Archaeologia Polona, vol. 33:1995, 173–186
PL ISSN 0066-5924

The use of stone resources from the Neolithic levels of Arene Candide (Liguria, Italy)

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A study of the chipped and ground stone tools from the Neolithic levels of Arene Candide was conducted by the authors. The chipped stone tools were examined for technological and typological information by Starnini and for microwear traces by Voytek. The ground stone tools were also studied in terms of manufacturing techniques and function by both authors. All materials were examined as to potential source of raw materials. The paper outlines the main findings of the study, including the differences among the assemblages associated with three archaeological cultures, the Early Neolithic Impressed Ware Culture, the Middle Neolithic Square Mouth Pottery Culture, and the Late Neolithic Chassey Culture.

KEY-WORDS: chipped stone, ground stone, Neolithic technology, microwear study

INTRODUCTION

The cave site of Arene Candide is located to the west of the town of Finale Ligure in the Savona district of Liguria, Italy. It overlooks the Mediterranean at a height of 89 meters above present day sea level. Following several digging forays in the late nineteenth century, a systematic excavation was conducted between 1940 and 1942 by Luigi Bernabò Brea, who was then Superintendent of the Superintendency for the Archaeology of Liguria. After the war, the excavation was resumed and lasted from 1948 to 1950. Arene Candide provides one of the longest sequences known in the northern Mediterranean, with layers dating to the Upper and Final Palaeolithic and a sequence of 28 layers which span the Early Neolithic to the Roman period (Bernabò Brea 1946, 1956; Maggi *et al.* 1993:346).

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In the mid 1980s, a project was conceived to analyze and publish the materials from Arene Candide, given the significance of the site, the excellence of the Bernabò Brea excavations and the good deposition of excavated materials. It is within that project that the authors undertook the analysis of the stone artifacts (earlier, Starnini had initiated the technological and typological study of the chipped stone artifacts — Starnini 1982–83). For this work, the Neolithic levels were subdivided into the following groups, according to stratigraphic and cultural sequences as indicated by Bernabò Brea (1946, 1956):

— Layer 28 (mixture of Late Palaeolithic and Early Neolithic materials which are not considered further in this paper although they are included in the total number of analyzed pieces given above);
— Layers 25–27 (Early Neolithic Impressed Ware Culture);
— Layers 23–24 (layers with characteristic artifacts from both Early and Middle Neolithic periods and thus considered separately);
— Layers 16–22 (Middle Neolithic Square Mouth Pottery Culture);
— Layers 14–15 (layers defined by Bernabò Brea, 1956:114, as marking the passage from the Middle to the Late Neolithic and thus separated in this work);
— Layers 8–13 (Late Neolithic Chassey Culture).

THE CHIPPED STONE ARTIFACTS

The Neolithic chipped stone artifacts examined from the Neolithic levels of Bernabò Brea's excavations number 1,340. The distribution of the total, excluding the 27 pieces from layer 28, is shown below:

Layers	# Retouched	# Unretouched	Cores	Total
25–27	68 (23.2%)	225 (76.5%)	1 (0.3%)	294 (100.0%)
23–24	58 (31.9%)	124 (68.1%)	—	182 (100.0%)
16–22	175 (34.3%)	334 (65.5%)	1 (0.2%)	510 (100.0%)
14–15	41 (46.1%)	46 (51.7%)	2 (2.2%)	89 (100.0%)
8–13	124 (52.1%)	113 (47.5%)	1 (0.4%)	238 (100.0%)

As seen, the percentages of unretouched pieces are greater in all groupings except the most recent (layers 8–13). As discussed below, these percentages can reflect a greater degree of curation than during the earlier periods. Starnini examined all materials using the Laplace method (1964) and the typometrical method suggested by Bagolini (1970). Voytek studied the artifacts for microwear traces, using a stereoscopic binocular microscope at a power of 50–100x. The results of these analyses are detailed in Starnini and Voytek (in press a).

