PERGAMON

Quaternary International 75 (2001) 113–130

Early Italy and the colonization of Western Europe

Paola Villa*

University of Colorado Museum, Boulder, CO 80309-0315, USA

Abstract

The early phases of human occupation in Italy are considered in the context of discussions on the chronology and patterns of hominid dispersal out of Africa and into Western Europe. This paper is therefore a synthesis and an evaluation of new data on three, interrelated topics: (a) the question of direct contacts between Italy and North Africa in the Lower and Middle Pleistocene through the Sicilian Channel; (b) the evidence for the successive dispersal in Western Europe of two different technical traditions; and (c) the nature and chronology of the earliest human occupation of Italy. Interpretations of bifaces and biface industries are discussed, as they are an important aspect of Out of Africa models. Hominid presence in Italy is documented at the beginning of the Middle Pleistocene, their route of entry apparently not through Sicily but from the north. In contrast to the 'Ubeidiya and Gesher Benot Ya'aqov assemblages in Israel, the earliest-dated biface assemblages in Italy — with a preliminary date at about 640 ± 70 ka — show no specific characteristics that would tie them to the African Acheulean. Evidence for a precedence of core-and-flake over handaxe industries is ambiguous; their interpretation as designating different groups of hominids lacks a sound archaeological basis. Since faunal exchanges with continental Europe are documented throughout the Pleistocene, the hypothesis of multiple episodes of human migration into Italy should be considered; however, we can neither support it or refute it because the archaeological assemblages do not inform us on specific migration events.

1. Introduction

This paper addresses the question of human contacts between Africa and Italy in the early phases of colonization of the Italian peninsula, that is, during the Lower and Middle Pleistocene. Hypotheses in favor or against the idea of population movements from Tunisia into Sicily and thence to mainland Italy have been discussed since the beginning of this century, when M. Boule suggested that the −200 m regression indicated by the submerged coastal plain in front of the Grimaldi Caves could have united Cap Bon, in Tunisia, with Sicily (Boule, in Alimen, 1975). Two hypothetical lines of evidence have since been brought into the discussion: faunal exchanges and similarities in lithic industries. In 1929, Vaufrey (1929, p. 215) vigorously denied the existence of contacts between Tunisia and Sicily. His arguments were based on differences in mammalian faunas between the two areas and on the absence of Lower and Middle Paleolithic sites in Sicily. In 1975, Alimen argued that such contacts may have taken place, relying on reports of Acheulean flake cleavers from southwest Sicily (Bianchini, 1973), which were unfortunately in uncertain and undated context. Alimen published a bathymetric map, based on the present-day sea-level configuration, showing that, with the lowering of sea levels during glaciation, a coastal plain would emerge east of Tunisia, while on the side of Sicily another coastal plain would incorporate the Adventure Bank, greatly reducing the distance between Africa and Europe (Fig. 1). According to a map published by Shackleton et al. (1984), during the Last Glaciation, sea level lowering to −120 m reduced the distance between Cap Bon and Sicily to about 60 km, while a narrow land bridge closed the Straits of Messina (present-day depth is 90 m). The Maltese islands, mainly Malta and Gozo, approximately 320 km from North Africa and 95 km from Sicily, are linked to Sicily by a submarine ridge that is for most of its length less than 90 m deep, so it would have formed another land bridge. However, as indicated below, Holocene and Upper Pleistocene paleogeography cannot be used for older periods in this part of the Western Mediterranean. Tectonic movements (faulting, uplifting, and subsidence) have exerted strong control over landforms (Alexander, 1988).

Since Alimen's paper, there has been a significant increase in the amount of data on Lower and Middle Pleistocene Italy. Although arguments and viewpoints

* Corresponding author. Fax: 1-303-738-0128.
E-mail address: villap@stripe.colorado.edu (P. Villa).

