This paper proposes a new methodology to study prehistoric lithic assemblages in an attempt to derive from that facet of prehistoric behavior the greater technocomplex system in which it was embedded. By using volumetric artifacts density and the frequency of raw material pieces within a given lithic assemblage, it becomes possible to identify whether these stone tools were created by residents.石 is mobile or logically organized foragers. The linking factor between assemblage composition and land-use strategy are the of creation within lithic assemblages as an expression of economic behavior. This method is used to study eight sites from southeastern Italy to test changes in adaptation during the Late Pleistocene. We compare and contrast Mountainian, Utaecka, post-Southern, and Epigravettian assemblages, and argue that the first three industries overlap considerable in terms of their technocomplex, flexibility. Epigravettian assemblages, on the other hand, display a different kind of land-use exploitation pattern than those seen in the earlier assemblages, perhaps as a response to deteriorating climatic conditions at the Late Glacial Maximum. While we discuss the implications of these patterns in the context of modern human origins, we argue that the methodology can help identify land-use patterns in other locales and periods.

Nous proposons une nouvelle approche pour l'étude des ensembles lithiques permettant d'identifier les systèmes techno-économiques dans lesquels ils s'insérèrent. Utilisant comme paramètres analytiques la densité volumétrique d'artefacts et le rapport outil/éclat, il devient possible d'attribuer un ensemble lithique préhistorique à un mode d'organisation "logique" ou à un mode de résidentialité. Le degré de "conservation" ou le niveau d'un ensemble lithique, interprété comme l'expression d'une attitude économique vis-à-vis de la matière première, constitue le levier de composition d'un ensemble lithique et mode préhistorique de résidentialité. Nous appliquons notre méthodologie à l'étude de huit sites de l'époque glaciaire à l'époque de l'âge du mobilier médiéval et néolithique. En comparant les résultats tirés d'ensembles matériels, la technicité, post-Southern et Epigravettian, nous constatons que les trois premières industries semblent caractérisées par une similitude qui se traduit par leur flexibilité technico-économique alors que l'Epigravettien apparaît distant par un mode d'exploitation du territoire, représentant vraisemblablement une adaptation aux climats plus froids du dernier maximum glaciaire. Nous interprétons les résultats de cette approche dans le contexte de l'époque de l'homme moderne, mais soulignons que cette méthodologie peut aussi permettre d'identifier les modes d'exploitation du territoire dans les zones sauvages d'autres périodes et régions.

Due to the prevalence of stone artifacts in the archaeological record, behavioral models for prehistoric nomadic foragers are based almost exclusively on lithics. Fortunately, the morphology of stone implements is a result of prehistoric activity and, therefore, can yield useful insights into the behavior of their makers. But, while chipped stone artifacts are widely recognized as fundamental components of the technologies used to acquire and process needed resources in prehistory, the causes and meaning of variability among and within lithic assemblages—especially with respect to retouched artifacts—remain hotly debated today. Two facets that have emerged from the debate surrounding the meaning of lithic variability are particularly relevant to the study of the adaptations of prehistoric foragers. The first of those contrasts the role of drift and selection in shaping lithic morphology. Some researchers view interassemblage variability as primarily the result of drift-like, stochastic processes often glossed as “cultural tradition.” From this outlook, patterns of similarities (treated like evolutionary homologies) and differences among lithic assemblages (especially, retouched tools) are felt to trace cultural descent spatially and temporally. The contrasting

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LATE PLEISTOCENE TECHNOLOGY, ECONOMIC BEHAVIOR, AND LAND-USE DYNAMICS IN SOUTHERN ITALY

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perspective sees lithic variability mainly as the result of selection favoring morphologies that bet-
ter serve to accomplish varying combinations of
resource acquisition and processing activities.
Thus, patterns of similarity (equated as evolution-
ary analogies) and difference among assemblages
are instead felt to indicate suites of resource acquis-
tion/processing strategies or "adaptive poses." In
Paleolithic archaeology, this facet is typified by the
well-known Bordes-Binford debate of the mid-
twentieth century (Binford 1973; Binford and Bin-
ford 1986, 1969; Binford and Sabloff 1982; Bordes
1969, 1973, 1981; Bordes and de Sonneville-Bor-
den 1970; see also Barton 1997; Barton and Nee-
ley 1996).

The second, related facet contrasts intentional-
ity and life-history approaches in how to interpret
lithic variability. In the original Bordes-Binford
debate, both sides viewed retouched artifacts as "tools" whose morphologies (i.e., the forms found in
archaeological assemblages) were the intended
product of ancient artisans behaving technologi-
cally according to mental templates (see also Mel-
lars 1996). To a degree, this perspective is
exemplified today, albeit in a more sophisticated
fashion, by the "cultural operatore" approach to the
study and classification of Paleolithic assemblages
(Bleed 2001; Boëda 1994, 1995; Boëda et al. 1990;
Lemmonnier 1992; Schläger 1994; Sellet 1993). In
contrast, a number of mostly American researchers
have argued that retouched artifacts in archaeo-
logical context are primarily the unintended—and
generally unwanted—end products of extanting
lithic artifact use-life through repeated resharpen-
ing. This model, now supported by numerous actu-
alistic studies and quantitative analyses of
prehistoric assemblages, attributes much of the
morphological variability in retouched tools to vari-
ations in the length and range of their life histo-
ries (Barton 1988, 1990a, 1990b, 1991; Barton et
al. 1996; Bleed 2001; Dibble 1984, 1987, 1988,
1995; Flenniken and Raymond 1986; Flenniken
and Wilke 1989; Hucock and Attenbrow 2003;
Hoffman 1985; Kuhn 1989, 1990, 1994, 1995; Rol-
land 1977, 1981; Rolland and Dibble 1990; Short
1989, 1996; Weedman 2002; Wilke and Flenniken
1991). While the initial form of a lithic artifact can
undoubtedly be shaped by cultural tradition or
intended function (or some combination of these
[Jelinek 1976, 1988; see also Bisson 2000]), the
final form recovered in archaeological context will
mainly be the result of the range of tasks performed,
length and intensity of use, and decisions about
whether to replace or rejuvenate the artifact. As
such, the morphology of archaeologically recov-
ered retouched stone tools may therefore be some-
what different from their initial one (Barton 1991,
1997; Dibble 1987; Prinson 1986; Neeley and Bar-
ton 1994).

