THE FOSSIL MAN OF MONTE CIRCEO: FIFTY YEARS OF STUDIES ON THE NEANDERTALS IN LATIUM

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THE PONTINIAN ON THE PLAIN: SOME RESULTS FROM THE AGRO PONTINO SURVEY

INTRODUCTION

The immediate area surrounding Monte Circeo is the Agro Pontino, where, for a number of years, the University of Amsterdam has been conducting a regional survey of archaeological surface materials. The area surveyed is bounded physiographically by the Fiume Astura to the northwest and by the Monti Lepini and Monti Ausoni to the northeast along with southeast and southwest coasts on either side of Monte Circeo.

The survey took place in three phases: an exploratory phase during which field methods were developed and data were collected to assess variability of archaeological materials in the area (Fig. 1); a second phase based on a probabilistic sampling design from which five transects running from the southwest coast to the Lepini range, one in each of the five N-S strata were surveyed — in sampling jargon, a systematic unaligned transect design (Fig. 2); and, finally, a problem-oriented phase during which additional data were gathered based on needs of particular research projects (Loving et al., 1991). This last phase has included drawing three shorter transects (nos. 6-8 on Fig. 2) for the land evaluation project (Kamermans et al., 1985) and resurveying fields with Middle and Upper Paleolithic materials for a research project that attempts to identify differences in mobility between the Middle and Upper Paleolithic using surface materials. The data for research based on survey materials are currently being used to identify distorting factors that may have influenced survey recovery

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(Verhoeven, 1991) and to find patterning between materials and landscape features at a very general level (Loving, Kamermans, 1991; Koot, 1991). This article concerns what we have learned so far about the distribution of Middle Paleolithic surface materials and some ideas we have about what is controlling that distribution.

THE REGION

A good deal of information about the physiography of the Agro Pontino has been published (e.g., Amadei et al., 1965; Blanc, Segre, 1953; Dragone et al., 1969; Segre, 1969; Sevink et al., 1982, 1984), and only a brief description will be provided here. The Agro Pontino is a stepped graben that can be simplistically divided into two parts

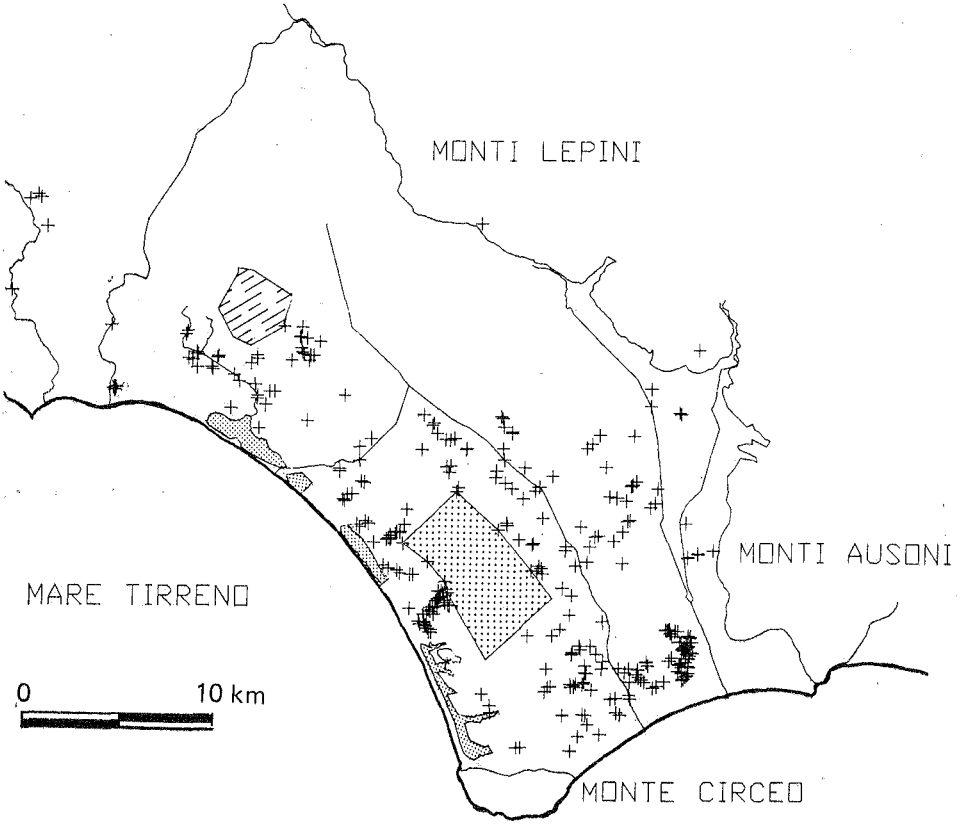

Fig. 1: Map of Agro Pontino showing locations of fields surveyed during the exploratory phase.

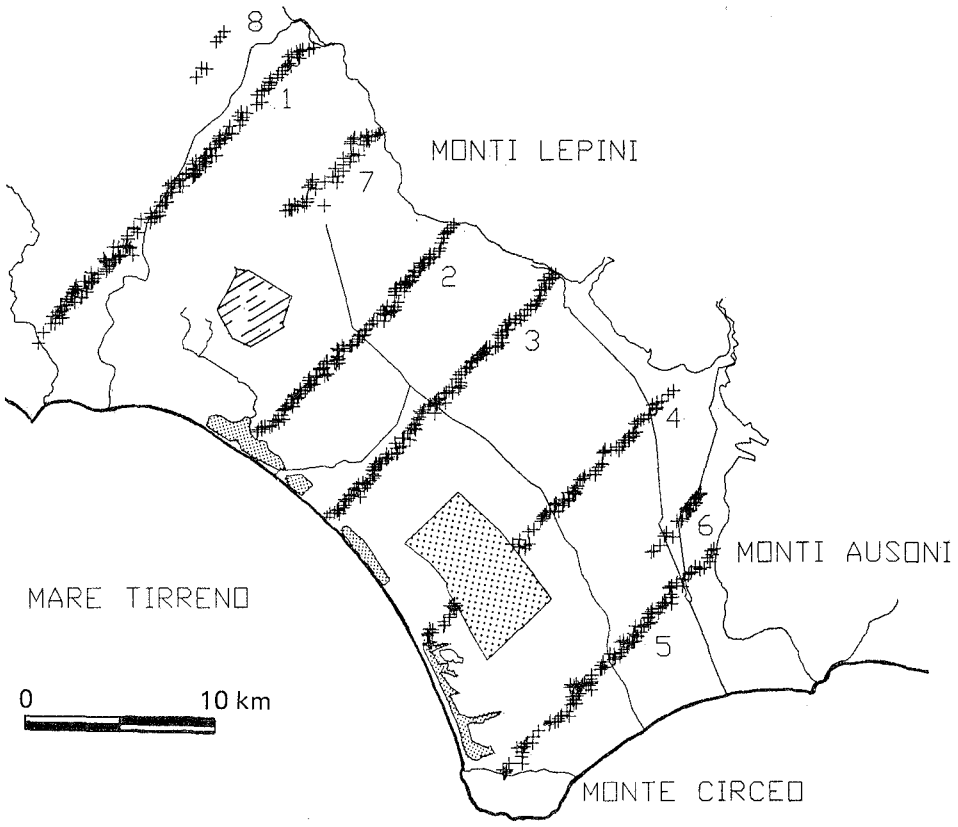

Fig. 2: Map of Agro Pontino showing location of transects selected for the probabilistic sample (transects 1 to 5) and additional transects selected for the land evaluation research project (transects 6 to 8).

