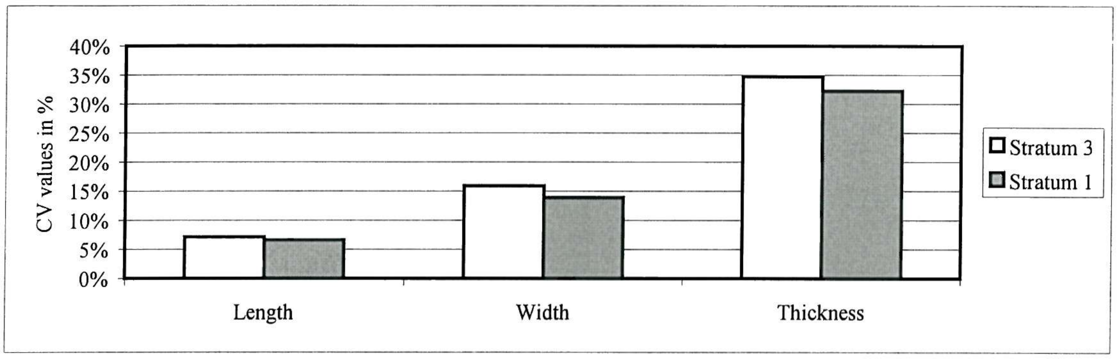


Figure 6.34. CV values for backed bladelets from strata 1 and 3.

Bearing in mind relatively small sample sizes, particularly in terms of length, the results of the CV analysis pointed towards a decline in CV values through time for all three dimensions from stratum 3 to 1. This suggests an increase in standardisation through time amongst backed bladelets; however, none of the differences were identified as significant by the *F* test (see Appendix III, table 3).

Chapter 7. Inter-site comparison of the lithic assemblages

7.1. Introduction

The aim of this chapter is to undertake a comparative analysis of the lithic collections from Klithi, Franchthi and Kastritsa, in order to highlight similarities and differences in the way that lithic production was carried out. To ensure that assemblages of sufficient size are compared, debitage and tools from the layers and horizons from each of the three sites were grouped together. The justification being primarily in order to generate reasonable sample sizes, although in some cases these remained small. The chapter consists of the following parts:

- In part one, comparative analysis of basic assemblage characteristics from the three sites is undertaken. These include overall proportions of raw materials, cores, secondary and inner debitage, and the proportions of the various tool types.
- In part two, the assemblages are compared metrically in order to identify any differences or similarities. The collections were compared graphically using frequency histograms and any differences observed were assessed using the Kolmogorov-Smirnov (KS) significance test. In addition, variance was compared between the three sites using the coefficient of variation (CV) and the F test.
- In part three, an additional method for assessing standardisation is introduced. Rather than size variability in the tools themselves, the method focuses in on the first stage of standardisation, blank selection. The approach was not attempted for the individual sites because most of the samples would have been too small when broken down into layers or horizons.

The chapter ends with a summary of the results.

7.2. Comparative analysis of assemblage characteristics

In this section a comparison is made between the basic assemblages at Klithi, Franchthi and Kastritsa, in order to investigate potential differences in the organisation of lithic production.

7.2.1. Basic assemblage structure

The structure of the three bulked assemblages is listed in table 7.1 and illustrated in figure 7.1, for information on methods of classification see chapter 3.

Table 7.1. Structure of the sampled assemblage from Klithi, Franchthi and Kastritsa.

Lithic category	Klithi	Franchthi	Kastritsa	Total
Unworked raw materials (pebbles, nodules, tablets)	6 (0.07%)	0	3 (0.1%)	9
Cores	106 (1.2%)	141 (3.6%)	102 (3.4%)	349
Debitage (flakes, blades, bladelets, atypical)	3140 (37.7%)	1372 (34.9%)	2017 (68.2%)	6529
Tools	990 (11.9%)	171 (4.3%)	317 (10.7%)	1478
Microburins	105 (1.2%)	17 (0.4%)	24 (0.8%)	146
Chips (≤1cm)	3824 (46.0%)	1660 (42.2%)	359 (12.1%)	5843
Debris (natural, knapped, burnt)	144 (1.7%)	569 (14.4%)	132 (4.4%)	845
Total	**8315 (54.7%)**	**3930 (25.9%)**	**2954 (19.4%)**	**15199**

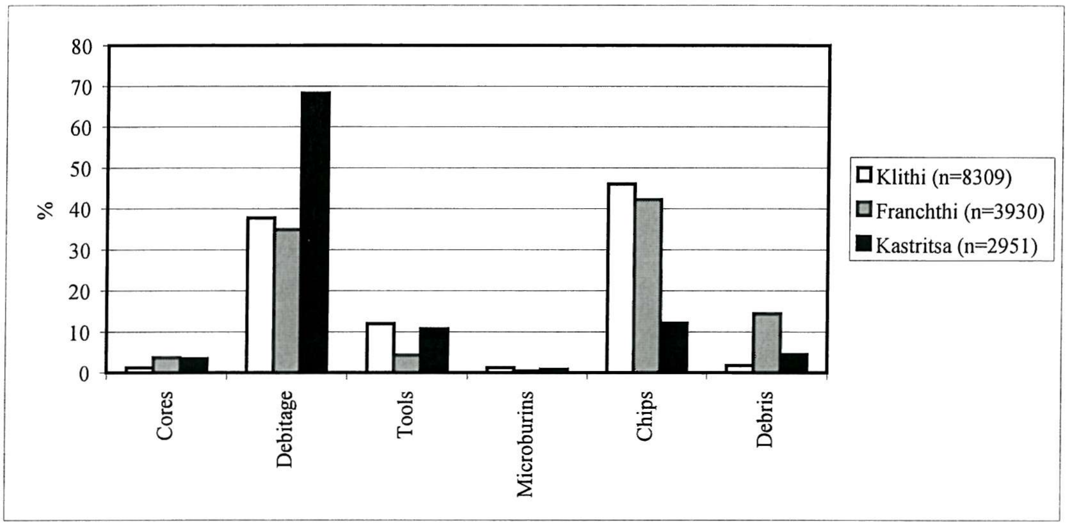


Figure 7.1. Basic structure of the bulked assemblages from Klithi, Franchthi and Kastritsa. Unworked raw materials were excluded due to small sample size.

Unretouched debitage, chips and debris were the most significant component of all three collections (fig.7.1). Klithi and Franchthi were broadly comparable in the proportions of both small and large unretouched material. However, significantly more debitage was present at Kastritsa, where it comprised almost 70% of the collection. Conversely, chips were far less common than at the other two sites, just 12% compared to 46% at Klithi and 42% at Franchthi. This significant difference in the proportions of chips is definitely not an artefact of the sampling strategy. At all three sites, the sediments were sieved in broadly the same way, for a background to this see Bailey 1997b:48; Perlès 1987:99-118; Bailey *et al.* 1983:29. Moreover, Adam (1997:488) obtained similarly low frequencies of chips in her study of strata 1 (13.9%) and 3 (9.7%) from rectangles 2, 4 and 5 at Kastritsa. Why then is there such a large difference in the proportions of chips at Kastritsa, compared to both Klithi and Franchthi?

On the face of it, this suggests that flint was being relatively less intensively worked at Kastritsa than either Klithi or Franchthi, so generating less small debitage. An alternative explanation may be that the raw materials used at Klithi and Franchthi were producing relatively more chips per unit worked than at Kastritsa. A third possible reason for the significant differences in the proportions of chips may relate to the intensity of site maintenance. Waste removed from living floors would tend to exaggerate the contribution of smaller pieces, as larger pieces are relatively more likely to be gathered. So if site maintenance was being carried out at Klithi and Franchthi but not at Kastritsa, then we would expect smaller proportions of large debris at the former two sites, as does appear to be the case. However, if we remove chips and debris and recalculate the proportions, it becomes clear that debitage at all three sites was in fact broadly comparable, with 72% at Klithi and roughly 80% at both Franchthi and Kastritsa. This suggests that site maintenance is not the answer, since, if it was, debitage proportions at the more extensively maintained sites would be lower, and clearly they were not. The most plausible explanation is that raw materials used at the three sites were affecting the generation of variable proportions of debitage fractions. Larger good quality nodules were being exploited at Kastritsa, while those from Klithi and Franchthi tended to be smaller and flawed. This resulted in assemblages at the latter two sites with significantly more chips, both around 50% of total recorded lithics, with only 16% at Kastritsa.

Cores, tools and technical pieces occurred at differing proportions at all three sites, although in all cases they comprised only a small part of each collection. Tools were poorly represented at Franchthi whereas they were more common at Klithi and Kastritsa, where they are almost equally as frequent. Cores were rare, particularly at Klithi, the significance of which will be discussed further in following sections.

7.2.2. Raw materials

The very small numbers of unworked raw materials at the three sites, just six small pebbles at Klithi and three at Kastritsa (tbl.7.1), suggest that nodules were rarely being carried into the sites, and then left unworked, whether lost or cached. Although no unworked material was found at Franchthi, a few primary flakes were recovered, suggesting at least some unworked or minimally worked material was introduced. The lack of unworked raw materials suggests that provisioning of sites (*sensu* Kuhn 1995) was rarely undertaken, and by implication that needs were most often met by the use of material carried into the site by individuals, in all probability as partially worked cores. However, the significant amounts of debitage, tool making and core maintenance debris indicate that the majority of stages of the chaîne opératoire were present at all three sites.

7.2.3. Cores

The total core sample consisted of 349 pieces of which 309 (88.5%) were complete and 40 (11.5%) fragmented or, in rare cases especially at Klithi, heavily burnt. Klithi contained significantly fewer cores as a proportion of the complete assemblage than either Franchthi or Kastritsa (fig.7.2).

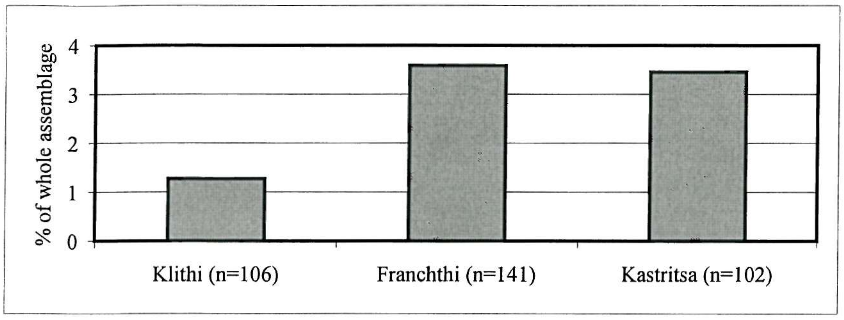


Figure 7.2. Cores expressed as a proportion of each assemblage total.

There are a number of possibilities as to why cores were relatively less common at Klithi. The first is that they were more extensively worked and therefore produced greater quantities of material per unit. Indeed, cores at Klithi tended to be shorter and had smaller platforms than the other two sites, although the impact of smaller raw materials to begin with may in fact account for this. But if cores were being worked further at Klithi, then we would expect to see enhanced levels of non-cortical material compared to the other two sites. The fact that we do not (see section 7.2.4 further below), suggests that more intensive working and the production of relatively larger volumes of material per core is not the answer. Alternative explanations may either be that cores were being introduced at an earlier stage at Klithi, so leaving relatively more waste per unit for a given level of core use than the other two sites. Alternatively, cores may simply have been carried away from Klithi more often than at either Franchthi or Kastritsa. Support for the first scenario can be found in the fact that raw materials would have been available for collection immediately below the site of Klithi. These would have produced more waste than partially prepared cores, particularly considering the rather poor quality of the Klithi material. Additionally, Klithi produced almost twice as much material with cortex than either Franchthi or Kastritsa, again suggesting that raw materials were being introduced in a relatively less worked state. It is therefore likely that the early stage working of nodules at Klithi accounts for the relatively lower core frequencies, simply as a result of the relatively greater quantities of waste being produced per unit. As to whether cores were being regularly carried away from Klithi in greater numbers than at either Franchthi or Kastritsa, only further research will tell. However, considering the poor quality of the raw materials, this is considered unlikely.

7.2.3.1. Core characteristics

Table 7.2 presents a complete breakdown of core characteristics. The numbers listed in each category may vary, the reason being that cores were selectively used to assess different variables on the basis of breakage patterns. So for instance a core missing part of its platform could still be used to measure overall length.

Table 7.2. Morphological characteristics of the core samples from Klithi, Franchthi and Kastritsa.

Characteristics	**Klithi (n=106)**	**Franchthi (n=141)**	**Kastritsa (n=102)**	**Total (n=349)**
Complete cores	89 (84.0%)	131 (92.3%)	81 (79.4%)	309 (88.5%)
Core fragments	17 (16.0%)	10 (7.1%)	21 (20.6%)	40 (11.5%)
Core type	**n=105**	**n=141**	**n=102**	**n=348**
Flake	88 (83.8%)	124 (87.9%)	73 (71.5%)	285 (81.9%)
Bladelet (blade)	17 (16.2%)	17 (12.0%)	29 (28.4%)	63 (18.1%)
Core shape	**n=104**	**n=138**	**n=102**	**n=344**
Amorphous	38 (36.5%)	31 (22.4%)	44 (43.1%)	113 (32.8%)
Cores on blanks	9 (8.6%)	28 (20.2%)	32 (31.3%)	69 (20.0%)
Conical/semi conical	38 (36.5%)	28 (20.2%)	20 (19.6%)	86 (25.0%)
Cuboid/tabular	6 (5.8%)	50 (36.2%)	4 (3.9%)	60 (17.4%)
Other (oval, sphere)	13 (12.5%)	1 (0.7%)	2 (1.9%)	16 (4.7%)
Number of platforms	**n=105**	**n=141**	**n=101**	**n=347**
One	40 (38%)	30 (21.2%)	14 (13.8%)	84 (24.2%)
Two	47 (44.7%)	80 (56.7%)	52 (51.4%)	179 (51.5%)
Three	14 (13.3%)	28 (19.8%)	31 (30.6%)	73 (21.0%)
Four	4 (3.8%)	3 (2.1%)	4 (4.0%)	11 (3.2%)
Direction of removal	**n=104**	**n=138**	**n=101**	**n=343**
Longitudinal	90 (86.5%)	89 (64.5%)	62 (61.3%)	241 (70.3%)
Multidirectional	14 (13.3%)	49 (35.5%)	39 (38.6%)	102 (29.7%)
Platform preparation	**n=104**	**n=138**	**n=100**	**n=342**
Absent	30 (28.8%)	100 (72.4%)	50 (50.0%)	180 (52.6%)
Trimming	64 (61.5%)	33 (23.9%)	18 (18.0%)	115 (33.6%)
Faceting	4 (3.8%)	5 (3.6%)	27 (27.0%)	36 (10.5%
Multi	6 (5.7%)	0	5 (5.0%)	11 (3.2%)
Cortex	**n=89**	**n=135**	**n=83**	**307**
0 %	15 (16.8%)	65 (47.4%)	34 (41.0%)	113 (36.8%)
0-50%	65 (73.0%)	67 (49.3%)	47 (56.6%)	178 (58.0%)
50-100%	9 (10.1%)	4 (2.9%)	2 (2.4%)	15 (4.9%)
Core abandonment reasons	**n=104**	**n=138**	**n=102**	**n=344**
Size	73 (70.2%)	100 (72.4%)	84 (82.3%)	257 (74.7%)
Raw material	22 (21.2%)	22 (15.9%)	3 (2.9%)	47 (13.7%)
Uncertain	9 (8.6%)	16 (11.5%)	15 (14.7%)	40 (11.6%)

Core type, flake versus bladelet/ blade

Flake cores were far more common than blade/bladelet types at all three sites (fig.7.3).

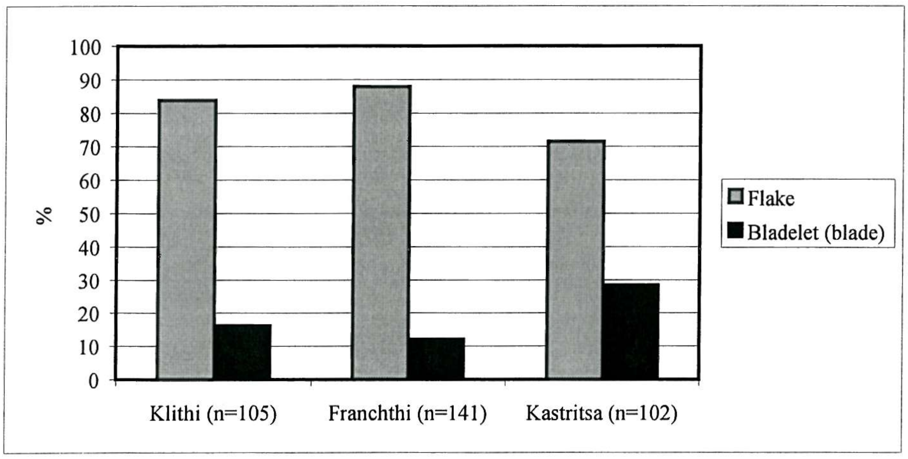


Figure 7.3. Proportions of flake and bladelet/blade cores.

This suggests either that flakes were the primary objective, or blade/bladelet cores were relatively more likely to be transported away from the sites as part of personal gear, and thus be underrepresented. Alternatively, flake cores may simply represent the final stages in the life of a blade/bladelet core. This is probably the most plausible explanation for the high flake core frequencies. As size declines and hinge and step fractures accumulate, the numbers of blades/bladelets reduces until the core can only be used to produce flakes. Blade/bladelet cores require the use of better quality and importantly larger raw materials. Those employed at Kastritsa were both, which goes some way towards explaining the higher proportions of bladelet/blade cores present at the site. Conversely, raw materials at Franchthi were the smallest and therefore least suitable, thus accounting for the lower overall proportions of blade/bladelet cores. It should be noted here that some discrepancies do exist between the frequencies of core types noted by other researchers, most notably Adam (1989), an issue that has been touched upon in the individual site chapters. For instance, in her study, blade/bladelet types accounted for almost 57% of cores from strata 1 and 3, in rectangles 2, 4 and 5 at Kastritsa (Adam 1989), while 6 (31.6%) out of 19 at Klithi were similarly classified (*ibid.*:239). The differences in proportions noted in Adam's work and my own probably relate to the way in which cores were classified. I erred on the cautious side when describing them, and only included those with complete laminar scars as blades/bladelets. I suspect that in her classification those with incomplete but probable laminar scars were included, thus accounting for the much higher proportions. Nonetheless, both approaches pointed to blade/bladelet cores at Kastritsa as being more common than at either Klithi or Franchthi.

Core shape

Considerable variability existed amongst core shapes from the three sites although all can be accounted for in terms of the manufacture of blades/bladelets and differences in the raw materials available. In figure 7.4, conical/semi-conical cores were combined with other (i.e. oval, sphere) as they were probably the same types of cores. Conical cores were most often geared towards the production of blades and bladelets and therefore their apparent predominance at Klithi suggests an emphasis on the production of these types of blanks. An additional reason may simply be that that the raw materials used at Klithi were best suited for use as conical cores. Conversely, cores on blanks were least common at Klithi, followed by Franchthi and then Kastritsa, where they comprised over 30% of the collection. Most of these were only very minimally worked, suggesting expedient and transient use. Their presence is probably more strongly linked with the form of raw material at Kastritsa, in particular where nodules were large enough to allow blanks of sufficient size to be produced. The presence of significant proportions of cuboid/tabular cores at Franchthi reflects the tabular nature of the raw materials available.

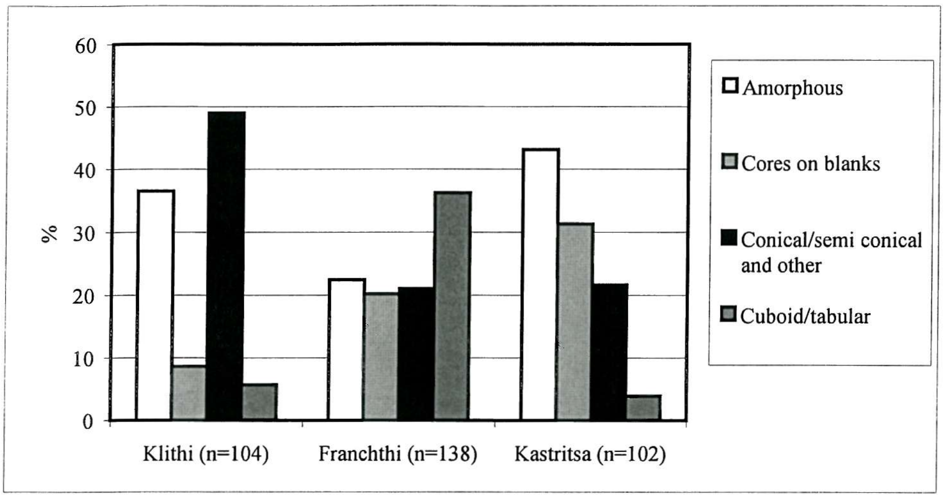


Figure 7.4. Core shapes.

The pattern suggested by core form is of blade/bladelet production at all three sites, but with relatively more emphasis at Klithi. However, actual blade/bladelet proportions at the three sites were broadly comparable. At Klithi and Kastritsa they comprised around 25% of all debitage, and 20% at Franchthi (see section 7.2.5 further below), suggesting no direct correlation between conical cores and enhanced levels of blade/bladelet production. It needs to be borne in mind that blades/bladelets can be produced by other core types as well, in particular cuboid/tabular and cores on blanks. Perhaps then the higher conical frequencies at Klithi simply reflect the guiding influence of raw materials on the final core shape. Smaller nodules would have limited the options available to the knapper, and in particular the number of platforms that could be brought into use. As seen in figure 7.5, Klithi produced almost twice as many single platform cores as Franchthi and almost three times as many as Kastritsa. Moreover, longitudinal flaking, commonly associated with single platform cores, was more common at Klithi (fig.7.6). Single platform cores used for blade/bladelet production usually become conical in shape simply as a result of working. This suggests that, despite similar blade/bladelet proportions at all three sites, the restrictions imposed by raw materials at Klithi in particular favoured the use of conical cores. Limitations in terms of size and internal flaws meant that, once exhausted with respect to the primary platform, the cores at Klithi were relatively less likely to be rejuvenated. Support for this is seen in the relatively lower frequency rejuvenation flakes and core tablets amongst technical pieces at Klithi (section 7.2.5, tbl.7.6).

Number of platforms and removal direction

The majority of cores at all three sites had at least two striking platforms (fig.7.5), although cores with only a single platform were almost as common at Klithi. They were least common at Kastritsa. As argued above in terms of core shape, this probably reflects the influence of nodule size on the way in which the core is worked. Small nodules reduce the number of platforms potentially usable, which in turn will affect the final shape of the discarded core. On the other hand larger nodules provide the scope for the use of more platforms, and in many cases represent the only way in which bigger cores can be maintained. Indeed, the highest proportion of cores with three or more platforms occurred at Kastritsa, and probably correlates with the predominance of less formal types, in particular amorphous and cores on blanks. Despite the use of multi-platform and less formally shaped cores at Kastritsa, similar proportions of blades/bladelets were being produced. This suggests that the use of larger raw materials at Kastritsa allowed greater diversity in core form and platform configuration, whilst at the same time still allowing the production of blades/bladelets. At Klithi however, the smaller and more fragmentary nature of the raw materials meant that multiple platform cores were significantly less common.

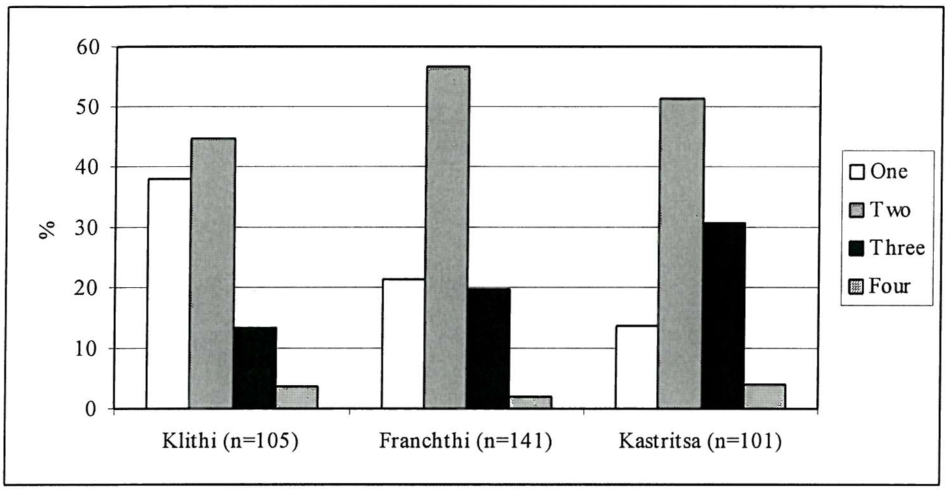


Figure 7.5. Number of striking platforms on cores.

Flaking at all sites was predominantly longitudinal, particularly at Klithi (fig.7.6), whereas at Franchthi and Kastritsa there was an increase in the proportions of multidirectional flaked cores. As mentioned above this probably reflects the relative predominance of single platform conical types at Klithi.

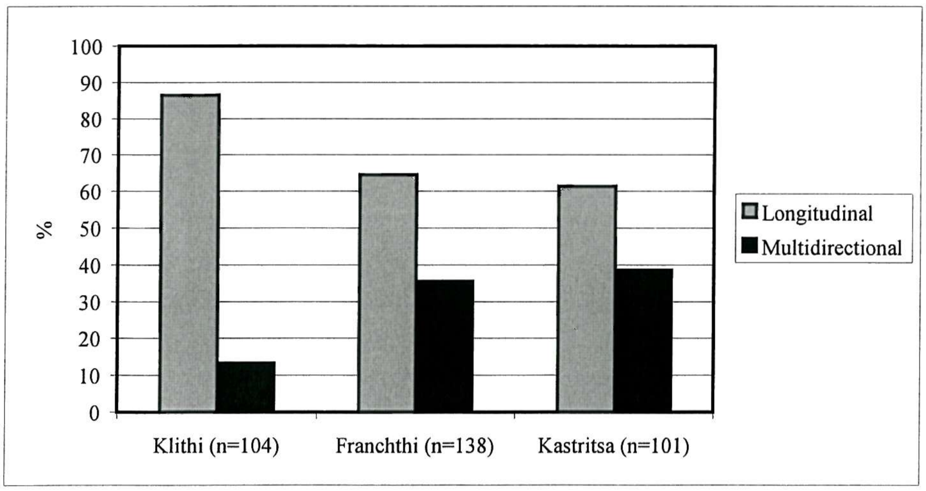


Figure 7.6. Direction of removals on cores.

Core shape, platform numbers and flaking direction all suggest that although blade/bladelet production was almost as common at all three sites, at Klithi more effort was needed to produce and maintain cores simply because of the limitations of the raw materials.

Platform preparation

Platform preparation varied considerably in both occurrence and type. Most cores at Franchthi and Kastritsa lacked any, while trimming was significantly more common at Klithi and facetting was more common at Kastritsa (see also Adam 1989:250). Trimming is most often used to remove overhangs and to shape the platform perimeter ready for the next removal. Its dominance at Klithi probably relates to the greater use of single platform conical blade/bladelet cores, and more investment in maintenance.

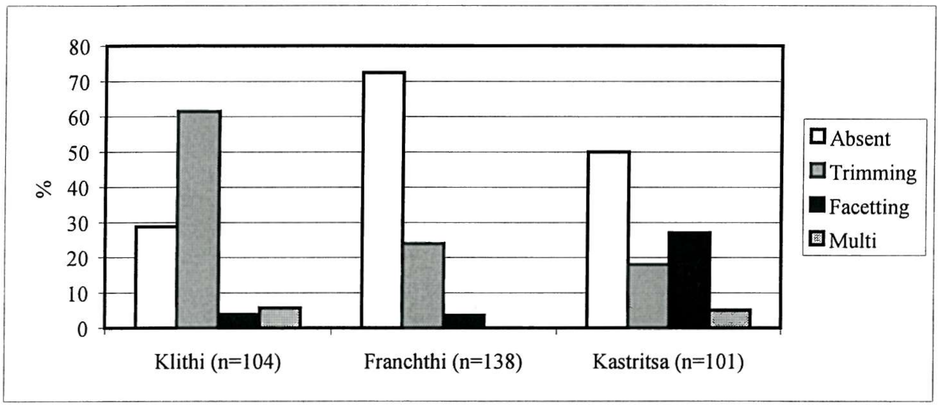


Figure 7.7. Platform preparation.

The relative lack of platform modification at Franchthi was at first puzzling, however as shown in figure 7.8, it probably relates to the large component of cuboid/tabular cores at the site. These appear to have been rarely trimmed, thus, accounting for the relatively high proportions of cores with no platform preparation.

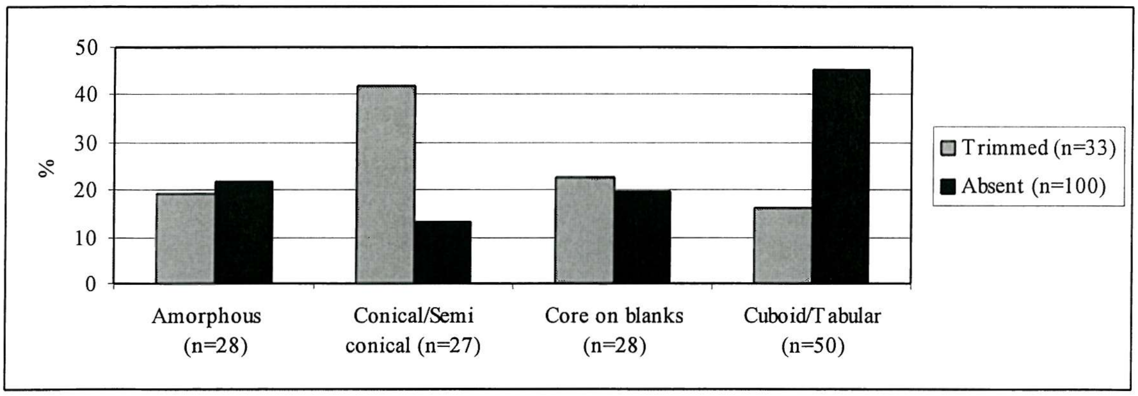


Figure 7.8. Platform preparation and core shape at Franchthi.

The higher frequencies of facetted cores at Kastritsa probably relate to the larger size of the raw materials being used, and the greater emphasis on longer blade removals. However, it is doubtful whether, with such small cores, facetting could provide any real advantages over simply utilising the existing flat platform. An alternative explanation may be that in the case of larger cores with more platforms, many of which would be adjacent, platforms would appear to have been deliberately facetted, when in fact they simply represent previous removals. Adjacent platforms were present on 29.3% (n=29) of cores at Kastritsa, but only on 18.1% (n=19) at Klithi, and this may explain the apparently higher frequencies of facetting observed at Kastritsa (18.8%, n=19), compared to Klithi (4%, n=4). However, Franchthi contradicts this interpretation, with 35.7% (n=50) of cores with adjacent platforms, but only 3.6% (n=5) cores facetted. One reason for this may be the relatively low levels of preparation overall at Franchthi, which as argued above is a result of the greater use of expedient cuboid/tabular cores. These are more likely to have multiple platforms than those made on rolled pebbles, simply as a result of their more angular flattened shape of the raw materials. An important proviso in all of this is the small sample sizes. With just four facetted cores at Klithi and five at Franchthi, any conclusions need to be seen as speculative at best.

Cortex

Cores were grouped on the basis of proportions of cortex, the three groups being 0%, those with less than 50%, and those with more than 50%.

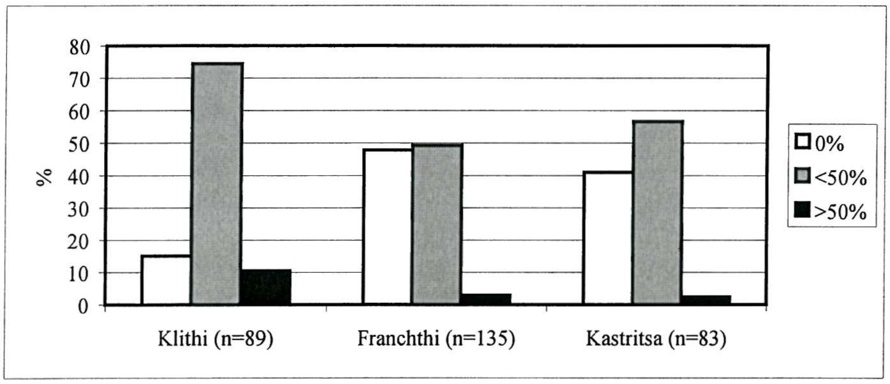


Figure 7.9. Estimate of cortex cover on cores.