We find the evidence supporting the life-history
perspective especially compelling for many pre-
historic assemblages and feel that, while social
temporal certainty can contribute to lithic morphol-
y, the fundamental role of lithic technology in a
forager economy means that selection is likely a
much more important determinant of lithic form.
From this perspective, technological decisions
about the replacement and/or maintenance of lithic
artifacts are embedded in a wider web of economic
considerations and load-use strategies because of
the variable cost/benefit balance (in time and energy)
of lithic raw material procurement and dif-
ferential effectiveness of forms and rejuvenated arti-
facts in critical resource acquisition and processing
tasks. Hence, while there is undoubtedly insight to
be gleaned from the study of "retouched stone"
"tools" alone, we would argue that these behav-
iorally meaningful information can be obtained
from problem-oriented studies of how retouched
implements relate to the whole of a site's lithic
assemblage (including unreworked debitage, cores,
and other production debris) and the larger context
of forager socioeconomic systems. This perspec-
tive is supported by three additional points about
prehistoric technological behavior and its expres-
sion in the archaeological record.

First, it appears highly unlikely that retouched
artifacts represent the only lithic material used by
prehistoric foragers. There is, in fact, substantial
evidence from microwear studies that unreworked
flakes were frequently used for a range of functions
by prehistoric hunter-gatherers (Byers 1987; Kee-
ley and Toth 1981; Young and Barford 1990).

Secondly, retouched "tools" usually comprise
only a small fraction of the total lithic assemblages
found in archaeological contexts. Relying on
typologies that focus almost exclusively on
retouched stone implements therefore prevents
archaeologists from addressing the full range of
prehistoric technological behavior. Because unre-
touched flakes were actively used components of prehistoric lithic assemblages and because other forms of debitage and cores (as manufacturing and maintenance by-products) indicate artifact production and use, it is necessary to develop methods to incorporate the full range of lithic products in the analysis of chipped stone assemblages in order to gain a complete picture of prehistoric technological— and therefore economic—behavior. Despite its importance, studies of debitage have tended to be rare in general (see Ahler 1989; Sullivan and Rozen 1985), although recent publications have begun to emphasize its analytical usefulness (e.g., papers in Andrés and Bonifazi 2001; see also Hiscock 2002).

Lastly, it is essential that lithic variability be framed within broader theoretical frameworks in order to assign meaning to recurrent observable patterns in the archaeological record and help formulate further research questions. For example, building on forager studies by Binford (1979, 1980), a number of scholars have provided integrated models linking technological behavior to stone artifact form and patterns in lithic assemblages (e.g., Bamforth 1986, 1991; Bamforth and Beske 1997; Blood 1986; Kuhn 1989, 1991, 1992; Nelson 1991; Short 1989, 1996; Nelson 1991), for instance, articulates a clear difference between curated and expedient lithic assemblages in the archaeological record. The unique nature and structure of each type of assemblage, and their position at opposite ends of a continuum of economic behavior (see also Shore 1996 for a review of the concept of curating), constitute useful theoretical reference points upon which we can formulate a general model of the relation between economic behavior, mobility strategies, and relevant aspects of lithic variability at the assemblage level. With this in mind, we endeavor to identify variables that monitor lithic variability consistently across different assemblages within a framework designed to address questions of prehistoric forager land-use.