The distribution of used tools is indicated below:

Layers	# Used tools	# Unused pieces	Total
27–25	57 (19.3%)	237 (80.7%)	294 (100.0%)
24–23	44 (24.2%)	138 (75.8%)	182 (100.0%)
22–16	139 (27.2%)	373 (72.8%)	510 (100.0%)
15–14	35 (39.3%)	54 (60.7%)	89 (100.0%)
13– 8	100 (42.0%)	138 (58.0%)	238 (100.0%)

The above table shows an increase in the proportion of used pieces through time. Again the assemblage from the Chassey Culture layers appears to stand out from the others in that the number of used pieces is almost half of the assemblage. It is also interesting to note that in all groupings, the percentage of used tools is less than the corresponding percentage of retouched instruments. This shows that although used pieces tended to be retouched, not all retouched pieces had been used.

THE GROUND STONE ARTIFACTS

A total of 677 ground stone tools were examined from the Neolithic levels of the Bernabò Brea excavations of Arene Candide. For the purpose of analysis, the total was divided into two large categories of tools: edge tools (138) and grinding tools (539). Complete data bases accompany the publication of the Arene Candide materials (Starnini and Voytek in press b). The two categories correspond broadly to two main groups of rocks used in this assemblage, namely, sedimentary and metamorphic rocks for the grinding tools and metamorphic rocks for the polished edge tools.

Both medium-coarse grained and fine grained sandstones, with calcareous cement, are the most common sedimentary rocks. Sources near the cave are known. Many of the burnishers are made of a very hard, dark grey, silicified limestone which is also easily found in the area. The polished edge tools are made quite exclusively of greenstone of metamorphic origin. These artifacts have already been studied petrographically by Ricq-de Bouard (1980, 1987, 1989–90; Ricq-de Bouard *et al.* 1990:fn 6) and thus, no further analyses were conducted. The most common rock is eclogite, sometimes easily identifiable macroscopically because of the presence of garnet. Jadeite was also used (Starnini and Voytek in press b).

All ground stone tools were examined with a stereoscopic binocular microscope for evidence of wear traces including scratches, striations, polishing, and chipping and attrition of stone. The nature of the traces differs greatly, depending on the type of rock. Quartzite cobbles, for example, show very little wear, as compared with a piece of sandstone that has been worn down from intensive use as a sharpening stone for an adze or axe.

In addition, the reuse of these tools can mask original usage, which complicates functional analysis. However, such situations are more obvious with the edge tools rather than the grinding tools. In fact, there was little evidence for reuse of grinding tools, except for the reuse of broken grindstones and handstones made of sandstone. Sandstone tools appear to have merited reworking in comparison to the omni-present quartz cobble.

A breakdown of the total by type of artifact is given below:

Grinding tools		**Edge tools**	
Handstones	249	Adzes	78
Burnishers	138	Pestles	19
Grindstones	45	Axes	7
Hammers	33	Adze butts	7
Pebbles	25	Chisels	5
Handstone-hammers	29	Scrapers	5
Whetstones	25	Butt fragments	4
Choppers	5	Flakes	4
		Fragments	4
		Edge fragments	3
		Edge flakes	2
		Axe butts	1
		Adze flakes	1

GRINDING TOOLS

The overwhelming majority of the grinding tools come from the Square Mouth Pottery Culture layers.

	Handst.	**Burn.**	**HH**	**Hamrs**	**Pebbs**	**Grindst**	**Whetst**	**Chp**	**T**
8–13	8	12	1	2	3	0	4	0	30
14–15	3	4	1	0	1	0	0	0	9
16–22	198	107	25	26	16	39	16	2	429
23–24	17	12	2	2	3	3	2	3	44
25–27	13	3	0	3	2	3	3	0	27
Totals	239	138	29	33	25	45	25	5	539

Such a skewed distribution minimalizes the value of comparing the different Neolithic periods. It is clear that the Square Mouth Pottery Culture layers evidence the most intense use of stone resources. The handstone appears to be the most

common type of grinding tool except in the Chassey layers. Furthermore, there are no grindstones in the Chassey, again differentiating the nature of this later occupation from that of the earlier periods.

EDGE TOOLS

The ground edge tools from the Neolithic levels number 138. As was the case with the grinding tools, the definition of types within this classification was problematic. Five general categories emerged from the study, namely, convex adzes, flake adzes, axes, chisels, and other edge tools. There is some variation as to the quantities of types in each of the Neolithic horizons. As shown below, adzes are found in all. Again, the SMP Culture layers show by far the greatest variability of types which may equally reflect usage as well as degree of reuse of raw material and nature of occupation.