(Kamermans, 1991). Its upper part lies along the coast where a number of beach ridge-lagoonal systems have developed. Its lower part, which in this paper is referred to as the "graben", lies between the beach ridge-lagoonal system and the Lepini and Ausoni ranges and is filled with lagoonal, alluvial, and colluvial clays and peats (Fig. 3). The beach ridge-lagoonal system consists of a more or less ordered series of littoral deposits that formed seaward through time; beginning with the most recent deposits these are referred to as the Terracina level (the modern coast), which was formed during the Holocene, the Borgo Ermada and Minturno levels, dated to about 90,000 BP and 125,000 BP respectively by amino acid racemization (Hearty, Dai Pra, 1986), and the Latina level, the transgression of which has been dated (by K-Ar) to 450,000-650,000 BP, much older than previously thought (De Wit et al., 1987).

Slightly north of Sabaudia behind the Terracina lagoonal deposits is a fossil high energy beach ridge containing gravels and in many

places pebbles of sufficient size and quality for making stone tools. This ridge, which is part of the Borgo Ermada complex, runs northwest following the coastline a little past Fogliano. There, slightly more inland, is a similar ridge associated with the Minturno level, which continues running northwest to the Astura. Larger flint pebbles do not seem to occur south of Sabaudia along the coast, at least as far as Minturno. They do occur, however, to the north of the Agro Pontino. Beneath the Minturno level pebble deposits found on the surface there is another pebble bed with even larger pebbles. These larger pebbles and associated shells are being dredged up from about 10 meters below

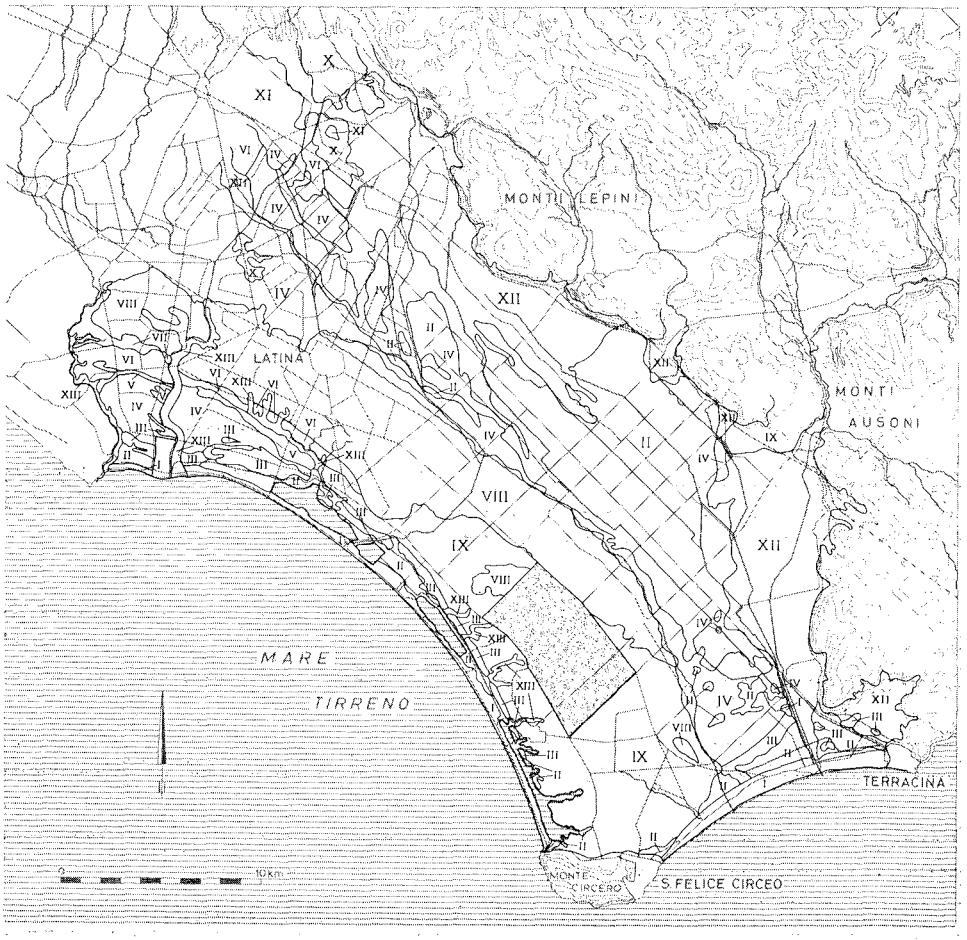

Fig. 3: Map of the Agro Pontino showing division into land units based on parent materials, age of land surfaces, and major soil types. I: Terracina level beach ridge; II: Terracina level lagoon; III: Borgo Ermada level beach ridge; IV: Borgo Ermada level lagoon; V: Minturno level beach ridge; VI: Minturno level lagoon; VII: Latina level beach ridge; VIII: Latina level lagoon; IX: Aeolian deposits; X: Volcanic deposits; XI: Travertine plateaus; XII: Alluvio-colluvial basin fill.

the present-day surface at the Cava di Sabbia near Latina (see Fig. 25 in Sevink et al., 1984). Presumably these beds were exposed in incisions in prehistoric times.

Much of the beach ridge-lagoonal area has some aeolian cover; older aeolian deposits, associated with the Minturno level, occur on the surface from the north of the Parco Nazionale to slightly north of Borgo Grappa, and younger aeolian deposits, much of which are thought to have been deposited during the Late Glacial, extend from Monte Circeo north to about the middle of the Parco.

The graben sediments consist primarily of lagoonal clays, which have been found stratified in some areas and have been associated with the coastal levels (Sevink et al., 1984: 19-20). Today, the Terracina level clays and associated peats constitute much of the surface of the area; surface exposure of the Borgo Ermada and Minturno level lagoonal clays occurs along the southwestern edge of the graben in the north, and that of the Borgo Ermada level follows this edge southward almost the entire length of the Agro Pontino. Tuffs and travertines border the northern boundary of the survey area. Colluvial and alluvial deposits overlie the clays along the mountain side of the graben and are particularly extensive in the northern part.

The tectonic features and the low elevation of the area account for its peculiar hydrology. The only rivers to traverse the area are the Astura to the north and the Ameseno in the south, whose outlet to the sea has been periodically cut off by beach ridges. Surface and underground runoff from the mountains ends up in the graben. Surface runoff from the beach ridge-lagoonal system is accomodated by short drainage channels leading to the sea on the western and southern sides and to the graben on the eastern side. Soil drainage conditions in this area are highly variable, depending on whether sands overlie other sands or clays, the thickness of the clays, etc.

Distribution of the Middle Paleolithic on the Agro Pontino

Middle Paleolithic artifacts

Middle Paleolithic artifacts were identified as such if they could be assigned to Bordes's (1961) types 1-24 and they "stylistically" resembled published Middle Paleolithic materials found in sealed contexts (Taschini, 1972, 1979) and/or those on exhibit in the Museo Nazionale Preistorico Etnografico 'Luigi Pigorini' in Rome.

The archaeological survey found Middle Paleolithic materials on all of the older surfaces of the Agro Pontino. By older surfaces is meant the exposed surfaces of sedimentological units that were deposited before or during the course of the Middle Paleolithic period (conventionally, ca. 100,000 BP - 33,000 BP in southern Europe). These include all the marine terraces except the Terracina level, the older

aeolian sands, volcanic soils, and the travertine. With a few exceptions, Middle Paleolithic artifacts were not found on surfaces of more recently deposited sedimentological units.