**Methodology**

Recently, Barton developed a simple approach to link assemblage-scale variability with Late Pleistocene behavioral patterns at sites in Gibraltar and eastern Spain (Barton 1998; Villaverde et al. 1998). Rather than focusing on formal properties of retouched tools, this whole assemblage analysis approach examines the nature and intensity of technological behavior by comparing artifact volumetric density and the relative frequency of retouched pieces within an assemblage. Artifact volumetric density is defined as the total number of pieces of chipped stone per cubic meter of excavated sediment, and is used as a proxy for artifact accumulation rate. The relative frequency of retouched pieces is simply the count of retouched "tools" (e.g., the pieces in Bamforth Middle Paleolithic type list minus unretouched types 1-3 and 5) divided by the total number of pieces (including all flakes, cores, and other debitage) in the assemblage. Artifact volumetric density potentially can vary with excavation technique (e.g., different-sized screens or net screening) and so direct comparisons can only be made between sites when this is accounted for. It also can vary as a result of fluctuating sedimentation rates during deposition (see Barton and Clark 1993; Farrand 2001; Stern et al. 2003; and/or a range of post-depositional taphonomic processes that can reduce its final volume through selective dismemberment of some sedimentary components (e.g., Karkanas et al. 2000; Weiner et al. 2002). To avoid the potential impact of time averaging, it would be preferable to calculate actual artifact accumulation rates rather than use artifact density as a proxy, but many sites—including those discussed here—lack the high-resolution radiometric dating required to do this. Fortunately, there is no indication that sedimentation rates varied by orders of magnitude within each of the sites analyzed here and in fact, as we discuss below, the analysis of lithic assemblages presented here holds the possibility to help distinguish those cases where sedimentation rates do vary significantly. We certainly do not mean to trivialize the need for detailed geoarchaeological studies in helping to understand site formation processes when possible. Rather, our model simply posits that wherever there is a direct relationship between assemblage’s relative frequency of retouched pieces and its artifact volumetric density that holds constant the relationships between three components of an assemblage: (1) its absolute size, (2) its relative frequency of retouched pieces, and (3) the sedimentary volume in which it is found. Based on the expectations about lithic technology outlined below, if an assemblage does not conform to the model, the
most likely source of distortion should be the excava-
ted volume of archaeological sediment, a factor that
can then be isolated, thereby highlighting those
layers that might have been subjected to variable
rates of sediment deposition and retention.
Results from Gorham's Cave and other Iberian
Palaeolithic sites (i.e., Barton 1998; Vilas et al.
1998) display a strong negative relationship
between artifact density and relative frequency of
retooled pieces (Figure 1). Assuming that the
overall need for stone tools does not change sig-
ificantly over time, this relationship can serve as
a heuristic device to infer technoeconomic behav-
ior from archaeological assemblages. If we com-
bine the theoretical framework for lithic technology
discussed above with the long-term evolutionary
tendency for humans to make critical economic
decisions to maximize benefit/cost ratios within a
perceived sociocultural context (Winterhalder
and Smith 2000), assemblage characteristics will
be influenced by the propensity to maximize lithic
utility under varying land-use strategies. Under
conditions of effective local lithic scarcity—con-
trolled as much by human land-use decisions and
 situational variables as by absolute raw material
distribution—hunter-gatherers are expected to con-
serve lithic resources by producing fewer flakes
and extending the use-life of flakes that are pro-
duced through regular maintenance (i.e., reouch).

Under conditions of effective local lithic abun-
dance, on the other hand, such preservation mea-
sures are unnecessary, leading foragers to produce
and discard more flakes while investing comparati-
vously little effort in extending their use-life through
repeated maintenance and resharpening.

Given these considerations, the two ends of the
curation-exploitation continuum depicted in Figure
1 can be assigned to prevalent site-use strategies
within a continuum of residential to logistical
mobility (Barker Binford 1979, 1980). Exploitant
assemblages are often deposited at the "base
camp" or "central residences" of logistically orga-
nized hunter-gatherers (Binford 1980; Nelson
1991). In such contexts, lithic raw material is usu-
ally effectively abundant due to direct local avail-
bility, embedded procurement, and/ or stockpiling
of material at the site. This reduces the premium
of preserving raw material, resulting in comparati-
vously higher artifact densities and assemblages
comprised mostly of unreouched flakes. These
high densities are also the result of the longer oc-
cupation spans that characterize such sites, which
directly influence the quantity of lithic production
derbris that accumulates at a site (Morrow 1996a).

Figures associated with such assemblages tend to be
only minimally prepared, since extracting the max-
imum number of blanks from a single nodule is not
the most important consideration. Overall, this