1040-6182/01/$20.00
PII: S1040-6182(00)00083-5

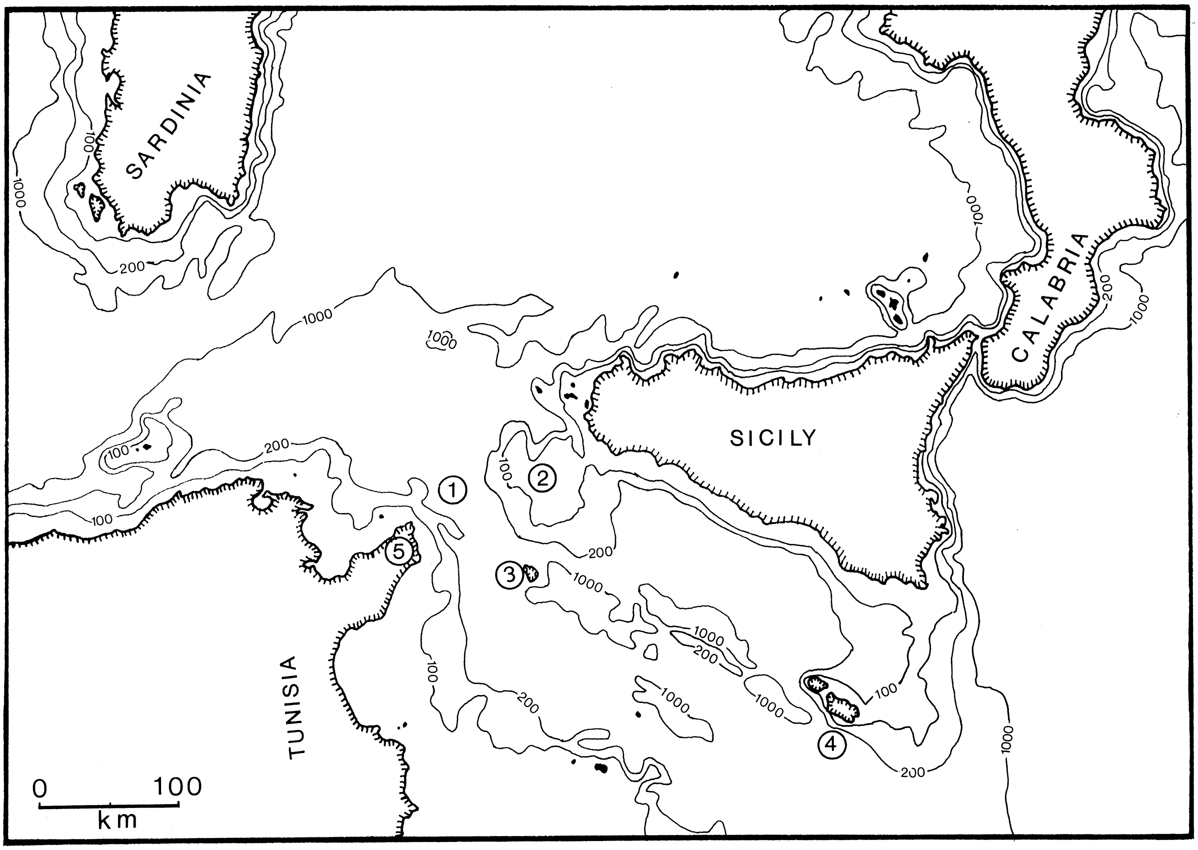

Fig. 1. Bathymetric map of Sicily, North Africa and the Maltese Islands (Malta, Gozo). Key: 1 = Sicilian Channel; 2 = Bank of Adventure; 3 = Pantelleria; 4 = Malta and Gozo; 5 = Cap Bon. At − 100 m a land connection would exist between Malta, Gozo and Sicily; the emergence of the Bank of Adventure would greatly reduce the distance between Cap Bon in Tunisia and Western Sicily (redrawn after Atlante Enciclopedico Touring Club, Italia, 1986).

now differ from those of Vaufrey and Alimen, uncertainties and disagreements about the age and origin of the earliest industries continue (e.g., Roebroeks and van Kolfschoten, 1994, 1998; Villa, 1996). My purpose is therefore to present advances in knowledge and the new data sets that now exist. When objective data are insufficient, I will try to present the various opposing views, providing readers with the opportunity to make their own decisions as to the validity of the conflicting interpretations. Following the path of previous scholars, my survey of the earliest evidence of human occupation in Italy will begin with Sicily and will move northward to discuss the chronology and significance of the so-called pre-Acheulean or Mode 1 industries in the peninsula.

2. Sicily in the Lower and Middle Pleistocene

The prehistoric record of Sicily for the Lower and Middle Pleistocene is based on faunal associations documenting strong "insularity" patterns, that is dwarfism of large herbivores, such as elephants, hippos and ruminants, and gigantism of small vertebrates, e.g., rodents (Freudenthal, 1971; Roth, 1990). These patterns suggest an absence of large terrestrial predators, with probable high population densities for the herbivores, and isolation from the mainland with only occasional episodes of immigration. The implications of this isolation are that the absence of a human record for this time period may be significant and not just due to preservation. In contrast to other terrestrial mammals, early hominids might have had the ability to cross the open sea (Morwood et al., 1998), but, as the record stands, there are no sites in Sicily that point to such connections in early times.

2.1. *Vertebrate faunas and stone artifacts*

Four different vertebrate associations are documented in the Pleistocene of Sicily (Bonfiglio and Insacco, 1992; Bonfiglio and Piperno, 1996; Bonfiglio et al., 1997); only the most recent is found in association with stone artifacts and human remains. The oldest, dated to the Early Pleistocene and found in various outcrops of Monte