The exceptions include a number of items found in recent fill along the coast, which we know has been brought in as part of the (continuing) reclamation of the area, and one or two pieces in recent alluvium at the foot of the Lepini range, which were probably washed in from the mountainside. The most important exceptions are the Middle Paleolithic finds from the graben on surfaces mapped as Terracina lagoonal deposits (Sevink et al., 1984). These materials have been found in chromic vertisols, whose parent material in the graben consists of a relatively thin layer of Terracina level lagoonal clays overlying lagoonal deposits of the Borgo Ermada level where they are at a slightly higher elevation than the surrounding area (J. Sevink, personal communication). The materials are currently coming up in the plow zone. Although not very common — we encountered one concentration and several isolated items — they provide evidence for use of the graben during the Middle Paleolithic, which we did not think was possible to find by surface survey.

It is difficult to know how far back human use of the Agro Pontino extends. We did not find any materials that might be attributable to the Lower Paleolithic [1]. We know from U-Th dates of the uppermost layer at Grotta Guattari that the Middle Paleolithic predates 51,000 BP, and preliminary ESR dates of all the layers at Guattari range between 60,000 and 50,000 (Bietti, 1988). In fact, the Middle Paleolithic materials found in all the stratified caves in the area discussed by Bietti (1988) — Grotta della Cava, Grotta dei Moscerini, Grotta di S. Agostino, and those on Monte Circeo — seem to date to the glacial period.

A somewhat earlier date might be indicated by the rounded artifacts that were recovered by the survey. About 75% of the 277 rounded items, some of them re-retouched, were found in association with the pebble beds of the Borgo Ermada beach ridge north of Sabaudia. In most cases, they were found along with "freshly"-chipped tools and debitage. We suppose that the rounding of the artifacts occurred during the formation of the Borgo Ermada beach ridge and that the artifacts were discarded before or during that time, ca. 90,000 BP, although we don't know exactly where they were discarded. Also, about 22, less than 10%, were found in association with the pebble beds of the Minturno level. There seems to be some possibility, therefore, that the Agro Pontino was occupied during the Last Interglacial or earlier.

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[1] This does not mean that evidence for the Lower Paleolithic may not be found. It is possible that stone tools, if made of limestone, have not survived on the surface in the Agro Pontino, or, if they do survive, were not recognized by us amongst the limestone chunks that are brought in to enrich agricultural fields.

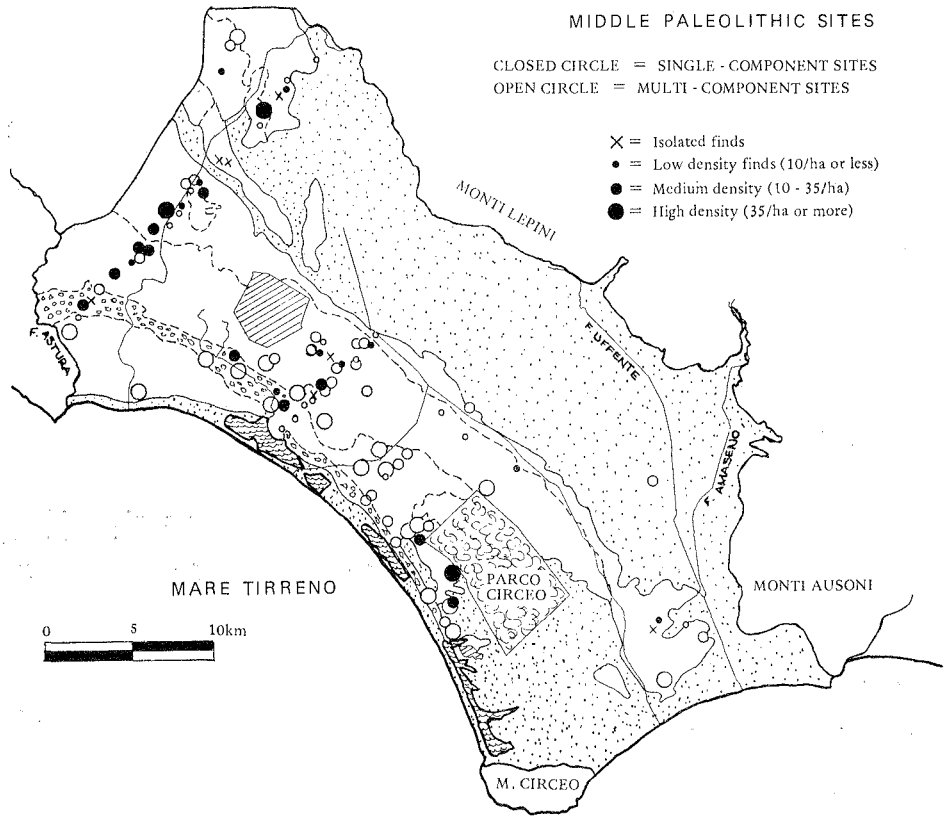

Fig. 4: Map of Agro Pontino showing the location of all Middle Paleolithic sites identified during the survey.

Middle Paleolithic fields and sites

During the survey the agricultural fields were used as the observation units; they also constituted the sampling elements in the probabilistic sampling design. Whenever artifacts were found, that location was considered a findspot. At several stages of our work, adjacent fields were amalgamated into findspots if the spatial distribution of their finds appeared to be continuous. The findspots were then dated on the basis of 'diagnostic' artifacts, and all the fields belonging to the findspot were assigned the same date, regardless of whether or not they had yielded the relevant diagnostic artifacts. A re-evaluation of the findspots taking into account physiographic features of the landscape resulted in further realignment of the fields vis-a-vis findspots, which are referred to hereafter as sites.

One of the things that we thought the survey data should provide

was an estimate of the percentage of fields in the Agro Pontino that contained finds of various time periods. From the exploratory phase data it was estimated, accepting a 10% error, that about 650 agricultural fields, the sampling elements of the design, would need to be surveyed to determine the proportion of fields with finds in the region that could be expected to contain Middle Paleolithic artifacts. In all, 727 fields and one isolated profile were surveyed along the five transects; artifacts were found in 500, or 68.8%, of them, and Middle Paleolithic artifacts were found in 197, or 27.1%, of them, which is 36.6% of the

TABLE 1

AREA SURVEYED AND AREA SURVEYED ASSOCIATED WITH MIDDLE PALEOLITHIC ARTIFACTS, SHOWN BY TRANSECT AND SEDIMENTOLOGICAL UNITS

	Area surveyed	*Area with Middle Paleolithic artifacts*	
	ha	*ha*	*%*
Transect 1	25,641	14,567	56.8
Tuff	7,173	4,034	56.2
Latina level beach & lagoon	6,041	2,789	46.2
Minturno level beach, coastal & inland lagoons	1,805	1,204	66.7
Minturno level travertine	0,591	0,591	100.0
Borgo Ermada level inland lagoon	10,030	5,949	57.9
Transect 2	12,019	7,872	65.5
Latina level lagoon	7,691	5,614	73.0
Minturno level beach & lagoon	2,346	1,215	51.8
Borgo Ermada level beach & lagoon	1,529	1,043	65.5
Borgo Ermada level inland lagoon	0,453	0,000	
Transect 3	11,276	6,649	58.9
Latina level lagoon	3,371	0,780	20.7
Minturno level aeolian cover	7,029	5,172	73.6
Borgo Ermada level beach & lagoon	0,539	0,539	100.0
Borgo Ermada level inland lagoon	0,337	0,158	46.8
Transect 4	3,590	1,300	36.2
Latina level lagoon	1,815	0,000	
Borgo Ermada beach	1,300	1,300	100.0
Borgo Ermada inland lagoon	0,475	0,000	
Transect 5	4,429	0,661	14.9
Borgo Ermada coastal lagoon	4,429	0,661	14.9

fields with any artifacts at all. From these data, it was calculated that there is a .95 probability that the proportion of fields in the Agro Pontino with Middle Paleolithic materials ranges from 23.8 to 30.4%.