![Figure 1](image1.png)
modality of technological behavior can be taken to indicate a reduced need for a portable and versa-
tile lithic toolkit at the base camp, and it Figure 1, it is associated with assemblages found in the lower
right-hand corner.
Curated assemblages, on the other hand, are expected to be associated with residential mobility,
where the central locus of activity of a hunter-
gatherer group changes frequently. However, assemblages deposited by task groups on logisti-
cal forays away from a central residential site can also be expected to display this pattern, since they
tend to have specifically manufactured, reliable tools (sensus Bled 1986) to execute these extrac-
tion tasks. In both cases, because sites are occupied only for short periods of time, the stone tool assem-
blages created by mobile foragers tend to be of low density and comprise mostly reshaped (i.e., re-used)
tools, while the curated assemblages of residentially mobile foragers will comprise mostly exhausted maintainable lithics, those deposited by logistical task groups will contain a majority of reliable tools (Kuhn 1989). Cores found in curated assemblages can be expected to be pre-
pared cores that produce more cutting edge per vol-
ume (e.g., discoidal cores, some forms of recurrent Levallois cores, or prismatic blade cores) and be fairly "exhausted" at time of discard (see Shott 1996). This pattern results from brief site occupa-
tions by highly mobile foragers who carry with them a lightweight, easily maintained and polyva-
 lent toolkit (Kuhn 1989, 1994, 1996; cf. Morrow 1996). This mobility strategy, in turn, creates an 
effective raw material scarcity that elicited conserv-
ing behavior from those who rely on it. As such, curated assemblages represent risk-minimizing strategies that aim to provide a constant supply of functional tools in times or places where they can-
not be manufactured due to either lack of suitable material or preparation time (Barham and Bled 1997). In Figure 1, this strategy is associated with sites found in the upper left-hand corner.
There is, of course, a large amount of variability that is expected along the behavioral continuum 
linking curation and expediency (see Barton 1998: Figure 1; Villaer et al. 1998: Figure 5). There are several potential causes for this variability, none of which is mutually exclusive. One is variation in land-use patterns, which in turn affects effective raw material availability and tool design considerations (Bled 1986; Nelson 1991). Another is that given assemblages usually represent palimpsests of multiple occupations of a site by groups that may rely on different land-use and technoeconomic strategies. As mentioned above, variable sedimentation rates affecting arte-
fact volumetric density represent another potential factor contributing to the location of an assemblage 
on the graph. Low sedimentation rates will shift an assemblage's position toward the upper right-hand corner, while high sedimentation rates will have the opposite effect, dragging assemblages toward the lower left. In terms of creating interpretive ambiguity, the impact of high sedimentation rates would be most severe for assemblages deposited at logis-
tical base camps. Low sedimentation rates would most significantly distort patterns for highly curated assemblages deposited by residentially mobile hunter-gatherers or by the task groups of logistical collectors. Alternatively, assemblages in the upper right-hand corner might represent a completely differen-
tial technological strategy akin to the "snowbound Neanderthal" model proposed by Rottlund (1981), where a site is occupied for long periods even though raw material is effectively scarce.
A significant advantage of this whole assem-
b Iage method with regards to comparing prehistoric stone tool assemblages is that it can be used across traditionally assigned geographic and temporal typological divisions. For instance, for the Eurasian Paleolithic, two distinct typological systems have been used to describe the morphological variability 
of Middle and Upper Paleolithic stone tools (Bordes 1953, 1961; de Sonneville and Perrot 1951, 1954, 1955, 1956). Since most interpretations of Paleolithic behavioral variation are biased on pat-
terns in the distribution of stone tools, this dichotomy effectively establishes (and reinforces) a de facto behavioral distinction between the two periods (Marks et al. 2001; Riel-Salvatore and Clark 2001). However, Grayson and Cole (1998) have recently suggested that the alleged greater number and diversity of tools in early Upper Pale-
olithic assemblages is essentially a side-effect of larger assemblage sizes as opposed to a qualitative shift in the mental capacities of Late Pleistocene modern humans (cf. Harrold 1989), thereby highlighting the limited heuristic potential of typological approaches to assess and explain inter-assemblage variability. As well as avoiding the issue of non-
comparable classificatory systematics, a whole assemblage analysis approach can easily be applied to a wide number of assemblages reported in the archaeological literature. It simply requires count data for entire assemblages along with matched tool counts, and volumetric information on the excavation units from which assemblages were recovered; these data are commonly found in published accounts.

We propose this methodology as an additional component of a growing "analytical arsenal" that helps archaeologists reconstruct prehistoric behavior from chipped stone assemblages. While a single method can generate sound interpretations, one should ideally combine a variety of methods operating at different scales of resolution (i.e., artifact-vs. assemblage-based) in order to obtain a thorough understanding of technoeconomic behavior, since each has advantages and limitations. For instance, while the methodology advocated in this paper does not quantitatively estimate the degree of curtailment of individual artifact types within an assemblage (cf. Dibble 1987, 1995; Kuhn 1990, 1992), it includes all retouched artifacts in its assessment of general land-use patterns as opposed to relying only on certain classes of retouched pieces on certain kinds of blades to do so (e.g., scrapers on flakes). Our method can thus serve both as a heuristic to generate interpretations that can be complemented by artifact-based methods, and as a potential confirmatory "check" for the results of such analyses aiming to reconstruct past technoeconomic strategies. However, before the interpretation of artifact- and assemblage-based measures of curtailment can be compared, it is necessary to develop the methodology needed to arrive at an assemblage-based measure on its own.

Sample Selection

There are, in Paleolithic studies, few topics more contentious than the so-called Middle to Upper Paleolithic transition, and what this entails in terms of changes in hominin behavior (Bar-Yosef and Pipenn 2000; Clark 1999; Stringer and Donahue 2001). Because whole assemblage analysis offers a uniform way to track changes in land-use and technoeconomic strategies across typologically defined periods, we focus this study on a series of sites that have yielded Middle, Upper, and "transitional" Paleolithic assemblages. The selected sample comprises eight tightly clustered sites located on the Iberian coast of the Talento peninsula, in southern Italy, near the city of Nardò (Table 1). These sites were excavated in the 1960s and 1970s by teams from the Istituto Italiano di Preistoria e Protostoria, the University of Siena, and the University of Florence, reportedly using modern recovery techniques. Most of the excavated assemblages were described in their entirety, with retrieved tools, debris, and cores being described typologically and in terms of their raw material. All the sites contain Middle Paleolithic deposits, four contain Upper Paleolithic deposits (Proto-Aurignacian and Epigravettian), and five contain deposits attributed to a "transitional" industry, the Uluzzian.