Cores at Klithi were the most cortical out of the three sites, followed by Kastritsa and then Franchthi. Intuitively, this suggests more intensive working at Franchthi. However, it needs to be remembered that the raw materials used at Kastritsa were much larger than those available at either Klithi or Franchthi. Bigger cores allow more of the outer surface to be removed prior to them becoming too small to work. Conversely at Klithi, initially smaller nodules resulted in cores abandoned with relatively more cortex remaining. Because of the different starting configurations, the amount of cortex remaining is probably not a valid index of working intensity between the three sites.

Core use life and abandonment

Size was the major reason for abandonment within all three collections (fig.7.10), with cores worked until too small to be held. Within this category were also included those pieces abandoned because of the accumulation of hinge and step fractures, which were very much more common on smaller cores. These sorts of fracture become more frequent as the core declines in size, so becoming more difficult to grasp, while at the same time smaller mass results in less inertia on impact. As a result, the core twists each time it is struck, so further encouraging hinge and step terminations.

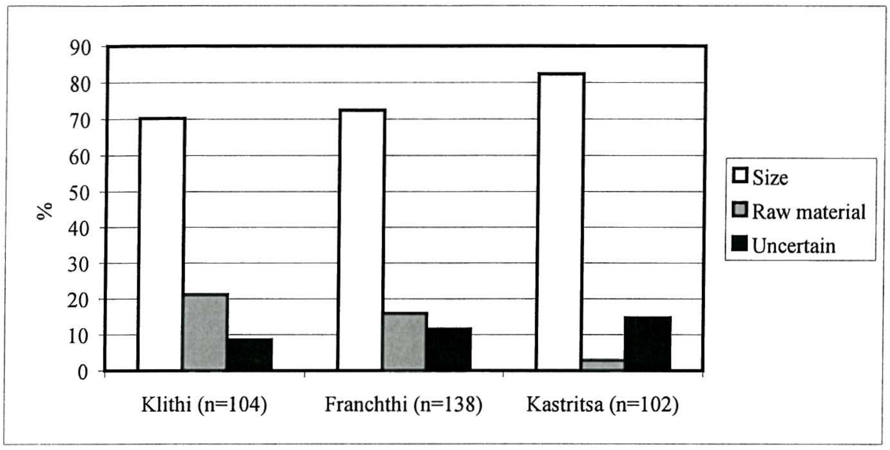


Figure 7.10. Reasons for core abandonment.

The poor quality of raw materials employed at Klithi and Franchthi was responsible for just over 20% and 15% respectively of core abandonment. Better quality raw materials at Kastritsa resulted in fewer cores abandoned, while at the same time perhaps accounting for the slightly greater proportions discarded for no apparent reason, whether cached, lost or simply not needed.

7.2.4. Primary, secondary and inner proportions

The presence of cortex is an indicator of the stage at which a blank was removed from the core, and gives an indication of the location of the piece on the chaîne opéretoire. The figures listed in table 7.3 and illustrated in figure 7.11 are for combined debitage and tools. Primary material was poorly represented, as expected, although their proportions are slightly higher at Klithi suggesting that at least some raw materials were being introduced as unworked pebbles. The higher proportions of secondary material at Klithi also supported this interpretation. Pebbles would have been available for collection within the Vikos gorge just below the site. Secondary material was significantly less common at both Franchthi and Kastritsa, suggesting that raw materials were entering the site in a more worked state.

Table 7.3. Primary, secondary and inner proportions amongst debitage >10mm and tools all sizes.

Debitage and tools	Klithi (n=4130)	Franchthi (n=1543)	Kastritsa (n=2334)	Total (n=8007)
Primary	83 (2.0%)	11 (0.7%)	13 (0.5%)	107 (1.3%)
Secondary	1789 (43.3%)	343 (22.2%)	532 (22.8%)	2673 (33.3%)
Inner	2258 (54.7%)	1189 (77.1%)	1789 (76.7%)	5236 (65.4%)

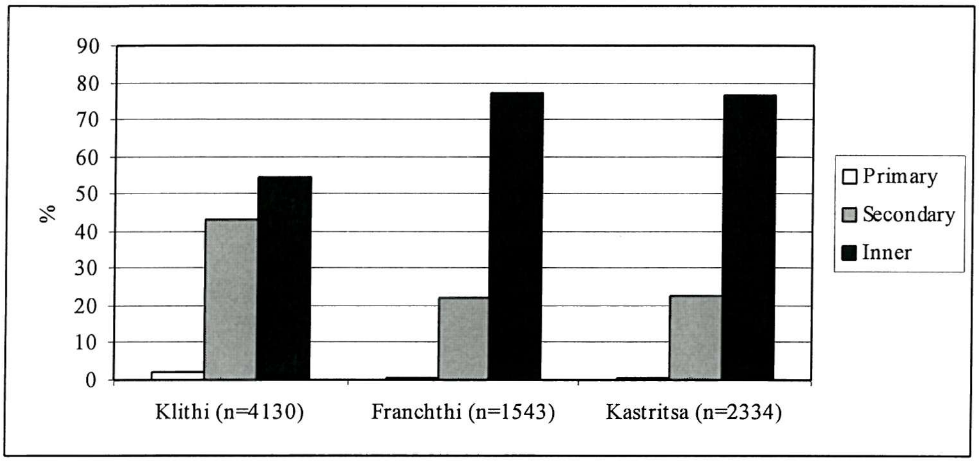


Figure 7.11. Primary, secondary and inner proportions of debitage >10mm and tools all sizes.

The proportions of primary, secondary and inner debitage found at the three sites compared well with the results obtained in a series of experimental assemblages in which pebble based narrow blade Mesolithic material was replicated (Marshall 1997). In these, it was found that, despite differences in original raw material size, broadly similar assemblages were generated. Primary flakes accounted for just 2% of debitage, secondary between 20% and 40% and inner between 60% and 80%. Both Franchthi and Kastritsa fell within these predictions with just over 20% secondary and almost 75% inner. They were at the extremes of the predictions though suggesting that raw materials were probably being introduced as pre-worked cores. Conversely, Klithi produced higher secondary proportions (43.3%) than predicted by the experimental assemblage, suggesting that raw materials were being introduced relatively more often than in the other two sites, either as unworked nodules or only very slightly worked cores. An additional explanation may be that inner material had been preferentially removed from the site. Indeed, refitting at Klithi has suggested that some material, predominantly tools, were removed (Wenban-Smith 1997). Interestingly, broadly similar proportions of secondary and inner debitage were noted for local and exotic flint at Klithi, the latter comprising approximately 30% secondary and 70% inner, both within the parameters predicted by the experimentally produced assemblages. This suggests that the non-local raw materials may not have been derived from any great distance, or alternatively that they were being differentially conserved. The first scenario is considered more likely for the moment, however more work needs to be done on sourcing of the materials used not only at Klithi but at Franchthi and Kastritsa as well.

Analysis of chips provided no new insights as to how raw materials were being introduced. In fact chips were present in similar proportions at all three sites (tbl.7.4 and fig.7.12). Initially it was expected that secondary and inner chips would show a similar pattern to that identified for larger debitage and tools, namely higher secondary proportions at Klithi, compared to both Franchthi and Kastritsa. That this was not the case meant that chips were a less useful index of the way in which raw materials were being introduced than was hoped. In retrospect however, this pattern should not have been totally unexpected. Chips tend to be associated with platform maintenance and failed removals, and therefore predominantly inner.

Table 7.4. Chips from the three collections.

	Klithi	Franchthi	Kastritsa
Secondary	103 (4.6%)	63 (3.9%)	5 (3.2%)
Inner	2143 (95.4%)	1562 (96.1%)	153 (96.8%)

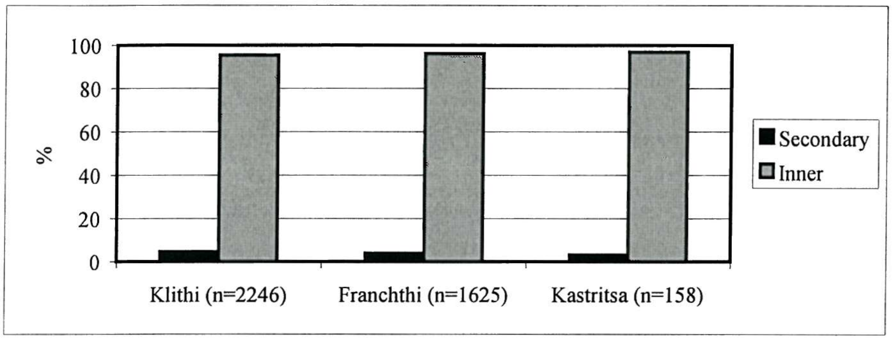


Figure 7.12. Proportions of secondary and inner chips (<10mm).

7.2.5 Flake, blade and bladelet proportions

The proportions of flakes, blades and bladelets in the three collections for both unretouched debitage and tools are listed in table 7.5 and illustrated in figures 7.13 and 7.14.

Table 7.5. Proportions of flakes, blades and bladelets amongst debitage and tools.

	Klithi (n=4130)	
	Debitage (n=3140)	**Tools (n=990)**
Flakes	2008 (63.9%)	356 (35.9%)
Blades	280 (8.9%)	129 (13.0%)
Bladelets	809 (25.7%)	492 (49.6%)
Atypical	43 (1.3%)	13 (1.3%)
	Franchthi (n=1543)	
	Debitage (n=1372)	**Tools (n=171)**
Flakes	1045 (76.2%)	56 (32.7%)
Blades	48 (3.4%)	3 (1.7%)
Bladelets	278 (20.2%)	109 (63.7%)
Atypical	1 (0.07%)	2 (1.2%)
	Kastritsa (n=2334)	
	Debitage (n=2017)	**Tools (n=317)**
Flakes	1115 (55.7%)	65 (20.5%)
Blades	363 (17.9%)	60 (18.9%)
Bladelets	537 (26.6%)	191 (60.2%)
Atypical	2 (0.09%)	1 (0.3%)

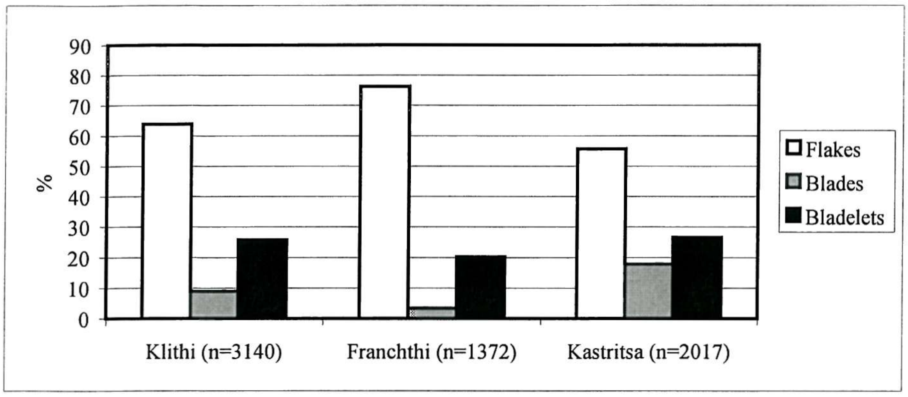


Figure 7.13. Proportions of unretouched flakes, blades and bladelets. Atypical pieces were omitted.

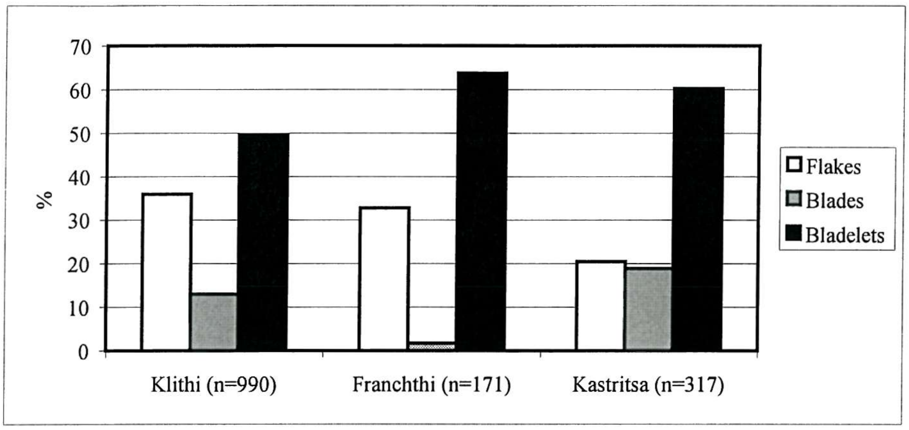


Figure 7.14. Proportions of tools made on flakes, blades and bladelets. Atypical pieces were omitted.

As expected, flakes dominated the debitage collection, whereas most tools were made on bladelets. Klithi and Kastritsa produced similar proportions of bladelets, although they were slightly less common at Franchthi. Significantly more blades were produced at Kastritsa, followed by Klithi and then Franchthi, consistent with the limitations imposed by the raw materials used at both the latter sites. In his series of experimental assemblages, Marshall (1997:131) noted a fairly consistent pattern in terms of the numbers of blades/bladelets and flakes produced despite original pebble size. Flakes comprised between about 80% and 95% of all debitage collections, compared to just 5% to 20% blades/bladelets. At the three sites however, blade/bladelet proportions deviated significantly from these expectations. At Klithi, they comprised 35% of unretouched debitage, almost 25% at Franchthi and 44% at Kastritsa. These figures are all the more significant if we consider that blades/bladelets are likely to have been selectively removed from the sites, so reducing their contribution still further. One explanation may be that raw materials were being introduced partially worked, presumably as cores. Earlier stage nodule and core preparation results in very many more flakes being produced, while the removal of this initial stage would result in relatively fewer flakes in the collections, and thus a corresponding predominance of blades. Some support for this interpretation is found at Franchthi and Kastritsa, where secondary debitage, most common at earlier stages in the knapping sequence, were less common than predicted by Marshall (1997). However the opposite was found at Klithi where secondary material was more common, perhaps again reflecting the smaller and more fragmentary nature of flint at Klithi. A less charitable explanation may simply be that the inhabitants of the three sites were better knappers.

Blades/bladelets provide a range of functional choices, which is why the majority of tools were made on these types of blank. Long and sharp, they can easily be transformed into tools while their narrow and relatively repetitive shape means that they are easily combined to form composite artefacts. The fact that relatively fewer tools were made on flakes at Kastritsa than at the other two sites probably reflects the presence of higher quantities of good quality blades/bladelets. Conversely at Klithi and Franchthi, the greater use of flakes for the manufacture of tools reflects the relatively lower blade/bladelet availability, again probably as a result of the limitations of smaller raw materials.

Technical pieces, an index of manufacturing and maintenance intensity

Technical pieces are the waste from the preparation, manufacture and maintenance of other objects or artefacts. Crested flakes or blades/bladelets are used in the early stages of core preparation to guide the first removal. They can also be used at later stages to correct mistakes and to bring new areas of the cores surface into production. Core rejuvenation blanks are usually removed in order to correct some problem with the core, most commonly platform, flaking surface angle, or the accumulation of hinge/step fractures. Similarly, core tablets are most often used to remove an unproductive platform, often as a result of crushing, unsuitable flaking surface angle, or the accumulation of hinge/step fractures.

Burin spalls are as the name suggest, the waste from burin manufacture, whereas microburins are in most cases the waste from backed artefact production, where they are most commonly used to remove the bulb from the proximal end of the blank. The proportions of technical pieces at the three sites are listed in table 7.6 and illustrated in figure 7.15.

Table 7.6. Technical pieces.

Types of technical pieces	**Klithi**	**Franchthi**	**Kastritsa**
Crested blanks	48 (18.7%)	6 (13.9%)	11 (8.1%)
Core rejuvenation blanks	9 (3.5%)	6 (20.9%)	30 (22.2%)
Core tablets	39 (15.2%)	13 (30.2%)	43 (31.8%
Burin spalls	55 (21.4%)	7 (16.3%)	27 (20.0%)
Microburins	105 (41.0%)	11 (25.6%)	24 (17.7%)
Total	**256**	**44**	**135**

The frequencies of technical pieces at the three sites suggested a number of differences in terms of both core use and artefact manufacture. At Klithi for instance, cresting was more common than at either Franchthi or Kastritsa. This probably reflects the irregular nature of nodules at Klithi, where setting up of the initial removal was much more of a challenge. Conversely, core maintenance debitage, in particular rejuvenation blanks and tablets were relatively rare at Klithi. Again this probably reflects the limitations imposed by small nodule size at Klithi, were cores were just too small to rejuvenate.

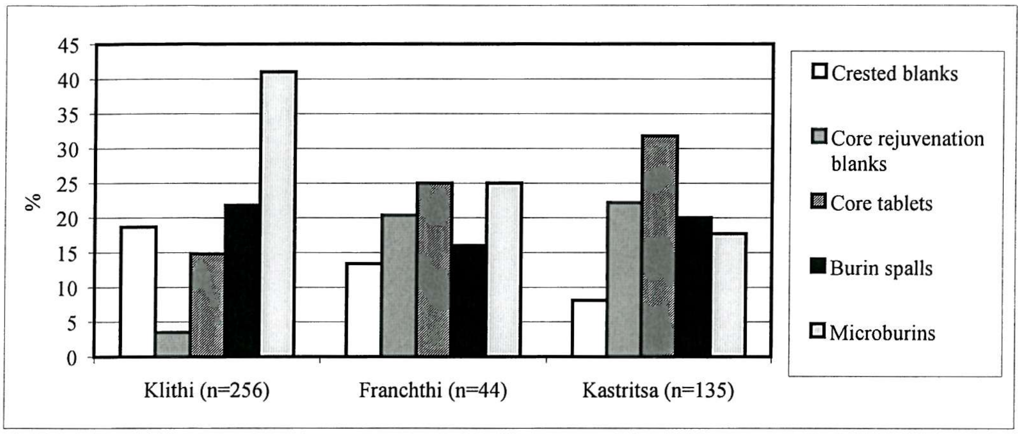


Figure 7.15. Technical pieces.

Conversely, at Franchthi and Kastritsa, cores were probably large enough to enable rejuvenation. In terms of artefact manufacture, burin spall frequencies were similar at all three sites, suggesting similar rates of manufacture. Microburins were much more common at Klithi and Kastritsa. Their low presence at Franchthi is due to the fact that the microburin technique was used only in phase IV but not in phases II and III (see section 5.4.1).

7.2.6 Tools

The tool inventories from Klithi, Franchthi and Kastritsa are listed in table 7.7 and illustrated in figure 7.16.

Table 7.7. The tool inventories.

Tool group	Klithi (n=990)	Franchthi (n=171)	Kastritsa (n=317)	Total (n=1478)
Artefacts with backed retouch	413 (41.7%)	132 (77.2%)	168 (53.0%)	713 (48.2%)
Shouldered bladelets	3 (0.3%)	0	2 (0.6%)	5 (0.3%)
Microgravettes	0	0	7 (2.2%)	7 (0.5%)
Artefacts with linear retouch	156 (15.7%)	6 (3.5%)	27 (8.5%)	189 (12.8%)
Aurignacian blades	0	0	1 (0.3%)	1 (0.06%)
Notches/Denticulates	125 (12.6%)	14 (8.1%)	20 (6.3%)	159 (10.7%)
Truncations	33 (3.33%)	3 (1.7%)	5 (1.5%)	41 (2.8%)
Borers	33 (3.33%)	0	10 (3.1%)	43 (3.0%)
Scrapers/Composite tools	97 (9.7%)	13 (7.6%)	45 (14.1%)	155 (10.5%)
Burins	115 (11.6%)	2 (1.1%)	30 (9.4%)	147 (9.9%)
Geometric microliths	3 (0.3%)	1 (1.1%)	0	4 (0.3%)
Miscellaneous/atypical	12 (1.2%)	0	2 (0.6%)	14 (0.9%)

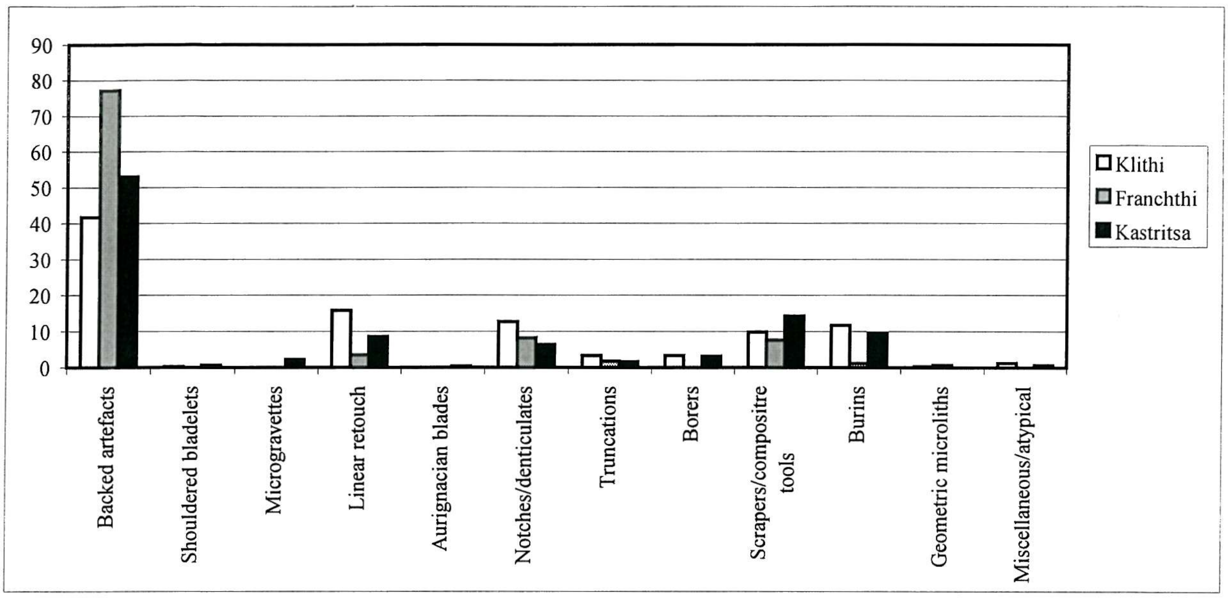


Figure 7.16. The tool inventories.

As can be seen, backed artefacts were the most common type of tool at all three sites (fig.7.16), although there was considerable variability in the proportions present. Significantly, Franchthi produced the highest frequency of backed pieces, followed by Kastritsa and then Klithi. Correspondingly however, Franchthi was poorly represented in other classes of artefacts. The predominance of backed artefacts has often been taken as an indicator of hunting (Perlès 1987; Straus 1987a). On this basis, the order of sites in terms of hunting intensity would be Franchthi, Kastritsa and lastly Klithi. In terms of tool diversity however, Klithi is followed by Kastritsa and then Franchthi. Moreover at Franchthi, tools comprised only 4% of total lithics (tbl. 7.1), compared to around 10% at both Klithi and Kastritsa.

The picture that emerges is of the three sites being used in different ways and with variable intensities. On the basis of backed pieces, Franchthi would appear to be the most extensively geared towards hunting, followed by Kastritsa and lastly Klithi. This was supported by the overall diversity of artefacts present; at Klithi it suggests that a wide range of activities were carried out, followed by Kastritsa and then Franchthi where diversity and absolute numbers of tools were low. Microscopic analysis of a small but diverse tool sample from Klithi demonstrated that they were being used for a range of activities, such as the processing and preparing of food, the cutting and shaping of wood, and cloth making (Moss 1997-204-5; see also chapter 4). The presence of antler and bone tools at Klithi and Kastritsa, including needles, awls, points and spatulae (Bailey *et al.*1983; Adam and Kotjabopoulou 1997) supports the interpretation of a range of activities being undertaken. These may have included hide processing, stitching, basket making or the weaving of grass mats (Owen 1999). Additional differences in the formal tool inventories include the presence of Microgravettes and Aurignacian blades at Kastritsa, albeit in very small numbers, but which were absent at Franchthi and Klithi. Microgravettes are usually considered as variants of backed points, whereas Aurignacian blades are a type of scraper. Conversely, Kastritsa lacked geometric microliths, which were present, albeit in very small numbers at both Klithi and Franchthi. On the basis of the largest of the formal groups, the backed pieces, it would appear that all three sites were part of a single Balkan technological tradition, characterised by the predominance of backed bladelets (Kozlowski 1999:319). However, some have suggested that the apparent differences in bone tools at Klithi and Kastritsa (Adam and Kotjabopoulou 1997:253-4) indicate that different groups might have occupied these two areas, despite being broadly contemporary and in relatively close proximity.

7.3. Inter-site metric comparison

7.3.1. Introduction

In this section, basic metric parameters are compared for cores, debitage and formal tools. The aim is to investigate any significant differences between the three sites in terms of the above categories. Unretouched debitage includes flakes, bladelets and blades; formal tools include backed bladelets, artefacts with linear retouch, notches/denticulates, scrapers and burins. The formal tool types were chosen on the basis of the presence of sufficiently large samples, although in some cases it will be noted that they are still unfortunately quite small. Each class of debitage and tool is compared between the three sites on the basis of length, width and thickness. It will be noted that in some cases the number of pieces used to generate the frequency distribution for one dimension may not be the same for another. This is because of differential breakage; so for instance a snapped bladelet can be used to measure width and thickness but not length. In this way it was possible to maximise data recovery even with fragmentary material. For a complete listing of maximum, minimum and mean dimensions, as well as mean, standard deviation and coefficient of variation values for the debitage and tools included in this analysis, see table 7.9. It needs to be remembered that an analysis of this type is of necessity going to be speculative. By bulking assemblages in order to generate reasonably sized collections, we are in effect conflating very long periods of time, some of which do not overlap. Moreover, the small assemblages that we are in the end confronted with will in many cases consist of only tens of pieces. With this in mind, what can we make of the data? The short answer is that it is the best we have and consequently the following comparisons need to be seen only as suggestive of differences within and between the sites.

7.3.2. Cores

The sample included in this analysis consisted of 301 cores, of which 210 were classified as amorphous in shape, and 91 as conical. The basic dimensions and numbers of pieces included in the study are listed in table 7.8. As will be noted, the numbers used in this analysis are slightly less than in part one of this chapter (section 7.2.3.1). In this section, those cores with any suggestion of breakage were excluded, so reducing the sample slightly.

Table 7.8. Mean (SD), maximum and minimum dimensions of cores.

Dimension	Klithi (n=89)		Franchthi (n=131)		Kastritsa (n=81)	
	Amorphous (n=44, 49.4%)	Conical (n=45, 50.6%)	Amorphous (n=104, 79.4%)	Conical (n=27, 20.6%)	Amorphous (n=62, 76.5%)	Conical (n=19, 23.5%)
Length (mm)						
Minimum	11.7	13.6	10.1	16.4	12.8	17.7
Maximum	65.5	60.8	48	50	100	51.6
Mean (SD)	33.9 (11.6)	32.1 (9.8)	26.1 (8.6)	28.9 (7.9)	38.6 (15.8)	36.3 (9)
Platform width (mm)						
Minimum	4.3	7	3.4	13.6	2.5	15.9
Maximum	38.4	45.6	64.2	52	62.3	43.3
Mean (SD)	20.9 (8.7)	21.8 (8.6)	24.4 (12.9)	30.1 (10.6)	28.9 (14.4)	24.6 (7.2)
Platform breadth (mm)						
Minimum	0.3	4.3	0.1	5	0.2	9.3
Maximum	27.7	27.4	57.1	46.4	45.8	31.1
Mean (SD)	9.1 (6.7)	12.3 (6.3)	15 (9.9)	22.2 (11.5)	15.8 (9.8)	17 (5.8)
Percentage of platform worked (%)						
Minimum	9.2	16.9	21	57	13	45.5
Maximum	100	100	100	100	100	100
Mean (SD)	66.8 (25.4)	67.8 (22.6)	87.6 (19.7)	94 (13)	78.4 (26.5)	84.2 (21.7)
Platform circumference (mm)						
Minimum	34.5	27	26.7	54	18.8	43.8
Maximum	138	152	225	155	165	121
Mean (SD)	73.2 (24.5)	70.7 (24.4)	79.7 (35.8)	89 (27.4)	82.1 (33.9)	73.6 (19.4)

The analysis is also slightly different in that, in addition to frequency histograms, scattergrams are also used to present the dimensional data. In order to assess the significance of any differences between the three sites, the Kolmogorov-Smirnov (KS) test for significance is used (alpha=0.05). In order to increase sample sizes, cores were collated on the basis of shape. Those previously defined as tabular, flake, cuboid, amorphous and others were grouped as amorphous, while the rest were defined as conical, including conical themselves as well as the small number of spherical cores. Grouping the assemblages in this way was considered justified on the basis of a formal (conical) versus informal (amorphous) classification of core shapes. Formal cores were more intensively planned and maintained, and were dominated by single platform blade/bladelet types. Amorphous cores appeared less well planned, were made on a wider and less formal variety of blank types. In addition they were more likely to have multiple platforms and varied considerably in shape.

However, despite being grouped as formal and informal, there was little significant difference noted in basic dimensions with cores collated from all three sites (fig.7.17). This suggests that despite their overall form and although classified as formal and informal, the limitations imposed by raw materials were similar, irrespective of type, and resulted in similar dimensional parameters.

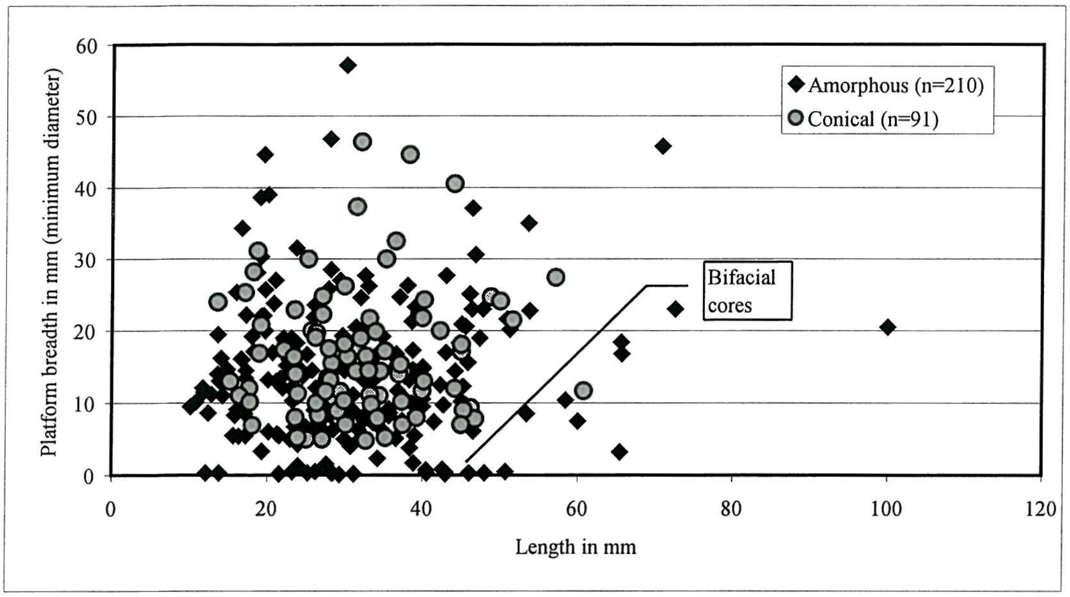


Figure 7.17. Length against platform breadth for all complete cores.

However, amongst the amorphous cores was an additional component of what are referred to here as bifacial cores, with platform breadths less than 2mm. These had been worked to an edge through alternate flaking along a ridge, so resulting in a platform with little or no breadth. They were most common at Klithi (n=8, 18.2%), and Kastritsa (n=9, 14.5%) and less at Franchthi (n=4, 3.9%).

Amorphous cores (n=210)

Amorphous cores tended to be longer at Kastritsa (fig.7.18), although a similar central tendency of between 30mm and 40mm was shared with Klithi. The latter contained an additional component of shorter cores not present at Kastritsa. Amorphous cores at Franchthi tended to be the shortest overall, with a central tendency of between 20mm and 30mm. According to the KS test, the amorphous core length frequency distributions between Klithi and Franchthi ($Dmax_{obs}=32.6>Dmax_{0.05}=24.5$), and Franchthi and Kastritsa ($Dmax_{obs}=43.8>Dmax_{0.05}=21.8$) were significantly different, but not Klithi and Kastritsa ($Dmax_{obs}=11<Dmax_{0.05}=26.8$).

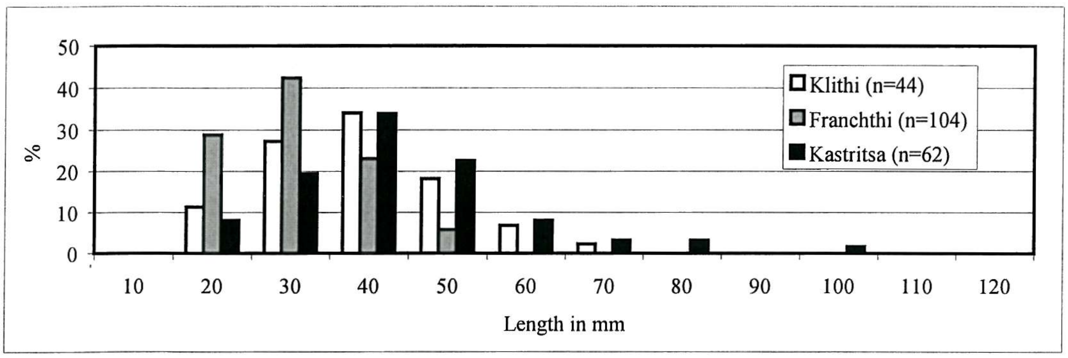


Figure 7.18. Length of amorphous cores.