From our results, however, it is apparent that these fields are not found evenly distributed in the Agro Pontino. As mentioned in the previous section, evidence for the Middle Paleolithic is found mainly on older surfaces. But even on these older surfaces the fields with Middle Paleolithic finds or associated with Middle Paleolithic sites are not evenly distributed. Table 1 shows the differences from north to south that were recorded along the five transects selected for the probabilistic sampling phase of the survey (Fig. 2). The data are given in areal units rather than counts of fields since field sizes differ systematically [2]. These data show that from north to south there is a slight increase along transect 2 and then an abrupt decrease between transects 3 and 4 in the percentage of area on older surfaces with Middle Paleolithic artifacts. This general north-south pattern is greatly accentuated on the Latina level.

The Middle Paleolithic sites have been subdivided into those that seem to contain only Middle Paleolithic lithic artifacts, which are termed 'single-component' sites, and those with Middle Paleolithic artifacts together with lithics from more recent periods, termed 'multi-component' sites. Not surprisingly, the results from the probabilistic sample showed that the densities of lithic artifacts in fields belonging to single-component sites (fields not systematically surveyed were excluded) are considerably less than those in fields belonging to multi-component sites (N1 = 45, mean = 18.7/ha, s.d. = 21.97; N2 = 124, mean = 40.32/ha, s.d. = 101.35; after transformation into logarithms: $t = -1.65$, $df = 97.6$, $p = .05$). Data from the 425 fields surveyed during the exploratory and problem-oriented phases also show this pattern (N1 = 15, mean = 2.56, s.d. = .86; N2 = 74, mean = 3.65, s.d. = 1.19; after transformation into logarithms: $t = -3.36$, $df = 87$, $p = .001$).

Table 2, which is based on the probabilistic sample, shows the differences in lithic artifact densities from north to south subdivided

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[2] Sizes of agricultural fields vary according to dominant sediments in the Agro Pontino. Mean sizes of fields decrease from the colluvium, to the aeolian sandy sediments, to the beach ridge-lagoonal 'mosaic' of sediments, to the heavy lagoonal clays, and to the peats (after log transformation: $F = 10.885$, $df = 4$, $p < .001$).

[3] The density figures used are based on artifact recovery during a single survey of an agricultural field. Obviously, it is generally possible to increase artifact density by one or more repeated visits to a field. Densities were calculated by dividing the number of flint artifacts and debitage by the actual area covered in square meters in each field, which was recorded during the survey, and multiplying by 10,000 in order to reduce the number of decimal places to make handling of the figures less cumbersome. Thus, the standardization 'per hectare' should not be taken literally and should only be used in a comparative fashion.

into single-component and multi-component sites [3]. Average densities from north to south increase about one and one-half between transects 2 and 3, but then more than triple between transects 3 and 4. Although Table 2 has no multi-component sites on the Borgo Ermada level between San Felice Circeo and Terracina, Fig. 4, on which all sites in the Agro Pontino known to us are plotted, shows that they do occur. Three multi-component sites comprising ten fields were found during the exploratory phase (lithic density: mean = 23.0, median = 14.1, range = 1.8 – 67.2). All of these are closer to the coast than the path

TABLE 2

ARTIFACT DENSITIES PER HECTARE IN FIELDS ASSOCIATED WITH MIDDLE PALEOLITHIC SINGLE-COMPONENT AND MULTI-COMPONENT SITES SHOWN BY TRANSECT AND SEDIMENTOLOGICAL UNIT

	Fields associated with Multi-component sites				*Middle Paleolithic finds Single-component sites*			
	N	*mean*	*median*	*range*	*N*	*mean*	*median*	*range*
Transect 1	44	27.8	11.6	1.9-377.0	33	21.1	12.5	.9-110.1
Tuff	12	21.1	10.4	2.3- 93.8	5	4.0	4.5	.9- 5.6
Latina level beach & lagoon	6	28.6	29.3	8.7- 45.9	14	24.4	12.6	2.2- 76.8
Minturno level beach & lagoon	4	18.0	18.3	2.1- 33.3	3	24.1	19.8	7.7- 44.8
Minturno level travertine	1	28.8						
Borgo Ermada level inland lagoon	21	33.1	8.6	1.9-377.0	11	23.7	17.0	5.5-110.1
Transect 2	41	24.2	16.0	.5-184.6	7	16.0	14.7	4.5- 19.6
Latina level lagoon	33	27.1	17.7	1.8-184.6	7	16.0	14.7	4.5- 19.6
Minturno level beach & lagoon	3	1.9	2.1	.5- 3.2				
Borgo Ermada level beach & lagoon	5	18.2	14.5	3.3- 34.6				
Transect 3	32	52.8	17.4	1.7-890.4				
Latina level lagoon	2	6.1	6.1	3.8- 8.3				
Minturno level aeolian cover	26	60.4	16.9	1.7-890.4	1	13.5		
Borgo Ermada level beach & lagoon	3	29.7	30.9	26.9- 31.4				
Borgo Ermada inland lagoon	1	18.5						
Transect 4	7	156.6	95.2	56.5-557.0				
Transect 5					4	5.4	5.6	2.0- 8.5
Borgo Ermada lagoon					4	5.4	5.6	2.0- 8.5
ALL	124	40.3	15.9	.5-890.4	45	18.7	12.1	.9-110.1

of transect 5. This difference, that is, single-component sites more inland than multi-component ones, may indicate that more of the Borgo Ermada level between San Felice Circeo and Terracina was exploited during the Middle Paleolithic than in later periods.

Several observations can be made about the overall distribution of Middle Paleolithic sites based on the data presented in Tables 1 and 2 and on Fig. 4. We have already noted that there is a general decrease in number of sites from north to south. In the north along transects 1 and 2 there is a rather continuous spread of sites, and more single-component sites than in areas to the south. In the central part the site distribution is more discontinuous, and on the eastern side of the Parco, where the lagoonal deposits of the Latina and Borgo Ermada levels appear, more fields were surveyed than on the western side, but no Middle Paleolithic artifacts were found at all.

A major factor affecting this distribution, although not necessarily the only one, is geological. More recent aeolian cover is more extensive in the southern half of the marine terrace complex than is apparent on the soil map published by Sevink et al. (1984). It is probable that the more recent aeolian deposits are at the surface on the Borgo Ermada level between San Felice Circeo and Terracina and on the southerly parts of the Latina level lagoon (J. Sevink, personal communication) and that they buried Middle Paleolithic materials. The upper part of the soils on the Borgo Ermada level lagoon in this area have a rather coarse texture, and some are solodic planosols (Sevink et al., 1984: 110), indicating an abrupt textural change (in this case, from sandy loam to sandy clay loam or clay; see Sevink et al., 1984, section 9) within 125 cm of the surface in the FAO soils classification (1974). Most of the soils in the southern Latina level lagoon are also solodic planosols. More recent aeolian cover may even have extended further north to the level of transect 3 on the Latina level where sites with Middle Paleolithic materials occur but have a discontinuous distribution. In contrast, the virtually continuous distribution of archaeological materials found along transects 1 and 2 are what one might expect in a fossil landscape.