Palmia di Cemoña (1993, 2001) describes the Uluzzian as a uniquely Italian transition industry (but see Koumouzelis et al. 2001; Koumouzelis, Kritiotakis et al. 2001) characterized typologically by backed lunate microliths and pieces equidistant—of splintered pieces—Demars and Laurent 1989:94–95, 98–99), and technologically by a predominantly flake-based blank production system (see Kuhn and Bietti 2000). It is quite different from the Châtelperronian industries of southwestern France and northern Spain into which some researchers mistakenly attempt to subsume it (e.g., Gioia 1988, 1990; Musi 2001). However, the Uluzzian may well represent a local manifestation of broader sociodemographic and evolutionary trends occurring in Eurasia as a whole between 40,000–30,000 years B.P. (d'Errico et al. 1998; Kuhn and Bietti 2000). This study offers the potential to test whether or not the behavior reflected in Uluzzian assemblages is more closely related to Middle or Upper Paleolithic patterns, and whether there are marked differences in economic strategies that coincide with the beginning of the Upper Paleolithic.

It is important to emphasize that our sampling strategy, focused on a set of comparable locales, effectively creates a useful testing to study diachronic changes in land-use patterns as it holds the location of human activities constant. If in that context the flexibility of technoeconomic strategies can be shown to vary markedly through time, we have clear evidence that the area’s use by foragers must have been dictated by different factors and motivations over time. This also may help inter-
per the uneven number of assemblages from each period in our sample (see Table 1), since dramatic fluctuation in the incidence of occupation (i.e., the number of assemblages per time-unit) is likely to be related to changes in land-use patterns (see discussion below).

Results

Artifacts volumetric density and frequency of retouched pieces were computed for all assemblages for which the information was sufficient to do so, and the results are plotted graphically in Figure 2. Despite the generally good quality of information, it was not always possible to get the necessary data, even for all the layers from a single site. This means, for instance, that the Mousterian and Epigravettian layers of Groto del Cavallo, while unquestionably present (Palma di Cesuna 1964, 1965; see also Sarli et al. 2000, 2002), could not be incorporated in a comparison with the Uluzzian layers, since only the latter had reported debitage counts. These discrepancies in data reporting might well be due to the comparatively greater emphasis placed on describing the Uluzzian layers that, as the time the site reports were published, documented a hitherto unknown Paleolithic industry. Furthermore, many Middle Paleolithic sites were already known in Italy, and as a result, the Middle Paleolithic assemblages from coastal Salento may have been considered less important to describe in their entirety, especially since detailed typological inventories of their contexts had been given. Despite these shortcomings, there are still enough data to identify interesting relationships. Correlation coefficients also were computed for each site (Figure 2) to indicate the strength of relationships between retouch frequency and artifact density across time. Following Barton (1998; Vilanova et al. 1998), a log scale is used for both axes of the graph. As indicated above, time-transgressive potencies in lithic variability were analyzed for each site individually to limit comparing assemblages deposited under different sedimentary environments. While most sites display an overall adherence to the negative relationship predicted by the model, r values are low in many cases—usually due to a few anomalous assemblages. Some of these anomalous patterns could result from variation in sedimentation rates (e.g., Barton 1998). For instance, at Serra Cicona A, the low correlation coefficient is due to a single Mousterian assemblage with an anomalously low artifact density for its frequency of retouched pieces, possibly due to a higher sedimentation rate during the accumulation of that assemblage. Unfortunately, available published data do not allow us to explore this possibility here. However, another factor seems even more important for the sites under scrutiny here, namely the nature of the raw material used to manufacture...
the lithic assemblages. While many documented Paleolithic industries from western Eurasia were made on high-quality, fine-grained cryptocrystalline material such as flint or varieties of chert, almost all Middle Paleolithic and Early Upper Paleolithic assemblages from coastal Salento contain substantial proportions of tools, cores, and debitage made on locally available, poor-quality siliceous limestone of various kinds and a minority of lithic artifacts made on flint, chert and/or quartzite (Palma di Cesnola 1996; Peretto 1992). Interestingly, in his study of the assemblages from Grotta Caves, Barton (1998:15) also notes that flint—which is not readily available locally—was the most intensively curated raw material while locally abundant quartzite pebbles were used to manufacture mostly expedient, lightly retouched implements.
As mentioned above, artifact assemblages probably represent palimpsests of multiple occupations in most cases, due to the often slow accumulation of deposits in cave and rock shelter sites, regardless of the care taken in excavation (Barton and Clark 1993; Barton et al. 2002). Under these conditions, there are at least three scenarios through which local and exotic raw materials can become amalgamated within a single assemblage. First, logistical hunter-gatherers occupying a given site simply may have acquired and used a variety of raw materials in proportion to their availability within a given range from the site. In this case, all materials would be curated and modified to a more or less equivalent degree, controlled by the land-use considerations outlined above. Second, hunter-gatherers coming from elsewhere and occupying a given site for a period of time might have discarded exhausted artifacts made on distant raw material at that site, and used local raw material to execute tasks during their occupation of the site as well as to "gear up" in expectation of their next reoccupation across the landscape. Third, within a single depositional episode, groups with differing land-use strategies and associated raw material consumption regimes could have occupied a given site sequentially, discarding distinct lithic production debris that became mixed postdepositionally. In the latter two cases, different raw materials could display different degrees of citation-related maintenance (i.e., refitting). These explanations are not mutually exclusive, of course, and it is in fact likely that they combined to create the patterns of artifact discard detected in the archaeological record. This suggests it could be useful to further subdivide prehistoric lithic assemblages—in this case those from coastal Salento—on the basis of raw materials to help us better distinguish among technological behaviors.