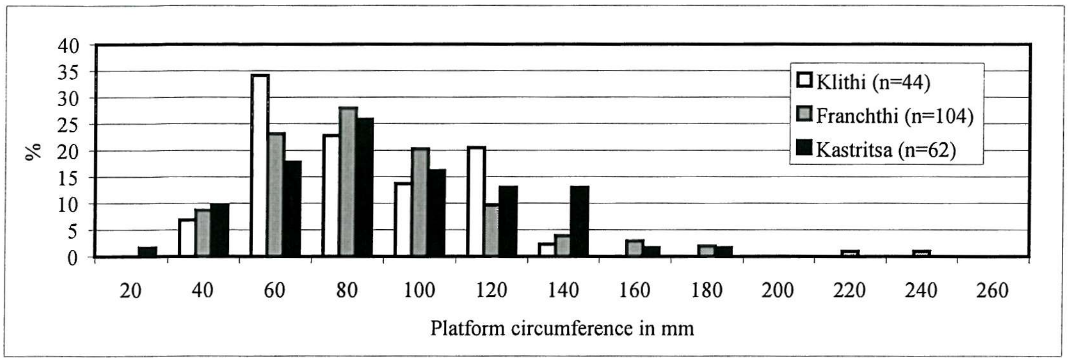


Figure 7.19. Platform circumference of amorphous cores.

Measured platform circumference was similar at Franchthi and Kastritsa, although Kastritsa produced a few slightly larger pieces. Klithi produced higher frequencies of smaller platform cores although with a possible bimodality, the second much smaller peak being at between 100mm and 120mm. Although less conclusive, a possible second peak was present at Kastritsa at between 100mm and 140mm. According to the KS test, the amorphous core platform circumference frequency distributions between Klithi and Franchthi ($Dmax_{obs}=7.9<Dmax_{0.05}=24.5$), Klithi and Kastritsa ($Dmax_{obs}=13.4<Dmax_{0.05}=26.8$) and Franchthi and Kastritsa ($Dmax_{obs}=8.8<Dmax_{0.05}=21.8$) were not significantly different.

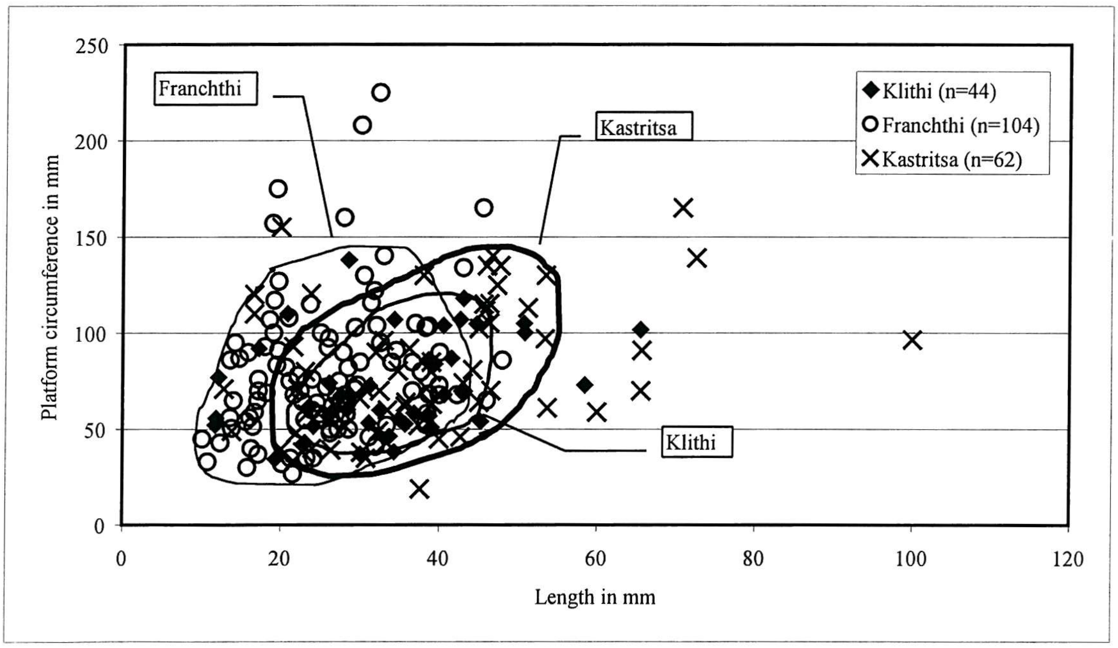


Figure 7.20. Length against platform circumference for amorphous cores.

The presence of longer pieces at Kastritsa compared to Franchthi can be seen in the scattergram, (fig.7.20) although both sites produced broadly comparable ranges of platform circumferences. Overall, Klithi produced amorphous cores with the shortest length and platform circumference of all the three sites.

Conical cores (n=91)

The longest conical cores came from Kastritsa, followed by Klithi and then Franchthi. The central tendency at Kastritsa was between 30mm and 40mm, whereas Franchthi and Klithi shared a similar central tendency of between 20mm and 30mm. According to the KS test, the conical core length frequency distributions between Klithi and Franchthi ($Dmax_{obs}=16.3<Dmax_{0.05}=33.1$), and Klithi and Kastritsa ($Dmax_{obs}=25.7<Dmax_{0.05}=37.2$) were not significantly different, but between Franchthi and Kastritsa ($Dmax_{obs}=42>Dmax_{0.05}=40.4$) it was.

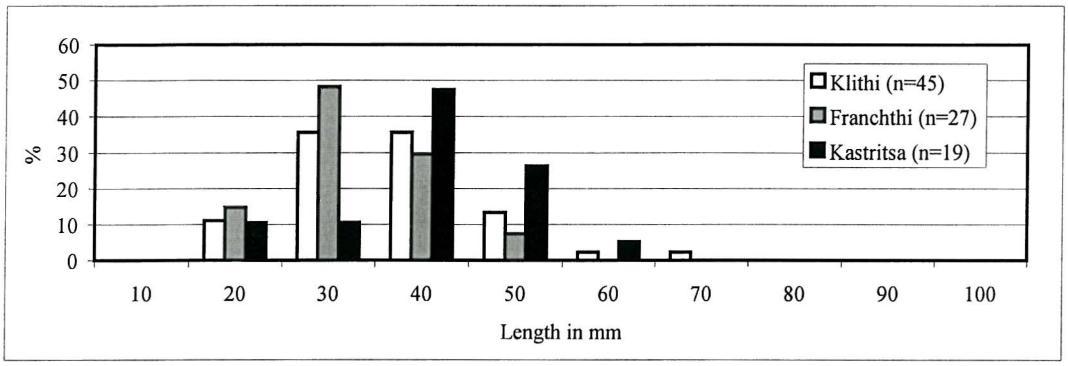


Figure 7.21. Length of conical cores.

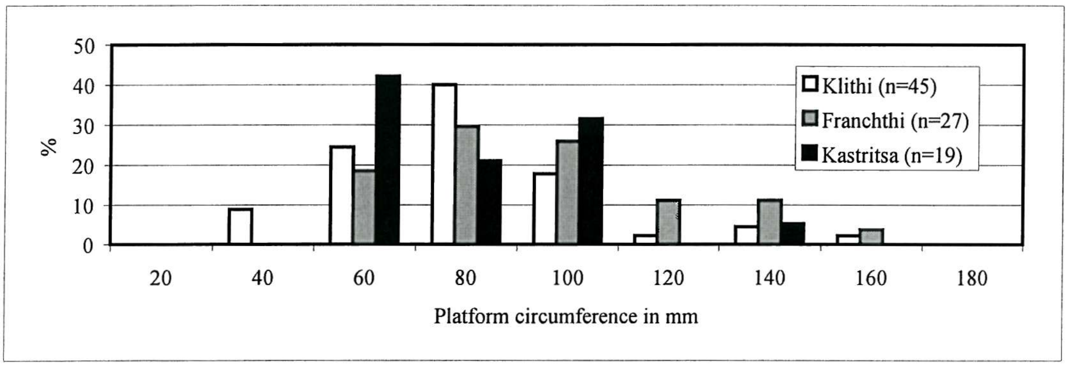


Figure 7.22. Platform circumference of conical cores.

The picture was less clear in terms of platform circumference, although Klithi and Franchthi shared a similar central tendency at between 60mm and 80mm. According to the KS test, the conical core platform circumference frequency distributions between Klithi and Franchthi ($Dmax_{obs}=25.1<Dmax_{0.05}=33.1$), Klithi and Kastritsa ($Dmax_{obs}=10.1<Dmax_{0.05}=37.2$) and Franchthi and Kastritsa ($Dmax_{obs}=23.6<Dmax_{0.05}=40.4$) were not significantly different.

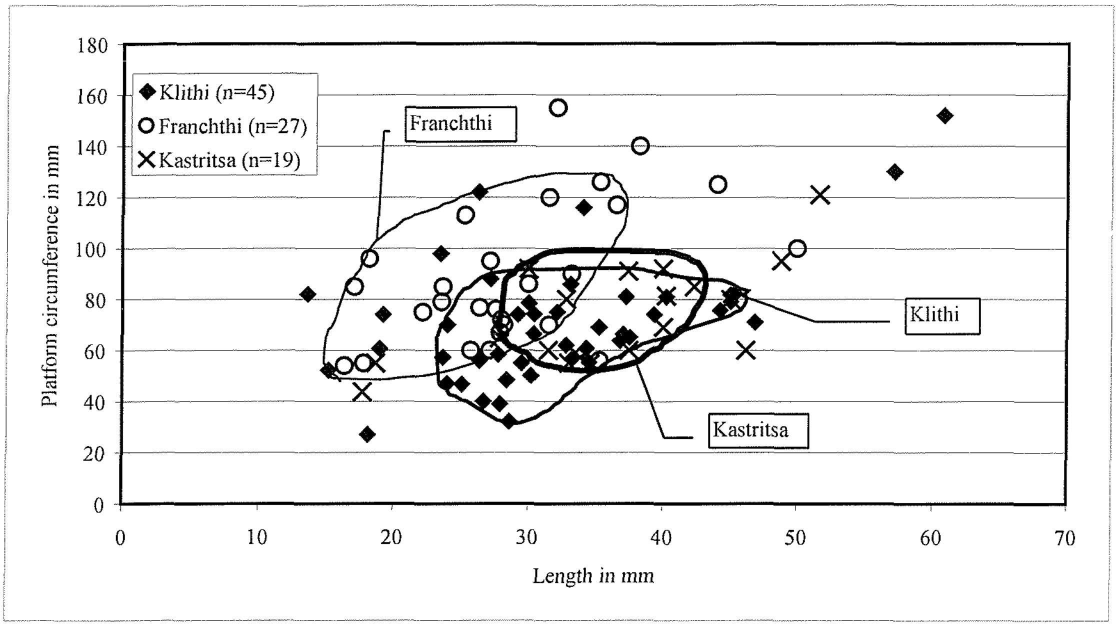


Figure 7.23. Length against platform circumference of conical cores.

The absence of shorter cores at Kastritsa can be seen in the above scattergram (fig.7.23), as can the presence of shorter cores at Franchthi. The presence of cores with smaller platform circumferences can be seen at Klithi, as can the few from Franchthi with much larger platforms. Note the similar upper limit for platform circumference at both Klithi and Kastritsa.

Platform working

Platform working, expressed as a percentage of total circumference, suggested broadly similar patterns of working between both amorphous and conical cores with a first apparent peak at around 70% (figs.7.24-5). The second peak for those worked all the way around the platform for both types of cores at Franchthi and Kastritsa was significantly large. Interestingly however, at Klithi the second peak was poorly represented. As a guide to intensity of core use, this would suggest that the highest intensity of platform working occurred at Franchthi and Kastritsa, with much less emphasis on the utilisation of the entire platform at Klithi. The KS test for amorphous cores indicated a significant difference in platform perimeter working between Klithi and Franchthi ($Dmax_{obs}=45.9>Dmax_{0.05}=24.5$) and Klithi and Kastritsa ($Dmax_{obs}=34.4>Dmax_{0.05}=26.8$), but not Franchthi and Kastritsa ($Dmax_{obs}=19.1<Dmax_{0.05}=21.8$). Similarly for conical cores a significant difference was indicated between Klithi and Franchthi ($Dmax_{obs}=61.5>Dmax_{0.05}=33.1$) and Klithi and Kastritsa ($Dmax_{obs}=43.2>Dmax_{0.05}=37.2$), but not Franchthi and Kastritsa ($Dmax_{obs}=22.6<Dmax_{0.05}=40.7$).

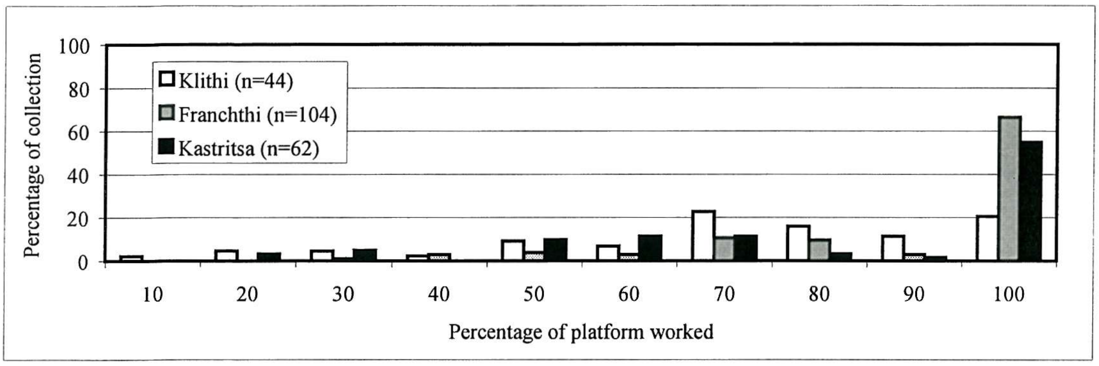


Figure 7.24. Percentage of platform perimeter worked of amorphous cores.

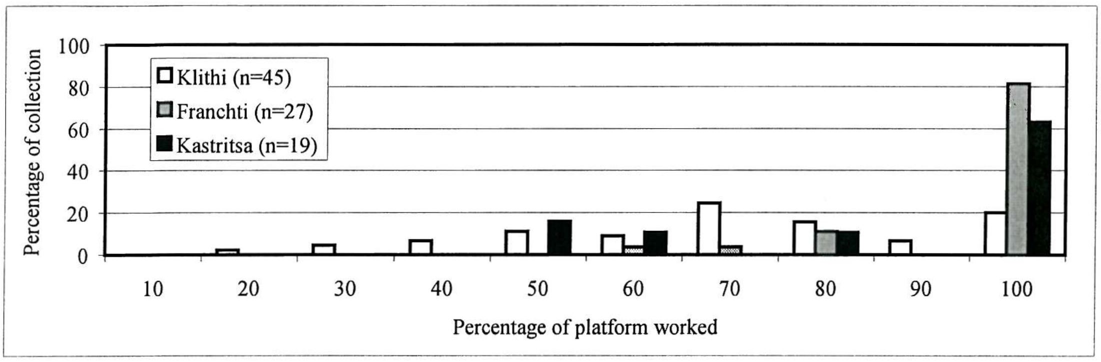


Figure 7.25. Percentage of platform perimeter worked of conical cores.

It should be remembered, however, that raw material configurations varied considerably from site to site. The patterns noted in terms of the proportion of the platform perimeter used can be attributed possibly to raw material limitations. At Franchthi for instance, tabular raw materials, although of restricted length, had larger platform diameters, so allowing the knapper to work more of the platform perimeter before the core became too small to hold. Similarly at Kastritsa, larger raw materials allowed for more of the platform to be utilised prior to the core becoming too small to grasp. At Klithi however, raw materials were much smaller, so that cores would have a much shorter life. Along with variable internal quality, the small size of available raw materials at Klithi would have significantly limited the extent to which whole platforms could be worked.

7.3.4 Debitage and tools

Table 7.9. Mean (SD), maximum and minimum dimensions of debitage and tools.

			Klithi	Franchthi	Kastritsa
Flakes	Length	Number	828	537	579
		Mean (SD)	19 (9.0)	17 (6.5)	22.8 (10.5)
		CV (log)	15.3%	13.1%	14.3%
		Maximum	86.3	44.0	62.8
		Minimum	0.9	4.0	6.1
	Width	Number	2008	1045	1115
		Mean (SD)	15 (6.1)	14.3 (5.6)	18.0 (7.6)
		CV (log)	14.3%	14.4%	14.1%
		Maximum	61.1	40.0	72.7
		Minimum	3.3	1.4	3.5
		Number	2008	1045	1115
		Mean (SD)	4.5	4.8	4.7

			Klithi	Franchthi	Kastritsa
Backed bladelets	Length	Number	45	36	53
		Mean (SD)	20.8 (7.4)	19.4 (6.0)	25.2 (5.4)
		CV (log)	11.8%	10.0%	6.7%
		Maximum	43.6	40.0	43.6
		Minimum	9.3	10.6	13.0
	Width	Number	338	102	156
		Mean (SD)	5.6 (2.0)	6.2 (3.0)	6.4 (1.7)
		CV (log)	21.3%	11.4%	14.4%
		Maximum	12	10.2	11.6
		Minimum	2.0	4.0	3.6
		Number	338	102	156
		Mean (SD)	2.4 (1.0)	3.7 (2.0)	2.6 (0.8)

	Thickness	CV (log)	42.9%	42.3%	44.3%
		Maximum	25.5	16.5	22.4
		Minimum	0.7	1.0	0.6

	Thickness	CV (log)	45.2%	42.4%	32.7%
		Maximum	6.6	4.7	5.2
		Minimum	0.9	1.1	1.2

			Klithi	Franchthi	Kastritsa
Bladelets	Length	Number	270	147	255
		Mean (SD)	20.6 (6.7)	17.3 (5.0)	25.1 (9.0)
		CV (log)	10.2%	9.5%	10.6%
		Maximum	47.6	33.8	79.0
		Minimum	10.1	10.5	11.7
	Width	Number	809	278	537
		Mean (SD)	8.0 (2.2)	6.8 (2.0)	8.7 (2.0)
		CV (log)	15.1%	14.9%	12.4%
		Maximum	12	12	12
		Minimum	2.1	2.3	2.1
	Thickness	Number	809	278	537
		Mean (SD)	3.3 (1.6)	3.1 (1.4)	3.4 (1.7)
		CV (log)	44.3%	44.4%	43.1%
		Maximum	12.4	9.1	12.2
		Minimum	0.7	1.0	0.7

			Klithi	Franchthi	Kastritsa
Backed blades	Length	Number	2	1	3
		Mean (SD)	32.8 (11.4)	-	48.3 (6.9)
		CV (log)	34.7%	-	14.8%
		Maximum	38.7	-	55.0
		Minimum	27.0	-	41.1
	Width	Number	10	1	11
		Mean (SD)	14.7 (2.6)	-	14.7 (2.8)
		CV (log)	6.5%	-	6.6%
		Maximum	19.0	-	21.3
		Minimum	12.2	-	12.2
	Thickness	Number	10	1	11
		Mean (SD)	4.2 (2.1)	-	4.5 (1.5)
		CV (log)	33.8%	-	24.4%
		Maximum	9.3	-	6.8
		Minimum	2.3	-	2.5

			Klithi	Franchthi	Kastritsa
Blades	Length	Number	80	26	152
		Mean (SD)	37.3 (8.1)	34.0 (6.7)	43.5 (7.6)
		CV (log)	6.3%	5.4%	7.5%
		Maximum	66.8	52.0	77.4
		Minimum	24.0	25.1	24.0
	Width	Number	280	48	363
		Mean (SD)	15.0 (2.5)	14.1 (2.0)	16.2 (3.7)
		CV (log)	5.7%	4.7%	7.5%
		Maximum	27.1	21.1	37.2
		Minimum	12.1	12.1	12.1
	Thickness	Number	280	48	363
		Mean (SD)	5.6 (2.7)	6.2 (2.0)	5.8 (3.0)
		CV (log)	29.1%	18.2%	28.2%
		Maximum	14.7	11.7	21.1
		Minimum	1.1	3.0	1.0

			Klithi	Franchthi	Kastritsa
Artefacts linear retouch	Length	Number	77	None found	12
		Mean (SD)	10.9 (21.0)	-	31.0 (17.7)
		CV (log)	17.7%	-	19.7%
		Maximum	63.8	-	71.4
		Minimum	3.2	-	3.8
	Width	Number	157	6	27
		Mean (SD)	12.6 (6.0)	9.2 (4.7)	17.8 (8.7)
		CV (log)	20.5%	21.6%	18.6%
		Maximum	42.1	17.7	36.4
		Minimum	2	5.4	.5.3
	Thickness	Number	157	6	27
		Mean (SD)	4.2 (2.3)	1.9 (0.8)	5.1 (2.9)
		CV (log)	42.6%	58.7%	36.0%
		Maximum	14.4	3.6	12.3
		Minimum	0.9	1.4	1.5

			Klithi	Franchthi	Kastritsa
Backed flakes	Length	Number	34	20	None found
		Mean (SD)	15.7 (5.5)	17.5 (7.4)	-
		CV (log)	13..3%	15.8%	-
		Maximum	26.6	30.8	-
		Minimum	7.0	7.7	-
	Width	Number	68	29	1
		Mean (SD)	12 (4.2)	11.7 (6.1)	-
		CV (log)	13.8%	18.4%	-
		Maximum	30.5	34.6	-
		Minimum	5.1	5.6	-
	Thickness	Number	68	29	1
		Mean (SD)	3.1 (1.3)	3.7 (2.0)	-
		CV (log)	41.3%	42.1%	-
		Maximum	6.7	9.5	-
		Minimum	0.7	1.1	-

			Klithi	Franchthi	Kastritsa
Informal tools	Length	Number	243	10	67
		Mean (SD)	27.8 (10.9)	29.0(12.8)	41.4 (18.0)
		CV (log)	13.9%	12.9%	13.3%
		Maximum	61.3	60	92
		Minimum	5.3	13.8	6.8
	Width	Number	402	32	110
		Mean (SD)	15.7(6.1)	17.0 (8.1)	17.8 (8.1)
		CV (log)	14.9%	12.8%	15.1%
		Maximum	45	27.7	42.3
		Minimum	4	8.3	7.2
	Thickness	Number	402	32	110
		Mean (SD)	5.2 (2.7)	7.2 (3.7)	6.4 (4.0)
		CV (log)	33.7%	31.7%	32.5%
		Maximum	16.1	16.1	22.4
		Minimum	1.8	1.8	1.6

Unretouched flakes

Flakes at Klithi were similar to those from Franchthi in terms of length, although all three sites had a similar central tendency of between 12mm and 16mm (fig.7.26).

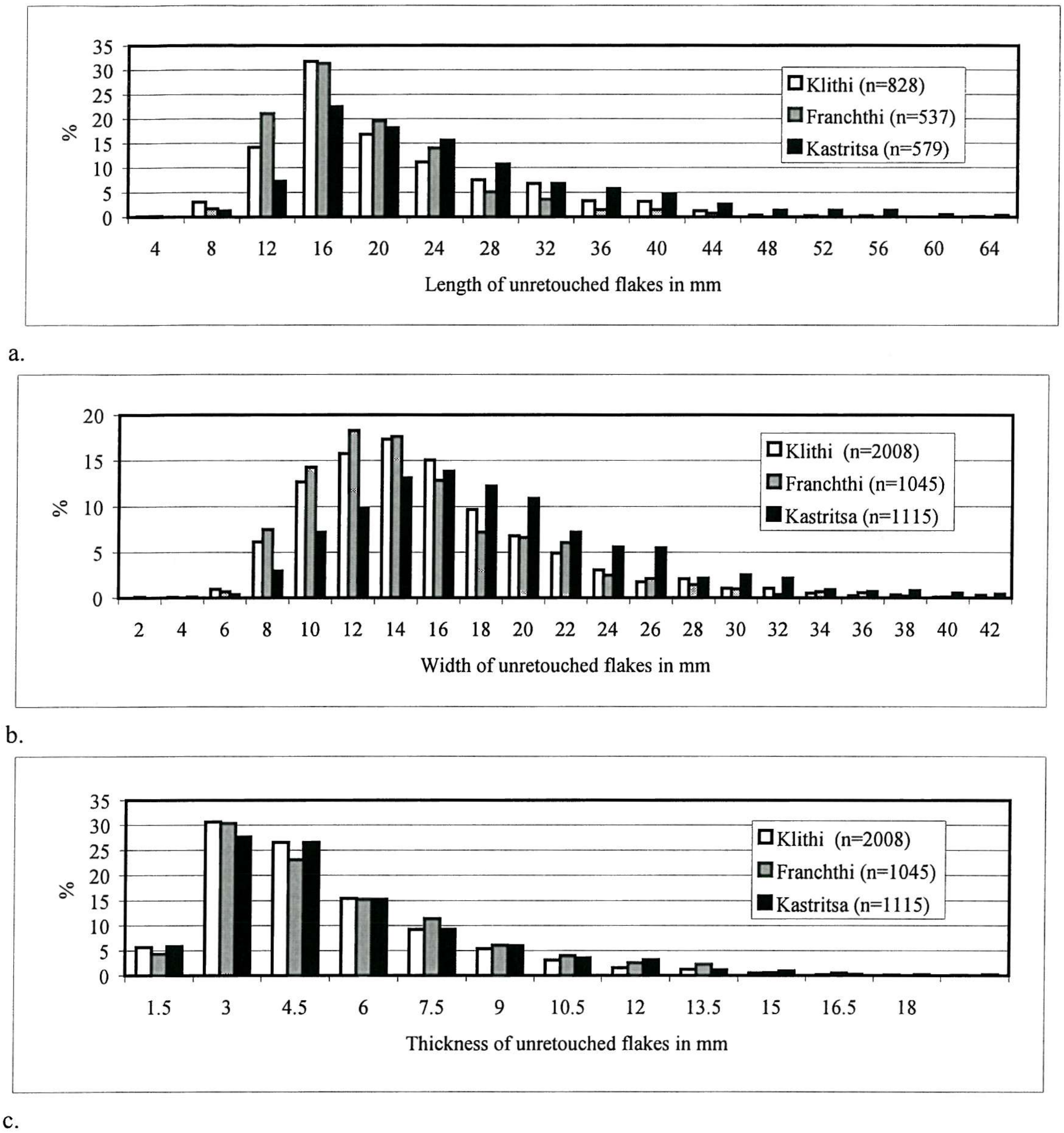


Figure 7.26. Length (a), width (b) and thickness (c) of unretouched flakes.

There was a small component of longer pieces at Kastritsa, and to some extent at Klithi as well, but which were absent at Franchthi, particularly those over 24mm in length. The KS test indicated a significant difference in unretouched flake length between Klithi and Franchthi ($Dmax_{obs}$=10.8>$Dmax_{0.05}$=7.5), Klithi and Kastritsa ($Dmax_{obs}$=16.8>$Dmax_{0.05}$=7.4) and Franchthi and Kastritsa ($Dmax_{obs}$=24.7>$Dmax_{0.05}$=8.2). In order to measure the degree of variability, in other words the deviation from the mean, the coefficient of variation (CV) was applied. All three sites were very similar in terms of variability around the mean for flake length, although Franchthi appeared slightly less variable, with a CV of 13.1%, followed by Kastritsa (14.3%) and then Klithi (15.3%). The *F* test (α =0.05) identified Klithi and Franchthi, and Franchthi and Kastritsa as significantly different, but only marginally (see tbl.1, Appendix for a complete listing of *F* test results). It should be remembered that when working with very large samples, even very small differences in CV values will be identified as significant according to the *F* test.

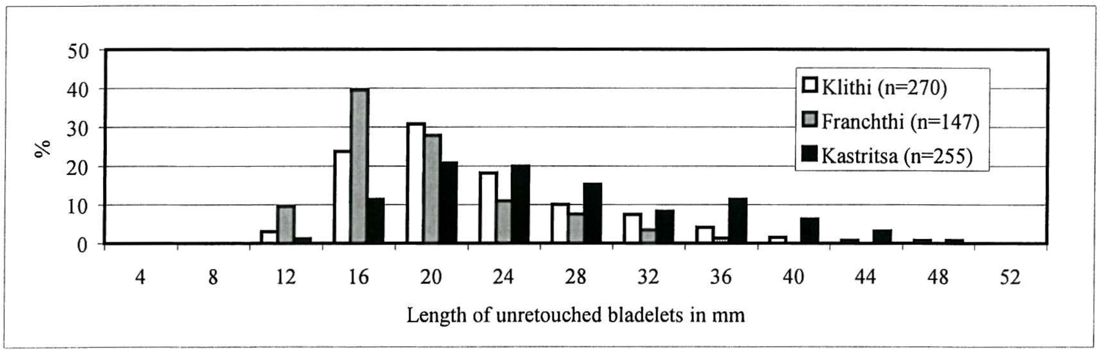
As regards flake widths, similar frequency profiles were present at Klithi and Franchthi, with wider pieces relatively more common at Kastritsa. Despite this, the KS test indicated a significant difference in unretouched flake width between Klithi and Franchthi ($Dmax_{obs}=5.4>Dmax_{0.05}=5.2$), Klithi and Kastritsa ($Dmax_{obs}=20.6>Dmax_{0.05}=5.1$) and Franchthi and Kastritsa ($Dmax_{obs}=23.9>Dmax_{0.05}=5.9$). As with length, all three sites had similar variance around the mean with Kastritsa (14.1%), followed by Klithi (14.3%) and then Franchthi (14.4%). Despite the significant degree of similarity in CV values from all three collections, the *F* test identified Klithi and Kastritsa, and Franchthi and Kastritsa as significantly different, although again by only the smallest of margins.

Flake thickness, showed again a significant degree of similarity between all three sites, even at Kastritsa, which as we have seen, tended to be both longer and wider. The KS test indicated a significant difference in unretouched flake thickness between Klithi and Franchthi ($Dmax_{obs}=5.3>Dmax_{0.05}=5.2$), but not Klithi and Kastritsa ($Dmax_{obs}=3<Dmax_{0.05}=5.1$) or Franchthi and Kastritsa ($Dmax_{obs}=2.3<Dmax_{0.05}=5.9$). Variance was also broadly comparable, with a CV value at Franchthi of 42.3%, followed by Klithi (42.9%) and then Kastritsa (44.3%). The *F* test identified only Klithi and Kastritsa as significantly different.

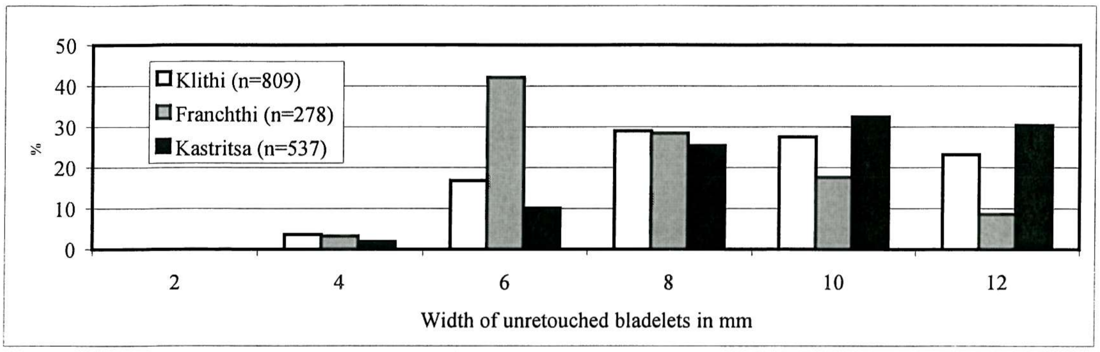
On balance, Klithi and Franchthi appeared most similar in terms of length and width while Kastritsa produced both longer and wider flakes. However there was very little difference in the thickness of flakes being produced. Variances, as an indicator of the degree of dispersal amongst the three dimensions, were broadly similar at all three sites, although there was a slight suggestion that flakes at Franchthi were less variable than at Klithi and Kastritsa. However, this was by no means convincing and it would probably be safer to say that there was no observable difference in variance amongst flake dimensions at the three sites.