It is difficult to know whether the spatial discontinuity of sites in the older aeolian area north of the Parco, which are associated with the Minturno level, can be accounted for by an additional layer of aeolian cover. In an earlier analysis (Loving et al., 1985) the occurrence of Middle Paleolithic tools on surfaces near San Andrea that had been mapped as recent aeolian cover was explained by incision through or levelling down to older deposits and by the difficulty in distinguishing older from more recent aeolian cover by the properties of the soils in this area. In the older aeolian area north of the Parco, 49 of the fields ascribed to Middle Paleolithic sites are on slopes along drainage channels, which are being eroded or, in some cases, levelled, and 10 are on level, seemingly undisturbed surfaces. One would expect that if more recent aeolian cover could account for discontinuity, then downcut

fields would have higher artifact densities than those with undisturbed surfaces. This seems to be the case (N1 = 49, mean = 90.5, s.d. = 178.2, N2 = 10, mean = 57.2, s.d. = 74.3), but the differences are not sufficient to have much confidence in the observation (after transformation into logarithms: t = .32, df = 57, p = .374).

This preliminary assessment of post-depositional conditions seems to indicate that surfaces in the Minturno level aeolian area have been rather stable, at least until the 1930s reclamation and the inception of intensive agriculture. Thus, for the present we accept that the survey data more or less accurately reflect site distribution in this area. That is, relative to areas more to the north their distribution is more discontinuous. Also, we note from Table 2 that, relative to the more northerly sample, the preponderance of fields are associated with multicomponent Middle Paleolithic sites and that the mean and maximum lithic densities are higher, but the median about the same, possibly indicating that not only were more of these sites reused through a long period of time, but some intensively so. And, in fact, after log transformation of densities, the difference between fields on the Minturno level aeolian area (N = 27, mean = 2.88, s.d. = 1.31) and other fields on the first three transects (N = 131, mean = 2.53, s.d. = 1.19) is not significant statistically at $\alpha = 0.05$ (t = 1.44, df = 156, p = .075). Although the aeolian area is more dissected than other older surfaces in the Agro Pontino, we do not think these attributes are related to topography. Relative to the rest of the Agro Pontino, more fields in this area are along drainage channels (N = 381, chi-square = 31.1, df = 1, $p < .001$). Also, on older surfaces in the Agro Pontino more fields associated with Middle Paleolithic sites are next to drainage channels than fields not associated with Middle Paleolithic sites (N = 381, chi-square = 14.72, df = 1, $p < .001$). But in the Minturno aeolian area, the association is merely a function of the number of fields associated with Middle Paleolithic sites and next to drainage channels (N = 34, chi-square = .053, p = .816). The phi-square value, however, is very low (.03), indicating that drainage channels are not a good predictor for site location. Thus, we conclude that the topography of the area was conducive to occupation, but other factors, as yet unknown, must account for the spatial distribution and re-occupation of sites.

A final characteristic of the distribution to be discussed is the exceedingly high artifact densities on transect 4 west of the Parco. This seemed to us to be related to the pebble beds exposed there, since more fields with pebbles in the sediments were associated with Middle Paleolithic sites (chi-square = 6.53, df = 1, p = .01). The average density of artifacts in fields with pebbles in the matrix is higher (N = 38, mean = 51.2, s.d. = 92.6) than that in fields without pebbles (N = 211, mean = 44.9, s.d. = 98.8), but this seems to be due to high-density outliers, like those on transect 4 (after transformation to logarithms: t = .89, df = 247, p = .18). This result is a surprise because we expect

that the pebble beds were like quarries where at least preliminary reduction producing a lot debitage, and consequently higher lithic densities, was done. During the field survey, however, it was in most cases difficult to draw sharp boundaries of the extent of the pebble beds and in some cases difficult to decide whether or not pebbles were in the matrix at all on the basis of their exposure at the surface. We also expect that sites associated with the pebble beds would be multi-component ones unless exposure of the pebbles is recent or occurred only during the Middle Paleolithic period. We note that six single-component sites are associated with the pebble beds. Given these observations, it seems reasonable to suggest that the pebble beds were differentially exposed in the past as well and that the artifact density on pebble beds is in part a function of the spatial and temporal extent of the exposure of the pebble beds.

Middle Paleolithic materials and environmental features

Today, the Agro Pontino is a linear environment; that is, it is long relative to its width, and its width is constricted by mountains along one side and the sea along the other. The linearity is due to the stepped graben, which is oriented along the length of the plain, and the associated drainage conditions accentuate the linearity. During periods of high sea level, much of the graben is marsh and lagoon.

Linear environments have implications for prehistoric human populations. Wobst (1974) demonstrates through simulation that, under the assumptions of low population density, roughly bounded and overlapping territorial ranges, and hexagonal packing of groups, 175-475 people would have been required to maintain a viable mating network in prehistoric hunter-gatherer societies. In a later paper (1976), he argues, under the same assumptions, that it would have been difficult to maintain viable mating networks in linear environments where groups cannot be central in a hexagonal arrangement and distances between groups become great. If this were true in the Middle Paleolithic, it is possible that the Agro Pontino was not 'occupied' in the strict sense, but only opportunistically exploited in passing. Moreover, looking at the situation today, one could think that drainage conditions related to the graben would have oriented movement into and through the area along the length of the plain as well. From about Norma to slightly north of Terracina, it may have been difficult, if not impossible, to travel from the mountains directly across the plain to the southwest coast. One would have travelled either along the foot of the mountains or along or parallel to the southwest coast, which could be reached by first crossing near the Astura in the north or along the southeast coast between Terracina and San Felice Circeo.

Assuming that local tectonic faulting has not altered relative eleva-

tions among formations, we can surmise that with the onset of the last glaciation, the linear aspect of the Agro Pontino would have begun to lessen. The lowering of the sea level not only would have widened the marine terrace complex, but also indirectly drained at least part of the graben. As conditions became colder and drier the Agro Pontino may have even seemed attractive relative to surrounding areas. It would have been warmer than the inland and a reliable source of fresh water. Moreover, with decreasing biomass due to colder and drier conditions, the structure of the plant communities may have changed to support a denser population of herbivores and possibly humans, depending on what they were eating (Kelly, 1983). Any increase in the human population density would help alleviate the effects of the linear environment as well.

From analysis of a pollen core near Rome, Follieri et al. (1988) have proposed a calibration of changes in vegetation and inferred climatic conditions in Lazio. The last fluctuation of wetter conditions before the glacial period ended around 80,000 BP. Thereafter to ca. 50,000 BP, minor fluctuations in humidity occurred and the presence of Mediterranean elements indicates that winters were generally not very cold. Generally dry conditions seem to have prevailed until the Holocene.

It is difficult to evaluate a general proposition that the Agro Pontino became more suitable for human occupation, as conditions became drier and the sea level lowered, with the archaeological evidence. As stated in the previous section, the archaeological data available from closed contexts on Monte Circeo and along the coast show that these were either occupied only during the glacial period or have no preserved materials dating to the Last Interglacial. If changes in the quantity of artifacts in these sites are an indication of greater or lesser suitability of the area, then low numbers of artifacts in the lower layers of Grotta del Fossellone (Blanc and Segre, 1953) and at Grotta della Cava, which is thought to date to the early part of the last glaciation, in comparison with the greater numbers in the upper layers of Fossellone and the later caves provides tenuous, assumption-laden support.