The information contained in the published site reports allows us to recalculate artifact density and refitted tool frequencies, with assemblages subdivided by raw material class, at four of the eight Salento sites. After subdividing by raw material, all four of these sites display very strong negative relationships, also indicated by their r values (Figure 3.3). This underscores the not surprising importance of accounting for raw material differences in whole assemblage analyses of prehistoric materials (Anderfisky 1994). However, we cannot simply assume that fine cryptocrystalline materials always

![Graphs showing the relationship between absolute artifact density and frequency of refitted pieces after differentiation between sites (i.e., high-quality raw material) and Santamasso (i.e., low-quality raw material) sub-assemblages, for the four sites for which adequate information is available. Symbols: □ = Mousterian (poor quality raw material); ● = Neanderthal (good quality raw material); O = Cro-Magnon (good quality raw material); □ = Uthic (good quality raw material); □ = Epigravettian (good quality raw material).]
will be highly curated and poorer quality materials will be used in an expedient manner. For example, all the Epigravettian assemblages in our sample contain tools made ex-clusively on flint and yet fall toward the expedient end of the continuum.

We also can make somewhat more subjective assessments for several sites that lack sufficient published information to subdivide assemblages by raw material. Although precise counts are missing, the Middle Paleolithic and Uluzzian assemblages from Marcello Zut, Cavallo, Serra di Ciceria A, and Uluzzo are described as containing significant proportions of artifacts made on silcrete limestone (Borzetti von Löwenstern 1963, 1964; Danzíoni and Nardi 1986; Palma di Cesnola 1964, 1965, 1966, 1967). However, a recent review of the assemblages from the Salento documents more or less gradual decrepitude in limestone utilization during the course of the Uluzzian, although limestone implements never completely disappear (Palma di Cesnola 1993:81–115). It is only with the much later Epigravettian (assumed to date to after ca. 20,000 B.P.)—represented at Cavallo, Uluzzo, and Uluzzo C by several Rosanellian and Epi Rosanellian layers—that limestone becomes scarce and its influence on patterns of lithic variability becomes negligible. Given this, it is likely that at least the Middle Paleolithic and Uluzzian layers of the four sites mentioned above would generate patterns that conform to expectations if sufficient information on raw material was available.

At Serra di Ciceria A, the early Upper Paleolithic assemblages studied separately display an extremely strong adherence to the pattern predicted by the model (r = -99, p = .009, N = 4) even without raw material differentiation. Sperone (1981) reports that limestone is abundant in both the Uluzzian and proto-Aurignacian layers, but that it only dominates the assemblage in layer D, the lowermost Uluzzian level. Despite this, layer D is tightly clustered with the proto-Aurignacian layers (A and B), while the more “flinty” Uluzzian assemblage of layer C has lower relative frequencies of retouch, indicating an overall more expedient strategy than that of layer D.

Discussion

The results of this study have important implications for our understanding of the Middle-Upper Paleolithic transition and the origins of modern humans. An important feature of the patterns seen in both Figures 2 and 3 is that artifact curation, and by implication techno-economic strategies, do not vary systematically according to time. That is, Middle Paleolithic, Uluzzian, and Upper Paleolithic assemblages all appear to be distributed across the spectrum of technological behaviors represented here. This is also the case for Gibraltar, where techno-economic behaviors and inferred land-use strategies seem more closely tied to environmental variation than to archeologically defined “cultures” (Baron 1998). This has ramifications for our understanding of the Late Pleistocene hominid behavior in southern Italy and also, more generally, for our construal of the nature of the so-called Middle-Upper Paleolithic transition. In terms of the Italian Paleolithic sequence, this study suggests that in those locales where assemblages of both Middle and Early Upper Paleolithic materials can be compared using a common analytical framework, there is no marked qualitative economic shift between the two periods. The kinds of exploited raw materials and the range of techno-economic organization remain stable across this analytical boundary. During the various Mousterian, Uluzzian, and proto-Aurignacian occupations of the coastal Salento sites, flint was highly curated and, by extension, was likely considered a finite and highly valued resource to be managed carefully. This kind of behavior is usually taken for granted—and rarely demonstrated—for the modern human populations of the Upper Paleolithic, but its presence in the Middle Paleolithic contrasts sharply with views of Neanderthals as qualitatively different from us behaviorally (e.g., Gamble 1995; Gargett 1999; White 2000). In fact, what the data suggest is that flint only became economically abundant to foragers in the Salento during the Late Upper Paleolithic, while it remained effectively scarce prior to that time.

To further evaluate this, we compare the lithic evidence for techno-economic behavior among archaeologically defined chronotaphological assemblage groups: Mousterian, Uluzzian, Protoaurignacian (early Upper Paleolithic), and Epigravettian (late Upper Paleolithic). Given the very strong correlation between retouch frequency and artifact density, we use retouch frequency alone as a simple proxy measure of the curion-expedien-sympn spectrum. As seen in Figure 4, this not only
supports the equivalence of the range of technoeconomic behavior from the Middle to Upper Paleolithic in the Salento sites, but also reveals an even more striking pattern. There is virtually no change in the range or distribution of technoeconomic behaviors expressed in these assemblages from the Mousterian through the early Upper Paleolithic, be it the Uluzzian or the proto-Aurignacian. However, the late Upper Paleolithic is distinctive in that it is characterized only by a narrow range of techno-economic behavior at the expedient end of the broader Late Pleistocene behavioral spectrum.