Pellegrino (near Palermo, Northern Sicily) includes various endemic species of large-sized small mammals, such as a shrew (*Episoriculus* sp.), a field mouse (*Apodemus maximus*), a glirid (*Leithia* sp.), along with a mustelid (*Pannonictis*), a hare (*Hypolagus*), and another large-sized rodent, a ctenodactylid (*Pellegrinia panormensis*). While the rest of the fauna is European in origin, the ctenodactylid indicates African connections, this rodent family never having been found in continental Europe (Thaler, 1972; Kotsakis, 1979). This endemic fauna suggests that Sicily was isolated from the continent after the arrival of several small mammals from continental Italy. *Pellegrinia panormensis,* which never made it to Calabria, probably arrived in Sicily from North Africa at an earlier period, either through a land bridge or by island hopping. It should be noted that the Sicily Channel area has been subsiding since the Middle Pleistocene (Bonfiglio and Berdar, 1979), so there may have been, *in earlier times*, a land connection with Africa. Deep marine basins were present in the area of the Messina Straits before the Middle Pleistocene, separating the continent from Sicily; however, knowledge of the paleogeography of the Straits, affected by tectonics and faulting, is incomplete. Uplifting of the Calabrian coast on the Tyrrhenian Sea is documented in Late Pleistocene–Holocene times by the occurrence of Last Interglacial marine beach deposits at altitudes of 60–90 m; older marine Quaternary deposits are found at an altitude of about 1000 m (Ascenzi and Segre, 1971; Bonfiglio et al., 1986; Aïfa et al., 1988).

The second faunal complex, present in the Hyblean Plateau and in the Palermo mountains (Fig. 2) also includes species with marked endemic features, such as the dwarf elephant (*E. falconeri*), various micromammals, reptiles, amphibians and birds, and a canid (*Vulpes vulpes*). The better-known deposits are from karstic infillings (e.g., Spinagallo Cave in the Hyblean plateau) but the most significant are those in fluvio-lacustrine deposits from the margins of the Hyblean plateau. At Comiso, limnic deposits with *E. falconeri* overlie Lower Pleistocene marine sands and contain fresh-water mollusks attributed to the early Middle Pleistocene. Thus, the *E. falconeri* assemblage is dated to an early phase of the Middle Pleistocene, confirming some absolute age estimates based on ESR and controversial aminoacid racemization dates on remains from karstic cavities (Bonfiglio, 1992; Bonfiglio and Insacco, 1992; Bonfiglio et al., 1997). Stratigraphically above the fluvio-lacustrine deposits are alluvial sands containing elements of the third, and later, faunal association, with the medium-sized *E. mnaidriensis*. Fig. 2 shows that the Hyblean Plateau consists of a central part that emerged in the Lower Pleistocene while the transitional areas between the plateau and northeast and northwest Sicily were occupied by marine basins. Uplifting during the Middle Pleistocene formed land connections (Bonfiglio and Piperno, 1996).

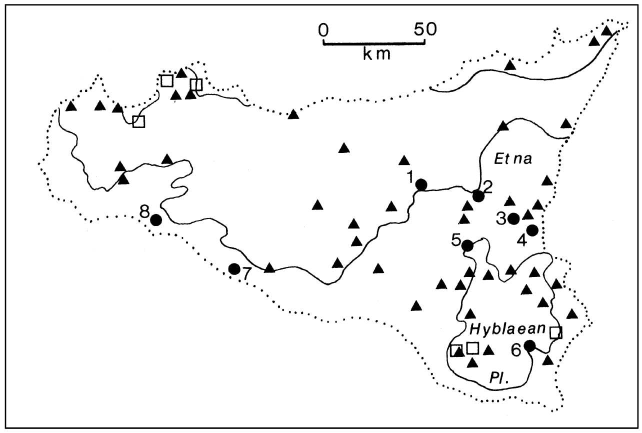

Fig. 2. Geographic outline of Sicily in the Lower Pleistocene (thick line) and the present coastlines (dotted lines). Southwestern and parts of Eastern Sicily (including Etna) were submerged. Key: dots = 1–8 hypothetical Lower Paleolithic sites; open squares = deposits with *E. falconeri*; triangles = deposits with *E. mnaidrienis* and *H. pentlandi*. Modified after Bonfiglio and Piperno (1996).

The third faunal complex associates endemic species such *as E. mnaidriensis*, *Hippopotamus pentlandi*, and two small-sized cervids (*Cervus elaphus siciliae* and the dwarf *Megaloceros carburangelensis*) with less endemic elements such as elephants of less-reduced size (*E. antiquus leonardii*), carnivores (*Ursus arctos, Canis lupus, Crocuta spelaea, Felis leo spelaea*), and bovids (*Bos primigenius, Bison priscus*). This association, more widely distributed than the preceding ones, is found in deposits perhaps preceding and certainly succeeding Last Interglacial deposits. It is clearly derived from continental forms that entered Sicily through Calabria and proceeded as far as Malta through the emerged isthmus of the Sicily Channel (Gliozzi et al., 1993). *H. pentlandi* is considered by some a descendant and reduced form of *H. antiquus*, found in mainland Italy in the Tasso and Farneta faunal units of the Upper Villafranchian (i.e., Lower Pleistocene; Azzaroli et al., 1982; Marra and Bonfiglio, 1998). *E. mnaidriensis* clearly represents a second wave of elephant immigration with respect to the older and smaller form *E. falconeri*; their affinities and phylogenetic relationships remain unclear although most authors think that the full-sized *E. antiquus* was their ultimate ancestor (Caloi et al., 1996).