Unretouched bladelets

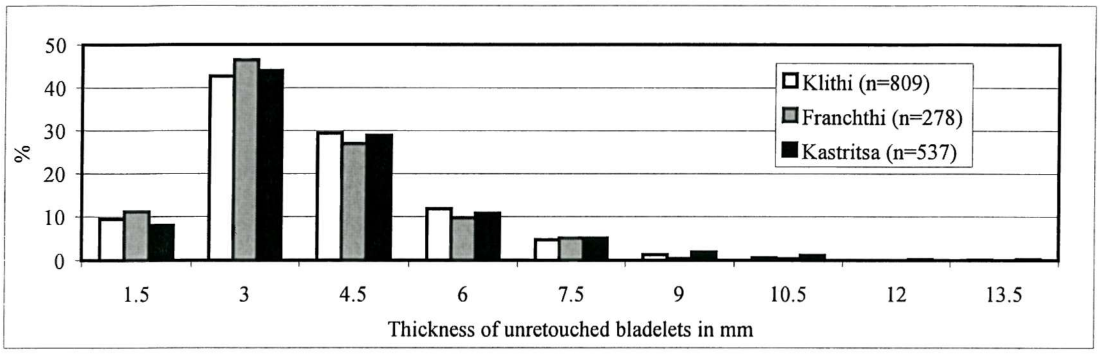
Both Klithi and Kastritsa shared a similar central tendency of between 16mm and 20mm for bladelet length, while Franchthi produced many shorter pieces, with a central tendency of between 12mm and 16mm.



a.



b.



c.

Figure 7.27. Length (a), width (b) and thickness (c) of unretouched bladelets.

The pattern was of shorter bladelets at Franchthi, followed by Klithi and then Kastritsa. The KS test indicated a significant difference in unretouched bladelet length between Klithi and Franchthi ($Dmax_{obs}=19.5>Dmax_{0.05}=13.9$) Klithi and Kastritsa ($Dmax_{obs}=22.5>Dmax_{0.05}=11.9$) and Franchthi and Kastritsa ($Dmax_{obs}=43.7>Dmax_{0.05}=14.1$). In terms of variance, all sites produced similar CV results with 9.5% at Franchthi, followed by Klithi (10.2%) and then Kastritsa (10.6%). The *F* test suggested that Franchthi was significantly different to both Klithi and Kastritsa.

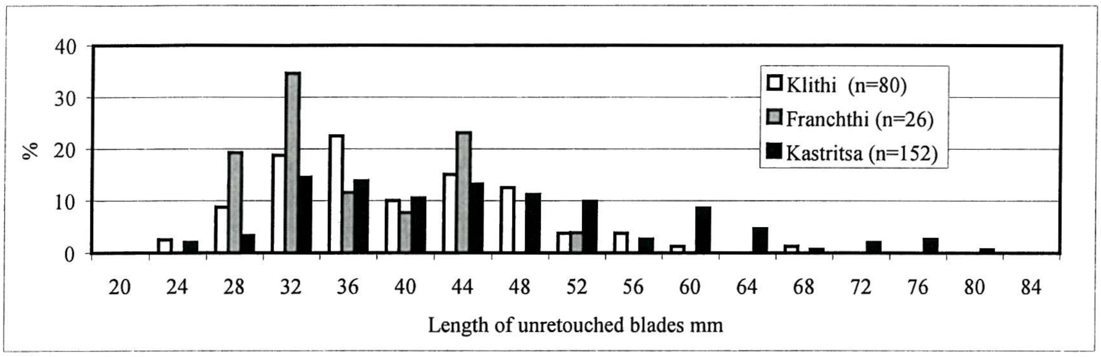
Franchthi produced the narrowest bladelets overall followed by Klithi and then Kastritsa. All three had different central tendencies, Franchthi from 4mm to 6mm, Klithi from 6mm to 8mm and Kastritsa from 8mm to 10mm. As with length, the KS test indicated a significant difference in unretouched bladelet width between Klithi and Franchthi ($Dmax_{obs}=24.3>Dmax_{0.05}=9.5$), Klithi and Kastritsa ($Dmax_{obs}=12.2>Dmax_{0.05}=7.6$) and Franchthi and Kastritsa ($Dmax_{obs}=36.5>Dmax_{0.05}=10$). All three sites produced bladelets of similar variance, with CV values of 12.4% for Kastritsa, followed by Franchthi (14.9%) and then Klithi (15.1%). The *F* test indicated that Kastritsa was significantly different to both Klithi and Franchthi.

All three sites produced bladelets of similar thickness, with a central tendency of between 1.5mm and 3mm. However, unlike length and width, the KS test indicated no significant difference between Klithi and Franchthi ($Dmax_{obs}=3.7<Dmax_{0.05}=9.5$), Klithi and Kastritsa ($Dmax_{obs}=0.7<Dmax_{0.05}=7.6$) or Franchthi and Kastritsa ($Dmax_{obs}=3.7<Dmax_{0.05}=10$). All produced similar variances, with CV values of 43.1% for Kastritsa, followed by Klithi (44.3%) and then Franchthi (44.4%), while the *F*

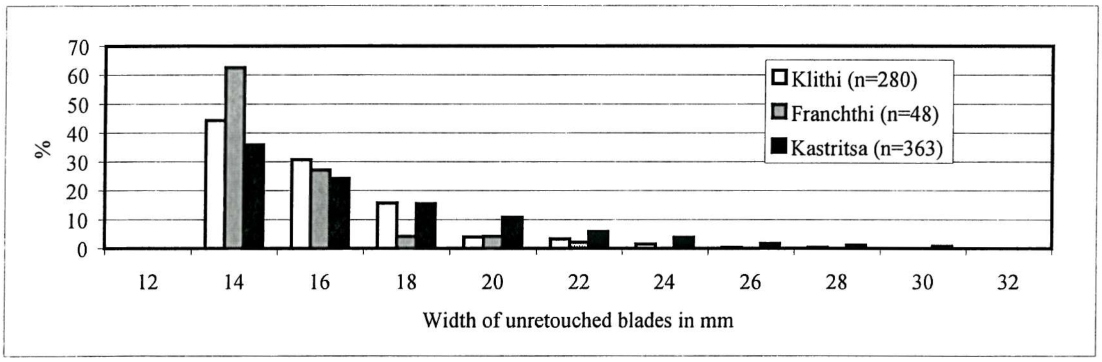
test identified no significant difference between any of the three sites in terms of variance of bladelet thickness.

Overall, it would appear that bladelets were shorter and narrower at Franchthi, followed by Klithi and then Kastritsa, and that these differences were significant at the 0.05 level. In terms of thickness, none of the three sites were significantly different at the 0.05 level. Kastritsa displayed the least width variance and was identified as significantly different to both Franchthi and Klithi. There was no apparent difference in thickness variance at all three sites.

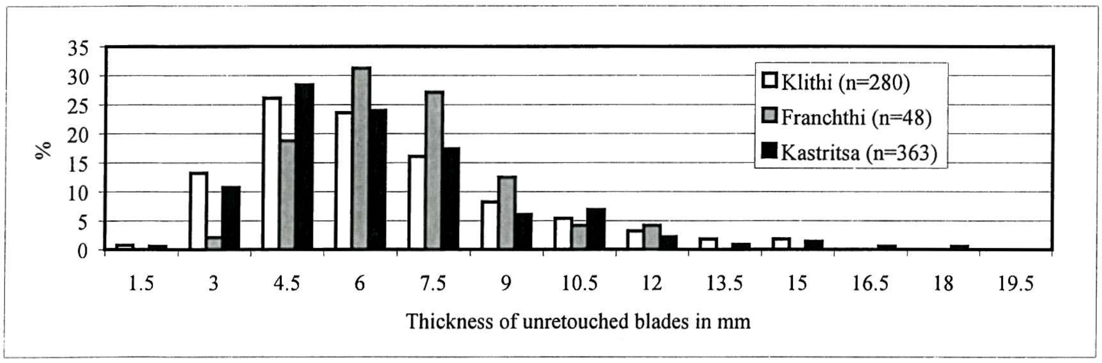
Unretouched blades



a.



b.



c.

Figure 7.28. Length (a), width (b) and thickness (c) of unretouched blades.

Unretouched blades showed some interesting patterns not identified amongst flakes and bladelets, which were probably related to the unsuitability of raw materials at both Klithi and Franchthi for blade production. The potential presence of non-local and as yet undifferentiated raw materials needs to be borne in mind. The length frequency histogram suggested a possible bimodality centring on 28mm to 32mm and then 40mm to 44mm. Despite some variability between the three sites, all appear to show a similar pattern. It appeared to be particularly pronounced at Klithi and Franchthi in both of which sites, raw materials would impose a limitation to blade production. Unfortunately the relative use of non-local raw materials at both sites remains as yet unknown, as do their sources, however it may be possible to speculate that the second peak relates to imported raw material use. Overall, the shortest blades were produced at Franchthi, followed by Klithi and then Kastritsa. The KS test indicated a significant difference in unretouched blade length between Klithi and Kastritsa ($Dmax_{obs}=21.6>Dmax_{0.05}=18.8$) and Franchthi and Kastritsa ($Dmax_{obs}=39>Dmax_{0.05}=28.9$), but not between Klithi and Franchthi ($Dmax_{obs}=23.8<Dmax_{0.05}=30.7$). The CV identified Franchthi (5.4%) as having the least length variance, followed by Klithi (6.3%) and then Kastritsa (7.5%), although the smaller blade sample at Franchthi needs to be borne in mind. The *F* test indicated that Kastritsa was significantly different to both Klithi and Franchthi in terms of variance. In other words blade lengths were most variable at Kastritsa, followed by Klithi and then Franchthi.

The three sites were quite different in terms of blade width, although all had a similar central tendency of between 12mm and 14mm. However, 12mm width represents the lower cut-off for blades. Franchthi produced the narrowest blades, followed by Klithi and then Kastritsa. The KS test indicated a significant difference in unretouched blade width between Klithi and Kastritsa ($Dmax_{obs}=15.2>Dmax_{0.05}=10.8$) and Franchthi and Kastritsa ($Dmax_{obs}=29.6>Dmax_{0.05}=20.9$), but not Klithi and Franchthi ($Dmax_{obs}=18.2<Dmax_{0.05}=21.3$). The CV values identified Franchthi (4.7%) with the least variance, followed by Klithi (5.7%) and then Kastritsa (7.5%). The *F* test indicated that these differences were all significant.

There was a strong similarity as regards blade thickness at Klithi and Kastritsa. Moreover and contrary to both length and width, Franchthi produced a significant component of thicker blades. However, the KS test indicated no significant difference in unretouched blade thickness between Klithi and Franchthi ($Dmax_{obs}=18.9<Dmax_{0.05}=21.3$), Klithi and Kastritsa ($Dmax_{obs}=2.6< Dmax_{0.05}=10.8$) or Franchthi and Kastritsa ($Dmax_{obs}=18.8<Dmax_{0.05}=20.9$). The similarity between Klithi and Kastritsa continued in terms of variance with CV values for Franchthi of 18.2%, followed by Kastritsa (28.2%) and then Klithi (29.1%). The *F* test indicated only Franchthi as being significantly different to both Klithi and Kastritsa.

Overall the shortest and narrowest blades were produced at Franchthi followed by Klithi and then Kastritsa, consistent with the limitations imposed by raw materials. A possible bimodality in length may suggest the use of larger non-local raw materials in small quantities at Franchthi and Klithi. Franchthi consistently produced the lowest variance, followed by Klithi and then Kastritsa.

Backed flakes

Compared to the debitage samples, retouched tools were very few in number, and therefore the results of the various analyses need to be considered with caution.

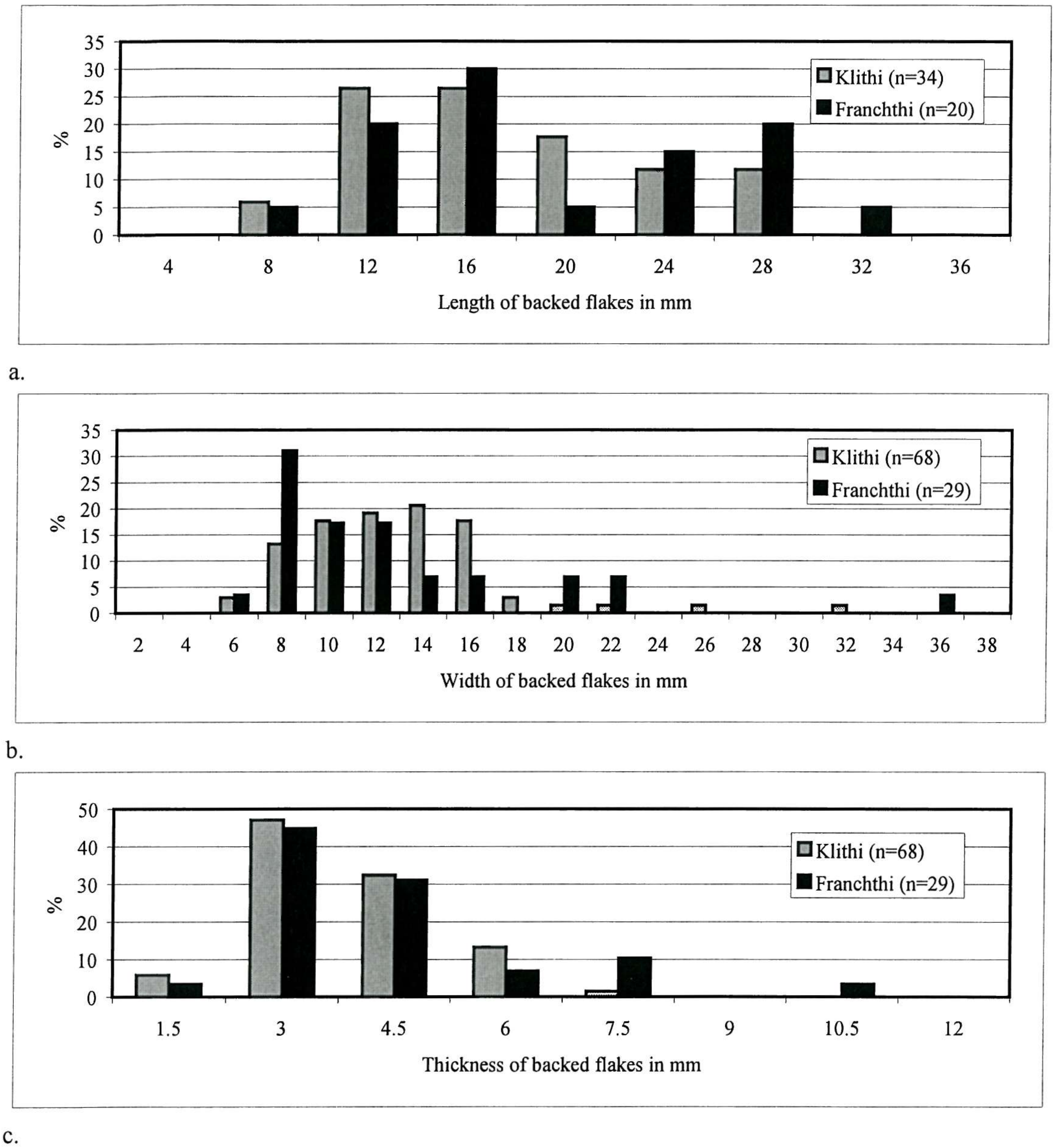


Figure 7.29. Length (a), width (b) and thickness (c) of backed flakes.

In the case of backed flakes, Kastritsa produced less than 5 pieces and was therefore excluded. Although Klithi and Franchthi shared a similar central tendency of between 12mm and 16mm, an additional component of shorter pieces was present at Klithi. However the KS test pointed to no significant difference in backed flake length between Klithi and Franchthi ($Dmax_{obs}=16.5<Dmax_{0.05}=38.3$). The apparent bimodality at Franchthi in particular, and possibly at Klithi as well, suggests the presence of a small number of larger backed flakes. The CV values suggested Klithi as having a slightly lower variance, 13.3% as compared to 15.8% at Franchthi. However the *F* test indicated no significant difference in variance for the two collections in terms of length.

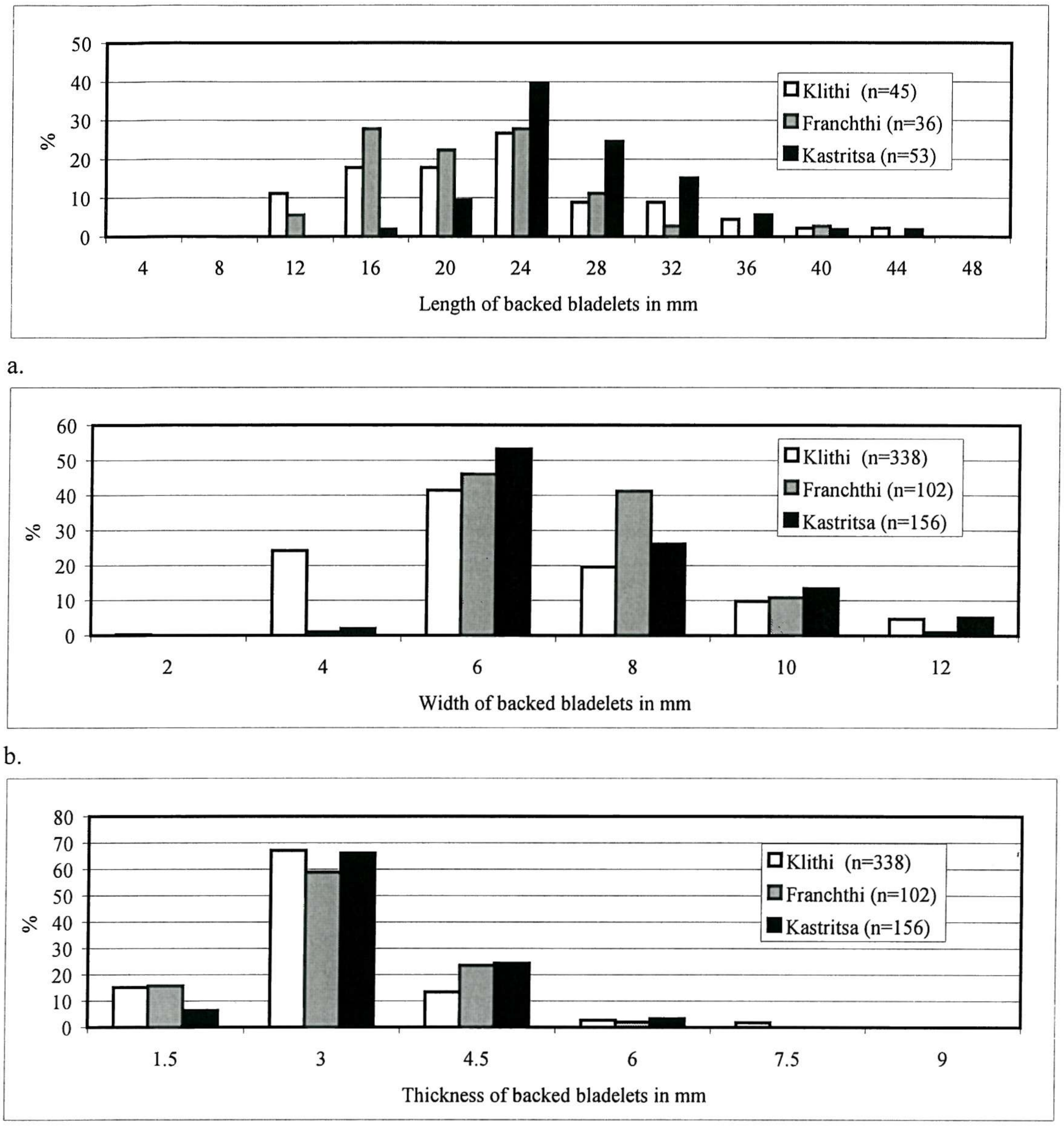
The width analysis benefited from larger sample sizes, with Franchthi producing more narrower backed flakes, and at Klithi in particular greater proportions of wider pieces. The central tendencies differed as well, with Klithi from 12mm to 14mm, and Franchthi much narrower at between 6mm and 8mm. Both collections appear to document quite rapid declines in wider tool proportions. In particular, backed flakes over 16mm appear to decline sharply at Klithi, while correspondingly those wider than 12mm at Franchthi decline significantly. This may suggest an upper useful width limit for backed flakes of around 16mm. Despite the differences observed, the KS test indicated no significant difference in backed flake width between Klithi and Franchthi ($Dmax_{obs}=18.3<Dmax_{0.05}=30.2$). The CV values suggest that Klithi had a lower variance (13.8%) compared to 18.4% at Franchthi. Moreover, the *F* test identified that this was a significant difference in variance between the two sites.

Although the distributions were very similar, Klithi produced slightly thinner backed flakes. However the central tendencies were the same at both sites, between 1.5mm and 3mm, the KS test indicated no significant difference ($Dmax_{obs}=12.3<Dmax_{0.05}=30.2$). The CV values pointed to Klithi (41.3%) as having slightly lower variance than Franchthi (42.1%), although the *F* test identified no significant difference between their variance.

Overall, Klithi appears to have produced shorter but also slightly wider and thinner backed flakes than Franchthi. A bimodality in length and width at Franchthi in particular but also possibly at Klithi may suggest an additional component of larger pieces, perhaps used as hand held artefacts. Most of the shorter pieces would have been impossible to grasp, suggesting that they were used in similar ways to backed bladelets, perhaps as hafted composites. The decline in pieces wider than 16mm may suggest an upper usefulness cut-off, while blanks thinner than 1.5mm appear to have been similarly ignored. The significant drop in proportions of pieces less than 1.5mm in thickness is a reoccurring pattern in both the debitage and tool assemblages. In terms of the debitage assemblages, it probably relates to the criteria used to eliminate smaller pieces from the analysis. Removing those less than 10mm has the effect of also eliminating much of the material less than 1.5mm in thickness. In terms of tools the same applies. However unlike debitage, tools less than 10mm were included in the analysis, so, the fact that not many were found suggests that thinner blanks may have been deliberately ignored. Variance as measured by CV for length, width and thickness was consistently lower at Klithi, however the *F* test identified only width variance as significantly different between the two sites.

Backed bladelets

Backed bladelets were similar in terms of length at Klithi and Franchthi, while those from Kastritsa tended to be longer. All three had the same central tendency of between 20mm and 24mm, although with a possible bimodality at Franchthi with pieces of between 12mm and 16mm. However, the effect of small sample size needs to be kept in mind with Franchthi in particular.



c.
Figure 7.30. Length (a), width (b) and thickness (c) of backed bladelets.

The KS test indicated a significant difference in backed bladelet length between Klithi and Kastritsa ($Dmax_{obs}=35.4>Dmax_{0.05}=27.6$) and Franchthi and Kastritsa ($Dmax_{obs}=44.3>Dmax_{0.05}=29.4$), but not Klithi and Franchthi ($Dmax_{obs}=12.2<Dmax_{0.05}=30.4$). The CV values indicated Kastritsa as having the least variance (6.7%), followed by Franchthi (10%) and then Klithi (11.8%), while the *F* test identified a significant difference in variance between Kastritsa and both Klithi and Franchthi.

Backed bladelets were similar in terms of width at Franchthi and Kastritsa, while Klithi produced an additional component of narrower pieces. However all three shared the same central tendency of between 4mm and 6mm. The presence of backed bladelets less than 4mm in width at Klithi suggests relatively more emphasis on producing narrower pieces than at either Franchthi or Kastritsa. The apparent difference cannot be explained by the availability of blanks, all three sites having similar proportions of narrower unretouched bladelets available. The KS test indicated a significant difference in backed bladelet width between Klithi and Franchthi ($Dmax_{obs}=22.7>Dmax_{0.05}=15.4$) and

Klithi and Kastritsa ($Dmax_{obs}$=22.7>$Dmax_{0.05}$=13.2), but not Franchthi and Kastritsa ($Dmax_{obs}$=6.9<$Dmax_{0.05}$=17.3). The CV values identified Franchthi as having the lowest variance (11.4%), followed by Kastritsa (14.4%) and then Klithi (21.3%), while the *F* test (α=0.05) identified a significant difference in variance between all collections.

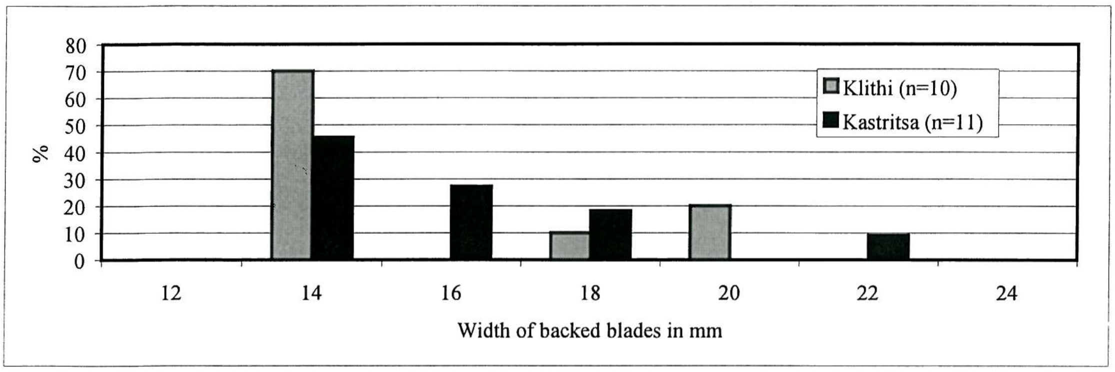
All three sites produced backed bladelets of similar thickness, although as with width, Franchthi and Kastritsa were much more alike, while Klithi produced fewer thicker pieces. All three collections shared the same central tendency of 1.5mm to 3mm. The KS test indicated no significant difference in backed bladelet thickness between Klithi and Franchthi ($Dmax_{obs}$=7.7<$Dmax_{0.05}$=15.4), Klithi and Kastritsa ($Dmax_{obs}$=9.8<$Dmax_{0.05}$=13.2) or Franchthi and Kastritsa ($Dmax_{obs}$=9.3<$Dmax_{0.05}$=17.3). The CV values identified Kastritsa as having the lowest variance (32.7%), followed by Franchthi (42.4%) and then Klithi (45.2%). The *F* test identified a significant difference in variance between only Kastritsa and Klithi.

Overall, Klithi produced the narrowest and thinnest backed bladelets, while Kastritsa produced the longest, widest and thickest. In terms of length, Klithi and Franchthi were similar, although the latter produced more shorter pieces. The decline in frequency of pieces less than 20mm in length at Kastritsa probably reflects the fact that with larger raw materials, longer backed bladelets could be produced. In fact, a similar pattern of decline in proportions of blanks shorter than 20mm was noted amongst unretouched bladelets at Kastritsa (see fig.7.27). At all three sites the decline in frequency of backed bladelets longer than 24mm may suggest a similar upper use limit as well as the limitations of raw materials.

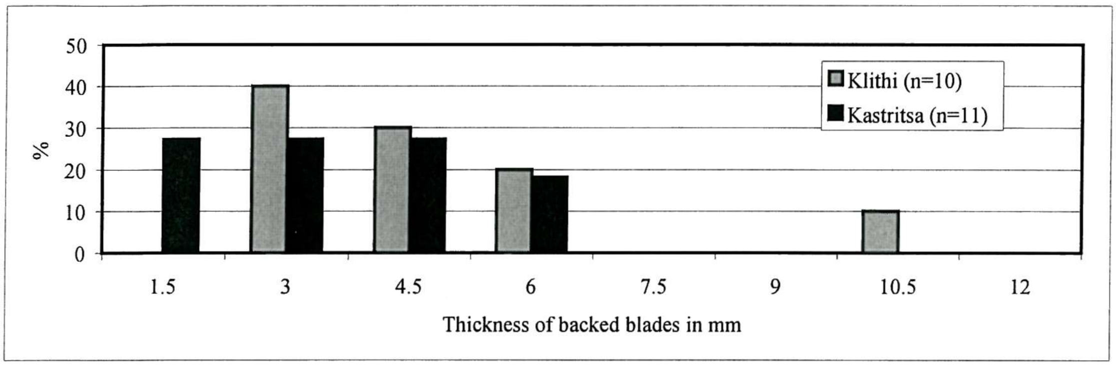
The thickness frequency histogram suggested that 1.5mm was probably the lower useful limit, while the decline in proportions of pieces over 3mm may suggest an upper limit. Pieces less than 1.5mm were probably too fragile to work or use while those thicker than 3mm would have been difficult to retouch. In all dimensions, Klithi consistently produced the highest variance and was, according to the *F* test, significantly different to one or both of the other sites in all dimensions. This reflects the presence at Klithi of shorter, narrower and thinner backed bladelets which were generally not present in the other two collections, again perhaps reflecting the limitations of raw materials and the use of a wider range of blanks.

Backed blades

The value of considering the backed blade profile is debatable considering the small size of the assemblages. With five to six pieces in length all three sites were excluded. The KS test indicated no significant difference in backed blade width ($Dmax_{obs}$=24.5<$Dmax_{0.05}$=59.4) or thickness between Klithi and Kastritsa ($Dmax_{obs}$=27.2<$Dmax_{0.05}$=59.4).



a.

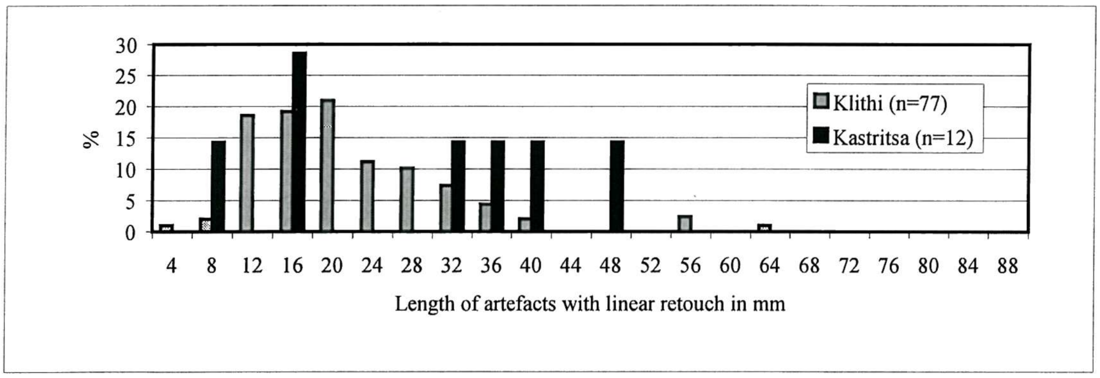


b.

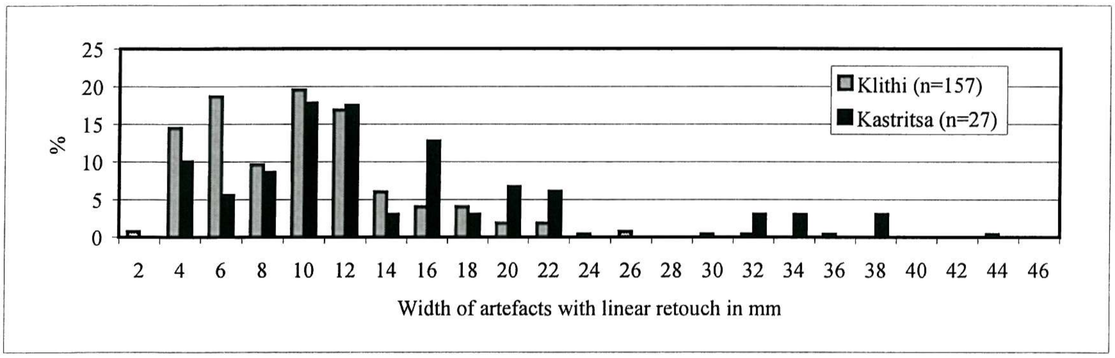
Figure 7.31. Width (a) and thickness (b) of backed blades.

Artefacts with linear retouch

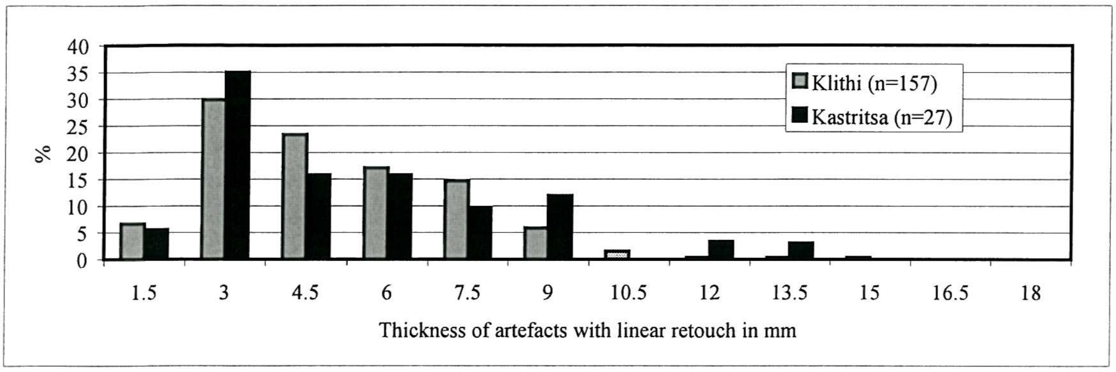
Artefacts with linear retouch were bulked in order to produce reasonably sized albeit still small samples, and included flakes, bladelets and blades. With less than five pieces, Franchthi was eliminated from the analysis.



a.



b.



c.