We have very little evidence of who might have been responsible for creating and depositing the industries found in the eight sites analyzed in this study. The only human fossils are two deciduous molars from Cavallo, Layer E, an Uluzzian layer. Messeri and Palma di Cesnola (1976; see also Palma di Cesnola and Messeri 1967) originally classified one of the teeth as anatomically modern and the other as Neandertal. However, a recent reexamination by Churchill and Smith (2000) assigned both to Neandertal individuals. Based on these data, and despite the acknowledged problems of
linking hominins to kinds of stone tools (see discussion in Riel-Salvatore and Clark 2001), it is possible that the Uluzzian was a purely Neanderthal industry (Kuhn and Bietti 2000). Given this, it should perhaps not come as a surprise that the economic pattern it displays share strong similarities to those extracted from the Middle Paleolithic layers of the sites from coastal Salento. What is surprising, however, is that the proto-Aurignacian industries from Serra Coeca display similar technoeconomic behavior as those observed in Uluzzian assemblages, patterns that are quite distinct from the Epigravettian patterns, despite the assumption that both techno-complexes were made by anatomically modern humans.

In light of these rather distinct patterns of land-use, intriguing interpretive insights can also be gleaned from the uneven number of sites from each period, especially as this relates to the Epigravettian. As seen in Table 2, absolute and relative numbers of assemblages are not directly correlated. For example, the more numerous Mousterian assemblages are nonetheless less relatively abundant than Uluzzian assemblages in our area. Table 2 shows that, if we except the two proto-Aurignacian assemblages, Epigravettian assemblages are relatively the least abundant in our sample, being noticeably less frequent than assemblages from the previous periods. In other words, in addition to observing a land-use pattern distinct from those of earlier occupants of the Salento coast, the makers of Epigravettian industries appear to have occupied the area less intensively than most of their forebears. Thus, the relatively low number of Epigravettian assemblages in our sample constitutes a corroborating thread of evidence indicating that rather different land-use strategies were in place for this area prior to and following the Last Glacial Maximum (LGM).

These complementary results suggest that, while human land-use strategies ranged from logistical to residential mobility over much of the Late Pleistocene at these sites, they became strongly focused on logistical strategies in the Epigravettian of the LGM. Admittedly, we are dealing here with a sample of two proto-Aurignacian layers, and we should be cautious about generalizing. However, a similar pattern is seen at Ghi-Valle (Barton 1996). Furthermore, in other studies in which a single method of measuring variability has been applied to archaeological data across the Middle Upper Paleolithic transition, changes in lithic technology do not correspond with the traditional distinction between the Middle and Upper Paleolithic (Goyon and Cole 1998; Kuhn 1995; Simek and Pril 1990). This leads us to suspect that an important (maybe the most important) archaeological distinction between the Middle and Upper Paleolithic in western Eurasia may be an artifact of the use of very different Middle and Upper Paleolithic typologies to characterize lithic variation (Clark 1997; Hiscock 1996). This does not discount the existence or importance of change in material culture and associated behaviors through the Late Pleistocene. However, the most important changes may well correspond with the Middle-Upper Paleolithic boundary as traditionally envisioned (Clark and Lindly 1989, 1991; Strauss 1997). For example, in the technoeconomic behaviors and inferred land-use strategies investigated here, the most significant change seems to correspond with the LGM (see Barton et al. 1994 for a comparable argument based on Paleoindian art). Similarly, a recent study of burial practices suggested more or less continuous, gradual change through the Late Pleistocene that culminated in recognizably modern behaviors by the LGM (Riel-Salvatore 2001). These results hold the potential for significantly re-framing the current debate about modern human origins. Most discussion today is focused on the nature of the biological transition from Neanderthals to modern Homo sapiens. It is probably safe to say that sometime between 40,000 and 25,000 years ago Neanderthals disappeared from western Eurasia. Whether by extinction, gene flow, or in situ
morpho-genetic change, it is likely that selection was the cause of this pervasive evolutionary event. However, the available archaeological evidence for critical economic behavior that could best account for the replacement of "archaic" with "modernity" in human populations indicates that the most important behavioral changes took place 30,000-20,000 years after the biological appearance of modern skeletal forms, but closely corresponding to worldwide environmental change in the Late Pleistocene. In our view, the most important question then becomes, "What were the selective forces driving the evolutionary spread of 'modernity'" rather than "What was the detailed process of this spread?" Given the apparent large temporal distinution between evidence for biological and behavioral change, this question looms very large in understanding our origins.

Finally, this study presents an alternative way to evaluate the meaning of "transitional" lithic industries like the Uluzzian and Châtelperronian in the Late Pleistocene. When we examine them from a perspective other than a purely typological one, the Early Upper Paleolithic industries from coastal Salento appear somewhat quite well with the range of adaptations represented by Middle and Upper Paleolithic assemblages. "Transitional" industries such as the Uluzzian may not, in fact, have been transitional in any sense of the word, but rather simply one of many different typological expressions of the same range of technologically variable characteristics found in the northern Mediterranean probably at least since the end of the last glacial. Thus, on behavioral grounds, it is hard to argue for a revolution in any kind coinciding with such archaeologically defined "cultures." Researchers may gain more useful interpretive insights by highlighting behavioral/functional patterns within complex lithic assemblages (i.e., contrasting tools and debitage) through the use of approaches such as the one developed in this paper, rather than losing the forest for the trees by limiting their interpretations to the minutia of typological analysis and clade operational reconstruction.