The youngest faunal complex, accompanying Upper Paleolithic (Epigravettian) artifacts in cave deposits, comprises non-endemic mammals. This new invasion from the mainland caused the extinction of the endemic forms (Gliozzi et al., 1993).

Various finds of pebble tools and flakes judged to be Lower Paleolithic in age have been reported from surface and marine terrace localities, but never in association with paleontological materials (Bonfiglio and Piperno, 1996). Their distribution, often in areas that were submerged in Lower Pleistocene times (Fig. 2), strongly suggests that they cannot be older than the Middle Pleistocene. We also note that:

(1) non-endemic or less-endemic faunas, with carnivores and herbivores, often associated with humans on the Italian peninsula, are found in Sicily only in the late Middle Pleistocene;
(2) lithic workshops specialized in the quarrying, knapping, and trading of flint are common in Sicily between the end of the Neolithic and the early Bronze Age. In areas where flint was not available, quartzite artifacts are found which closely resemble Lower Paleolithic choppers and bifaces made on quartzite cobbles (Nicoletti, 1996).

In view of the endemic faunas of the Lower and early Middle Pleistocene, the uncertain context of "Lower Paleolithic" artifacts, the absence of verified reports of Mousterian industries in Sicily (Mussi, 1992, p. 288), the absence of human remains before the Upper Paleolithic, and the tectonic history of the island and adjacent areas, we must conclude that Sicily is unlikely to have been an important connecting point between Africa and Italy until the Upper Paleolithic. Neanderthals have been found in Calabria, on the eastern side of the Messina Straits (Ascenzi and Segre, 1971; Bonfiglio et al., 1986) but not in Sicily, i.e., on the western side of the Straits. Present-day knowledge strongly suggests that human settlement of mainland Italy and faunal exchanges proceeded mostly from north to south and not vice versa. During the Early and Middle Pleistocene, nearly all the faunas present in continental Europe are also found in the peninsula (Azzaroli, 1999). The hominid and mammalian routes of entry into Italy must have been the northeastern or the northwestern sides of the peninsula, along the littoral margin.

3. Core-and-flake vs. biface industries and the colonization of Western Europe

There is a recurrent belief in European archaeology that core-and-flake industries (also called "Pebble Tool", "Pre-Acheulian", or "Mode 1" industries; Clark, 1969, p. 31) are older in time than biface industries, and that they may signify a first migration event out of Africa by hominids who were not making Acheulean handaxes (e.g., Bonifay and Vandermeersch, 1989; Carbonell et al., 1999b; older ref. in Villa, 1983, pp. 12–13). This belief has been strengthened by the dating of the TD6 assemblage from Gran Dolina to just before the Matuyama/Brunhes polarity change and of Fuente Nueva 3 in SE Spain to the upper Matuyama (Agustí et al., 1999). Neither assemblage contains bifaces or large flakes. However, in both cases we are dealing with rather small assemblages: 268 artifacts, including undetermined fragments and unmodified cobbles, at Gran Dolina TD6, and 49 artifacts at Fuente Nueva 3 (Turq et al., 1996; Carbonell et al., 1999a).[1] The size of an assemblage is relevant to the problem of presence or absence of bifaces, since a small assemblage may represent limited sampling of a tool-kit which included only a small proportion of bifaces (Villa, 1983; Kuman, 1998, p. 177).

To understand the ambiguities and doubts surrounding the chronology and the nature of the oldest assemblages in Italy, we need to examine some of the interpretations of the meaning of bifaces, the evidence supporting them, and the implications they bear. The interpretation of bifaces in adaptive, functional, or cultural terms is the premise upon which most views and models of human dispersal into Europe are based. A brief overview of competing hypotheses will throw some light on the conflict between more or less speculative arguments based on underlying convictions. See Fig. 3 for a map of the European sites mentioned in the text.

3.1. The meaning of bifaces

Ever since Breuil's hypothesis (1932) of parallel phyla, affirming the synchronous existence of two different cultural traditions of stone-tool making in Pleistocene Europe — that is, the Acheulean and the Clactonian — many European archaeologists have debated the meaning of industries with and without bifaces, and have felt the need to explain the meaning of handaxes (for which there is no single functional explanation) with recourse to some all-encompassing explanation, often using overall patterns of geographic distributions to make generalized inferences. Thus, according to Collins (1969) and Butzer (1977), bifaces are found in open, grassy environments; hunting and butchering of big game was one of the main occupation of the Acheulean population, as indicated by sites such as Torralba and Ambrona. According to Collins, the Clactonians, makers of a core and flake industry, were adapted to the temperate forest, did not hunt on a large scale, gathered vegetable foods and used wooden spears (cf. the Clacton spear) for fishing. Other non-biface industries, such as the so-called small-sized industries, from Bilzingsleben,

[1] According to Carbonell et al. (1999a), the 6 m^2 excavated in level TD6 produced 268 artifacts, that is, 19 cores, 145 flakes, 27 retouched flakes, 14 non-orientable fragments (shatters, a.k.a. chunks, a.k.a. debris), 44 weathered, indeterminate pieces, and 19 unmodified or battered cobbles. There are minor discrepancies between published reports. Slightly different counts in Mallol (1999) predate the more recent revisions of Carbonell et al. (1999), and we rely here on the later paper. The layer 2 at Fuente Nueva 3 was excavated over 21 m^2. The two assemblages can be called small by comparison with other early assemblages also in primary context and with a diverse fauna, such as the two East Gona 10 and 12 sites which total 2970 artifacts for 21 m^2 and Lokolalei 2c with 2067 artifacts for 17 m^2 (Semaw et al., 1997; Roche et al., 1999).