	Convex	**Flake**	**Axes**	**Chisels**	**Other**	**Total**
8–13	3	3	0	0	2	8
14–15	1	0	0	0	0	1
16–22	36	18	6	5	36	101
23–24	4	3	0	0	5	12
25–27	7	3	1	0	5	16
Totals	51	27	7	5	48	138

The "other" category includes manufacturing waste, which is most common in the Middle Neolithic layers. No manufacturing debris was found in the Early Neolithic Impressed Ware assemblage.

DISCUSSION: CHIPPED STONE ASSEMBLAGES

IMPRESSED WARE CULTURE ASSEMBLAGE

Within the chipped stone assemblage associated with the Impressed Ware Culture, the most characteristic elements are the borers and the isosceles trapezoid geometrics. The borers are formed with bilateral, steep retouch. The microwear analysis indicated that 14% of the used tools from this assemblage had been borers. This exceeds the proportion of borers found in the other assemblages (9% in the layers associated with the Square Mouth Pottery Culture and 6% in the assemblage associated with Chassey).

The geometrics are made with two straight or concave truncations. The microburin technique is not employed in the production of the trapezes, and in fact,

no instrument seems to have been obtained with this technique. On the other hand, truncations are common. Sickle inserts are rather rare, which suggests that agriculture did not play an important role in the subsistence strategy of this period. Microwear traces for sickle use were found on only 5% of the tools. There is a high percentage of steeply retouched instruments, and the chipping activity was mainly devoted to the production of narrow bladelets.

The chipped stone tools associated with the Impressed Ware Culture were used mainly on wood (28%) or hard materials, such as bone or antler (30%), and for processing skins and hides (18%). There is little evidence for reuse (5%) and little evidence for resharpening (7%). As far as function is concerned, the assemblage lacks variability.

However, a wide variety of rock types were used. Contacts with neighboring regions are noted in the small percentage of blonde flint from the lower Rhône Valley. Red jasper is present in the assemblage which suggests some link with eastern Liguria, where outcrops of this raw material are well known. Long-distance trade routes were already active in this period, as demonstrated by the presence of obsidian of Sardinian and Palmarolan provenance (Ammerman and Polglase 1993). The majority of the raw materials from the Impressed Ware levels are varieties of poor quality flints, probably from the limestone formations of the Ligurian Apennine (Antofilli, Borgo and Palenzona 1985). In particular, one outcrop of chalcedony has been localized very close to the cave, in the form of narrow veins between the formation named "sandstone of Verezzi" near Borgio Verezzi (Savona).

SQUARE MOUTH POTTERY CULTURE ASSEMBLAGE

The chipped stone assemblage changes with the beginning of the Square Mouth Pottery Culture. The lithic tool-kit appears to be more articulated which reflects an increase in cultural complexity. The incidence of reuse and resharpening among the tools increases to 10% and 12%, respectively, which is likely to be related to the improved raw materials of this period. The sheer quantity of pieces demonstrates a more intense and longer occupation of the site. Almost half of the total pieces were found in these levels. Only the first phase of this culture, namely the Finale-Quinzano phase which is characterized by the linear geometric style of the pottery decoration, is well represented in the cave. The typical instruments of this phase are geometric implements rectangular in shape, formed by two parallel truncations and sickle inserts with gloss parallel to the edge. The microwear analysis showed 15% of the tools were sickles. They suggest that agriculture was now playing a more important role in the subsistence strategy. In addition, the percentage of tools used on wood, 32%, was greater than in the Early Neolithic assemblage, while the percentage used on hard materials was considerably lower (22%).

Documented in the SMP layers is also an increase in raw material variety. Obsidian came from different sources of the west Mediterranean and, for the first time in the sequence, from the Isle of Lipari (Ammerman and Polglase 1993). Flints were derived from the central Alpine sources of the Monti Lessini (Verona) or the eastern fringe of the Garda morainic arc (Barfield 1987). Considering the cultural homogeneity of Northern Italy during the development of the Square Mouth Pottery Culture and its wide exchange, the presence of the Alpine raw materials on the Ligurian coast is not surprising.