Conclusions

The results of this study provide a number of important insights. On a methodological level, it appears that the approach described and employed here and in two previous papers (Baron 1999; Villaverde et al. 1999) is a useful method for distinguishing varying degrees of variation and expediency in archaeological lithic assemblages. Its potential to evaluate variability in techno-economic behaviors over long time spans is demonstrated in its application to assemblages spanning the entire Late Pleistocene at Gibraltar and eastern Spanish sites. Successfully applying this approach to generate useful insights into the behavioral adaptations and land-use strategies of Late Pleistocene hominids in southern Italy further demonstrates its applicability across an extensive geographic region. We also highlight the importance of differentiating among different raw materials in analyzing Paleolithic assemblages in this way (see also, e.g., Andrejczyk 1994).

As a potentially interesting aside that deserves further study, if the kind of patterning between the variables used here proves to be consistent across more prehistoric assemblages, this kind of whole assemblage analysis potentially can help distinguish variation in sedimentation rates at deeply stratified sites. Given the ease and accessibility of this method, it could help in addressing a series of deposition-related questions ranging from site formation processes to temporal change. Because we are dealing with lithics that are equally much more resistant to sedimentary diagenetic processes, the characteristics of any given assemblage (i.e., its overall size and its frequency of misshapen pieces) should not be impacted by sedimentary vagaries, keeping in mind that they represent time-averaged pictures of long-term behavioral trends. This means that assemblages derived from unusual sedimentary contexts (relative to the overall pattern of sediment deposition and retention within a given site) should be easily visible on a graph. For instance, an assemblage having at least 50 percent of its sedimentary volume should be immediately apparent because, instead of falling on the line dictated by the overall rate of sedimentary integrity of a site (the regression line), it would fall clearly below it, indicating an anomaly in its sedimentary context. Conversely, layers and assemblages accumulating under unusually fast deposition regimes and suffering little subsequent deflation should fall above the general pattern. In this way, the methodology we advocate not only offers the potential to highlight significant aspects of prehistoric behavioral variability, but also to tentatively identify which
layers of a site were subject to unusual sedimentary processes and, thus, where it might be more informative to conduct in-depth geoarchaeological analyses.

The easy applicability of the methodology described above potentially also makes it useful to tackle problems related to patterns in lithic technology in other places and/or periods. While we have thus far only tested it on Late Pleistocene assemblages from southern Europe, it should be emphasized that its applicability is by no means limited to those contexts. All archaeological assemblages comprising a chipped stone component are amenable to a study of technocomponent patterns based on the methodology presented here. For instance, one can readily see how it could be applied to Paleoesolian assemblages to address some of the issues related to land-use patterns recently raised by Bamforth (2002) by allowing researchers to better identify which assemblages represent expedient or curated technological strategies.

This paper had two principal goals: (1) to test the utility of a method of whole assemblage analysis proposed by Barton and colleagues to study prehistoric forager behavior in different regions, and (2) to assess variability in technocomponent behavior in hominid groups across the Middle-Upper Paleolithic transition using this uniform methodological tool. By generating interpretable patterns based on additional data, we demonstrate that the method is potentially applicable to a wide range of contexts provided raw material is given due consideration. It would be interesting to apply it to contexts other than Mediterranean coastal Paleolithic sites and in other periods, although such studies are beyond the scope of this paper. Ultimately, however, this research makes it clear that lithic assemblages are better analyzed as wholes and that exclusively relying on studies of retouched stone implements severely handicaps our understanding of prehistoric technocomponent strategies. Debitage, core, and other lithic elements all need to be included.

With respect to the second goal, this study suggests that Late Pleistocene lithic technology in southeastern Italy was geared toward, or organized according to, a flexible range of economic strategies. These would have balanced the need to move through the landscape to obtain sufficient food and raw material with the prolonged occupation of given areas where one or both of these resources were more easily procured. Our evidence indicates that this pattern was in place by the Middle Paleolithic in southern Iberia and southern Italy, and that the appearance of the Aurignacian and of allegedly modern humans did not fundamentally change the way people moved about and exploited the landscape. Only with the Last Glacial Maximum do we see a significant change, with humans specializing in a narrow subset of the strategies that characterize the Late Pleistocene as a whole.

This study enriches the growing set of critical frameworks that archaeologists can usefully employ to translate material remains into increasingly secure inference about prehistoric life. We believe that alternative methodologies such as the one proposed here can serve as stepping stones from which renewed studies of lithic technology and associated aspects of prehistoric behavior can be undertaken.

Acknowledgements: Margaret Nelson generously took the time to make excise suggestions that helped tighten and clarify the arguments presented here, and overall make this a better piece of work. Geoffrey Clark and Francis Harrold also provided useful commentary on the methodology used in this study, applied in a very early paper presented at the 2002 AAA meetings. Thanks are also due to Steven Schachar for a critical reading of a previous draft and for many useful editorial suggestions. Peter Biford, Peter Hiscock and two anonymous reviewers also offered very valuable suggestions and constructive criticism that helped strengthen the paper. Despite the important input of these colleagues, we alone are responsible for any errors of fact and/or logic included in this study. Support for fieldwork during this period was provided by the Social Sciences and Humanities Research Council of Canada.

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