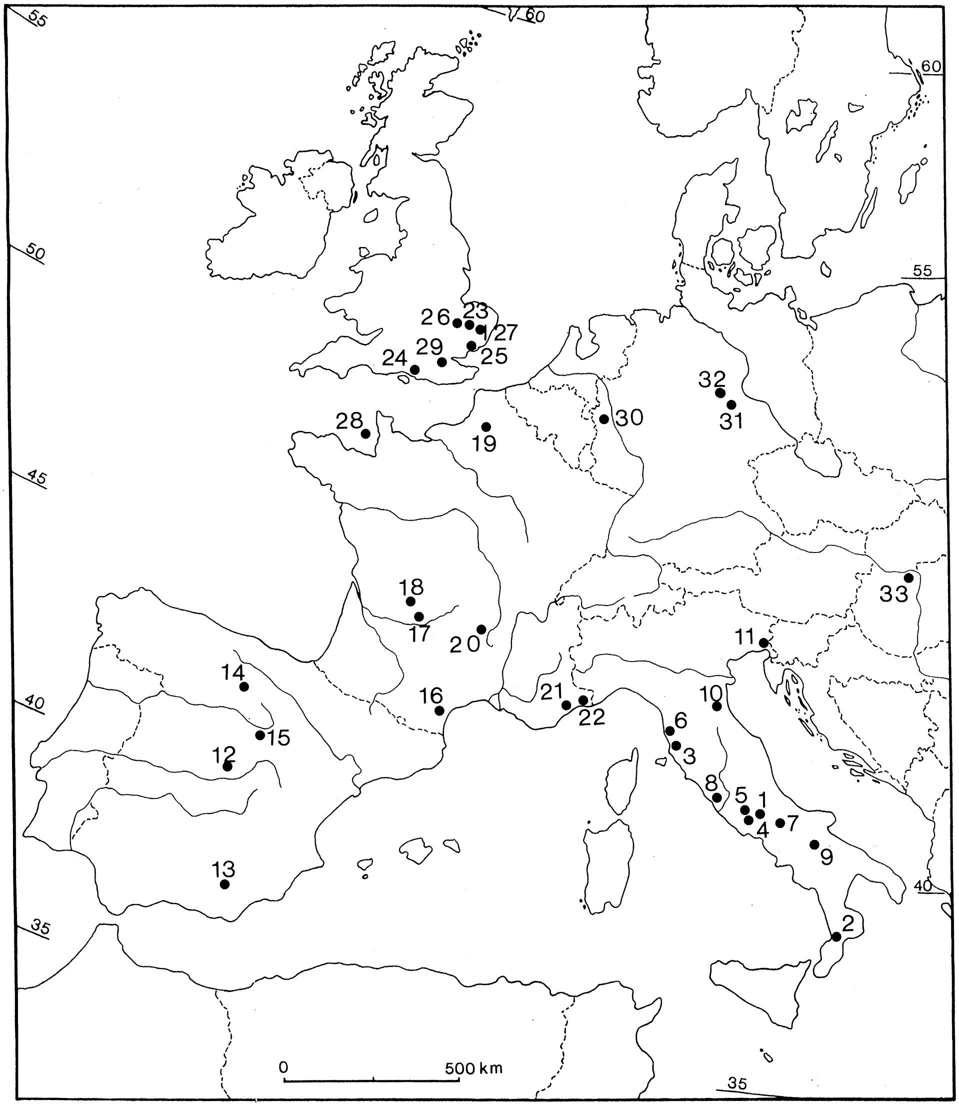

Fig. 3. Location of European sites mentioned in the text. Italy: 1 = Arce and Fontana Liri; 2 = Casella di Maida; 3 = Bibbona; 4 = Ceprano; 5 = Colle Marino; 6 = Collinaia; 7 = Isernia; 8 = La Polledrara; 9 = Loreto and Notarchirico; 10 = Monte Poggiolo; 11 = Visogliano. Spain: 12 = Aridos; 13 = Fuente Nueva 3; 14 = Gran Dolina; 15 = Torralba and Ambrona. France: 16 = Arago; 17 = La Micoque; 18 = Les Tares; 19 = Saint-Acheul; 20 = Soleihac; 21 = Vallonnet; 22 = Terra Amata. England: 23 = Barnham; 24 = Boxgrove; 25 = Clacton; 26 = High Lodge; 27 = Hoxne; 28 = La Cotte de St. Brelade; 29 = Swanscombe. Central and Eastern Europe: 30 = Miesenheim; 31 = Bilzingsleben; 32 = Schöningen; 33 = Vertesszöllös.