THE CHASSEY CULTURE ASSEMBLAGE

At Arene Candide the layers containing materials associated with the Square Mouth Pottery Culture are followed by those containing typical pottery of the southwestern aspect of the French Chassey Culture. The lithic industry from these later Neolithic levels also shows strong connections with the Chassey, from both a typological and a technological point of view. The presence of certain types of foliate arrowheads and the use of the southern France blonde-honey coloured flint are two of the more evident characteristics shared with the Chassey assemblages of southwestern France (Courtin 1974; Binder 1991). No elements from the previous SMP cultural tradition survived in the lithic assemblage of the Ligurian Chassey Culture. The proportion of sickles again drops to 4%. Tasks involving woodworking easily claim the highest percentage of the tools (35%). The comparatively higher percentage of chipped tools used in woodworking is balanced by the small number of ground edge tools from this period.

The highest percentage of chipped stone tools used on hides was from the Late Neolithic horizon (24%), while early and middle horizons yielded 18% and 17%, respectively. If these tools were the only indication of hide-working at Arene Candide, this activity would appear to have been of little significance. As indicated below, the working of hides was a principal endeavor during the Neolithic.

In addition to the use of the French flint sources, there was a change in obsidian sources (Ammerman and Polglase 1993). Obsidian from Palmarola disappears, and that from Lipari dominates. The incidence of reuse and resharpening among the tools is highest within the Chassey period assemblage at 13% and 15%, respectively. Unlike the case with the other periods, the resharpening is done exclusively with retouch. No burin techniques are used.

Together with this conservation of raw material, there is also an apparent change in hafting due to hafting techniques or to prolonged use of hafted tools. As discussed by Odell (1994), such developments can in turn be linked to curation of tools and permanence of settlement. In brief, both the raw materials and their treatment differed from the early periods, in addition to changes in tool typology.

DISCUSSION: GROUND STONE ASSEMBLAGE

HANDSTONES

The most common type of grinding tool is the handstone. Some of the handstones may have been used with one hand (like manos). They are quartz/quartzite or rarely limestone cobbles. The shape is invariably oblate spheroid. The size as well as shape were relatively standardized and the uniformity of these pieces through time is striking.

More than 34% of these handstones bore traces of red ochre, or less frequently, black manganese or yellow limonite. The staining marks a delimited worn or abraded area which is often circular in shape. A microscopic study of the worn areas produced varying results. In some instances the smoothed, polished grains suggest that many of the handstones had been used in processing hides.

At the same time, it is likely that a stone served as a base for hide-processing. The worn areas of the cobbles were localized, either in the center of the surface or toward one end (Adams 1988:311). Ethnographic accounts support the microscopic analyses. Handstones are used for dehairing and whitening hides. A common practice is to rub a wet stone over the hide to soften tissues and remove them (Adams 1988:308, 313), often applying an agent such as brains or grease (Beaune 1989:59; Reed 1972:66). Given the extent of ochre staining on the handstones, it is clear this mineral was used in coloring hides, although ochre is also used in hide-processing for softening and cleaning (Audouin and Plisson 1982).

Other handstones have been purposefully modified. Examples are in sandstone or porphyroid. Some had been flaked from broken grindstones. In very few instances, the edges are ground as well as flaked to shape the handstone. The shapes in general are not standardized, and include a few examples of long oval shapes (so-called "loaf-shaped"). The only examples known of the shaped handstones are from the Early and Middle Neolithic levels. No examples were noted from the Late Neolithic Chassey Culture levels.

Except for five handstones which may have been utilized in ochre-processing, in general these tools had been used on stone grindstones to process other materials, possibly grain.

BURNISHERS

The second most common tool were the burnishers. These tools are found in all Neolithic periods, although only few examples are known from the Early Neolithic. Most are limestone, although greenstone examples are plentiful in the later Neolithic. Although the shape varies in particulars, it tends to be either a flat pebble or a lozenge-shaped pebble with beveled ends. The beveling is the result of prolonged

use. The proportional size tends to be standardized through time, although they do not bear any traces of manufacture to shape or size them. In other words, they suggest purposeful choice of pebbles.

The use of the burnishers for pottery is documented mainly by the scratches which cover these pieces due to the quartz minerals in the clays, either naturally or included as temper. These polishing stones are relatively common and suggest that at least one or more steps in the production of pottery took place in the cave.

On the other hand, some of the burnishers may have been tools in hide-processing, especially the examples which have scratches perpendicular to the long axis of the stone. There is occasional evidence for ochre-staining on some of these pieces. Experimentation with these soft stones on hides would be the best way to test for formation of scratches. Another potential usage of the burnishers, as sharpening stones for edge tools, was suggested by Bernabò Brea (1956:104). We have not, however, replicated the wear patterns which are characteristic of the burnishers with this type of usage.