From the survey data we can compare the Borgo Ermada with older levels in several ways to see if there are any indications for more intensive occupation of the Agro Pontino through time. Table 3 summarizes the data in Table 1 and also gives data on density of artifacts in fields associated with single-component Middle Paleolithic sites. The percentage of the areas of fields associated with Middle Paleolithic sites is only slightly greater on the surfaces older than the Borgo Ermada level, and the mean lithic densities on the older surfaces are slightly higher. The low magnitude of differences between the Borgo Ermada level and the older surfaces could signify that human exploitation of the region intensified only after the Borgo Ermada level was sufficiently dry to transverse. Drop rates were calculated

TABLE 3

COMPARISONS BETWEEN THE BORGO ERMADA LEVEL AND OLDER LEVELS

Area with Middle Paleolithic artifacts (probabilistic sample):

	Area surveyed *ha*	*Area with Middle Paleolithic artifacts* *ha*	*%*
Older surfaces	37.823	21.399	56.6
Borgo Ermada level	19.092	9.650	50.5

Densities of lithic artifacts found in fields associated with single-component Middle Paleolithic sites (all samples):

	N	*Density per hectare* *mean*	*median*	*range*
Older surfaces	45	18.834	12.531	.9-121.600
Borgo Ermada level	15	18.798	10.000	2.2-110.063

Drop rate:

	Mean density	*Time span*	*Number of years*	*Drop rate per 1000 years*
Older surfaces	18.834	100,000-35,000 BP	65,000	.29
Borgo Ermada level	18.798	90,000-35,000 BP	55,000	.34
Calculated rate for older surfaces	—	100,000-90,000 BP	10,000	.004

by dividing the mean density by the number of thousands of years from a beginning date — 100,000 BP for the older surfaces and 90,000 BP for the Borgo Ermada level — to 35,000 BP. Densities were used rather than counts because the density values were calculated taking survey coverage of fields into account. Assuming that drop rates for all surfaces were equivalent after 90,000 BP, that is, that they were .34 per 1000 years, the drop rate from 100,000 to 90,000 BP is .004, which would seem to indicate that exploitation of the area before the stabilization of the Borgo Ermada level was negligible.

The Middle Paleolithic materials coming from the Borgo Ermada level in the middle of the graben indicate that at least part of that area was sufficiently dry to move about after the sea level lowered. But, would expansion of the area and concomitant decrease in linearity been sufficient to support one or more groups more or less continuously? We cannot answer this question, but we can look at selected features of the artifacts collected by the survey and their

location with respect to raw material sources, which may tell us something about how people moved in the area during the Middle Paleolithic.

The raw material source for most of the Middle Paleolithic artifacts found in and around the Agro Pontino are the pebble beds that follow the coast from north of the Agro Pontino to just north of Sabaudia. The distance of the cave sites discussed above to these pebble beds varies from 9 km, Monte Circeo, to 40 km, Grotta dei Moscerini and Grotta di San Agostino (as the crow flies). On the Agro Pontino plain itself, sites are situated on the pebble beds, as is Canale Mussolini, to ca. 17 km away from them. Such distances are within the range of logistical mobility of ethnographically known hunters and gatherers, although 7-8 km seems to be the maximum range for a day's trip (Kelly, 1983). Certain aspects of some of the assemblages in the cave sites may be a function of distance. S. Kuhn (personal communication) has noted that the tools at Grotta di San Agostino are generally smaller than those at other sites. We don't know whether these tools are smaller as a result of progressive reduction from use or the bringing in of smaller pebbles or blanks, but the former would indicate maintenance and recycling and the latter less weight in transport, both of which are responses to restricted access to raw materials (Bamforth, 1986). Also, at both Grotta della Cava (14 km distant from the pebble beds) and Grotta dei Moscerini stylistically Pontinian tools have been made on local materials, limestone and shell, respectively, as well as on pebbles. These local materials may have been preferred for specific tasks, or perhaps they show that there wasn't sufficient time to collect flint pebbles before a particular task needed to be performed (Torrence, 1983).

If the Agro Pontino were exploited primarily in passing, on the way to the Monte Circeo or to and from the coast and the Ameseno, for example, then one would expect travel to generally follow the pebble beds exploiting the area around them and discarding expediently used tools, as defined by Binford (1977). Expedient use of tools refers to making them when needed, using them, and then discarding them at the spot where used; this is opposed to the curation of tools which refers to making the tools in anticipation of future need, transporting them, using them, and then, if necessary, maintaining and/or recycling them.

Regardless of how groups moved in and through the area in the Middle Paleolithic, a certain amount of curation was necessary to use the pebbles for tools since they had to be carried away from the pebble beds to where they were discarded. Moreover, as Bamforth (1986) has pointed out, the distribution of raw materials affects whether tools are used expediently or are curated. If these materials are locally available, then in many cases expedient use is more energy efficient, whereas if the materials are not locally available, it is more energy efficient to anticipate need and curate essential tools. If the

distribution of pebble beds in the Agro Pontino were the major factor affecting lithic technology, one might expect to find more evidence for expedient use and less for curation in the vicinity of the pebble beds and the opposite becoming the case with further distance from the pebble beds.

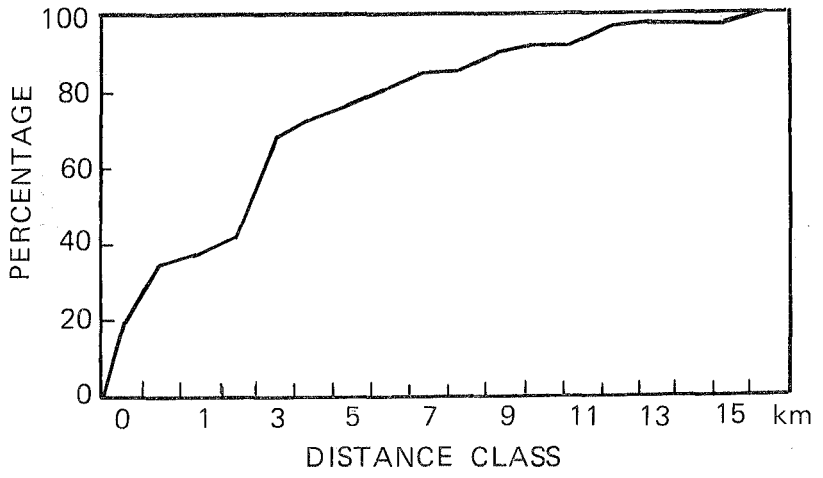

Fig. 5: Cumulative percentage diagram showing the increment in the percentage of artifacts found in fields associated with single-component Middle Paleolithic in distance classes leading from the raw material source.

To examine whether the Agro Pontino materials exhibit the structure of expedient or curated assemblages and to see how this changes over distance, certain features of the lithics from single-component sites were described controlling for distance from the pebble beds. Distance was measured as the crow flies from sites to the nearest pebble bed in tenths of kilometers and the artifacts were divided into distance classes — associated with the pebble beds, 0.1 to 1 km away from the pebble beds, 1 to 2 km away from the beds, etc. The cumulative percentage diagram (Fig. 5) shows that the percentage of the total number of artifacts (497) generally decreases with increasing distance to the pebbles; no Middle Paleolithic artifacts associated with single-component sites were found in the 8-9 km distance class and only one artifact was found, at 16.9 km distant, beyond 14 km. Over 85% of the artifacts were found within 8 km, the distance of a one-day trip in Kelly's data.