Vertesszöllös, Isernia, and Arago, were described as preferentially associated with wooded environments and wooden tools, while Acheuleans were adapted to colder and steppic environments (Svoboda, 1987).

Some scholars believe that hominid taxa and stone tools are associated, and that changes in stone-tool assemblages reflect changes in hominid evolution. Thus, for Foley (1987); Foley (1987; see also Foley and Lahr, 1997), *Homo erectus* spread out of Africa bringing bifaces with him. As "hominids diverged in different parts of the Old World, so did their technology". In East Asia the habit of making handaxes was abandoned, and the Asian *H. erectus* reverted to pebble tool industries. In Europe the handaxe habit was maintained, and as *Homo heidelbergensis* evolved into Neanderthals the stone industries changed into the Mousterian (which shows clear continuity with the Acheulean and conserves bifaces until quite late in the Mousterian of Acheulean Tradition). The similarity in distribution of Neanderthals and Mousterian industries and the co-occurrence of blade industries with the spread of anatomically modern *H. sapiens* are, to Foley, proof of the strong relationship between hominid taxa and stone-tool making traditions. The pattern of continuity, stability on a continental scale, and very slow change apparent in the Middle and early Upper Pleistocene fossil and archaeological record of Eurasia, is broken by the appearance of anatomically modern humans, whose technologies show more intra-assemblage complexity and change rapidly, both geographically and temporally. Relative to modern humans, early hominids had behaviors that were relatively fixed and stereotyped, changes in stone industries reflect changes in biological evolution.

A critique of Foley's viewpoint can be found in Clark (1989), who argues in particular against the link between modern humans and blade technologies (cf. d'Errico et al., 1998; Bar Yosef and Kuhn, 1999) and, more generally, between technologies and hominid phylogenies. His basic message seems to be that concentration on conventional index fossils results in arbitrary, simplistic generalizations that ignore the variability and the historical contingencies documented in the archaeological record.

Of course, the precursors of Foley's ideas are to be found within debates among archaeologists working in Africa concerning the interstratification of the Developed Oldowan and the Acheulean at Olduvai and other East African sites, and the species of hominids involved in making them (Clark, 1970, 1975; Leakey, 1971, 1975; Isaac, 1972, 1975, 1984; Bar Yosef and Goren-Inbar, 1993, pp. 191–201).

Questions about the meaning of biface industries would be resolved if we knew the function of handaxes. But there is no consensus and, except in a handful of cases, no clear proof of the variety of ways they were utilized by early hominids. It has been suggested that handaxes might have been used in butchery, particularly of large mammals (meat cutting is documented by microwear on two handaxes from Hoxne; Keeley, 1980, p. 143, 146; see also Jones, 1980, 1994; Schick and Toth, 1993), or, conversely, that they are associated with plant gathering (Clark and Haynes, 1969; Binford, 1972). In 1975, J.D. Clark suggested that the large cutting tools of the Acheulean (i.e., certain handaxes and cleavers) could have been used for bark stripping for feeding on the inner bark of trees. However, fairly good evidence of the association of bifaces with large mammal butchery has been provided by the sites of Aridos (Villa, 1990) and Boxgrove (Ashton and McNabb, 1994). In Africa, association of bifaces with the bones of a single hippopotamus is indicated at the site of HAR-A4 in the Middle Awash (< 0.6 Ma; Clark, 1987). Handaxes might have been sources of flakes; this kind of utilization is also documented in the Mousterian of Acheulean Tradition (Villa, 1983, p. 10; Jones, 1994, p. 296; Boëda et al., 1996; Geneste, 1999).

Pursuing more general explanations, Keeley (1980, pp. 160–162, 168–170, 175; 1993) suggested that, with the exception of specialized forms such as cleavers or ficrons, handaxes were not made for any exclusive function, but were compact, multipurpose, and expendable tools, used primarily in hunting and gathering expeditions away from home bases, a conclusion he reached based on the context and distribution of handaxes in British sites and on apparent negative correlation between handaxes on one hand and debitage and small tools on the other. Task-specific localities or locations of resources away from the base camp would have high proportions of bifaces; more permanent camps would have mainly small tools and manufacturing waste. In other words, many Acheulean assemblages from sites located in flood plains or on ancient riverbanks were not living sites but might represent aggregates of artifacts that have accumulated through time because of repeatedly performed tasks at special locations away from the home base (Villa, 1983, pp. 23–28).

Indirectly related to Keeley's suggestion are the ideas of Jones (1994) concerning the differences between Acheulean and Developed Oldowan bifaces at Olduvai. Jones makes a distinction between: (a) handaxes that were deliberately produced in the form in which we find them, that is, the classic Acheulean handaxes and cleavers, made from large flake blanks with a minimum of secondary working; and (b) smaller and less-regular bifaces that have very variable morphologies and are extensively flaked with a lot of secondary trimming.