Figure 7.32. Length (a), width (b) and thickness (c) of artefacts with linear retouch. Length outliers from Kastritsa were omitted.

With only twelve pieces at Kastritsa, few definite conclusions can be drawn concerning relative length difference compared to Klithi. However, Kastritsa overall produced longer pieces with linear retouch, although the KS test indicated no significant difference between the two collections ($Dmax_{obs}=40<Dmax_{0.05}=53.9$). The CV values indicate that Klithi has the lowest variance (17.7%) compared to Kastritsa (19.7%), but the *F* test identified no significant difference in variance between the two.

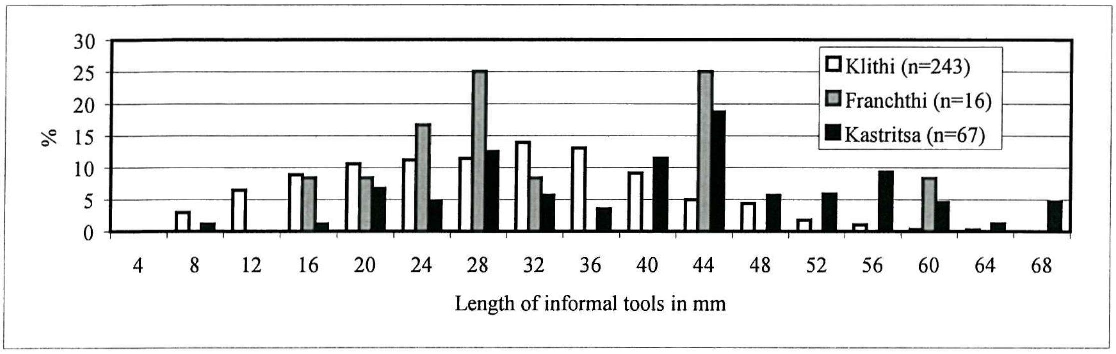
Kastritsa produced wider pieces than Klithi, particularly those over 12mm. In addition, a possible bimodality in the width distribution at Klithi was suggested, centring on 4mm to 6mm and then on 8mm to 10mm. This probably relates to the width difference between blade/bladelet based artefacts with linear retouch, and those made on flakes. The KS test indicated no significant difference in width between Klithi and Kastritsa ($Dmax_{obs}=23.3<Dmax_{0.05}=28.3$). The CV values indicated Kastritsa as having the lowest variance (18.6%) compared to Klithi (20.5%), however the *F* test identified no significant difference between them.

Artefacts with linear retouch were basically the same in terms of thickness at Klithi and Kastritsa, but with the possible suggestion of a small component of thicker pieces at the latter. Both had a similar central tendency of between 1.5mm and 3mm. The KS test indicated no significant difference in thickness between Klithi and Kastritsa ($Dmax_{obs}=9.9<Dmax_{0.05}=28.3$). The CV values indicated Kastritsa as having the lowest variance (36%) compared to Klithi (42.6%), however the *F* test identified no significant difference between them.

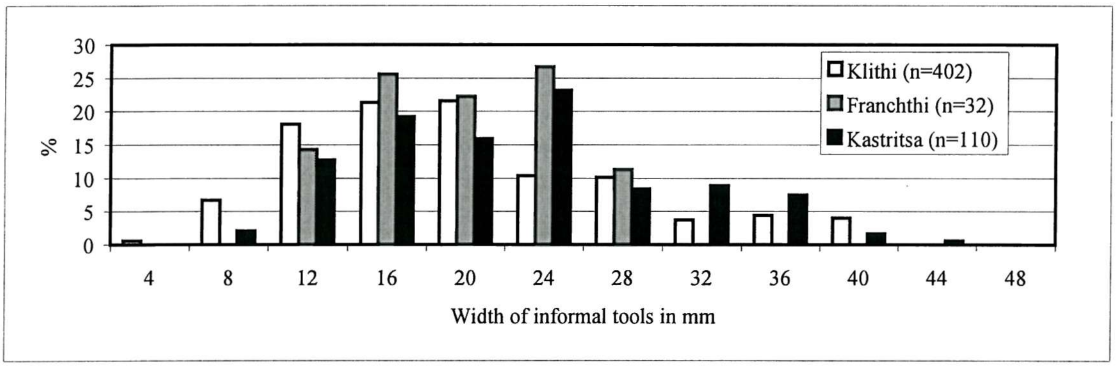
Artefacts with linear retouch were longer and wider at Kastritsa, although in terms of thickness there was no real difference between the two sites. There was no clear difference in terms of variance either. Kastritsa was larger in terms of length and Klithi in terms of width, however the differences were not significant. The possible bimodality in width proportions at Klithi is probably related to the alternate use of blade/bladelet and flake blanks for the manufacture of these artefacts.

Informal tools

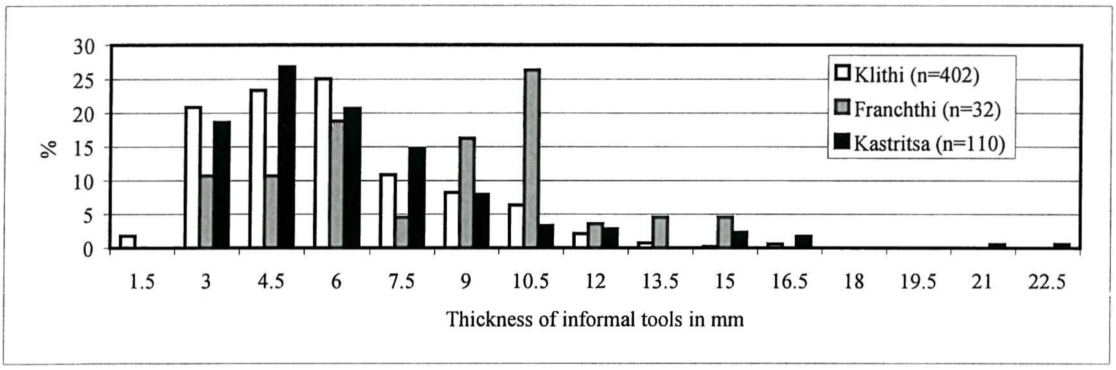
Informal tools consisted of truncations, notches/denticulates, borers, burins and scrapers. They were grouped on the basis of having been made on a range of blanks, including flakes, blades, bladelets and cores.



a.



b.



c.

Figure 7.33. Length (a), width (b) and thickness (c) of informal artefacts.

The frequency distributions for informal tools were much more irregular and dispersed than was the case for either debitage or formal tools. This probably reflects the wider range of sizes and shape configurations that were used to make up these artefacts. Overall, Klithi and Franchthi produced similar frequencies of informal tool lengths, although Franchthi with its smaller sample size was more variable. Kastritsa produced the longest informal tools overall. The KS test indicated a significant difference in informal tool length between Klithi and Kastritsa ($Dmax_{obs}$=43.2>$Dmax_{0.05}$=19.4), but not between Klithi and Franchthi ($Dmax_{obs}$=20.7<

$Dmax_{0.05}$=40.2) or Franchthi and Kastritsa ($Dmax_{obs}$=35<$Dmax_{0.05}$=42.9). All three collections had broadly similar central tendencies of between 24mm and 28mm, but with a possible second peak at between 40mm and 44mm for Franchthi and Kastritsa. In both cases the major contributors to this second peak were notches/denticulates and scrapers. The CV values suggested that Franchthi had the lowest variance (12.9%), followed by Kastritsa (13.3%) and then Klithi (13.9%). However the *F* test identified no significant difference in variance between any of the sites in terms of informal tool length.

The width frequency histogram presented a much more regular profile. Kastritsa produced wider tools overall, particularly those over 20mm in width, while Klithi produced more narrower tools than Franchthi. All three sites appeared to share a similar central tendency of between 12mm and 16mm, however with a possible second peak at Franchthi and Kastritsa of between 20mm and 24mm. In the case of Franchthi this second peak appears to reflect the presence of wide scrapers and in the case of Kastritsa of wide burins. The lack of pieces wider than 28mm at Franchthi probably reflects the upper cut-off imposed by smaller raw materials. The KS test indicated a significant difference in informal tool width between Klithi and Kastritsa ($Dmax_{obs}$=18.4>$Dmax_{0.05}$=14.6), but not Klithi and Franchthi ($Dmax_{obs}$=11.2<$Dmax_{0.05}$=27) or Franchthi and Kastritsa ($Dmax_{obs}$=18.5<$Dmax_{0.05}$=29.2). The CV values suggested that Franchthi had the lowest variance (12.8%), followed by Klithi (15%) and then Kastritsa (15.1%). However, the *F* test identified no significant difference in variance between any of the sites in terms of informal tool width.

Klithi and Kastritsa were similar in terms of thickness, but with the latter producing slightly more thicker pieces. The central tendency for all three collections was between 3mm and 6mm. Interestingly, Franchthi produced significantly higher proportions of thicker pieces, although the relatively small sample size must be borne in mind. The second peak consisted exclusively of scrapers, which tended to be thicker at Franchthi compared to those from the other two sites. The KS test indicated a significant difference in informal tool thickness between Klithi and Franchthi ($Dmax_{obs}$=37.1>$Dmax_{0.05}$=27) and Franchthi and Kastritsa ($Dmax_{obs}$=36.1>$Dmax_{0.05}$=29.2), but not Klithi and Kastritsa ($Dmax_{obs}$=4.4<$Dmax_{0.05}$=14.6). The CV values suggested that Franchthi had the lowest variance (31.7%), followed by Kastritsa (32.5%) and then Klithi (33.7%). However the *F* test identified no significant difference in variance in informal tool thickness between any of the sites.

In terms of length and width, the informal tools from Klithi and Franchthi were smaller than those produced at Kastritsa, presumably as a result of the size of the raw materials being used. Bearing in mind the smaller sample size at Franchthi, it would appear as though informal tools were being made to more or less the same dimensions as those at Klithi. In terms of thickness however, Klithi and Kastritsa appeared very similar, while informal tools, principally scrapers were being made much thicker at Franchthi. This can be explained by the relatively greater numbers made on abandoned cores at Franchthi than at the other two sites. In fact, of the 13 scrapers at Franchthi, 3 (23%) were made on cores, one of 16mm and the other two almost 10mm in thickness. Reuse of cores as scrapers at the other two sites was much less common, with just a single example each at Klithi (1%) and Kastritsa (3%). Franchthi produced the lowest variance values for all three dimensions while Klithi was the highest in terms of length and thickness, although none was identified as significant by the *F* test.

7.4. Standardisation through blank selection

7.4.1 Introduction

In this section, the analysis shifts from the examination of finished pieces whether debitage or artefacts, to the analysis of the process of blank selection. The results of knapping are not always predictable and although the knapper may attempt to produce blanks of the desired size or shape for use as artefacts, the results will rarely be ideal. This suggests that selection of the best pieces is likely to have been undertaken, and that this provides us with an index for standardisation. In assemblages where artefact size and shape is not critical, a greater diversity of blanks will be selected for use, whereas in a technology where the size and shape of artefacts produced was more critical, blank selection would be expected to be more discriminating. In this section, the extent to which blanks were being deliberately selected is assessed by comparing background dimensional frequencies of unretouched blanks available for use, against retouched tools. In this way, the first stage of any system of standardisation is measured, the initial selection of suitably sized blanks. This is referred to as a comparison between the "background", that is the blanks available for use, against the "foreground" of finished artefacts.

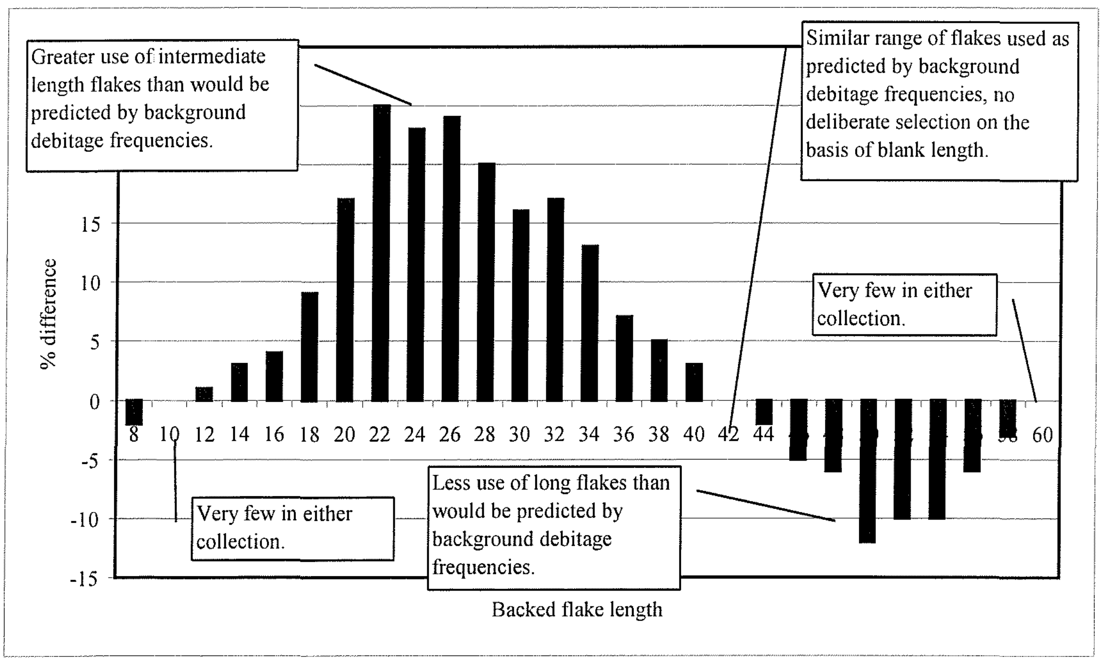


Figure 7.34. Schematic illustration of the "background" versus "foreground" analysis.

In practical terms, the analysis was undertaken by comparing lithic assemblages from the three sites using length, width and thickness. The frequency distribution for each artefact type was compared against its corresponding debitage assemblage. So for instance backed bladelets were compared against bladelets. This was done by subtracting debitage frequencies for each dimension interval from that of retouched tools. The results are illustrated in figure 7.34 above using a fictitious length of backed flakes dataset. The results indicate deliberate selection of blanks at frequencies greater than would be suggested if the full range of debitage present was being utilised up until 40mm. After this point there is less deliberate selection, in fact it would appear as though these fractions were being deliberately avoided, although some limited use was undertaken. Admittedly, none of the real frequency distributions was as straightforward as the example used above.

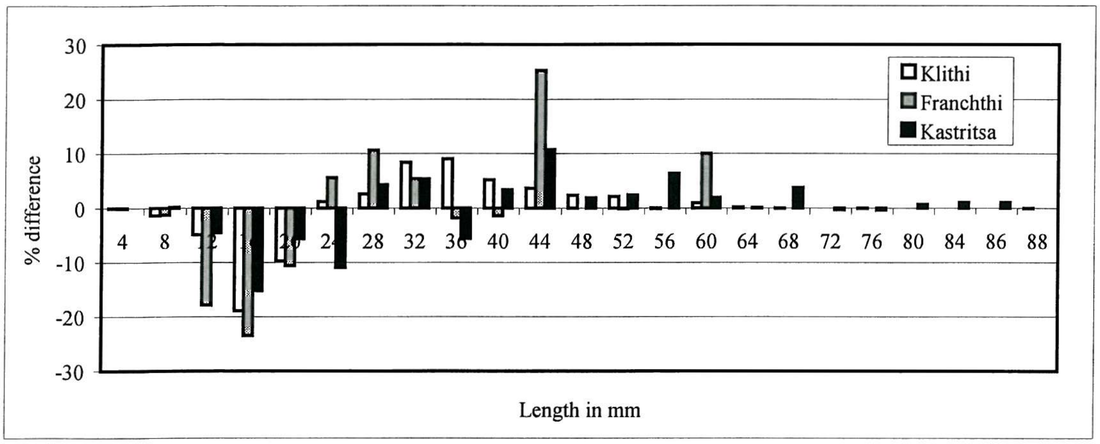
As with the previous analysis, internal stratigraphy was ignored and the collections bulked in an attempt to produce assemblages of workable size. Despite this, some groups remained too small for inclusion, in this case defined as a minimum of five pieces. As a result, in some cases, only two of the sites were included, however this is clearly flagged during the analysis.

7.4.2 Informal tools

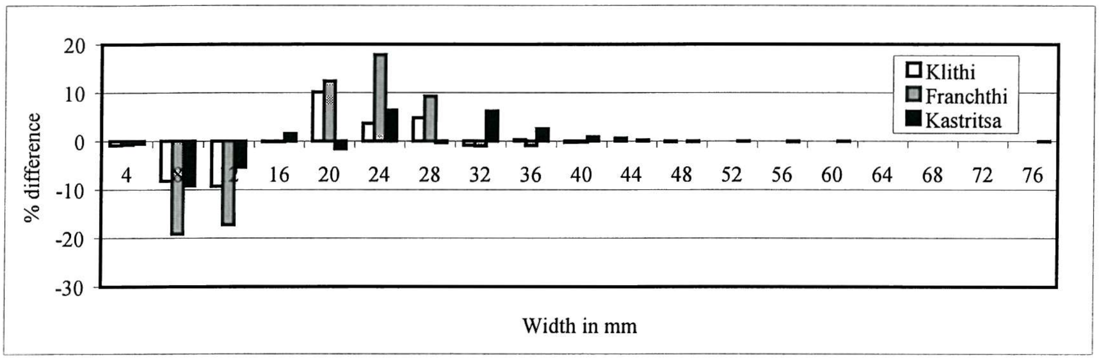
The whole of the unretouched debitage (flakes, bladelets and blades) assemblage was compared against bulked informal artefacts, including truncations, notches/denticulates, borers, burins and scrapers. These artefacts were grouped as informal since there appears to have been no deliberate selection of either flakes or blades/bladelets for their manufacture. Again as with all other analyses, the rationale behind the bulking of artefact groups was to increase sample size. However, even with this some samples remained small, for instance in Franchthi (tbl.7.10), and therefore conclusions need to be seen as speculative.

Table 7.10. Numbers of debitage and artefacts measured for the bulked assemblages.

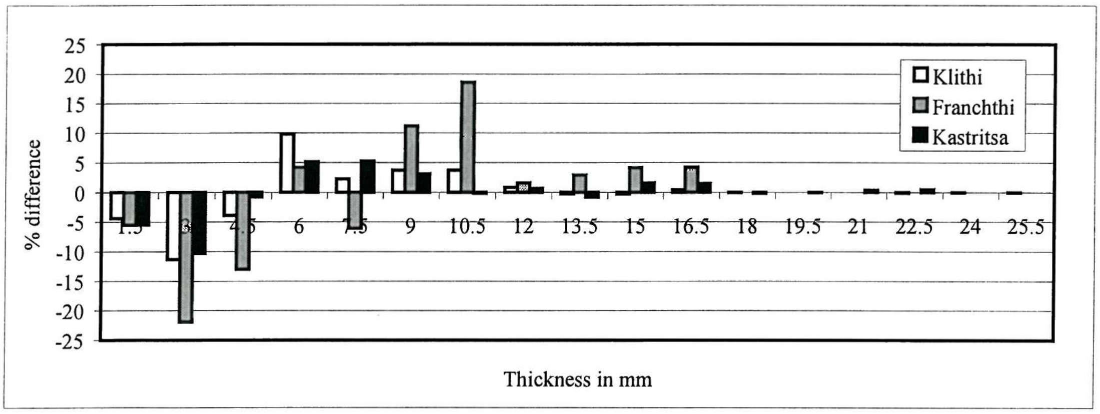
Site name	Bulked unretouched debitage including flakes, bladelets and blades, numbers measured for:			Bulked informal artefacts including truncations, notches/denticulates, borers, burins and scrapers, numbers measured for:		
	Length	**Width**	**Thickness**	**Length**	**Width**	**Thickness**
Klithi	1178	3097	3097	242	402	402
Franchthi	710	1371	1371	16	32	32
Kastritsa	937	2015	2015	67	110	110



a.



b.



c.

Figure 7.35. Percentage difference between frequencies of bulked informal artefacts and the bulked debitage assemblage for length (a), width (b) and thickness (c).

The observed differences between the informal tools and the bulked debitage assemblage suggested a number of size thresholds for the selection of blanks. Relative selection exceeded that predicted by the background debitage frequencies for pieces longer than 24mm. Shorter pieces were being used, however at a rate relatively lower than would be predicted if selection was simply dependent on the availability of blanks irrespective of length. Similarly, deliberate selection of pieces wider than 16mm appears to have taken place. These were preferentially used relative to narrower pieces, and although some use of narrower pieces was taking place, this was at a lower frequency than would be predicted by background debitage proportions. Moreover, relatively preferential use was being made of pieces thicker than 4.5mm for the production of informal artefacts, while thinner pieces although used, appear to have been less actively selected.

It is unclear which of these metric parameters would have been the primary decider for the selection of blanks with which to make informal tools, let alone other aspects such as shape or raw material quality. What the analysis has suggested is that broad size parameters were conditioning blank selection for informal tools. In terms of length, a lower cut-off was suggested at around 24mm, while for width and thickness it was 16mm and 4.5mm respectively. Below these dimensions, although pieces were being used, they appear to have been relatively less frequently selected than would be predicted had no deliberate selection taken place. In other words pieces had simply been picked up at random. Clearly this is unlikely to occur, as the knapper will have a good idea of the optimal size parameters for the artefact in mind. However, the analysis does emphasise that small debitage was being selectively ignored for these types of artefact. This relative selection of longer, wider and thicker blanks whether flake, bladelet or blade may be to do with the way in which these artefacts were used. Most were probably hand held, therefore requiring certain minimum dimensions in order that the tool be securely grasped. The size parameters listed above, namely 24mm by 16mm as a minimum for hand held artefacts would seem to fit this expectation. All sites showed the same pattern in lower threshold although there was some suggestion that even larger pieces were being utilised at Kastritsa. The peaks present at Franchthi, although apparently significant, actually only consist of three and two artefacts respectively.

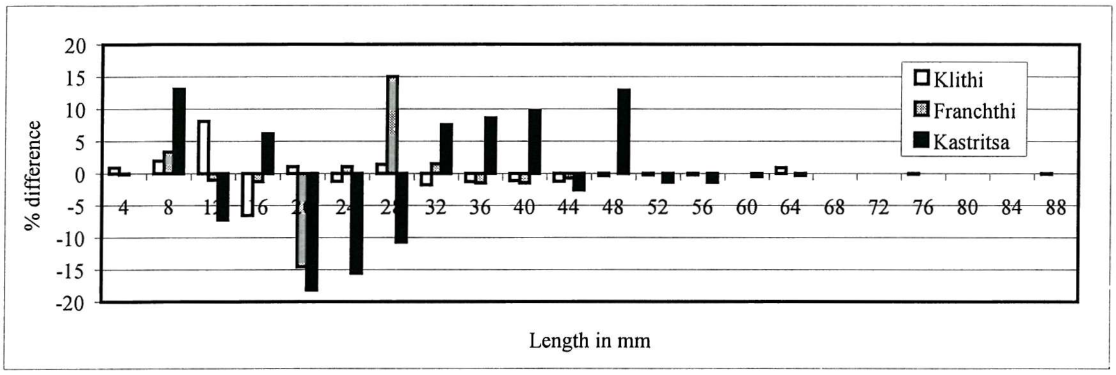
7.4.3 Formal tools

Formal tools were grouped on the basis of deliberate use of specific blanks, therefore allowing comparison with their respective debitage type. The three groups were retouched flakes, retouched bladelets and retouched blades. Retouched flakes included the two subgroups, backed flakes and flakes with linear retouch. Retouched bladelets included four subgroups, backed bladelets, bladelets with linear retouch, and the very rare microgravettes and shouldered bladelets. Both the latter were found mainly at Kastritsa. The numbers used for the measurement of each dimension are listed in table 7.11, and to reiterate from section 7.3.1, the number of artefacts used to measure each dimension will differ depending on breakage patterns.

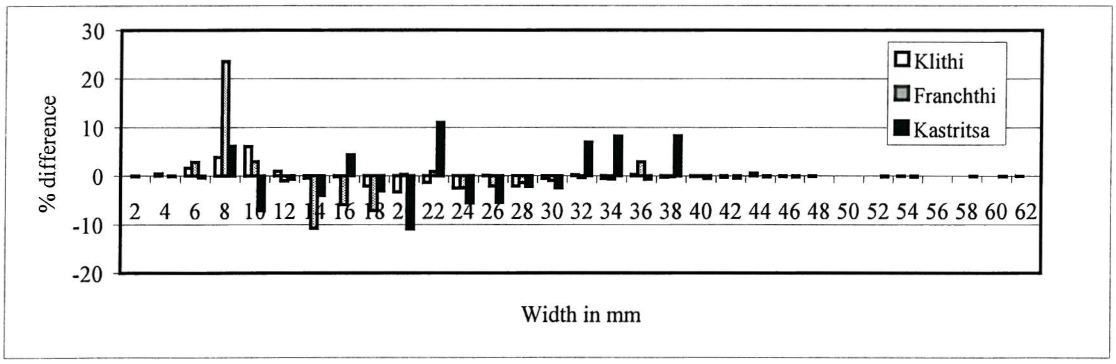
Unretouched flakes against backed flakes and flakes with linear retouch

Table 7.11. Numbers of debitage and artefacts measured for unretouched and retouched flakes.

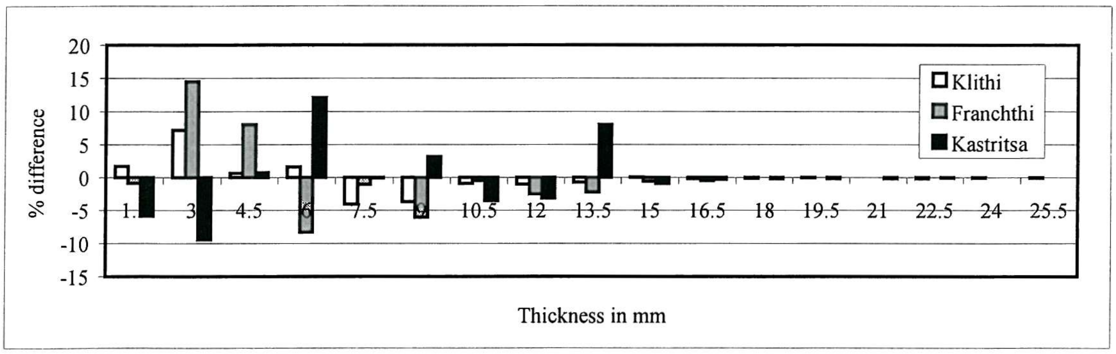
Site name	Bulked unretouched flakes, numbers measured for:			Bulked formal flake based artefacts including backed flakes and flakes with linear retouch, numbers measured for:		
	Length	Width	Thickness	Length	Width	Thickness
Klithi	828	2008	2008	84	159	159
Franchthi	537	1045	1045	20	25	25
Kastritsa	524	1115	1115	7	12	12



a.



b.



c.

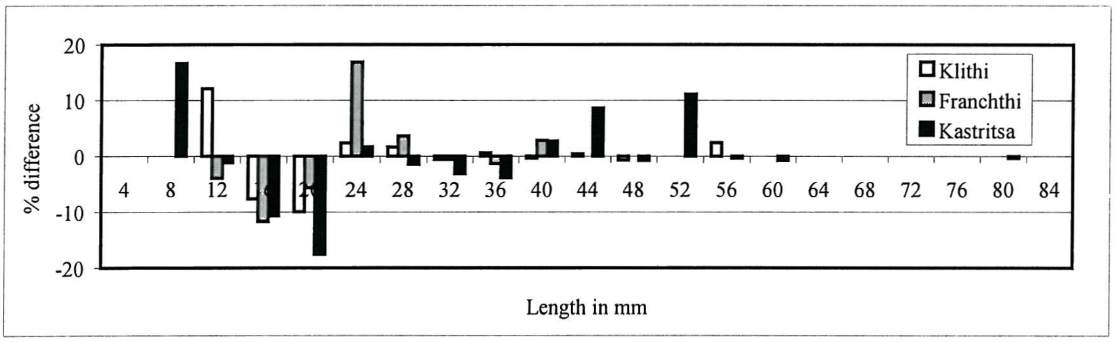
Figure 7.36. Percentage difference between frequencies of bulked retouched flakes and bulked flake debitage for length (a), width (b) and thickness (c).

Despite the size of the flake debitage assemblage, the retouched flake assemblage was relatively small from both Franchthi and Kastritsa. Differences between tool and debitage frequencies for flakes were less than clear. This probably reflects the use of a wider range of blanks of varying size and shape, but also the effects of the small sample size. At Klithi, deliberate selection of flakes between 8mm and 12mm appears to have occurred, along with blanks over 6mm in width and 1.5mm in thickness.

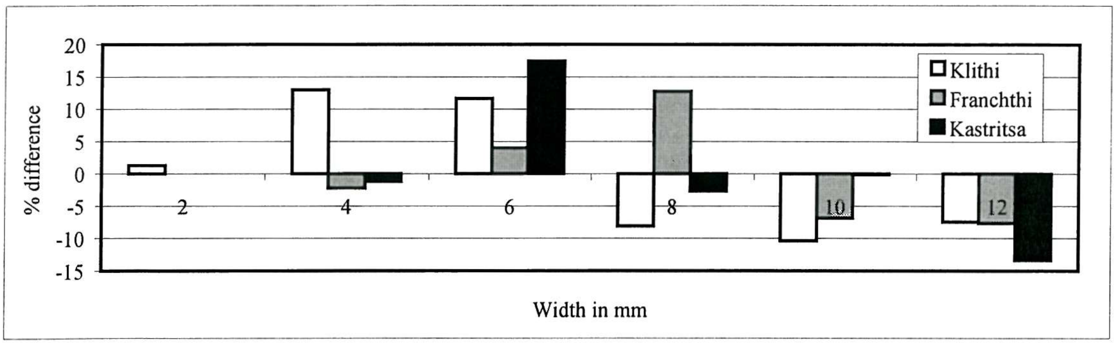
Unretouched bladelets against backed bladelets, bladelets with linear retouch, microgravettes and shouldered bladelets

Table 7.12. Numbers of debitage and artefacts measured for unretouched and retouched bladelets.

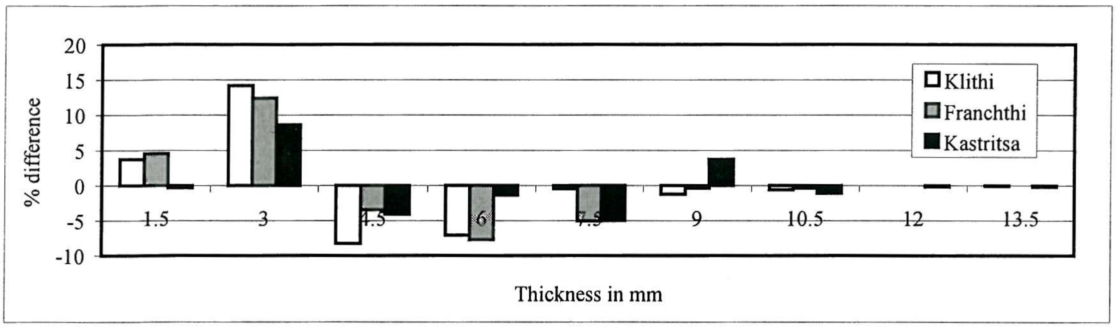
Site name	Bulked unretouched bladelets, numbers measured for:			Bulked formal bladelets based artefact including backed bladelets, bladelets with linear retouch, micrograveттes and shouldered bladelets, numbers measured for:		
	Length	**Width**	**Thickness**	**Length**	**Width**	**Thickness**
Klithi	270	809	809	66	383	383
Franchthi	147	278	278	36	105	105
Kastritsa	255	537	537	62	170	170



a.



b.



c.
Figure 7.37. Percentage difference between frequencies of bulked retouched bladelets and bulked bladelet debitage for length (a), width (b) and thickness (c).

Selective use of bladelet blanks at Klithi was suggested by the relative lack of use of blanks less than 20mm in length than would be predicted by background debitage proportions. The peaks seen at Klithi and Kastritsa for pieces less than 12mm in length were produced by very small proportions of bladelets with linear retouch. Although small in number, these pieces made up a large proportion of their respective collections, and therefore overly biased the distribution. The same can be said for rare microgravettes and shouldered points at Kastritsa, which, although small in number, were significant when converted to proportions. The distribution needs to be seen in broad terms, where it suggests that the preferred length for backed bladelets and other related tool types was over 20mm. This does not mean that shorter pieces were not being regularly made. In fact, around 50% of both the Klithi and Franchthi collections were less than 20mm in length. What it does indicate however is that the proportions of tools shorter than 20mm were lower than would be predicted by background debitage frequencies.