TABLE 4

PERCENTAGE OF DEBITAGE FOUND IN SINGLE-COMPONENT MIDDLE PALEOLITHIC SITES GROUPED BY DISTANCE CLASSES RELATED TO PEBBLE BEDS

Distance class, tenths of km	*No. of artifacts*	*Percent of debitage*
At pebble bed	98	48.9
0.1 - 0.9	81	51.8
1.0 - 1.9	12	50.0
2.0 - 2.9	19	42.1
3.0 - 3.9	110	50.0
4.0 - 4.9	44	63.6
5.0 - 5.9	25	44.0
6.0 - 6.9	17	23.5
7.0 - 7.9	26	42.3
8.0 - 8.9	0	
9.0 - 9.9	19	52.6
10.0 - 10.9	12	33.3
11.0 - 11.9	2	50.0
12.0 - 12.9	19	63.2
13.0 - 13.9	11	45.5

Since it is the structure of assemblages that indicates expedient technology or curation and since the number of artifacts per distance class varies, the percentages of artifacts in a distance class possessing attributes selected, rather than counts, were used to compare the distance classes. One feature that theoretically indicates expedient technology is that tools, regardless of condition, and debitage exhibit a regular proportional relationship among assemblages (Binford, 1977: 35).[4] This expectation stems from expedient technology being a direct reflection of intensity of tool use; tools are made, used, possibly broken, resharpened or replaced, and discarded at the site of activity. Thus, the amount of debitage in an assemblage is a function of the number of tools made and resharpened and is constant from assemblage to assemblage. In looking at single-component sites, we had noted a

[4] If one is interested in using Binford's theoretical expectations and applying them directly as we have done, then one should be aware that these expectations are based on 'holding all other factors constant'. We use Binford's expectations for providing a general overview of the data and simultaneously for giving some theoretical grounds for the interpretation of the analytic data.

high correlation between the numbers of tools and debitage ($r = .919$, $r^2 = .844$, $p < .001$). Over the distance classes, the percentage of debitage from class to class is reasonably constant and ranges between 42% and 52% in 10 of the 14 classes with more than one artifact; three of the classes range to 65% and one, the 6-7 km class, has only 23% debitage (Table 4).

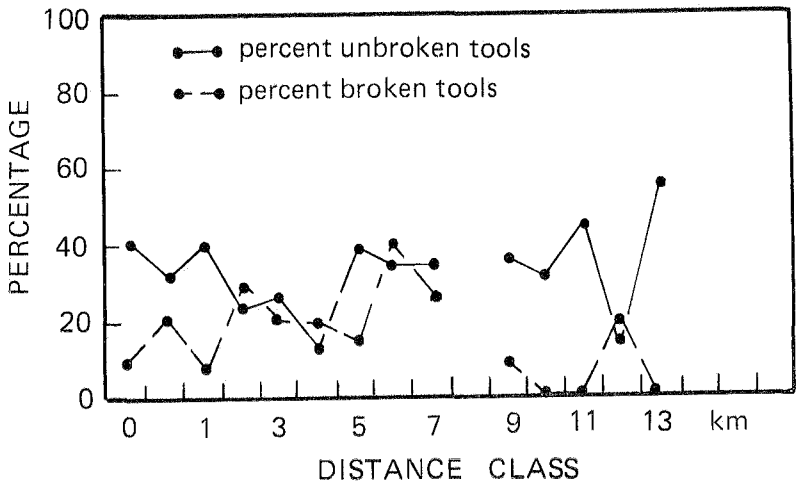

Fig. 6: Percentages of unbroken tools and broken tools compiled from single-component Middle Paleolithic sites shown by distance class.

A second feature that indicates expedient technology is that the percentages of broken tools and unbroken tools in assemblages have no regular relationship. This is because the number of tools made and then broken and replaced with new tools compared with that not broken is a function of the intensity of tool use only. The plot of the percentage of broken tools and unbroken tools by distance classes (Fig. 6) shows that there is no systematic relationship from 0 to 8 km and that the percentage of unbroken tools is higher in distance classes between 9 and 14 km.[5] Altogether these data indicate that most move-

[5] This difference is not discussed further because the sample used for this analysis was single-component Middle Paleolithic sites, which were usually identified by the presence of at least one, usually unbroken, Middle Paleolithic artifact. In this situation, the smaller the sample with only one diagnostic artifact, the greater the percentage of unbroken tools in the assemblage.

ment was within 8 km of the pebble beds and that raw material accessibility placed little constraint on technology in the Agro Pontino. In general, the structure of the assemblages among the distance classes indicates an expedient technology.

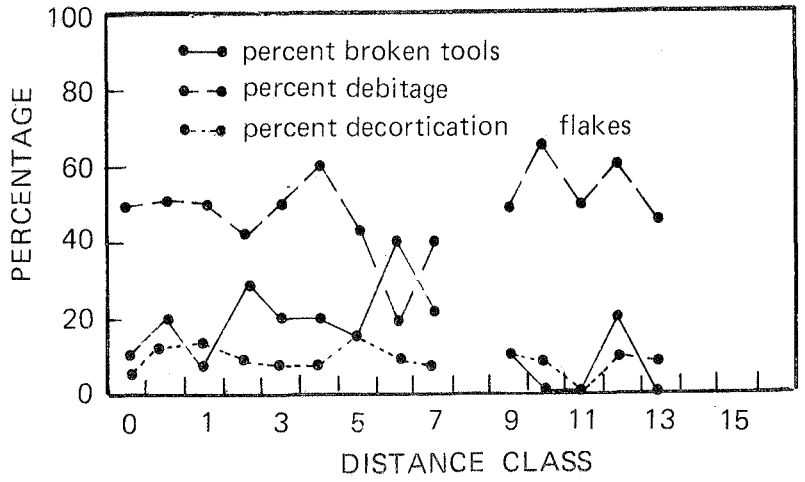

Fig. 7: Percentages of broken tools, debitage, and decortication flakes compiled from single-component Middle Paleolithic sites shown by distance class.

We also looked for evidence of curation among the distance classes. One theoretical expectation for curation is that there should be a regular proportion between broken tools and debitage (Binford, 1977: 35). This is because as tools are exhausted or broken they are discarded at the site and replaced, which produces debitage, but the new tools are transported away from the site in anticipation of future use. Fig. 7 shows that the percentage of broken tools and that of debitage do not exhibit a regular relationship over distance, except between the pebble beds and the 0.1-1 km class and between the two furthest away distance classes. Curation in the vicinity of the pebble beds might be expected simply because they were "quarries" where one fetched raw materials and produced blanks and tools, but more often than not did not use them there. Curation in the furthest away classes could, indeed, be related to anticipated movement far enough away from the raw material source that it was more energy efficient to carry tools and materials than to return to the pebble beds.