The first kind might represent well-designed but quickly made and quickly discarded tools carried by hominids in their repeated visits to known areas in their quest for food. The second kind would correspond to re-used and re-flaked artifacts, whose size and shape were created through use and which might be expected in areas where lithic resources were scarce or not immediately available. Thus in both Keeley's and Jones' interpretations emphasis is placed on the idea that handaxes (or some forms of them) are associated with mobility in the quest for food, seasonal rounds, and repeated visits to the same foraging areas. Similarly, Ashton and McNabb (1994) have pointed out that handaxes are curated tools in the sense that they were transported where needed, while McPherron (1994) has been able to show that the shape of European handaxes is in large part the result of intensity of reduction, implying that (some or most) handaxes are either cores or tools with a relatively long life history.

3.2. The colonization of Europe: a simple model

Several of the ideas presented above (i.e., the correlation of stone technologies with different populations; the concentration on index fossils; the idea that bifaces are associated with changes in patterns of land use, with greater mobility of tools, and repeated visits to the same resource areas) have been subsumed in a recent reformulation of the parallel phyla concept by Carbonell et al. (1999b), which adapts it to new discoveries in Europe and the Mediterranean area. Following the example of Toth and Schick (1993) and Foley and Lahr (1997) in using Grahame Clarke's terminology, the Oldowan or "core-and-flake" industries are called Mode 1, and biface industries are called Mode 2. Grahame Clark

(1969, p. 30) believed that lithic technologies, as stages in technical developments, did not necessarily replace one another but were additive, in the sense that particular industries combined different techniques and old forms were retained or discarded according to adaptive needs. Instead, Carbonell et al. think of them as technical and cultural traditions belonging to two different human groups with different subsistence strategies. Mode 1 industries are for immediate use; they lack a systematic procedure of production and are characterized by low mobility of objects. They persisted in Africa, showing some technical evolution (Developed Oldowan), until 1 Ma, well after the appearance of Mode 2 industries at 1.5–1.4 Ma. The latter are characterized by the production of large flakes (as observed by Isaac, 1969) and standardization in tool production and configuration. In contrast to Mode 1, the subsistence strategies of Mode 2 groups were founded in planning and organized mobility with greater control of territories or resource areas, in addition to more sophisticated control of raw materials and more complex knapping methods and morphologies.

The arrival of Mode 1 industries in Europe between 1.0 and 0.5 Ma (at sites such as Gran Dolina, Fuente Nueva 3, Korolevo, Vallonnet, Soleihac, Monte Poggiolo, Colle Marino, and Isernia) was the result of competition with the Mode 2 populations, who effectively took over all the Rift Valley (including its northward extension, i.e., Israel), displacing Mode 1 groups. This radiation of Mode 1 groups may coincide with a faunal dispersal during an interglacial.

Carbonell et al. suggest that Mode 2 industries arrived in Europe at about 500 ka, with two sites being slightly older (Notarchirico and Carpentier quarry). The introduction of Mode 2 in Europe represents a sudden change, implying the arrival in Europe of populations producing the Mode 2 technology (already developed) or a cultural diffusion. Since it occurred long after the appearance of Mode 2 in Africa at 1.5–1.4 Ma and does not appear to be associated with a faunal dispersal, Carbonell et al. speculate that this delay may be due to the slow demographic growth of Mode 2 populations in Africa and resistance to the expansion by Mode 1 groups. Complete replacement of the Mode 1 technology took some time, due to the lingering efficiency of Mode 1, which had successfully adapted to temperate environments, as exemplified by the interstratification of Mode 1 and 2 assemblages at Notarchirico and Korolevo (Carbonell et al., 1999b, p. 132 and Table 1).

3.3. *Neat, plausible, and wrong?*

Leaving aside for the moment controversies concerning the chronology of the oldest occurrences in Spain, France, and Italy (Roebroeks and van Kolfschoten, 1998), several facts of context and association do not fit the proposed scenario.

First, there has been no "complete replacement" of Mode 1 by Mode 2 industries in Europe. "Mode 1" industries (i.e., core-and-flake assemblages that do not show evidence of the Levallois technique and cannot be defined as Mousterian or Mode 3 assemblages), are a common occurrence in Middle Pleistocene Europe and are dated later than the supposed age of Venosa Notarchirico and Korolevo (where Mode 1 industries are said to linger by Carbonell et al.). A list of major occurrences, older than OIS 8 or 7, would include: High Lodge (dated to the same OIS 13 as the Acheulean of Boxgrove), Schöningen, Bilzingsleben, and Vertesszöllös (probably OIS 11), Miesenheim (OIS 13?, however this is a very small assemblage), Clacton, Barnham, and Swanscombe Lower Loam (OIS 11) and, in Italy, Venosa Loreto (which is younger than Notarchirico), Visogliano (dated by faunas to the middle part of the Middle Pleistocene, later than Isernia), Bibbona and Collinaia (tentatively related to OIS 11), and La Polledrara (OIS 9) (for details, see Anzidei and Arnoldus Huyzendveld, 1992; Bosinski, 1995; Mania, 1995; Mussi, 1995; Roberts et al., 1995; Valoch, 1995; Conway et al., 1996; Caloi et al., 1998; Boschian et al., 1999; Petronio and Sardella, 1999; Piperno, 1999; Stringer and Hublin, 1999).