Forty-five grindstones/grindstone fragments were examined, of which only 13 were complete. All bore evidence of shaping and maintenance. Over half of the specimens are of sandstone. Porphyroid grindstones are also known, as well as quartzite, limestone, and chloritoschist.

Although some may have been the basal stones for grinding grains, grindstones were extensively used in the processing and application of ochre. Out of all grindstones and grindstone fragments, close to two-thirds had clear evidence of being used with ochre. No grindstones are known from the Chassey Culture levels, a fact which reflects either different activities or different site function and/or settlement pattern (Lancaster 1986; Nelson and Lippemeier 1993).

WHETSTONES

Two general types of whetstones were noted. One is comprised of pieces of quartzite, limestone, porphyroid, or serpentine schist, *i.e.*, fine-grained metamorphic rock. The second general type is made from fine-grained sandstone. Grindstone fragments were often used as whetstones. Over half of the whetstones analyzed are the second type. Neither of the two types show evidence of manufacture, and alteration of the original rock was due to its use as a sharpening stone, for ground stone edge tools and for bone tools. The two categories do not directly pertain to function. There is no strict pattern of certain rocks being used for stone and others for bone.

CHOPPERS

Only five examples are known of this type of tool. One is of porphyroid, one is composed of prasinite, and the others are of quartzite, made on cobbles. These tools have been flaked on the used end to construct a relatively sharp edge. It is feasible that

the quartzite examples had been used in bone tool manufacture (Starnini, Voytek and Maggi in press). Quartz and quartzite are excellent rock types for working bone since quartz grains can cut into the bone without chipping like flint.

HAMMER-HANDSTONES

A type which was differentiated from other handstones was the so-called "hammer-handstone". It is invariably a quartz or quartzite cobble that had been used as a handstone. Its function is believed to be directly connected with the processing of ochre or other mineral pigments or pulverizing other hard substances.

CONVEX ADZES

The convex adze corresponds to that reported in Vol. II of the Arene Candide publication (Bernabò Brea 1956:102–3).

They are generally characterized by their elongated shape and elliptical section. In general, this type of adze is somewhat larger and heavier than the adzes on flakes and the so-called axes. The blanks were cobbles and pebbles which explains, to some degree, the shape of the tools. They were subjected to pecking and grinding to achieve the form desired. Little flaking appears to have characterized the manufacture process. This is apparently common for ground edge tools made of greenstone, which does not lend itself to flaking (*e.g.*, Saintot 1985:129). The majority of the convex adzes had been made on ecologite, with substantially fewer examples of other greenstones.

FLAKE ADZES

A second type of adze was made on a flake rather than a pebble or cobble. The use of the flake adzes appears to differ from the convex types, and they follow a different pattern of reuse and resharpening which obviously affects their final form. The surfaces of the flake adzes are extremely polished, through both manufacture and use. While less than 10% of the convex adzes were polished very finely, over one-third of the flake adzes were so made. Even in the cases with so-called crude surfaces, the actual cutting edge is extremely polished and thin. As with all the ground edge tools, the overwhelming majority of the flake adzes are composed of eclogite.

AXES

Axe manufacture and surface treatment appear to be the same as for the adzes. The ratio of the cutting edge to the length of the tool is almost exactly the same for the axes and convex adzes, while the surface treatment is similar to that found in the case of the flake adzes.

The principal difference between the adze and axe appears to be hafting, with the axes having been hafted laterally (as shown in the example from Pollera, Bernabò Brea

1946:175) and the adzes longitudinally. This difference would explain the distinctive angles of working, and yet, would not cause the occurrence of major variation in wear traces. The choice of raw material follows the pattern for ground edge tools, with eclogite again being the most common.

CHISELS

In general, the distinction of some pieces as chisels is also based on general shape, with a narrow edge differentiating a chisel from an adze (Bernabò Brea 1946:174). The surfaces of the chisels resemble those of flake adzes and axes — highly polished from continuous use on wood and frequent resharpening. Four chisels were clearly reworked from larger pieces. In this respect, chisels were a means of extending the uselife of a tool. As discussed below, pestles were frequently gleaned from exhausted edge tools as well.