The percentage of decortication flakes in the assemblages varies little across the distance classes (Fig. 7), showing that there was probably little variation in the reduction state of the raw material trans-

ported. There are, however, interesting differences in changes in the sizes of cores over distance. The frequency distribution of the weight of cores, which is used to estimate size, is highly skewed to the right. Thus, the difference between the mean and median can provide a measure of the consistency of core reduction over the distance classes. If the difference is small in a distance class, all cores were being reduced to about the same size before discard; if the difference is large, some cores were being discarded before they were reduced to a 'minimum' size. Fig. 8 plots the mean and median weights of cores in grams by the distance classes. The difference between the mean

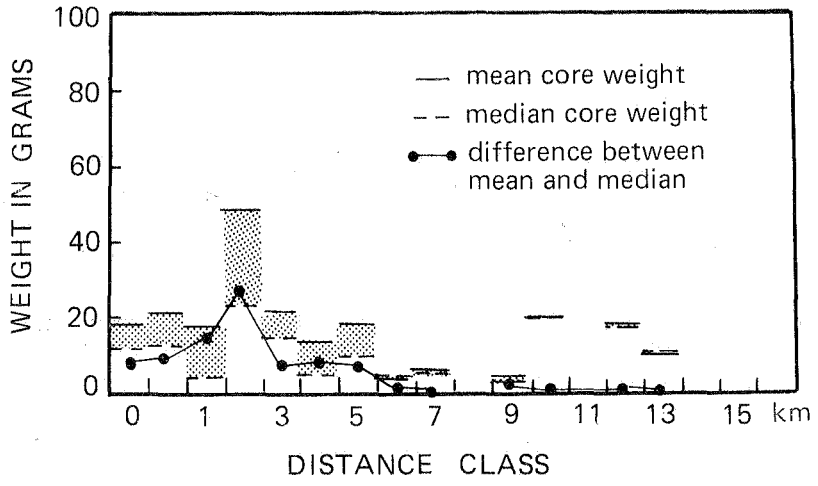

Fig. 8: Median and mean weights of cores compiled from single-component Middle Paleolithic sites shown by distance class.

and median is considerable through the 5-6 km distance class, whereas in the classes further away there is virtually no difference between the mean and the median. It is possible that this difference indicates that up to 6 km it was considered more energy efficient to discard the cores on the spot and to return to the raw material source when more were needed than to carry them around. Between this 6 km point and 10 km, it seems to have been more energy efficient to carry around the core until it was exhausted rather than replacing it. Beyond 10 km, sizes of discarded cores are not only less variable, but also bigger on the average. Perhaps this means that beyond this point only smaller cores and blanks were transported.

Results from the preliminary analysis of single-component sites on the Agro Pontino indicate that the exploitation of the area had a spatial orientation that followed the distribution of the pebble beds and that, except perhaps the outermost reaches of the area, indicate expedient technology, showing that raw material accessibility was not a serious constraint in this period. On the basis of these results, we would seem to have some evidence for use of area being primarily in passing. On the other hand, given the quantity of artifacts used for this analysis, ca. 6% of the lithics collected by the survey, and the quality of the data — surface material, lack of chronological control, etc. — we cannot rule out more permanent occupation of the area at some point during the Middle Paleolithic. It is possible that evidence for such resides in the composition of Middle Paleolithic assemblages in multi-component sites.

CONCLUDING REMARKS

Results from analyses of the Agro Pontino survey data help identify variation in the region. We hope they eventually will lead to more detailed knowledge about exploitation of the area during the Middle Paleolithic and improve our ability to place excavated sites in a regional context.

Although the analysis of the survey data is far from complete, certain factors affecting the distribution of Middle Paleolithic materials are becoming apparent. A major geological factor is post-depositional aeolian cover; its presence in the southern half of the area has been known for a long time, but it seems to have been more extensive than previously thought. We think, however, that land surfaces in the northern half of the area have been relatively stable, and if chronological distinctions can be made, then much can be learned about Middle Paleolithic exploitation of the region simply from surface materials.

Another factor affecting the distribution of Middle Paleolithic materials is changes in landscape features related to glacial processes that occurred during the course of the Middle Paleolithic. Although we think there is some evidence for the Agro Pontino being visited during the Eem, we have suggested that environmental conditions may have precluded occupation of the area. These conditions changed during the glacial phase. When they changed, and we don't know when that was, more intensive use of the area should have become possible.

A final factor, which we have just begun to explore, is the structure of movement of Middle Paleolithic groups through(out) the Agro Pontino. We used the localized distribution of the pebble beds and compared assemblages at varying distances to the beds, which were the raw material source for stone tools. Energy costs of transporting pebbles around the Agro Pontino do not seem to have been a constraint,

and most of the assemblages examined have the properties of expedient technology. At furthest distances there are some indications for curation, and we have suggested that this resulted from anticipation of movement further away from the pebble beds. So far, we have no evidence for residential occupation on the Agro Pontino, but much work remains to be done.

ACKNOWLEDGEMENTS

Many people have contributed to our work in the Agro Pontino (Voorrips, 1991). We want to mention in particular A. Bietti, who, beside of being the motor of the Monte Circeo Conference, is, and has been, pivotal in pulling together modern Paleolithic research in the Agro Pontino. Equally, A. Segre and J. Sevink shared their extensive knowledge of the geology and the soils in the area with us; without this knowledge this paper could not have been written.

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ABSTRACT

An archaeological survey of the Agro Pontino has been completed by the University of Amsterdam. Agricultural fields included in five transects, selected under a systematic non-aligned sampling design, were surveyed in order to characterize the surface archaeology of the Agro Pontino at a regional level. The

archaeological record of the earlier periods, not surprisingly, seems to be controlled primarily by the geological situation. Overall, the Middle Paleolithic is less well-represented than the estimate based on the non-random sample, but somewhat more frequent on surfaces of an appriopriate geological age. Aeolian cover obscures the surface record of the Middle Paleolithic in the area around Monte Circeo. In general, however, the Middle Paleolithic is well-represented on surfaces of sufficient age and stability in the rest of the Agro Pontino survey area.

In contrast to findspots with a number of microliths and no Middle Paleolithic tools, which most probably represent the Epipaleolithic through the Neolithic in the Agro Pontino, those with Middle Paleolithic tools tend not to be densely concentrated or numerous unless they are associated with materials of a more recent date. Materials collected during the survey are examined for differences and similarities at the regional level, the 'site' level, and the artifact level that may indicate the use of the Agro Pontino during the Middle Paleolithic.

RIASSUNTO

E' stata realizzata, da parte dell'Università di Amsterdam, una ricognizione archeologica dell'Agro Pontino. Per poter definire le caratteristiche dell'archeologia di superficie dell'Agro Pontino, a livello regionale, sono stati esaminati terreni agricoli inclusi in cinque settori, selezionati in base ad uno schema di campionamento sistematico. Com'era prevedibile, le testimonianze archeologiche più antiche appaiono fondamentalmente legate alla situazione geologica. Rispetto ad una stima basata su di un campione non preso a caso, il Paleolitico Medio risulta essere complessivamente meno ben rappresentato, tuttavia esso è abbastanza più frequente sulle superfici corrispondenti all'epoca geologica appropriata. Una copertura eolica nasconde le testimonianze di superficie del Paleolitico Medio nella zona attorno al Monte Circeo, tuttavia, nella restante area di ricognizione dell'Agro Pontino, tale periodo è in generale ben rappresentato sulle superfici di età e stabilità sufficienti.

Al contrario di quanto accade per i luoghi in cui sono stati rinvenuti numerosi microliti senza alcuno strumento del Paleolitico Medio (che nell'Agro Pontino sono molto probabilmente riferibili ad un'età compresa fra l'Epipaleolitico ed il Neolitico), i siti con strumenti del Paleolitico Medio tendono a non essere densamente concentrati o numerosi, a meno che in essi non siano presenti anche reperti di età più recente. I materiali raccolti durante la ricognizione, esaminati sulla base delle differenze e delle somiglianze a livello rgionale, a livello di sito e come manufatti, possono fornire un'indicazione sull'uso dell'Agro Pontino durante il Paleolitico Medio.