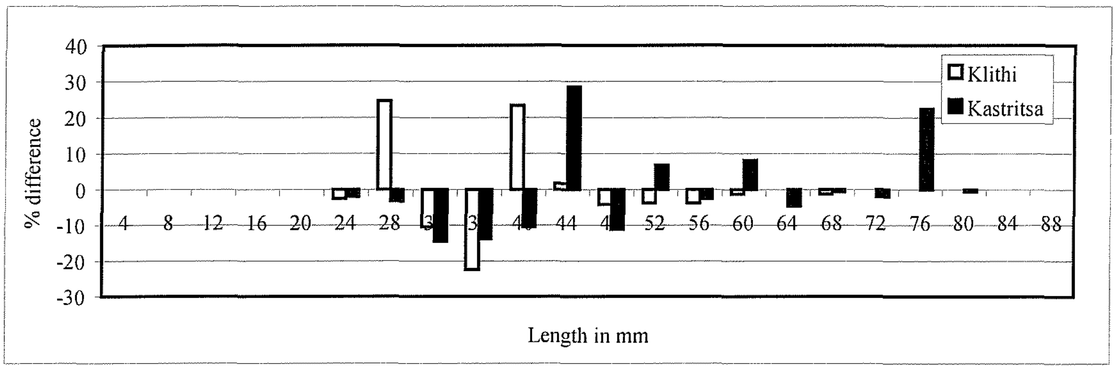
In terms of width, the collections all showed similar patterns of blank selection, although slightly wider pieces appear to have been relatively selected at Franchthi. Beyond 6mm at Klithi and Kastritsa bladelets appear to have been selectively ignored, and beyond 8mm at Franchthi. It must be remembered that amongst these artefacts, width is the most likely to be altered by retouch. Although difficult to estimate, this decrease in size may have been up to a third of overall width. This would tend to shift the frequency distribution to the right, suggesting that blank selection for the manufacture of backed bladelets would have been relatively more common amongst pieces up to 9mm wide.

All three sites showed a similar pattern with relative selection of blanks of less than 3mm in thickness at rates above that which would be predicted by background frequencies. Thicker bladelets appear to have been deliberately ignored at all sites, presumably because of the difficulties in backing.

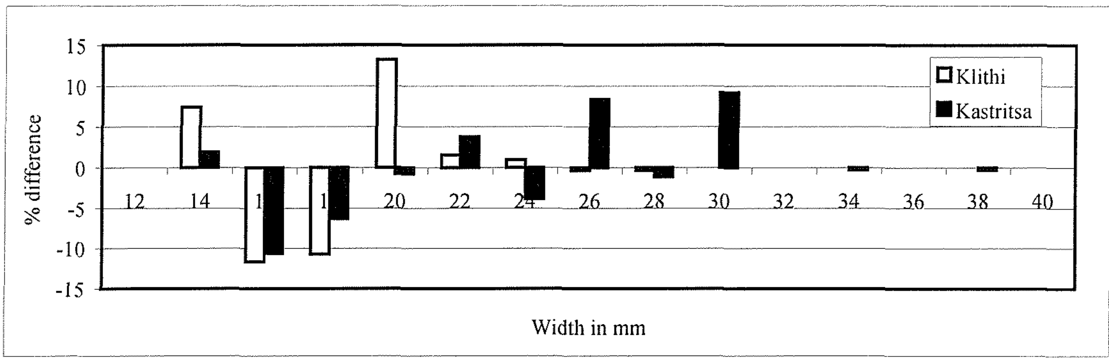
Unretouched blades against backed blades and blades with linear retouch

Table 7.13. Numbers of debitage and artefacts measured for unretouched and retouched blades.

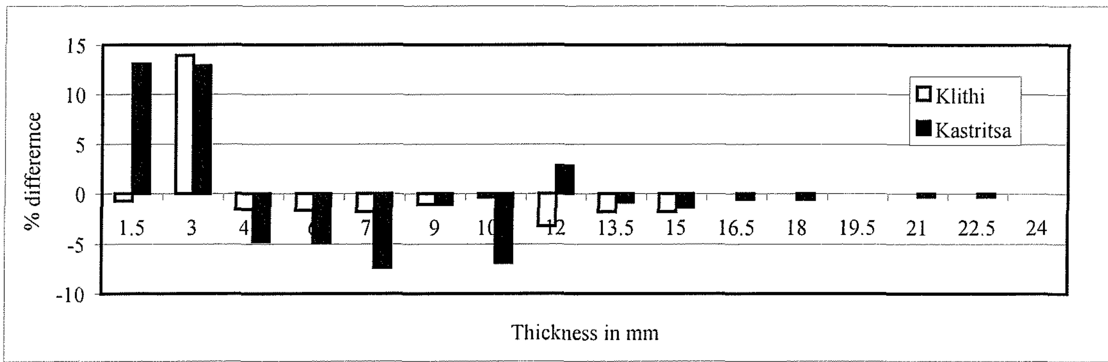
Site name	Bulked unretouched blades, numbers measured for:			Bulked formal blade based artefacts including backed blades and blades with linear retouch, numbers measured for:		
	Length	**Width**	**Thickness**	**Length**	**Width**	**Thickness**
Klithi	80	280	280	8	31	31
Franchthi	26	48	48	1	1	1
Kastritsa	152	363	363	6	21	21



a.



b.



c.

Figure 7.38. Percentage difference between frequencies of bulked retouched blades and bulked blade debitage for length (a), width (b) and thickness (c).

The retouched blade sample was very small and therefore any conclusions drawn need to be considered as speculative. Blades were defined as laminar pieces wider than 12mm, therefore with a corresponding length cut-off of 24mm. The backed and linear retouched blade assemblages are prohibitively small for detailed analysis of length.

The slightly larger width assemblages suggest relative avoidance of blades of between 14mm and 18mm. However, this does not correspond well with the observed length frequency distribution for blade based artefacts in which most were in fact between 16mm and 18mm in length. This suggests that the use of blades overall was at levels lower than predicted by availability of blanks.

As with bladelets, 3mm appears to have been the upper limit for active blade selection over and above the proportions available as blanks. Although use was taking place of narrower and wider pieces, this would have been discouraged by difficulties in applying backing.

7.5. Summary

Morphological characteristics of cores

Cores were as common at Franchthi and Kastritsa, comprising around 3.5% of the respective assemblages, whereas at Klithi they were less common, comprising just 1.3%. The most plausible explanation for this is that cores were introduced at Klithi at an earlier stage, bearing in mind that raw material is available for collection just below the site. The lower core proportions therefore probably reflect the greater quantities of debitage being produced. Moreover, cores at Klithi tended to be more extensively worked than at Franchthi and Kastritsa, so too enhancing debitage proportions relative to cores, although the smaller size of raw materials at Klithi may also have resulted in smaller cores.

Flake cores were the most common types in all three collections, by a long margin. At Kastritsa they comprised just over 70% of cores, followed by 84% at Klithi and 87% at Franchthi. Since blade production would have been an important element of core use, it is likely that the high flake core proportions mentioned above are in fact an incorrect reflection of blade/bladelet type proportions. As a core is utilised and in particular as it becomes too small to hold effectively, bladelet removal success drops significantly. This results in cores with traces of flake rather than bladelet removals, so probably accounting for their apparent importance. Other researchers have attributed more bladelet production of the collections on the basis of a less strict interpretation of what constitutes a bladelet core (see for instance Adam 1989). Nonetheless, both methods highlighted Kastritsa as producing more bladelet types, probably because of the better quality raw materials available.

Core shape, number of platforms and removal direction

Despite significant variability amongst core shapes at the three sites, Klithi produced significantly more conical cores. They were also present at Kastritsa and Franchthi, and both at similar proportions. Most conical cores were single platform types and most were worked longitudinally, explaining the relatively higher frequencies at Klithi. Single platform cores were almost twice as common at Klithi than either Kastritsa of Franchthi. The fact that all three sites were geared towards bladelet production suggests that the differences observed in terms of shape, number of platforms and removal direction, are probably related to differences in raw materials. In particular, limitations imposed by the small rolled pebbles used at Klithi resulted in a predominance of cone shaped single platform cores. At the other two sites, more variability in raw material form and quality, in particular at Kastritsa resulted in a greater diversity of shapes, numbers of platforms and removal directions. This is not to say that given raw materials of sufficient quality, a diversity of core forms represents the optimal way in which to produce blades. Rather, large raw materials require the use of more platforms and removal directions, simply because of the difficulties associated in maintaining a single platform throughout the longer life of a larger core.

Platform preparation

Of the deliberate forms of platform preparation, trimming or chipping across the platform edge was most common at Klithi, followed by Franchthi and then Kastritsa which were very similar. At Klithi at least, this probably relates to the greater use of single platform conical and related shape cores. In this case, trimming is an essential part of the knapping process, allowing fragile overhangs to be removed and so enabling the hammer strike to be more accurately placed. The significant lack of any platform preparation at Franchthi is related to the higher frequencies of more expedient cuboid/tabular cores, which appear to have been only rarely modified, while at Kastritsa it probably reflects the more extensive use of amorphous cores. The relatively higher incidence of facetting at Kastritsa may be due to larger raw materials and therefore more frequent larger bladelet or blade production, in which modification of the platform enables removals. It is doubtful, however, whether with such small cores, facetting represents an efficient method. Alternatively, larger cores with more platforms, many of which are adjacent, produce flaking surfaces that appear to be facetted, but which are in fact previous removal scars. This may explain the higher frequencies of facetting observed at Kastritsa but not at Franchthi, although the lower levels of preparation overall at the latter needs to be taken into account.

Cortex

Cores at Klithi retained the most cortex, followed by Kastritsa and then Franchthi, which were quite similar. This probably reflects the small size of pebble raw materials used at Klithi. Although cores had reached the stage at which they could no longer be held, they still retained significant cortex coverage. At Kastritsa and to some extent Franchthi, larger raw materials to begin with allowed more cortex removal prior to the limitations of size being encountered. This suggests that in the case of the three sites, cortex proportions cannot be used as an index of working intensity, as initial raw material starting conditions were dissimilar.

Core use life and abandonment

The most common reason for core abandonment in all three collections was small size. The second most common was poor raw material quality, at Klithi and Franchthi at least. The much better raw material at Kastritsa was apparently only rarely responsible for a core being abandoned. All of these differences can be attributed to the various raw materials used at the three sites, and in particular the relatively poor quality of that available at Klithi and Franchthi. Apart from this, differences in abandonment criteria suggest that cores were not being used any differently at the three sites.

Basic assemblage structure

Proportions of primary, secondary and inner debitage

The presence of more primary, albeit in very small proportions, but more importantly, higher secondary proportions amongst both debitage and tools at Klithi indicates that unworked nodules and partially worked cores were introduced at an early stage. Both Franchthi and Kastritsa, which were very similar to one another, produced less than half as much secondary material as Klithi. This suggests that raw materials at both the former sites were being introduced at broadly similar stages, and, by implication, that they were being sourced from comparable spatial scales. At Klithi however, the most likely scenario is of local scale derivation from the river below the site. Interestingly, local and exotic raw materials produced broadly similar primary, secondary and inner frequencies.

Proportions of flakes, blades and bladelets

Flakes were the most common debitage type in all three collections, whereas tools were more often made on bladelets. In any knapping process, the more specialised nature of blades/bladelets means that they are on the whole going to be less common than flakes, even if the purpose of the knapper was to produce blades/bladelets. Despite raw material constraints, all three sites produced broadly similar bladelet proportions, although they were slightly more common at Kastritsa. Blades, on the other hand, which are more demanding of raw materials, were almost twice as common at Klithi than Franchthi, and almost four times more common at Kastritsa. The better quality raw materials at Kastritsa definitely allowed more successful blade production.

Far more tools were made on bladelets than were present in the debitage collections of all three sites, pointing to the importance of this blank type. In fact bladelet based tools accounted for around 60% of retouched artefacts, while bladelet blanks accounted for just 25% of debitage. Conversely, blade based tools occurred at broadly the same proportions as blade blanks, and flake tools occurred at less than 50% the rate of flake debitage. This would suggest that in terms of blank preference, small narrow blades less than 12mm in width were most sought after, followed by blades over 12mm in width and then flakes. Despite the availability of blades at Kastritsa, they were used at broadly the same frequency as at Klithi and Franchthi. The production and use of blanks at the three sites would appear to have been largely geared towards bladelets. Any differences observed in the proportions of each of the blank types and their respective artefacts can probably be attributed to differences in raw material availability.

Technical pieces

Technical pieces associated with cores showed some differences between the three sites and in particular relate to the different stages at which technical pieces were produced. At Klithi for instance, the presence of crested blanks indicated early shaping of the core prior to first removals or with core reshaping in the course of knapping. These were less well represented at Franchthi and Kastritsa, suggesting perhaps that the technique was not necessary. Conversely, later stage core working technical pieces, such as rejuvenation blanks or core tablets, suggested more emphasis being placed on maintaining existing core use at Franchthi and Kastritsa. This is probably related to the relatively poor quality of raw materials at Klithi and the fact that rejuvenation later in a core's life would be very difficult as a result of the comparatively small size, as well as the fractured nature of those materials.

In terms of technical pieces associated with tool manufacture, burin spalls were present in broadly similar proportions at all three sites. However microburins declined significantly from Klithi, through Kastritsa to Franchthi where they comprised around 13% of technical pieces. On the face of it this suggests more extensive use of the technique at Klithi, and by implication an emphasis on associated backed tool forms.

Tools

The predominant tool form at all three sites was the backed bladelet, followed by the other tool types, which in all cases comprised less than 15% of their respective tool inventories. Klithi (10 out of 12) and Kastritsa (11 out of 12) produced similar diversities of artefacts, followed by Franchthi (7 out of 12). Correspondingly, Franchthi produced a much higher proportion of backed artefacts than Klithi or Kastritsa, which were broadly similar.

Metric characteristics of cores

Cores, length and platform circumference

Cores were divided up into amorphous and formal types. Amongst amorphous cores, Franchthi produced the greatest proportion of both short and short platform circumference cores, followed by Klithi and then Kastritsa. In fact Klithi fitted neatly into the overlapping region produced by the other two sites. All three sites had broadly similar lower platform circumference cut-offs, around 25mm, although, amongst conical cores, the picture was slightly different. Although Franchthi continued to produce the shortest cores, Kastritsa no longer produced those with the largest platform circumference. Instead, both Klithi and Kastritsa produced broadly similar platform sizes, although with a significant component of smaller pieces at Klithi particularly ones of less than 50mm.

Platform working

The proportion of the platform perimeter worked was assessed for both informal and formal cores. A similar pattern was noted for those with working all the way around. Significantly, the frequencies noted for informal and formal cores were very similar. Klithi produced far fewer cores worked around the entire perimeter than the other two sites. In fact Franchthi produced relatively higher proportions of these types.

Metric characteristics of debitage

Unretouched flakes

Unretouched flakes at Klithi and Franchthi were very similar in terms of length and width, although on balance, those from Franchthi were slightly shorter and narrower. At Kastritsa however, flake debitage tended to be much longer and wider. In terms of thickness, all sites were extremely similar with only the slightest hint of difference between Franchthi and Kastritsa. Testing for significance using the KS test identified most of the relationships as significantly different. However, large sample sizes produce very small Dmax0.05, and therefore even a small amount of variability is going to be identified as significant. In terms of length variance, the CV values suggested Franchthi as the most standardised, followed by Kastritsa and Klithi. However, all were very similar, and despite a significant *F* test result between Franchthi and the other two sites, it would probably be safer to argue for no difference in length variance. As with length, there was only the hint of a difference between the CV values obtained for width. Despite significant *F* test results between Kastritsa and the other two sites, it is probably fair to say that there was no real difference in width variance present. The thickness CV values were also very similar, and, although Klithi and Kastritsa were identified as significantly different by the *F* test, it is again probably safer to say that these were negligible.

Unretouched bladelets

Unretouched bladelets at Klithi and Franchthi were on balance more similar than either were to those from Kastritsa, where bladelets were very much longer. Those from Franchthi tended to be the shortest overall. As occurred with length, bladelets from Franchthi tended to be the narrowest, followed by Klithi and then Kastritsa. On the other hand, all three sites produced broadly similar thickness frequencies with only the slightest suggestion of thinner bladelets at Franchthi. The KS test identified all sites as significantly different in terms of length and width, but none in terms of thickness. In terms of length variance, the CV values suggested Franchthi as the most standardised, although the results from all three sites were very similar, the largest difference being just one percent. Despite this the *F* test identified Franchthi as significantly different to both Klithi and Kastritsa. The differences between the CV results for width were slightly larger, with a maximum difference of 2.7%. Kastritsa produced the most standardised bladelets, followed by Franchthi and then Klithi, while the *F* test suggested that Kastritsa was significantly different to both Klithi and Franchthi. The thickness CV values were very similar with just a 1.2% maximum difference. Despite this, the *F* test identified Franchthi as significantly different to both Klithi and Kastritsa.

Unretouched blades

Unretouched blades at all three sites were quite different in terms of length. At Franchthi, they tended to be shorter, followed by Klithi and then Kastritsa. As with length, bladelets from Franchthi tended also to be the narrowest, followed by Klithi and then Kastritsa. Klithi and Kastritsa produced very similar thickness distributions while Franchthi tended to produce thicker blades. The KS test identified a significant difference between Kastritsa and both Klithi and Franchthi in terms of both length and width, but the apparent large difference between Franchthi and the other two sites in terms of thickness was not statistically significant. In terms of length variance, the CV values suggested that Franchthi was the most standardised, followed by Klithi and then Kastritsa, although the maximum difference was only 2.1%. Despite this, the *F* test identified Kastritsa as significantly less standardised than either Klithi or Franchthi. The width CV results identified Franchthi as the most standardised, followed by Klithi and then Kastritsa, with a maximum CV difference of 2.8%. The *F* test indicated all sites as significantly different in terms of width variance. Thickness CV values for Franchthi were quite different from those of both Klithi and Kastritsa. Franchthi was apparently the most standardised, followed by Kastritsa and Klithi which shared more or less the same value. The *F* test identified Franchthi as significantly different to both Klithi and Kastritsa in terms of blade thickness.

Metric characteristics of tools

The unfortunate fact that many of the samples are very small sizes and that they were collected from deposits accumulated over many thousands of years means that the following interpretations need to be taken with a good pinch of salt.

Backed flakes

Only Klithi and Franchthi were of sufficient size to be included, having more than five pieces. Backed flakes from the two sites were broadly comparable in terms of length, although Franchthi tended to produce longer pieces. Conversely, Franchthi tended to produce slightly narrower pieces than Klithi, and in particular a series of narrow backed flakes from 6mm to 8mm in width. Klithi and Franchthi produced backed flakes of very similar thickness, although those from Franchthi were slightly thicker. The KS test identified no a significant difference between Klithi and Franchthi in any of the dimensions. Klithi had a slightly lower length variance, although this was not identified as significant by the *F* test, while Klithi also produced the lowest width CV, which the *F* test did identify as significant. Similarly, Klithi produced a slightly lower thickness CV than Franchthi, however this was not identified as significant by the *F* test. The possible bimodality in the length distribution in particular may suggest that more than one type of tool-kit was produced using backed flakes. Smaller pieces perhaps functioned as bladelet based tools, while larger pieces, particularly those over 20mm in length, may have been used as hand held artefacts. The fact that these were relatively more common at Franchthi may point to enhanced use.

Backed bladelets

Fortunately the backed bladelet sample was bigger, and included all three sites. Backed bladelets at Klithi and Franchthi were quite similar in length, while those from Kastritsa tended to be longer. Overall, those from Franchthi tended to be the shortest. However, in terms of width, backed bladelets from Franchthi were more similar to those from Kastritsa, while those from Klithi tended to be narrower. Again in terms of thickness, Franchthi and Kastritsa were similar, while those from Klithi tended to be slightly thinner. The KS test identified a significant difference between Kastritsa and both Klithi and Franchthi in terms of length, and between Klithi and both Franchthi and Kastritsa in terms of width. No significant difference was identified between any of the three collections in terms of thickness. In terms of length variance the CV values identified quite a large difference between the three collections. Backed bladelets at Kastritsa were the most standardised, having the lowest CV value, followed by Franchthi and then Klithi, the largest difference being 5.3% between Kastritsa and Klithi. The *F* test identified the difference between Kastritsa and both Klithi and Franchthi as significant. The width CV results identified Franchthi as the most standardised, followed by Kastritsa and then Klithi, with a maximum CV difference of 9.9% between Franchthi and Klithi. The *F* test indicated all sites as significantly different in terms of width variance. Thickness CV values identified Kastritsa as having the lowest variance followed by Franchthi and then Klithi, the maximum difference being 12.5% between Kastritsa and Klithi, which the *F* test identified as significant.

Backed blades

The backed blade collection was too small in terms of length to make any further analysis, and only at Klithi and Kastritsa were there sufficient numbers of pieces to continue with the analysis of width and thickness. All that can be suggested is that longer backed blades appear to have been made more often at Kastritsa. In terms of width and thickness, samples were extremely small, with just 10 and 11 pieces respectively. Backed blades at Klithi and Kastritsa appeared quite similar in terms of width, while those from Kastritsa appeared slightly thinner. Needless to say, with such small sample sizes, none were identified as significantly different by the KS test, while variance and the *F* test was pointless due to the small sample size.

Artefacts with linear retouch

Artefacts with linear retouch also suffered as a result of the small sample size, with only seven pieces from Kastritsa with length measures, while Franchthi was too small to include in terms of any dimension. All that can be said is that there was an additional component of longer pieces at Kastritsa. In terms of width and thickness, Klithi produced narrower and very slightly thinner pieces than Kastritsa, although none were identified as significant by the KS test. Klithi had the lowest length variance, although Kastritsa was lowest in terms of width and thickness. The CV differences in terms of length and width were minimal, at around 2%. For thickness it was 6.6%, however, none was identified as significant by the *F* test.

Informal tools

Informal tools tended to be similar in terms of length at Klithi and Franchthi, although those from Klithi were on balance slightly shorter. Conversely, those from Kastritsa tended to be longer. In terms of width, all three collections were more similar than was the case for length. However the basic pattern remained, with Klithi on balance the narrowest, followed by Franchthi and then Kastritsa. In terms of thickness however, Klithi and Kastritsa were very similar, while those from

Franchthi were very much thicker. The KS test identified a significant difference between Kastritsa and Klithi in terms of length and width, and between Franchthi and both Klithi and Kastritsa in terms of thickness. In terms of length variance, the CV values identified Franchthi as the most standardised, followed by Kastritsa and then Klithi, while in terms of width, Franchthi produced the lowest variance, followed by Klithi and then Kastritsa. Similarly, in terms of thickness, Franchthi appeared the most standardised, followed by Kastritsa and then Klithi. Length variance differed by only 1%, width by 2.3% and thickness by 2.4%, while none were identified as significant by the *F* test. All three dimensions suggested a second peak in frequency, particularly at Franchthi and Kastritsa. These are accounted for by small numbers of larger artefacts, in particular burins, notches/denticulates and scrapers. For instance, the significant second peak in thickness at Franchthi was due to the presence of cores reused as scrapers.

Standardisation through blank selection

The idea of standardisation through blank selection was not as useful as had been hoped, principally because of the limited small sample size in most of the tool assemblages and interpreting the differences in frequencies observed. However, a number of broad patterns were observed which pointed to some size thresholds and by implication, that deliberate choices were being made when selecting blanks for the manufacture of the various artefact types.

Informal tools

Amongst informal tools, the use of blanks shorter than 20mm appeared to be less common than if their use simply reflected background debitage frequencies. This suggests that 20mm represented a lower size threshold for these tool types. The only possible difference between the three sites was of a slightly higher use threshold for Kastritsa. In other words larger blanks were being selected. In terms of width, a similar lower size threshold was suggested for pieces less than 12mm. Although it would appear as though significantly fewer blanks of this size fraction were being deliberately selected at Franchthi, the small size of the sample limits its value. In much the same way, a lower size threshold was implied for thickness, where, amongst informal tools, blanks thicker than 4.5mm appear to have been selectively used. Again the picture is of Franchthi using very much less of the smaller fractions, however smaller sample size amongst tools needs to be taken into consideration.

Formal artefacts

Flake tools

Tools made on flake blanks produced a diffuse distribution which was difficult to interpret. The Kastritsa sample is too small to say much about, with only twelve pieces in the best case. However, Franchthi and in particular Klithi produced larger samples. The length distribution was very erratic, probably of little value in the case of Franchthi and definitely Kastritsa. At Klithi, the distribution was difficult to interpret but suggested the deliberate selection of flakes over 8mm in length, those over 6mm in width and 1.5mm in thickness.

Bladelet tools

Bladelet blanks appear to have been less regularly selected below 20mm in length, bearing in mind that those pieces included in the length measurement frequency histograms were complete with proximal and distal ends. The few pieces less than 12mm which suggest more use of shorter pieces consisted exclusively of bladelets with linear retouch. There was little convincing evidence for any differences in blank selection on the basis of length at the three sites. Bladelets wider than 6mm at Klithi and Kastritsa, and 8mm at Franchthi appear to have been ignored. Some use of narrower pieces did occur, however at lower relative frequency. All three sites showed a similar pattern of deliberate selection of bladelet blanks less than 3mm in thickness.

Blade tools

The blade collections were very small and in fact were absent from Franchthi. All that can be said for the other two sites is that longer blades, particularly those over 40mm appear to have been more frequency selected. There was also some suggestion that longer blade blanks were being selected at Kastritsa than Klithi. Relatively more frequent use of blade blanks over 18mm in width appears to have occurred at both sites, although again at Kastritsa there was the suggestion of more use of wider pieces. As with bladelets, 3mm appears to be the cut-off beyond which blanks were not deliberately selected for use, although clearly some were still being used.

Chapter 8. Discussion of the results

8.1. Introduction

The aim of this chapter is to present the results of the lithic analysis undertaken for Klithi, Franchthi and Kastritsa, as well as the comparative chapter, and to discuss these in the context of the question posed at the beginning of the thesis. That is, was apparent specialisation in subsistence accompanied by specialisation in technology? The chapter is structured according to the following sections:

- Raw materials.
- Core use and debitage.
- Tools.
- Technological specialisation.

8.2. Results of the comparative analysis of lithic assemblages

8.2.1. Raw materials

Klithi

Lithic production at Klithi was based almost exclusively on the use of locally collected small rolled flint pebbles. These were eroded by the river from in-situ bands within the local limestone bedrock, and were probably collected from the banks of the Voidomatis as rolled pebbles. Known as Voidomatis flint, this material occurs as light to moderately rolled pebbles of fine to medium grained, grey to black flint. It is quite extensively internally fractured and often has inclusions. The availability of this material so close to the site reduced the need for caching, although the impression gained during this research has been that irrespective of raw material availability, site provisioning was rare.

In addition to Voidomatis flint, some limited use was also made of an additional better quality raw material, the source of which remains unknown. Despite the quality of this material and the fact that it is likely to have been carried in from some distance, the evidence from Klithi suggests that it was being used in broadly the same way as the local collected Voidomatis flint. The only slight difference was the suggestion that, on the basis of higher secondary proportions, cores were entering the site in a more extensively worked state. Despite Roubet's (1997a) contention that exotic flint was being used to make larger tools, no statistically convincing evidence was found for this, at least in the sample studied.

Franchthi

Unlike Klithi where the focus was on one specific raw material, lithic production at Franchthi was based on a wide range of types including flint, chalcedony, jasper and radiolarite. The flint probably originated fairly close to the site and appears to have been collected as small rolled pebbles as well as tabular chunks, perhaps from in-situ outcrops. Many of the chalcedonies and jaspers are distinctive and internally of very good quality. However, little can be said at present about the range of sizes in which they could have been collected, clearly more work needs to be done in locating these deposits. Like Klithi, there appears to have been little attempt made to cache material at Franchthi. This suggests that the sources of at least some of the raw materials used at the site were close by. Alternatively, and what I think is more likely, caching or the provisioning of places was simply not occurring during this period and in this region.

Kastritsa

The bulk of the raw materials used at Kastritsa were of good quality and appear to have been introduced as lightly rolled pebbles which had been partially worked. Unfortunately, the origin of this material remains unknown, although on the basis of secondary proportions, there is no evidence to suggest that it was being carried in from any great distance. In addition, some very limited use was also being made of Voidomatis flint at Kastritsa, which although potentially collected near Klithi, was probably available throughout the length of the Vikos gorge and perhaps elsewhere due to river transport. There was no convincing evidence for caching of raw materials, and it is probably more likely that cores carried by individuals were meeting technological needs.

Differences in raw material use between the three sites

Each of the three sites produced a range of raw material types, although in all cases the bulk was comprised of what were probably locally occurring types. Overall, those used at Kastritsa were most conducive to better flint working because of their size and good quality. Klithi and Franchthi were equally as poor in terms of raw material quality. Although all sites contained at least a component of material of unknown provenance, at Kastritsa and Franchthi the bulk of the raw materials remain un-sourced. However, based on the ways in which this material was being used and the proportions of secondary versus inner amongst both debitage and tools, it would appear as though they were not located at any great distance from the sites. The introduction of partially worked cores and the lack of caching in any significant sense suggest that lithic provisioning was primarily of individuals.

8.2.2. Core use and debitage

Klithi

The majority of cores at Klithi were made on local Voidomatis flint, which despite being readily available, was of poor internal quality. Despite this, the knappers at Klithi were having considerable success in setting up and working cores of this material. Although a range of sizes and forms were being discarded, many cores appear to have been worked to a finite size limit, which suggests that in the end, the viability of cores was limited by the ability of the knapper to keep a hold of them. With raw materials locally available at Klithi, this suggests that the value of a core was not simply the raw materials it contained, but the effort which had been invested and the potential of a well set-up core to continue producing viable blanks. Evidence for the maintenance of cores can be found in the form of rejuvenation blanks and core tablets, as well as the use of cresting as a means of both pre-shaping and re-shaping the core profile. Flake cores were the most common type at Klithi, although this is probably not an indication of the objectives of the knappers. In later life as cores become more difficult to work and hinge and step fractures accumulate, the numbers of flake scars increase, often obscuring earlier bladelet removals. The overall form of many of the cores as well as the debitage point towards knapping at Klithi as largely geared towards bladelet production.

Flakes were the most common debitage form, comprising 63.9% of blanks greater than 10mm, followed by bladelets (25.8%) and then blades (8.9%). Blades were the longest blank form overall with peaks in frequency at around 34mm and 42mm. Blades and flakes were similarly as wide as one another, with a peak in frequency at 14mm. Bladelets tended to be slightly longer than flakes with a peak in frequency at around 18mm, but were the narrowest blank form with a peak at around 7mm. Exotic raw materials were being used in broadly similar proportions as Voidomatis flint, to make flakes (9.2%), bladelets (11%) and blades (9.2%), and on the whole both appear to have been used to make blanks of broadly comparable sizes. However, and bearing in mind the small samples of exotic blades in particular, there was a slight suggestion that both bladelets and blades made of exotic material tended to be slightly longer than those made of local Voidomatis flint.

Franchthi

Flaking at Franchthi appears to have been relatively expedient. The wide but short tabular cores encouraged production of flakes, while platform preparation was rare. The small number of conical cores, and the very rare occurrence of crested blanks points to only limited effort being made to produce formal bladelet producing types. However, bladelet scars were present on cores other than conical, while the efforts being made by the knappers at Franchthi to perpetuate the life of their cores, can be seen in the use of multiple platforms, rejuvenation attempts and their use until too small to hold.

Flakes were the most common blank form (76.7%), followed by bladelets (19.9%) and blades (3.4%). There was an apparent decline in both bladelets and blades through time from phase II, through III to IV. Blade blanks were the longest overall, with a peak in frequency around 30mm and then again at 42mm. Interestingly, although comprised of relatively small samples, this second peak of longer blades was noted in all three phases. Flakes and bladelets were more or less as long as one another, with a peak at around 14mm, although bladelets were narrower at around 7mm, compared to flakes at 12mm. Overall, there was evidence for a consistent increase in dimensions of all three debitage types through time from phase II, through III to IV.

Kastritsa

That raw materials were entering Kastritsa in relatively larger sizes is indicated by the larger debitage produced. In addition, their size and better quality also appears to have reduced the need for more involved core working, for instance through cresting or the use of conical cores. Overall it would appear that the availability of these better quality raw materials encouraged a wider range of approaches to core working, in terms of shapes, number of platforms and flaking direction. At Kastritsa, the use of better raw materials also appears to have been accompanied by relatively more platforms per core. This suggests an element of economising or at least perpetuating of core life through the incorporation of more platforms. On the other hand it may simply reflect larger starting size. Bigger raw materials will reach a point at which rejuvenation or platform switches become necessary, while still relatively large. Bearing in mind that rejuvenation may not always be successful, and anyway becomes more difficult the smaller the core becomes, we may expect cores in which raw materials were larger to begin with, will also be abandoned at slightly larger sizes.

Flakes were the most common blank form (56.2%), followed by bladelets (25.3%) and then blades (18.5%). Blades were the longest, with a broad frequency distribution centring on 40mm. Flakes tended to be shorter with a peak frequency around 14mm, compared to bladelets at around 22mm. Bladelets were narrow with a peak frequency at around 10mm, with flakes around 14mm. There appears to have been a consistent decline in dimensions through time from stratum 3 to 1 amongst all three blank types.