The ground edge tools were examined under a stereoscopic binocular microscope for traces of wear. The principal types recorded included microstriations; microscratches; edge "nibbling" (*i.e.*, microscars that run close together on the edge); flaking; abrasion; and patterns of polish and gloss. Sufficient evidence exists to argue that these tools had been primarily engaged in wood-working. The convex adzes had been used in tasks that took advantage of their weight such as chopping and splitting wood, as well as cutting. The flake adzes, on the other hand, were used mainly for finishing and planing wooden objects. Prolonged contact with the wood intensified the polishing of the edges. This is also true of the chisels. One of the chisels developed a gloss similar to the "sickle" sheen found on some chipped stone blades.

Several edge tools bore microstriations from use which ran perpendicular to the cutting edge. It appears that there was little difference in the direction of working wood with these tools. As mentioned earlier, the principal difference between the adzes and axes was found in the hafting.

Resharpening took the form of flaking and grinding, and the latter left specific patterns of scratching and/striations. Convex adzes with scratches and/or striations from resharpening show them as running parallel to the long axis of the piece, suggesting that the tranchets had been resharpened in such a manner — *i.e.*, in a longitudinal direction. The flake adzes were resharpened with grinding that was perpendicular to the long axis. At a certain point, the resharpening of the convex adzes made them unusable as cutting tools, and several were recycled into pestles.

PESTLES

Many of the pieces assigned to this category bear little similarity except for their having been used for hammering/pounding and grinding minerals and perhaps other substances. One group is comprised of reused fragments of greenstone. The second group of pestles is made up of edge tools which had been clearly convex adzes (except

for one axe) but their final usage had been as pestles. No fewer than 26 edge tools have been classified as such. The reworking of these tools was different from the first subgroup. These examples clearly represent the reuse of exhausted edge tools rather than reuse of fragments. When tranchets could no longer be resharpened, they were reused for grinding and pounding various substances including ochre and other minerals. The alternative method of reworking — *i.e.*, reducing tools into usable flakes — was not often taken, probably because of the nature of the rock which did not flake easily. As mentioned earlier, reduction techniques were practiced in the manufacture of chisels but they were not common.

The nature of the wear traces on the pestles is the result of pounding and grinding — worn, abraded, but not polished, surfaces. Similar wear has been documented elsewhere for such tools (*e.g.*, Binder ed. 1991:61). Some convex adzes reused as pestles show a very specific form of wear. One section of the distal end (the former tranchet) of the tool had been ground unidirectionally along a stone surface. Then the tool was reversed, turned 180 degrees in the hand, so that the other half of the tranchet was ground on the opposite surface. Alternatively, or in addition, the distal end (former tranchet) had been used in a circular grinding motion, possibly within a stone concavity. The substance thus ground is not known but at least some of these pieces had been used for pounding and grinding ochre.

CONCLUSIONS

In sum, the use of stone resources at Arene Candide appears to have changed through time, a development which also reflects changes in the exploitation of other resources, specifically woods and plants. In addition, the extent of resharpening and reuse also varied among the three periods outlined in this paper. As mentioned, the greatest incidence of resharpening and reuse of chipped stone is found in the Late Neolithic levels which we have related to the nature of the worked materials, improved rock resources, and a socioeconomic situation that placed a premium on conserving and curating tools made from those resources.

The ground stone tools from Arene Candide also suggest different usage of the site through time. The absence of grindstones and handstones for grain processing from the Late Neolithic Chassey Culture levels is significant in terms of subsistence activities at the cave. However, other examples show that the processing of foodstuffs was not the only task of the grindstones and handstones. They had also been intensively used in working and processing hides, ochre and other minerals; manufacturing and reworking other stone tools and bone items; functioning in pottery production (burnishing ceramics); and wood-working (the manufacture and maintenance of wooden vessels, tools, equipment, and structures). This variety is especially clear in the SMP Culture layers.

The stone assemblages from Arene Candide have proved to be an excellent source for information on subsistence, site function, and Neolithic technology and activities. As further comparative studies are done, the value of this research will certainly grow.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of Paolo Biagi, Roberto Maggi, and Guiseppe Vicino who contributed much to the study; to the Wenner-Gren Foundation for its support of the overall project; and to the National Endowment for the Humanities and Etif who helped support the microwear research.

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