Differences in core and debitage use between the three sites

Klithi contained far fewer cores (1.3%) as a proportion of the total assemblage, compared to 3.7% at Kastritsa and 3.9% at Franchthi. This relatively lower frequency of cores at Klithi is probably due to the size of the assemblage, and the fact that raw materials were being introduced very early in the knapping sequence. This combined with their poor quality, would have led to the generation of a relatively much larger debitage assemblage, in turn reducing the proportional contribution of discarded cores. Cores appear to have been used in similar ways at all three sites, although with some differences potentially attributable to differences in raw materials. In particular, the small size and poor quality of raw materials at Klithi led to the predominant use of formal conical shaped cores with smaller numbers of platform than either Franchthi or Kastritsa. Tabular raw materials at Franchthi appear to have led to more use of informal cores with larger numbers of platforms. The same appears to have occurred at Kastritsa, although here it would appear as though this was encouraged by the larger raw material sizes. The majority of core use at all three sites appears to have been geared towards blade/bladelet production, the relative success of which was determined by the nature of raw materials. Cores on the whole tended to be longer at Kastritsa, followed by Klithi and then Franchthi. However, in terms of platform size Franchthi were the largest overall, followed by Kastritsa and then Klithi. The length of cores at Kastritsa is a reflection of the availability of larger raw materials overall. The reasons for the larger platforms at Franchthi are not clear, although it may reflect the greater use of thin tabular raw materials.

Unretouched flakes tended to be longer at Kastritsa, particularly those over 20mm, followed by Klithi and then Franchthi. Flakes were also wider, with a peak frequency of around 15mm, compared to 12mm for Klithi and Franchthi. Bladelets were significantly longer at Kastritsa, although with a similar peak frequency as Klithi at around 18mm compared to 14mm at Franchthi. Similarly, bladelets were wider at Kastritsa, followed by Klithi and then Franchthi. There was no real difference in terms of thickness. Blades were also longer, wider and thicker at Kastritsa, followed by Klithi and then Franchthi.

8.2.3. Tools

Klithi

The tool inventory from Klithi was large and relatively diverse, comprising almost 12% (n=990) of the whole of the lithic assemblage sampled. The collection produced 14 morphologically distinct tool categories, of which backed bladelets were the most common type, comprising just over 34% of all retouched artefacts. There was a significant decline down to the next most common artefact categories, which comprised between around 9% and 13% of all tools, and included notches/denticulates, burins, scrapers and flakes with linear retouch. Tools were most commonly made on bladelet blanks (50%), although flake based artefacts were also relatively common (35.9%). Blade use was relatively rare at just 13%, although this was higher than their background frequency amongst debitage. The largest tools were blades with linear retouch and scrapers, although the largest tool in assemblage was a flake with linear retouch of 62.8mm in length. Of all the retouched artefacts, most (84.3%) were made on local Voidomatis flint, with just over 12% made on exotic materials, although this was slightly higher than their proportion amongst debitage (10%). Bearing in mind the relatively small sample sizes, no obvious evidence for any size differences between tools made on local or exotic raw materials were observed, despite Roubet's (1997a) contention that larger tools were being made more frequently from the latter. In addition, there was no apparent selective use of exotics for the manufacture of formal tools. Borers were the most commonly made tool using exotics (30%), while 16.7% of bladelets with linear retouch and 14.9% of backed bladelets were made on the same materials, although this was higher than its frequency amongst bladelet blanks (11%). Bladelets with linear retouch and backed bladelets were the second and third most commonly made tools on exotic raw materials respectively, and were higher than the mean of 13.5%. The tools least commonly made on exotic raw materials were truncations, burins and notches/denticulates, all at less than 10%.

The pattern amongst tools at Klithi, in particular the numbers and diversity of types suggests that in addition to backed bladelets and their supposed association with hunting, a range of other activities were also being undertaken, consistent with processing and manufacturing. This is further supported by the presence of tools made on antler and bone, including needles, awls, points and spatulae (Bailey *et al.* 1983; Adam and Kotjabopoulou 1997). These all suggest diversity of activities and by implication, a diversity of social structures such as task division. For instance, some members of the group could search for food, while others could be allocated with cooking, making tools. Notwithstanding the predominance of backed bladelets, the lithics present a picture not inconsistent with that of a site used by groups, perhaps families, in which a range of activities were undertaken. These groups would have been moving along the Vikos gorge, and as they went, were augmenting their transported lithic toolkit with raw materials collected from the banks of the river. Although raw materials from outside of the gorge appear to have been entering the site as more extensively worked cores, both types were being treated in more or less the same way, suggesting a flexible approach to the limitations imposed, particularly by Voidomatis flint. Although not the highest, the higher than average use of exotics in the manufacture of backed bladelets is probably consistent with their use as composite elements in a curated hunting technology. As such they are relatively more likely to be carried further, and therefore to be comprised of relatively more exotics. The higher frequencies of exotic borers is puzzling, and may suggest that these artefacts were in fact more extensively curated than they at first appear.

Franchthi

The tools at Franchthi were poor in quantity and frequency, comprising just 4.5% (n=171) of the total assemblage. The assemblage was also poor in diversity, with 10 categories identified overall, many comprising just a few pieces. The most common artefact type was the backed bladelets (59.6%), followed by backed flakes (17%), notches/denticulates (8%) and scrapers (7.6%). The relatively high frequency of backed bladelets led Perlès (1987) to suggest that during phases II and III, the site was used as a specialised hunting camp. The remainder of the collection consisted of less than three tools per category. Tools were most commonly made on bladelet blanks (64.1%), followed by flakes (32.7%), while the use of blades was extremely rare (1.8%). The largest tools overall were scrapers.

Despite an apparent, although slight, increase in tools as a proportion of the whole assemblage from phase II (4%), through III (4.2%) to IV (5.3%), tool diversity appears to have declined through time, with eight categories in phase II, four in phase III, before increasing again to seven in phase IV. Of the tool categories with reasonable sample sizes, namely backed bladelets, there was some suggestion of an increase in both width and thickness through time from phase II, through III to IV.

Kastritsa

The tool inventory of Kastritsa comprising 10.7% (n=317) of the total assemblage and was particularly diverse with 15 distinct artefact categories identified. The most common artefact type was the backed bladelet with 49.2% of tools, followed by burins (12.3%), scrapers (11%) and notches/denticulates (6.3%). The rest of the tool collection consisted of small numbers of each tool type, including seven microgravettes and a single Aurignacian blade. Tools were most commonly made on bladelet blanks (60.4%), and then flakes (20.6%) and blades (18.9%). The largest tools were scrapers with a maximum length of 86.3mm. The variety of artefact categories and the size of the tool collection suggests that a wide variety of tasks were being undertaken, further supported by the presence of tools made on antler and bone (Bailey *et al.* 1983; Adam and Kotjabopoulou 1997). The frequency of tools as a proportion of the whole assemblage increased through time from 8.2% in stratum 3 to 12% in stratum 1, while the number of categories increased from 12 in stratum 3 to 14 in stratum 1. Although not clear in all cases, primarily due to small sample sizes, there appeared to be a decline through time in the size of tools from stratum 3 to 1.

Differences in tools between the three sites

Klithi and Kastritsa produced similar tool frequencies at 12% and just over 10% respectively, compared to just 4.5% at Franchthi. Of all tools, backed bladelets were more common at Franchthi, comprising 59.6% of the tool assemblage, compared to 49.2% at Kastritsa and just 34% at Klithi. The assemblage was more diverse at Kastritsa with 15 categories, followed by Klithi with 14, and then with Franchthi with just 10. With categories not present at all sites, and small sample sizes overall, comparison between assemblages in terms of tool dimensions was difficult. One of the larger categories was backed bladelets, in which all three assemblages contained more than 30 pieces. Klithi and Franchthi were similar in terms of length, with a peak frequency of around 22mm. Kastritsa had the same peak frequency although it contained a significant component of longer pieces. There was a significant decline in frequency from 40% to just 20% of backed bladelets less than 20mm in length at Kastritsa, suggesting a lower cut-off. In terms of width and thickness, the differences between all three sites were less extreme, although on balance those from Klithi tended to be slightly narrower than either Franchthi or Kastritsa. Similarly, there was some suggestion that thinner pieces were more common at Klithi. Amongst artefacts with linear retouch, consisting of flake, bladelet and blade forms, and for which only Klithi and Kastritsa could be compared, those from Kastritsa tended to be slightly larger overall. Similarly, amongst informal tools consisting of truncations, notches/denticulates, borers, burins and scrapers, Kastritsa produced longer and wider pieces, followed by Klithi and then Franchthi. In terms of thickness, Franchthi produced the thickest informal tools. Overall, there was a considerable degree of similarity between all three sites in terms of tool dimensions. The most significant difference was the higher frequency of longer backed bladelets at Kastritsa. However the similarities amongst both width and thickness suggest that this difference was purely to do with availability of larger raw materials at Kastritsa.

8.2.4. Technological specialisation

In his study of artefact design, Bleed argued that one way in which technological downtime could be avoided was by using technology composed of sub-systems, which could be easily repaired or replaced. One way in which this could be done was to keep elements simple, and standardised in size and shape (*ibid.*:739-40). The development of standardised technologies has been considered as synonymous with the Upper Palaeolithic, at least in broad terms, and particularly in relation to the deteriorating conditions witnessed during the run up to the LGM. The most distinctive of these standardised artefact types were the backed bladelets. The significant presence of these artefacts at sites, amongst others, where a limited diversity of animals were hunted, so-called specialised sites, has resulted in an association between the two (Straus 1987a,b). My aim with this research was to investigate whether any association between the type of subsistence, whether specialised or generalised, and the type of technology could be demonstrated. In other words, do backed bladelets occur only in specialised sites and more generally is there any evidence to suggest that technology in these and other more generalised sites was being differentially standardised? The way in which standardisation was assessed was through a metric comparison of dispersion, in other words, the amount of variance around the mean. Four methods were used, the coefficient of variation (CV), percentage differences between the mean and each value, and the *F* and KS significance tests. The application of these methods produced a number of unexpected results, however they also highlighted the many ways in which standardisation could be achieved, such as during knapping, as part of blank selection, or during tool manufacture.

8.2.4.1. Standardisation during blank production

Klithi

At Klithi there were no obvious and consistent differences in terms of the degree of metric standardisation being achieved during core working and blank production. Blades/bladelets appeared slightly more standardised than flakes in terms of length, however they were less so in terms of width and thickness. In other words, apart from making flakes as opposed to blades or bladelets, the knappers at Klithi were not imposing any more or less standardisation depending on blank type.

Franchthi

In the same way as at Klithi, blades/bladelets at Franchthi appeared slightly more standardised than flakes in terms of length, but less so than width and thickness. Moreover, there was also little change in standardisation through time from phase II, through III to IV amongst flake length, width or thickness. In terms of blades/bladelets there was no obvious change in standardisation amongst length or width, however they did appear to become slightly more standardised in terms of thickness.

Kastritsa

At Kastritsa, blades/bladelets were more standardised than flakes in terms of length and thickness, but less so in terms of width. In all cases the difference in variance between artefacts was small and there was no obvious consistent pattern noted between any of the three dimensions. There was no clear shift in standardisation through time amongst flakes or blades/bladelets between the stratum 3 and stratum 1.

Differences in standardisation during blank production between the three sites

Standardisation was compared for each blank type and dimension between sites. So for instance flake width at Klithi was compared against flake width from Franchthi and Kastritsa. The CV and cumulative percentage differences, as well as the *F* and KS tests identified a number of significant differences between the three sites. However, there was no consistent or convincing pattern to this variability, apart from perhaps that material from Klithi always had a slightly higher variance, and by implication was less standardised than either Franchthi or Kastritsa. On balance, and considering the poor quality of raw materials at Klithi, this research strongly suggests that there was no difference in the level of metric standardisation achieved at the three sites. In other words, flakes were being made in broadly the same ways at all three sites, as were blades and bladelets.

8.2.4.2. Standardisation during blank selection

Evidence for differential blank selection amongst tools was sporadic, however a number of size thresholds for deliberate selection of blanks were suggested. Amongst informal tools, including truncations, notches/denticulates, borers, burins and scrapers, there appears to have been deliberate selection of blanks over 20mm in length. Although some use of shorter pieces did occur, this was at or below background blank proportions. Blanks over 12mm in width appear to have been relatively more frequently selected, as well as those over 4.5mm in thickness. Overall there appears to have been little difference in terms of relative blank selection at the three sites, apart from the suggestion of slightly longer pieces being used at Kastritsa.

Amongst formal flake based tools, sample sizes were small however at Klithi, deliberate selection of blanks longer than 16mm, wider than 10mm and thicker than 1.5mm appears to have occurred. The pattern for bladelet based tools was clearer and was suggestive of deliberate selection of blanks over

20mm in length at all three sites. At Klithi and Kastritsa, bladelet blanks appear to have been relatively more commonly selected below 10mm in width, and less than 3mm in thickness Amongst blade based tools, blank selection appears to have been focused on those over 38mm in length, 16mm in width and those less than 3mm in thickness. Overall, there was some suggestion that blade blanks being selected at Kastritsa were larger.

8.2.4.3. Standardisation during tool manufacture

Klithi

The pattern observed at Klithi was quite unexpected, in that backed bladelets appeared in most respects to be the least standardised element of the tool collection. Conversely, artefacts that would be expected to be unstandardised, were in fact the most. Ignoring blade based artefacts because of small sample size, the most standardised artefact category was scrapers. Although unexpected, this pattern was repeated at Franchthi and Kastritsa. Although there was considerable variability in variance between dimensions, the overall picture was of no obvious standardisation amongst what could be considered formal as opposed to informal tools. In terms of length, backed bladelets were the third most standardised artefacts after scrapers and notches/denticulates, while in terms of width and thickness they were the least standardised of all artefacts along with bladelets with linear retouch.

Franchthi

At Franchthi tool numbers and categories were small, in particular scrapers with only 13 pieces measured. In terms of length, backed bladelets appeared most standardised, although scrapers were apparently the most standardised artefact type in terms of width and thickness. The least standardised group overall were backed flakes. There was some evidence for an increase in standardisation of backed bladelets through time at Franchthi, in particular in terms of length and thickness between phases II and III.

Kastritsa

At Kastritsa the broad pattern of lack of standardisation amongst formal tool categories continued. Scrapers appeared the most standardised artefact type in terms of all three dimensions, although backed bladelets were the second most standardised in terms of length. However, in terms of width and thickness, they were the least standardised along with burins. There was a slight suggestion of an increase in standardisation through time amongst backed bladelets, particularly in terms of width and thickness. There was no clear association between formal tool types and enhanced levels of metric standardisation. In fact the opposite seems to be the case, with artefacts such as scrapers and notches/denticulates appearing more standardised according to the metric criteria.

Differences in standardisation between sites during tool manufacture

Only four tool categories were compared between the three sites due to small sample sizes. In addition, a number of specific types were combined in order to produce larger groups. The final categories investigated were backed flakes, backed bladelets, artefacts with linear retouch and informal tools. There was considerable variability in the patterns observed and a particular lack of consistency in the results. Moreover, in many cases the differences in standardisation as inferred by the CV values were very small. Backed flakes from Klithi appeared more standardised in all three dimensions than those from Franchthi, although backed bladelets at Klithi were the least standardised of all three sites. Backed bladelets from Kastritsa were the most standardised of all three in terms of length and thickness. In terms of informal tools, Klithi also appeared the least standardised in terms of length and thickness, while Franchthi appeared the most standardised in all three dimensions.

Overall, there was no obvious and consistent pattern of differential standardisation between sites, apart from the slight suggestion that both formal and informal tools were less standardised at Klithi than either Franchthi or Kastritsa. Again, the limitations of raw materials at Klithi may have played a part in this, as appears to have been the case with debitage.

8.2.5. Summary

The results of the analysis of the lithic assemblages from each of the sites, as well as in terms of one another, pointed to some differences, but on the whole the picture was predominantly of significant similarity. At all three sites, raw materials were introduced as partially worked pebbles and cores, predominately as personal gear. Despite some evidence for deliberate site maintenance at Kastritsa, this apparently did not extend to the provisioning of the site with raw materials. Once introduced, cores were being worked in broadly the same ways at all three sites, with bladelet production apparently the primary aim, as indicated by their much higher use for tool production. This is not to say that flakes were ignored, however considering the significant amounts of flake debitage produced during bladelet manufacture, finding suitable flake blanks is unlikely to have been a problem. Any differences in the range and size of blanks produced at the three sites can be explained by differences in the raw materials being used. Tools were being made in very similar ways as well, although some differences noted, for instance the lack of microburins in the earlier phases at Franchthi. As for the tools themselves some differences in the proportions of types were observed, although all three sites were dominated by backed bladelets. The rest of the tool collections consisted of small numbers of less formal types, although at Klithi, scrapers were common as well. In terms of the diversity of tools, Klithi and Kastritsa were very similar to one another, while the Franchthi assemblage was both smaller and less diverse. As with blanks, any differences in the size of tools can be explained in terms of raw materials used. The analysis of variance between the three sites identified no convincing evidence for differential standardisation of blanks or tools. However, a number of interesting "anomalies" were repeatedly identified within each of the collections. The first of these was that thickness was the least standardised dimension in all cases. The second was that scrapers were apparently the most metrically standardised artefacts, while backed bladelets were consistently amongst the least. Whatever the significance of this, the fact remains that backed bladelets were the most common and most distinctive of the artefacts in all three collections. That they were apparently less metrically standardised need not detract from their status as lithic markers, but rather that within the group there was considerable variability.

In order to summarise these results in relation to our expectations of what would constitute a specialised and generalised site, the table of theoretical expectations (tbl.8.1), which was presented previously in chapter 2, is compared against a summary of observations (tbl.8.2) as to the nature of lithic technology at the three sites.

Table 8.1. Some expectations as to lithic technology at specialised and generalised sites.

Characteristics	**Generalised sites exploiting a wide range of resources, located in benevolent environments**	**Specialised sites exploiting a restricted range of resources, located in risky environments**
Size and diversity of assemblages	Large lithic assemblages with high diversity of debitage and tools. All knapping stages from unworked nodules to abandoned cores.	Small lithic assemblages with low debitage and tool diversity. Emphasis on latter stages of the core reduction sequence.
Raw materials	Use of local or exotic or both depending on availability. Provisioning of people or places. Broad range of secondary and inner debitage.	Predominant use of exotic, irrespective of availability. Provisioning of people. Predominance of inner debitage.
Core use and discard	Formal and informal shapes. Cores more frequently discarded and at a wider range of sizes.	Predominance of formal shapes. Low rate of core discard at more reduced stages.
Tool manufacture or maintenance	High incidence of tool manufacture.	Predominance of tool maintenance.
Artefact design	Maintainable and reliable, curated and expedient.	Reliable and curated types predominate.

Based on the colour coding in table 8.2, it would appear that very few of the characteristics of the three sites could in fact be considered as typical of specialised sites. One possible exception to this was the site of Franchthi, where the assemblage was small and poor in diversity. On the other hand, the range of cores and debitage present suggested that the same range of tool manufacturing processes were being undertaken as at Klithi and Kastritsa. The other exception was Klithi, with a predominance of formal core shapes and relatively low levels of discard. However, this can probably be explained in terms of raw materials used at Klithi. Small and poor in quality, they encouraged the use of formal conical shapes. These in turn tended to produce large quantities of shatter and snapped pieces during use, and therefore as a proportion, cores appeared relatively less common.

Table 8.2. Characteristics of the lithic assemblages from Klithi, Franchthi and Kastritsa.

Characteristics	Klithi	Franchthi	Kastritsa
Size and diversity of assemblages	Large lithic assemblage with diversity of debitage and tools. All knapping stage from pebbles to abandoned cores.	Smaller lithic assemblage with diversity of debitage but low diversity of tools. All knapping stages from pebbles to abandoned cores.	Medium sized lithic assemblage with diversity of debitage and tools. All knapping stages from pebbles to abandoned cores.
Raw materials	Predominant use of local flint. Provisioning of individuals.	Predominant use of local flint. Provisioning of individuals.	Predominant use of local flint. Provisioning of individuals
Core use and discard	Predominance of formal core shapes. Relatively low core discard rates, mostly of exhausted pieces.	Formal and informal shapes. Higher rate of core discard, mostly exhausted pieces.	Formal and informal shapes. Higher rate of core discard, of exhausted and partially exhausted pieces.
Tool manufacture or maintenance	Predominance of tool manufacture.	Predominance of tool manufacture.	Predominance of tool manufacture.
Artefact design	Maintainable and reliable, curated and expedient.	Predominance of reliable curated tools.	Maintainable and reliable, curated and expedient.

Key: Heavy shading: contains aspects typical of generalised technologies
Light shading: contains aspects typical of specialised technologies
No shading: contains aspects typical of specialised and generalised technologies.

Lithic production at all three sites, despite displaying a few specialised aspects, pointed to the sites as more generalised. Our working assumption that Klithi was specialised, and Franchthi and Kastritsa generalised, cannot therefore be sustained, at least in terms of technology. There may be two explanations for this. First of all, there may be no link between specialisation in terms of subsistence and site location, and technology. In other words, specialised technologies were not related to specific sites but rather to specific activities, and that these were repeated in all sites throughout the region. An alternative explanation may be that technology and subsistence specialisation were linked, but that none of three sites studied is in fact specialised. The validity of these two alternative explanations is discussed further in the conclusions in relation to the whole concept of specialisation.

8.3. Backed bladelets as markers of specialised technology

Backed bladelets have been consistently associated with hunting technology, and on the basis of sites in the Mediterranean region, with so called specialised sites in particular (Straus 1987a,b). The dominance of backed bladelets in these assemblages suggests that they played an important role in late and postglacial subsistence strategies across the whole of the region. The site of Klithi in particular, but also Franchthi have been used as markers for these types of subsistence behaviour in the east of the Mediterranean region. The impression one gets when working with this material is of homogeneity in size. In other words they appear to have been made to both a specific form as well as size. One plausible reason for this is to do with their function as elements within composite tools as suggested by microwear analysis of backed bladelet samples from across Europe (Ibáñez-Estévez and Conzález-Urquijo 1996; Moss 1997; Tomásková 2000). Archaeological evidence suggests that one reason for this repetition of form and size was to do with hafting (Rozoy 1989:18; Bergman 1993:102; Cattelain 1997). The most complex and time consuming of any composite technology is the delivery mechanism. Whether a knife or projectile, the bone or antler handle requires many more hours of manufacture than do the cutting elements. It makes sense therefore that the latter be expendable. Notwithstanding the obvious importance of backed bladelets, their predominance probably has much to do with their role within composite tools. With elements arranged in series, the significant numbers of backed bladelets found at sites such as Klithi are easily explained particularly if we consider that there may have been six or more of these elements per artefact.

Despite the apparent distinctness of these artefacts, this study was unable to identify backed bladelets as significantly more metrically standardised than the rest of the tools in each of the sites. In fact, backed bladelets were consistently the least standardised artefacts, while scrapers were in all cases the most standardised. Moreover, no significant differences in metric standardisation amongst backed bladelets could be identified between the three sites despite Klithi's apparent status as a specialised hunting location. In fact if anything, backed bladelets at Klithi were less standardised than in either of the other two collections.

At the site level this suggests that backed bladelets, despite being made to a predetermined form, were not necessarily being made to any specific size template, apart from being generally thin, narrow and moderately long. The fact that metric standardisation as an explanatory model failed to describe the observed variability, suggests perhaps that the weakness of the approach lies in the way it deals with small artefacts. The smaller the artefact, the more difficult it becomes to spot incongruities in dimensions and equally to do much about them. Even very small absolute differences at the scale of a backed bladelet will mount in terms of percentage variance. For instance, a variance of 10% on a 5mm wide backed bladelet is only 0,5mm, compared to 5mm on a 5cm wide scraper. The backed bladelets will look less variable, however their CV values will be the same. This suggests that comparing artefacts of very different sizes will be difficult. Not because of problems with the method, but because what by eye may appear standardised, may in fact not be so. Throughout this study, the smallest dimensions and artefacts were constantly the least standardised. This is not to limit the significance of scrapers as apparently the most standardised artefact type. They consistently produced the lowest CV values and at the same time, varied the least with respect to the mean as indicated by the cumulative percentage difference. Rather than simply expedient artefacts, this suggests that scrapers were in fact being made to a fixed set of dimensions, perhaps because of hafting, or alternatively because they were being re-sharpened down to a finite size. Use wear analysis undertaken on an Upper Palaeolithic scraper sample from Spain has shown that those with traces of hafting tended to be more regular in shape than those which did not (Ibáñez-Estévez and Conzález-Urquijo 1996:25-47). To test this at Klithi, end and side scrapers were assessed separately for standardisation, with the working assumption being that if hafting tended to limit variability in all three dimensions, then end scrapers would be more likely to be affected. However, no significant difference in the level of metric standardisation was found.

8.4. Some comments on the methods of analysis

The methods used to investigate specialisation were all based on variance, which in various forms provides a measure of the degree of difference between the collection and its mean. The use of the coefficient of variation was an extension of simply using standard deviation as a measure of dispersal. The problem with the latter is that it was influenced by the size of the artefacts being compared. The coefficient of variation removes this effect by dividing the standard deviation by the mean. As such the method provides a measure of relative variance around the mean. Although this method worked relatively well, it still remained unclear as to whether the differences observed were in fact significant. In order to assess this, the *F* test was used. The way in which this method works is by calculating the variance around the mean for each set of data and then dividing one by the other. The result is then compared against *F* critical for a given significance level and sample size, and if larger, the variance between the groups is said to be significantly different. The *F* test results were calculated for all standardisation analyses listed in Appendices I-IV. Although in many cases the results of the CV analysis and the *F* test produced consistent results, on occasions they appeared contradictory. For example, a large difference in CV between two samples was identified by the *F* test as not significantly different, while for another sample, a sample with a negligible difference in CV was identified as having a significantly different variance. The reason for this is the way in which the two approaches are calculated, and in particular the fact that CV accounts for size, whereas the *F* test does not. The larger the artefact, the larger will be its variance, so producing a large quotient when one is divided by the other. This limits the value when comparing dimensions which are very different, however its effect was also observed amongst artefacts of similar size ranges, for instance when comparing width amongst backed bladelets and backed blades.

This suggested that an alternative method of assessing variance was needed, while at the same time a method of graphically presenting the differences highlighted by the CV results was considered useful. The method adopted is referred to in the text as cumulative percentage differences. Expressed as a cumulative frequency, difference between groups can be visually compared, and then tested for significance using the KS significance test. The method involved calculating the mean for each dimension, and then calculating the absolute percentage difference between it and each value. So for instance if we had a mean width of 10mm, then a backed bladelet of 5mm or 15mm in width would be said to be 50% different. These were then used to produce a histogram of relative differences, which were presented cumulatively for ease of comparison. The results of the cumulative frequency histograms consistently supported the results identified by the CV analysis, and at the same time allowed the significance of the observed differences to be tested using the KS test. These provided useful support for the results of the standardisation analysis and avoided the problems associated with the use of the F test.

Chapter 9. Conclusions

9.1. Introduction

Despite possessing a few specialised aspects, the three sites appeared, at least in terms of lithic technology, to be more generalised. The few differences observed between them can be explained either in terms of the quality and quantity of raw materials, or differing occupation rates. Our working hypothesis that Klithi was specialised and Franchthi and Kastritsa generalised, could not be sustained; or to be more precise, it has to be modified at least as far as Klithi is concerned. It was proposed that there might be two explanations for this. Either the link between specialised sites and technology does not exist, or alternatively that we have yet to find a truly specialised site.

9.2. The concept of specialisation in subsistence strategies

Klithi has traditionally been considered to be a specialised site. It has high densities of ibex bones to the virtual exclusion of all other species. It is located in a rugged mountainous region, and contains a lithic technology dominated by backed bladelets. However there are key aspects of Klithi, which suggest that it should not be considered as specialised. First of all, the high densities of ibex simply reflect background faunal resources, rather than any deliberate choices made. Secondly, although located within a rugged mountainous region, the site itself is not any higher than those to the north on the Konitsa plain (i.e. Boila, Kotjabopoulou *et al.* 1997:427) or to the south in the vicinity of Ioannina (i.e. Kastritsa, Bailey *et al.* 1983:29). Rather than along a dead end, the site is located on what would have been one of the best routes for traversing the region. Rather than as special purpose trips, this suggests that visits to Klithi were part of overall mobility strategies within the region. Thirdly, the nature of the lithic assemblage, in particular assemblage structure and standardisation, indicated no significant differences between Klithi and the other two sites. This suggests that a broad range of activities were being undertaken at Klithi, comparable if not more wide-ranging than at either Kastritsa or Franchthi.

At Klithi, the concept of specialisation. has been used to describe a narrow range of activities organised around the hunting and consumption of a specific animal species, mountain goat. Pichler (1999:482) has suggested that Gravettian populations of eastern Europe could be either specialists or generalists, but not both at the same time. My aim is to use Klithi in order to argue for exactly the opposite, that is, that specialised and generalised sites are part of the same diversified system. To do this, the following issues will be discussed:

- The exclusive use of caprines at Klithi does not indicate the deliberate selection of specific species at the expense of others, but simply the use of animals available.
- Klithi is unlikely to have been the destination of special purpose hunting trips, but rather an attractive stopover in an otherwise inhospitable region.

Hunting of single animal species as an indicator of specialised subsistence strategies

Specialised hunting is broadly defined as the procurement of a specific type, age or sex of animal species (Stiner 1994:313-4). At Klithi, hunting was focused on caprines with an additional emphasis on adult individuals (Gamble 1997), as good providers of fat, necessary for human development in cold environments such as those of the last glaciation (Stiner 1990:336). This suggests that specialised hunting was undertaken at Klithi. However, if we consider that specialised hunting actually means that of the range of available resources, people were only using some of them, then Klithi appears less specialised. Jochim (1981:106) argues that any attempt to investigate how a group copes with the challenges of limited resources, has to take into account the specific environmental parameters characterising each case study, and in particular the resources potentially available. For instance, if a group was utilising 10 resources, while another was exploiting 20, we may be tempted to infer that the latter group was more diversified, perhaps in response to greater subsistence insecurity. If however, the first group was exploiting 10 out of only 20 resources, whereas the second was using 20 out of 100, then the latter should be considered more specialised.

Klein (1999:532-4) makes the point that where the bones of a single species predominate, it is likely that this species also dominated the environs of the site. The bones need not therefore indicate deliberate selection, but simply the use of the only resources to hand. The abundance of reindeer at late Upper Palaeolithic sites in southwestern France is a case in point, since it almost certainly reflects climatic deterioration that all but eliminated other herbivores. The situation at Klithi appears to be in agreement with this. As the fauna of the site suggests, hunting was concentrated on one species simply because caprines constituted the only available animal hardy enough to live on the slopes of the Vikos gorge. Bones of other animals, such as red deer, which could indicate an expansion of hunting activities beyond the gorge, in the plain of Konitsa for instance, are absent from the fauna of the site (Gamble 1997). In addition, the faunal record suggests that the use of the site was occasional and seasonal (*ibid.*). The rockshelter was mainly visited during the warm months of the year when adult animals were generally in poor condition, but at the same time, would have been available in larger numbers while grazing around Klithi on the more water-retentive flysch soils above the site (Bailey 1997c:660). This suggests that it was not specialised hunters who were visiting Klithi, but groups who found themselves in the gorge, whether as part of their seasonal round or simply as a means for traversing an otherwise difficult environment at a specific time of the year. In effect, the Vikos gorge may have provided an east west access along which groups were travelling, while at the same time exploiting available ibex populations.

The use of novel locations as indicators of specialised behaviour

I have argued that subsistence at Klithi need not be considered as specialised, but rather as part of a more diversified system in which a wider range of resources and locations were being incorporated. Apart from the emphasis on single prey species, an additional argument made in support of ibex sites such as Klithi or those in the Spanish Pyrenees (Straus 1987a,b) as specialised, is that they are usually found at high altitudes. These were novel environments not previously exploited during the Paleolithic, the implication being that their use became feasible with increased planning depth during the Upper Palaeolithic.

Klithi is located at an altitude of approximately 500m, and nestles within one of the highest mountain ranges in Greece. However for the region as a whole the site and the Vikos gorge lie at relatively low altitude, and certainly not much higher than either the plain of Konitsa or the area around Ioannina. In fact rather than inhospitable, the Vikos gorge would have provided a useful access route through the area, so focusing activities along the gorge, and past the front of the site. Rather than a destination in its own right, Klithi is more likely to have been a stopover during movement from the area of the Konitsa basin, southeast towards the Ioannina basin and beyond. If so, then Klithi need not be considered as a site exclusively geared towards the exploitation of ibex.

Klithi has been often connected with Kastritsa and indeed the presence of Voidomatis flint suggests a common link, although the possibility that this may be found elsewhere in the region either as in-situ or derived deposits cannot be discounted. It would be an attractive proposition to suggest Kastritsa as a home base and Klithi as a special purpose hunting site. However, as discussed in chapter 8 and previously in this chapter, the evidence does not support this. Archaeologically, Klithi and Kastritsa appear very similar to one another. Both had similar tool proportions overall, while both produced a diversity of tools, including non-flint types, suggestive of a broad range of activities being undertaken. The artefacts were being made to broadly the same pattern at both sites, while there was no evidence found for any difference in metric standardisation between them. In fact, tools at Klithi appeared on the whole to be slightly less standardised than those at Kastritsa. In addition, both contained similar evidence for the presence of all aspects of core use and debitage production. If we combine this with Gamble's (1997:237) suggestion that Klithi could have been used for up to two months at a time, by groups of up to fifteen people, then what we appear to have at Klithi is a generalised residential site. Moreover, debitage accumulation rates per square meter at Klithi were more than ten times higher than at Kastritsa, while the differences were even more dramatic in terms of animal bones (Bailey and Woodward 1997:83). Klithi rather than Kastritsa emerges as the more intensively used site, although it is unclear which site was occupied for longer. Bearing in mind the monotony of the diet at Klithi and the restricted range of opportunities, an obvious conclusion would be that it was Kastritsa, but perhaps Klithi was frequented more often as suggested by the significant debitage and bone accumulation rates. Moreover, the paucity of structural features at Klithi suggests little investment in the site, perhaps again because visits were relatively short. Conversely, these were more common at Kastritsa (Galanidou 1997). The funnelling effect of the Vikos gorge and the location of Klithi close to the river would probably have resulted in more frequent visits by a captive audience of people moving along the gorge.

Klithi, foragers, collectors or serial specialists?

The discussion so far has reinforced the impression of Klithi not as a specialised hunting site, but as one in which the inhabitants had to make the best of a rather restricted and mundane menu. In this sense they appear more closely allied with Binford's foragers, or even perhaps serial specialists, than logistically organised collectors (1979, 1980). As foragers or serial specialists, groups were exploiting a range of food resources by positioning themselves within resource zones at specific times during the seasonal cycle. Unlike foragers however, it would appear as though there was a significant degree of re-use of sites, and although undoubtedly there are sites which remain to be discovered, the pattern was of an extensive use of sites regionally. In this sense we could refer to them as tethered foragers, as they appear to have been tied to a series of landmarks in the landscape, some of which as in the case of Klithi and Kastritsa, were caves and rockshelters

9.3. Epirus and Argolid, 20,000-13,000 years ago

This research focused on the three shelter and cave sites of Klithi, Franchthi and Kastritsa, with particular emphasis on the period between 20,000 and 13,000 years ago. This was marked by a significant deterioration in climate followed by relatively rapid improvement. During the LGM, conditions in Greece were cold and dry, with classic step vegetation, dominated by *Artemisia*, Chenopodiaceae and Gramineae, the result of a long deforestation process that had begun as early as 37,000 years ago (Perlès 2000:376-7). However, the impact of glacial conditions were not as extreme as in other regions in Europe, and in some restricted areas, trees appear to have survived (Bailey and Gamble 1990:150). Epirus was one of these areas, where with higher levels of precipitation and local topography, trees such as *Quercus* and *Pinus* continued to grow, even during open vegetation periods (Tzedakis 1993). For this reason, Epirus has been considered to be a refugium for plants and animals during the LGM, along with southwestern France (Jochim 1987), the area around the Black sea (Djindjian *et al.* 1999:239), Ukraine (Pichler 1999:491), northern Spain and parts of Italy (Bailey and Gamble 1990:148-150). On the other hand, further south on the Argolid peninsula where the site of Franchthi is located, botanical records have shown that during the LGM, step vegetation dominated the landscape even at high altitudes (Hansen 1991:155).

Human presence in Greece during the LGM is indicated by the use of sites such as Kastritsa (Bailey *et al.* 1983), Theopetra in central Greece (Kyparisi- Apostolika 1996:36), as well as Klisoura and Kefalari in the Argolid peninsula (Koumouzelis *et al.* 2001:536). All these sites were also in use before the LGM. Asprochaliko in Epirus (Bailey *et al.* 1983) and Franchthi (Perlès 1987) both appear to lack LGM deposits, although they contain evidence for earlier occupation. At present, the Greek Palaeolithic record contains too few sites to produce a picture of the impact of LGM on human settlement. On a European level, we know that areas such as central Europe which experienced the LGM in its extreme, were significantly depopulated (Klein 1999:522-3; West 1997:128-9), as opposed to eastern Europe (Pichler 1999:486) or the central Mediterranean province (Mussi 1990:133-139), which witnessed a slow expansion of human populations.

The onset of postglacial conditions in Epirus was marked by the expansion of Palaeolithic settlement into novel settings, such as the mountains. The use of Klithi begun at about 16,000 years ago, when due to a climatic "window of opportunity" (Bailey 1997c:663), the highlands of Epirus began to be exploited. Due to the relatively warmer and wetter conditions, increased precipitation led to renewed erosion by the Voidomatis river, which cut itself into its alluvial valley floor. The warmer conditions and increase in moisture encouraged vegetation growth which in turn attracted animals, such as caprines (*ibid.*; Macklin *et al.* 1997:358-9). In his study of the fauna from Klithi, Gamble (1997:238-9) argued that selective hunting is an example of the reduction of redundant behaviour, with the aim being to reduce risk. The shift towards this sort of strategy has been interpreted as a response of hunter-gatherers to environmental post LGM instability. During this period, the slow warming of the climate would have increased environmental productivity, but at the same time and at the larger scale would have had the effect of gradual submerging the prosperous coastal plains of Epirus and the Adriatic. This may have encouraged local populations to search for alternative food resources, and/or to intensify the exploitation of existing ones. Caprines from the interior of Epirus may have been one of these (Bailey 1997c:678). A similar strategy was identified at the site of Babanj in Herzegovina, where selective hunting of fat-rich female red deer, an attractive source of proteins and fat, was undertaken (Whallon 1999). The examples of Klithi and Babanj may reflect the response of populations in the Balkans to the loss of large coastal territories within a relatively short period of time. That selective hunting was a response to these changes in both climate and landscape reinforces the point that specialised hunting was not about concentrating on a specific species, while ignoring all others. Rather, it was part of an intensification of the use of a wider range of resources as part of what could be considered a more diversified economy. Sites such as Klithi, where only one species was hunted, but where a range of activities appear to have been undertaken, suggest that local populations were incorporating a broader range of resources and locations. Another option may have been to expand into areas outside of Epirus, for instance Albania, the Greek part of Macedonia or the southern regions of the former Yugoslavia. The presence at Klithi of flint that may have originated in these areas (Bailey 1997c) is an intriguing possibility and suggests the much wider regional social networks as yet unknown.

In their palaeogeographical study, Sturdy *et al.* (1997:611) have provided some suggestions as to the role of Klithi and Kastritsa within the region. Taking into account factors such as altitude, snow cover and high mountain ridges, they suggested that the eastern part of Epirus where Klithi and

Kastritsa are located, would have been off-limits apart from summer. During the colder months, occupation may have shifted west towards the coastal plain. Palaeolithic sites across Epirus (Bailey *et al.* 1997b), or more remote areas such as the island of Corfu (Sordinas 1996), may be the relics of this system. Future work on the relationship between these sites should provide additional insights as to the way that regional mobility was organised in Epirus.

In the case of the Argolid peninsula, sea-level during the LGM would have been about 100m lower than at present, which implies that not only this productive area was much more extensive, but that the peninsula was also connected with neighbouring regions such as Attica (Jameson *et al.* 1994:331). Therefore, any discussion about human settlement in the area during this period has to take into account that the peninsula would have functioned as a bridge between southern and central Greece. At the micro-scale, the area is comprised of a variety of topographic zones including coastal plains, low hills, valleys and higher mountains, and each of these was the habitat of a range of plants and animals (Payne 1974; Hansen 1991). In the period before the LGM, Franchthi was probably used only sporadically, the reasons for which are as yet unclear, although the frequent roof collapses associated with the colder conditions would certainly have discouraged all but the hard headed. Alternatively, the size of the coastal plain which extended approximately 6km out in front of the site (van Andel and Sutton 1987; Lambeck 1996), may have rendered Franchthi obsolete, that is until with rising sea levels after the LGM, the coast began to move closer (Bailey 1997c:267).

Prior to the LGM, Franchthi appears to have been used by small groups for the hunting of moderately sized herbivores, predominantly equids and cervids (Payne 1975). Analysis of lithic technology from the site, undertaken as part of this research has indicated the presence of the complete core reduction sequence. However, the quantities of lithic material were low, while tool diversity was poor. Low densities of botanical material (Hansen 1991) and sediment records (Farrand 1988) from the site from this period support the picture of low occupation density and infrequent use. For the period after the LMG the available lithic, botanical and sediment evidence indicates that the site must have been used more frequently than in the previous periods. Hunting would have been carried out as the main subsistence source, but now there is clear evidence that the inhabitants of the site were collecting fruits, cereals and a variety of legumes. Based on these species as well as from the very sporadic information about the fauna at the site, it seems that the cave was being used all year round. Rare for the Greek Palaeolithic, anatomic finds included shed milk teeth and a single infant rib suggests that family groups were visiting the site (Cullen 1995), although it remains unclear from which particular level of the late Upper Palaeolithic deposits these finds came from. Overall, the onset of the postglacial was marked by an increase of human activities at the site, which gradually became more intensified in the subsequent periods. The coastal plain covered by open woodland, and the surrounding high hills would have provided a variety of food opportunities to the local populations. In addition, the incidence of rock falls would have declined as the temperature rose, therefore improving the liveability of the site for longer term stays. Unfortunately, as to the position of the site within region, we are still largely in the dark, although faunal analysis underway at present should help to clarify this further. In addition, what is needed is a fuller understanding of the nature and location of raw material sources, both around the site and in the region as a whole, as well as a more systematic study of Franchthi in relation to its neighbourhood Palaeolithic sites, such as Kleisoura and Kefalari.

9.4. Contribution of the thesis to the study of the Greek Upper Palaeolithic

The comparative analysis of the sites of Klithi, Franchthi and Kastritsa has provided the basis for a more extensive regional perspective on Upper Palaeolithic settlement of Epirus, and further afield in the Argolid. The approaches used for the assessment of standardisation as an index for specialisation have highlighted a number of thought provoking results, which have suggested that our expectations as to the curated versus expedient components of these assemblages need to be reconsidered. In addition it has highlighted that standardisation in technology is much more than simply trying to reduce metric variability. It cannot be simply measured, but needs to take account of aspects such as the presence of repetitive shapes, symmetry, and even the way in which the whole manufacturing process are organised, from raw material collection to retouch.

Despite the appearance of Klithi as a specialised site, this research has suggested that in fact there was no difference between it and other sites in Epirus and beyond. This specialised versus generalised dichotomy is in this case unhelpful and presents a false picture for Klithi, as well as the other two sites. What the research suggests is that Klithi and Kastritsa were both generalised sites, and that they were being used in much the same way, as elements of diversified system.

The thesis has also highlighted the need for more detailed information as to the quality and location of raw materials in both regions. All sites contain both local and exotic raw materials, the sources of which can provide the basis for developing a much wider regional understanding of both areas.

Appendix I

Table 1. The *F* significance test results for debitage at Klithi.
The significance level is 0.05
Key : *F*.r. = *F* ratio, *F*.crit.= *F* critical value.

Length	
Flakes -Bladelets/Blades	*F*. r. = 1.27>*F*. crit. =1.16
Width	
Flakes -Bladelets/Blades	*F*. r. = 1.10>*F*. crit. =1.09
Thickness	
Flakes -Bladelets/Blades	*F*. r. = 1.17>*F*. crit. =1.09

Table 2. The *F* significance test results for tools at Klithi.
Key: as above, N/A: tool categories not included in the test due to small sample sizes.

Tool types	**Length**	**Width**	**Thickness**
B. Flakes - B. Bladelets	*F*. r. = 1.02 <*F*. crit. =1.70	*F*. r. = 1.24 <*F*. crit. =1.40	*F*. r. = 1.36 >*F*. crit. =1.34
B. Flakes- B. Blades	N/A	*F*. r. = 3.90 >*F*. crit. =2.77	*F*. r. = 1.11<*F*. crit. =2.02
B. Flakes- L. Flakes	*F*. r. = 2.15 >*F*. crit. =1.72	*F*. r. = 1.63 >*F*. crit. =1.46	*F*. r. = 1.74> *F*. crit. =1.46
B. Flakes - L. Bladelets	*F*. r. = 1.27 <*F*. crit. =1.89	*F*. r. = 1.71 >*F*. crit. =1.55	*F*. r. = 1.14 <*F*. crit. =1.55
B. Flakes - L. Blades	N/A	*F*. r. = 3.44 >*F*. crit. =1.93	*F*. r. = 1.02 <*F*. crit. =1.93
B. Flakes- Scrapers	*F*. r. = 1.43 <*F*. crit. =1.78	*F*. r. = 1.43 <*F*. crit. =1.44	*F*. r. = 1.53 >*F*. crit. =1.44
B. Flakes N/D	*F*. r. = 1.01 <*F*. crit. =1.69	*F*. r. = 1.44=*F*. crit. =1.44	*F*. r. = 1.27 <*F*. crit. =1.44
B. flakes Burins	*F*. r. = 1.64 <*F*. crit. =1.67	*F*. r. = 1.60 >*F*. crit. =1.44	*F*. r. = 1.84 >*F*. crit. =1.44
B. Bladelets- L. Bladelets	*F*. r. = 1.30<*F*. crit. =1.81	*F*. r. = 1.52>*F*. crit. =1.41	*F*. r. = 1.56>*F*. crit. =1.41
B. Bladelets-- Scrapers	*F*. r. = 1.27<*F*. crit. =1.69	*F*. r. = 1.63>*F*. crit. =1.32	*F*. r. = 1.12<*F*. crit. =1.32
B. Bladelets- N/D	*F*. r. = 1.04<*F*. crit. =1.59	*F*. r. = 1.28>*F*. crit. =1.26	*F*. r. = 1.73>*F*. crit. =1.26
B. Bladelets- Burins	*F*. r. = 1.68>*F*. crit. =1.57	*F*. r. = 1.43 >*F*. crit. =1.27	*F*. r. = 1.73 >*F*. crit. =1.27
B. Blades- B. Bladelets	N/A	*F*. r. = 4.38 >*F*. crit. =2.72	*F*. r. = 1.52 <*F*. crit. =1.90
B. Blades- L. Flakes	N/A	*F*. r. = 6.39 >*F*. crit. =2.76	*F*. r. = 1.55 <*F*. crit. =2.76
B. Blades- L. bladelets	N/A	*F*. r. = 6.70 >*F*. crit. =2.81	*F*. r. = 1.02 <*F*. crit. =2.81
B. Blades- L. Blades	N/A	*F*. r. = 1.13 <*F*. crit. =2.39	*F*. r. = 1.15 <*F*. crit. =2.39
B. Blades- Truncations	N/A	*F*. r. = 4.62>*F*. crit. =2.85	*F*. r. = 1.04 <*F*. crit. =2.85
B. Blades- N/D	N/A	*F*. r. = 5.63>*F*. crit. =2.74	*F*. r. = 1.13 <*F*. crit. =2.74
B. Blades- Borers	N/A	*F*. r. = 7.81>*F*. crit. =2.87	*F*. r. = 1.30 <*F*. crit. =2.85
B. Blades- Burins	N/A	*F*. r. = 6.27>*F*. crit. =2.75	*F*. r. = 1.65 <*F*. crit. =2.75
B. Blades- Scrapers	N/A	*F*. r. = 6.27.>*F*. crit. =2.75	*F*. r. = 1.72 <*F*. crit. =1.98
L. Flakes- L. bladelets	*F*. r. = 1.69<*F*. crit. =1.96	*F*. r. = 1.04 <*F*. crit. =1.51	*F*. r. = 1.52 <*F*. crit. =1.56
L. Flakes- L. Blades	N/A	*F*. r. = 5.63 >*F*. crit. =1.91	*F*. r. = 1.78 <*F*. crit. =1.91
L. Flakes Scrapers	*F*. r. = 2.80>*F*. crit. =1.67	*F*. r. =2.38 >*F*. crit. =1.41	*F*. r. = 2.67>*F*. crit. =1.41
L. Flakes - N/D	*F*. r. = 2.11>*F*. crit. =1.53	*F*. r. = 1.13 <*F*. crit. =1.37	*F*. r. = 1.36 <*F*. crit. =1.37
L. Flakes Burins	*F*. r. = 1.31<*F*. crit. =1.51	*F*. r. = 1.01<*F*. crit. =1.38	*F*. r. = 1.05<*F*. crit. =1.39

L. Bladelets-Scrapers	*F*. r. = 1.65<*F*. crit. =1.85	*F*. r. =2.50>*F*. crit. =1.50	*F*. r. = 1.76>*F*. crit. =1.50
L. Bladelets-N/D	*F*. r. = 1.25<*F*. crit. =1.72	*F*. r. = 1.19<*F*. crit. =1.47	*F*. r. = 1.11<*F*. crit. =1.54
L. Bladelets-Burins	*F*. r. = 1.29<*F*. crit. =1.92	*F*. r. = 1.06<*F*. crit. =1.48	*F*. r. = 1.61>*F*. crit.=1.55
L. Blades B. Bladelets	N/A	*F*. r. = 3.86>*F*. crit. =1.86	*F*. r. = 1.32<*F*. crit.=1.86
L. Blades - L. bladelets	N/A	*F*. r. = 5.91>*F*. crit. =1.98	*F*. r. = 1.17<*F*. crit.=1.98
L. Blades Truncations	N/A	*F*. r. = 4.07>*F*. crit. =2.02	*F*. r. = 1.19<*F*. crit.=2.02
L. Blades N/D	N/A	*F*. r. = 4.95>*F*. crit. =1.90	*F*. r. = 1.30<*F*. crit.=1.90
L. Blades Borers	N/A	*F*. r. = 6.90>*F*. crit. =2.02	*F*. r. = 1.30<*F*. crit.=2.02
L. Blades Burins	N/A	*F*. r. = 5.53>*F*. crit. =1.90	*F*. r. = 1.90=*F*. crit.=1.90
L. Blades Scrapers	N/A	*F*. r. = 2.36>*F*. crit. =1.91	*F*. r. = 1.50<*F*. crit.=1.91
Scrapers-N/D	*F*. r. = 1.32<*F*. crit. =1.64	*F*. r. = 2.10 >*F*. crit. =1.38	*F*. r. = 1.96 >*F*. crit. =1.38
Scrapers-Burins	*F*. r. = 2.13 >*F*. crit. =1.62	*F*. r. = 2.34 >*F*. crit. =1.38	*F*. r. = 2.84 >*F*. crit. =1.38
N/D-Burins	*F*. r. = 1.61 >*F*. crit. =1.47	*F*. r. = 1.11 <*F*. crit. =1.35	*F*. r. = 1.44 >*F*. crit. =1.35
Borers-B. Flakes	*F*. r. = 1.91 >*F*. crit. =1.84	*F*. r. = 2.00 >*F*. crit. =1.62	*F*. r. = 1.26 <*F*. crit. =1.61
Borers-B. Bladelets	*F*. r. = 1.96 >*F*. crit. =1.75	*F*. r. = 1.78 >*F*. crit. =1.47	*F*. r. = 1.72 >*F*. crit. =1.47
Borers-L. Flakes	*F*. r. = 1.20 <*F*. crit. =1.84	*F*. r. = 1.22 <*F*. crit. =1.57	*F*. r. = 1.37 <*F*. crit. =1.67
Borers-L. Bladelets	*F*. r. = 1.51 <*F*. crit. =2.07	*F*. r. = 1.16 <*F*. crit. =1.70	*F*. r. = 1.04 <*F*. crit. =1.70
Borers-N/D	*F*. r. = 1.88 >*F*. crit. =1.66	*F*. r. = 1.39 <*F*. crit. =1.53	*F*. r. = 1.00 <*F*. crit. =1.65
Borers-Truncations	*F*. r. = 1.10 <*F*. crit. =1.94	*F*. r. = 1.70 <*F*. crit. =1.80	*F*. r. = 1.08 <*F*. crit. =1.80
Borers-Burins	*F*. r. = 1.16 <*F*. crit. =1.64	*F*. r. = 1.24 <*F*. crit. =1.54	*F*. r. = 1.46 <*F*. crit. =1.66
Borers-Scrapers	*F*. r. = 2.50 >*F*. crit. =1.80	*F*. r. = 2.92 >*F*. crit. =1.56	*F*. r. = 1.94 >*F*. crit. =1.56
Truncations-B. Flakes	*F*. r. = 2.12 >*F*. crit. =1.82	*F*. r. = 1.18 <*F*. crit. =1.61	*F*. r. = 1.16 <*F*. crit. =1.61
Truncations-B. Bladelets	*F*. r. = 2.17 >*F*. crit. =1.74	*F*. r. = 1.05 <*F*. crit. =1.48	*F*. r. = 1.58 >*F*. crit. =1.48
Truncations-L. Flakes	*F*. r. = 1.01 <*F*. crit. =1.80	*F*. r. = 1.38 <*F*. crit. =1.67	*F*. r. = 1.49 <*F*. crit. =1.67
Truncations-L. Bladelets	*F*. r. = 1.67<*F*. crit. =2.05	*F*. r. = 1.45 <*F*. crit. =1.75	*F*. r. = 1.01 <*F*. crit. =1.70
Truncations-N/D	*F*. r. = 3.37>*F*. crit. =1.80	*F*. r. = 1.77 >*F*. crit. =1.65	*F*. r. = 1.10 <*F*. crit. =1.65
Truncations-Burins	*F*. r. = 1.29<*F*. crit. =1.62	*F*. r. = 1.35 <*F*. crit. =1.66	*F*. r. = 1.58 <*F*. crit. =1.66
Truncations-Scrapers	*F*. r. = 2.76>*F*. crit. =1.78	*F*. r. = 1.72 >*F*. crit. =1.56	*F*. r. = 1.79 >*F*. crit. =1.56

Appendix II

Table 1. *F* test results for debitage at Franchthi
The significance level is 0.05.
Key : *F*.r. = *F* ratio , *F*.crit.= *F* critical value.

Length	
Flakes -Bladelets/Blades	*F*. r. = 1.07<*F*. crit. =1.23
Width	
Flakes -Bladelets/Blades	*F*. r. = 1.03<*F*. crit. =1.16
Thickness	
Flakes -Bladelets/Blades	*F*. r. = 1.30>*F*. crit. =1.16

Table 2. *F* test results for tools at Franchthi.
Key : *F*.r. = *F* ratio , *F*. crit.= *F* critical value B= Backed retouch, N/D= Notches/Denticulates.

Tool types	Length	Width	Thickness
B. Flakes- B. Bladelets	*F*. r. = 2.24>*F*. crit. =1.89	*F*. r. = 4.43>*F*. crit. =1.59	*F*. r. = 2.00>*F*. crit. =1.59
B. Flakes- N/D	*F*. r. = 1.10<*F*. crit. =4.56	*F*. r. = 1.93<*F*. crit. =2.40	*F*. r. = 1.10<*F*. crit. =2.09
B. Flakes- Scrapers	*F*. r. = 1.09<*F*. crit. =4.56	*F*. r. = 3.68>*F*. crit. =2.47	*F*. r. = 2.74>*F*. crit. =2.47
B. Bladelets- Scrapers	*F*. r. = 2.06<*F*. crit. =2.48	*F*. r. = 1.20<*F*. crit. =1.85	*F*. r. = 1.38<*F*. crit. =2.34
B. Bladelets- N/D	*F*. r. = 2.04<*F*. crit. =2.48	*F*. r. = 2.30>*F*. crit. =1.82	*F*. r. = 2.18>*F*. crit. =1.81
Scrapers- N/D	*F*. r. = 1.00<*F*. crit. =5.05	*F*. r. = 1.90<*F*. crit. =2.66	*F*. r. = 3.01>*F*. crit. =2.66

Table 3. *F* test results for flakes, blades/bladelets and backed bladelets from phases II, III and IV
Key: as above.

Debitage types	Length	Width	Thickness
Flakes II-III	*F*. r. = 1.22<*F*. crit. =1.31	*F*. r. = 1.10<*F*. crit. =1.20	*F*. r. = 1.07<*F*. crit. =1.20
Flakes II-IV	*F*. r. = 1.07<*F*. crit. =1.26	*F*. r. = 1.02<*F*. crit. =1.18	*F*. r. = 1.09<*F*. crit. =1.18
Flakes III-IV	*F*. r. = 1.32>*F*. crit. =1.28	*F*. r. = 1.07<*F*. crit. =1.20	*F*. r. = 1.02<*F*. crit. =1.20
Blades/bladelets II-III	*F*. r. = 1.27<*F*. crit. =1.50	*F*. r. = 1.07<*F*. crit. =1.40	*F*. r. = 1.24<*F*. crit. =1.40
Blades/bladelets II-IV	*F*. r. = 1.02<*F*. crit. =1.65	*F*. r. = 1.00<*F*. crit. =1.35	*F*. r. = 1.00<*F*. crit. =1.38
Blades/bladelets III-IV	*F*. r. = 1.30<*F*. crit. =1.55	*F*. r. = 1.08<*F*. crit. =1.45	*F*. r. = 1.23<*F*. crit. =1.45
Tool types			
B. Bladelets II-III	*F*. r.= 5.0> *F*. crit.=3.0	*F*. r. = 1.11<*F*. crit. =1.74	*F*. r. = 1.13<*F*. crit. =1.92
B. Bladelets II-IV	*F*. r. = 2.26<*F*. crit. =2.68	*F*. r. = 1.28<*F*. crit. =2.05	*F*. r. = 1.15<*F*. crit. =2.07
B. Bladelets III-IV	*F*. r. = 2.33<*F*. crit. =3.07	*F*. r. = 1.15<*F*. crit. =1.50	*F*. r. = 1.01<*F*. crit. =1.73

Appendix III

Table 1. *F* test results for debitage at Kastritsa.
The significance level is .05.
Key : *F*.r. = *F* ratio , *F*.crit.= *F* critical value.

Length	
Flakes-Bladelets/Blades	*F*. r. = 1.08<*F*. crit. =1.16
Width	
Flakes- Bladelets/Blades	*F*. r. = 1.01<*F*. crit. =1.11
Thickness	
Flakes- Bladelets/Blades	*F*.r. =1.25>*F*. crit.= 1.11

Table 2. *F* test results for tools at Kastritsa.
Key: Backed bladelets include also microgravettes and shouldered bladelets. N/D= Notches/Denticulates.

	Length	**Width**	**Thickness**
Backed bladelets-Scrapers	*F*. r. = 1.23<*F*. crit. =1.75	*F*. r. = 1.80>*F*. crit. =1.50	*F*.r. =1.95>*F*. crit. =1.50
Backed bladelets-N/D	*F*. r. = 2.74>*F*. crit. =2.00	*F*. r. = 1.50<*F*. crit. =1.65	*F*.r. =1.55<*F*. crit. =1.65
Backed bladelets-Burins	*F*. r. = 4.32>*F*. crit. =1.73	*F*. r. = 2.15>*F*. crit. =1.48	*F*.r. =2.65>*F*. crit. =1.48
Scrapers- N/D	*F*. r. = 2.23<*F*. crit. =2.34	*F*. r. = 1.19<*F*. crit. =2.04	*F*.r. =1.25<*F*. crit. =2.04
Scrapers- Burins	*F*. r. = 3.51>*F*. crit. =2.10	*F*. r. = 1.96>*F*. crit. =1.74	*F*.r. =1.35<*F*. crit. =1.74
N/D- Burins	*F*. r. = 1.57<*F*. crit. =2.75	*F*. r. = 1.43<*F*. crit. =2.03	*F*.r. =1.70<*F*. crit. =2.03

Table 3. *F* test results for the analysis of debitage and tools through time at Kastritsa.

Debitage types	**Length**	**Width**	**Thickness**
Flakes Stratum 1-3	*F*. r =1.20<*F*. crit =1.22	*F*.r.=1.16=*F*.crit. =1.16	*F*.r =1.01<*F* crit =1.16
Blades/bladelets Stratum 1-3	*F*. r.=1.10<*F* crit. =1.28	*F*.r.=1.18=*F*.crit. =1.18	*F* r =1.09<*F*. crit =1.18
Tool types			
Backed bladelets Stratum 1-3	*F*.r.=1.11<*F*.crit.=2.01	*F*. r.=1.40<*F*crit. =1.52	*F*. r.=1.23<*F* crit =1.52

Appendix IV

Table 1. *F* test results for debitage at Klithi, Franchthi and Kastritsa.
The significance level is 0.05.
Key : *F*.r = *F* ratio, *F*.crit.= *F* critical value.

Debitage	Length	Width	Thickness
Flakes Klithi/Franchthi	*F*. r. = 1.46 >*F*. crit. =1.13	*F*. r. = 1.01 <*F*. crit. =1.09	*F*. r. = 1.04 <*F*. crit. =1.09
Flakes Franchthi/Kastritsa	*F*. r. = 1.45 >*F*. crit. =1.15	*F*. r. = 1.12 >*F*. crit. =1.10	*F*. r. = 1.06 <*F*. crit. =1.10
Flakes Klithi/ Kastritsa	*F*. r. = 1.00 <*F*. crit. =1.13	*F*. r. = 1.10 >*F*. crit. =1.09	*F*. r. = 1.11>*F*. crit. =1.09
Bladelets Klithi/Franchthi	*F*. r. = 1.29 >*F*. crit. =1.27	*F*. r. = 1.12 <*F*. crit. =1.18	*F*. r. = 1.05 <*F*. crit. =1.18
Bladelets Franchthi/Kastritsa	*F*. r. = 1.56 >*F*. crit. =1.27	*F*. r. = 1.20>*F*. crit. =1.18	*F*. r. = 1.05<*F*. crit. =1.19
Bladelets Klithi/Kastritsa	*F*. r. =1.20 <*F*. crit. = 1.22	*F*. r. = 1.35 > *F*. crit. =1.13	*F*. r. = 1.00<*F*. crit. =1.13
Blades Klithi/Franchthi	*F*. r. =1.44 <*F*. crit. = 1.79	*F*. r. = 1.55 > *F*. crit. =1.48	*F*. r. = 2.11>*F*. crit. =1.48
Blades Franchthi/Kastritsa	*F*. r. = 2.24> *F*. crit. =1.15	*F*. r. =2.24 > *F*. crit.=1.75	*F*. r. = 2.06> *F*. crit. =1.48
Blades Klithi/Kastritsa	*F*. r. = 1.55>*F*. crit. =1.39	*F*. r. =1.81 >*F*. crit. =1.20	*F*. r. =1.02<*F*. crit.=1.20

Table 2. *F* test results for tools at Klithi, Franchthi and Kastritsa. Only tool groups with substantial sample size are examined. All linearly retouched artefacts and informal tools were grouped together in order to create large, comparable groups.
Key : as above.

Formal tools	Length	Width	Thickness
Backed flakes Klithi/Franchthi	*F*. r. = 1.50<*F*. crit. =1.91	*F*. r. = 1.69>*F*. crit. =1.64	*F*.r. =1.34<*F*. crit. =1.64
Backed bladelets Klithi/Franchthi	*F*. r. = 1.45<*F*. crit. =1.72	*F*. r. = 2.93>*F*. crit. =1.31	*F*.r. =1.06<*F*. crit. =1.31
Backed bladelets Franchthi/Kastritsa	*F*. r. = 1.85>*F*. crit. =1.64	*F*. r. = 1.60>*F*. crit. =1.35	*F*.r. =1.31<*F*. crit. =1.34
Backed bladelets Klithi/Kastritsa	*F*. r. = 2.70>*F*. crit. =1.60	*F*. r. = 1.82>*F*. crit. =1.26	*F*.r. =1.42>*F*. crit. =1.26
Backed blades Klithi/Kastritsa	-	*F*. r. = 1.09<*F*. crit. =3.13	*F*. r. = 1.63<*F*. crit.=3.02
All linear retouched Klithi/Kastritsa	*F*. r. = 1.54<*F*. crit. =1.91	*F*. r. = 1.07<*F*. crit. =1.56	*F*.r. =1.06<*F*. crit. =1.73
Informal tools Klithi/Franchthi	*F*. r. = 1.74<*F*. crit. =2.09	*F*. r. = 1.28<*F*. crit. =1.62	*F*.r. =1.21<*F*. crit. =1.48
Informal tools Klithi /Kastritsa	*F*. r. = 1.14<*F*. crit. =1.35	*F*. r. = 1.15<*F*. crit. =1.27	*F*.r. =1.14<*F*. crit. =1.27
Informal tools Franchthi /Kastritsa	*F*. r. = 1.34<*F*. crit. =2.15	*F*. r. = 1.47<*F*. crit. =1.67	*F*.r. =1.06<*F*. crit. =1.55

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