Secondly, with the single exception of bifaces, no other traits can be used to distinguish Mode 1 and 2 assemblages. The technology of core reduction can vary from one assemblage to another, but no pattern can be considered exclusive to one or other of the two modes. Single platform cores, discoid, Levallois, alternate platform, and multidirectional cores occur in core-and-flake assemblages and in Acheulean assemblages. The same tool types can be found in assemblages of both groups. Thus, Terra Amata is a chopper-dominated assemblage with just a few bifaces (1.4–4.8% of all shaped tools; Villa, 1983, p. 19). Arago has been described as a small-sized, non-biface industry, dominated by small tools and comparable to Isernia, Bilzingsleben, and Vertesszöllös, yet there are bifaces not just in layer E (Svoboda, 1987) but in all layers, albeit in very low frequencies (0.4, 0.3, and 1.4% of all tools in layers G, F, and E, respectively; Lebel, 1984, p. 623). The same variety of scrapers, denticulates, and other small tools is found at High Lodge (a non-biface assemblage), and at Hoxne and Saint-Acheul (which are Acheulean assemblages; Ashton and McNabb, 1992). The same core reduction technology and the same range of flake tools have been observed in the Lower Gravel and Lower Loam (Clactonian) and Lower Middle Gravel (Acheulean) at Swanscombe (Ashton and McNabb, 1996).

Finally, the interstratification of the two kinds of assemblages is documented in East Africa (see below) and, out of Africa, at sites such as 'Ubeidiya, Notarchirico, Barnham, High Lodge, Swanscombe, La Micoque and La Cotte de St. Brelade. The change cannot be said to be unidirectional, since non-biface assemblages are found at the top of the ‘Ubeidiya sequence and at Notarchirico, in layer Alpha (Bar Yosef and Goren-Inbar, 1993: Fig. 38; Piperno et al., 1999a). Typological and technological analyses of the ‘Ubeidiya assemblages showed their homogeneity and the occurrence of repetitive patterns throughout the sequence. The excavators rejected the hypothesis that two cultural traditions were present at the site and view all finds as belonging to the same technical tradition (the Acheulean), which did not change through time (Bar Yosef and Goren-Inbar, 1993; Gilead, 1993). A similar view is expressed by Piperno et al. (1999b) for the interstratification observed at Notarchirico and in the Venosa basin.

In Africa, non-biface Mode 1 assemblages co-occur with Mode 2 assemblages in the Middle Awash valley (Ethiopia) throughout the late Early Pleistocene and the Middle Pleistocene. In the Kapthurin Formation (Kenya), assemblages with no or few bifaces are dated to between 0.6 and 0.28 Ma, and they are contemporaneous with Acheulean assemblages (Clark et al., 1994; McBrearty et al., 1996; Clark and Schick, 2000; McBrearty, 2000).

At Barnham, debitage from the production of bifaces has been found in the same layer as the Clactonian industry (Ashton et al., 1994). The non-biface industries of High Lodge and of Swanscombe Lower Loam underlie biface assemblages, but there is no evidence that this is part of a replacement phenomenon since the Clactonian at Little Thurrock, dated to OIS 9, postdates both High Lodge and Swanscombe, and is dated to the same time interval as the biface assemblages from Hoxne. The Clactonian industry of Swanscombe Lower Gravel contains one biface (Ashton and McNabb, 1996). At La Cotte de St. Brelade, layers H–D, which are at the bottom of the sequence and dated to OIS 7, contain no handaxes, and show a simple core technology and an abundance of denticulates and notches, similar to “Clactonian”, i.e., Mode 1 industries; they underlie layers C–A with typical Upper Acheulean handaxes and flake cleavers (Callow and Cornford, 1986 Chapter 32).

3.4. *A different explanation*

The problem with the categorical model of Carbonell et al. is that there is no balance between the synthetic and the analytic. The urge to put everything together using a single unifying principle (a simplified categorization of stone technologies) neglects data on Middle Pleistocene Europe and obscures the analytical details worked out in the last 30 yr. How are we to reconcile the continued existence of Mode 1 industries in Middle Pleistocene Europe, and their interstratification with Mode 2 industries, with the idea that these technologies were the repertoire of different groups of hominids and that one replaced the other? How do we explain that throughout the Middle Pleistocene, both in Africa and in Europe, non-biface industries keep reappearing?

Following the logic of Carbonell et al.’s argument, one might suggest that in Europe, Mode 1 industries were pushed to the periphery of the core area of Mode 2, and that this would explain their survival. Unfortunately the periphery seems to be right inside the core, since biface and non-biface industries are found both in East Africa and in the same regions of Western and Southern Europe well after OIS 12, and are even interstratified at some sites. After OIS 8–7, non-biface industries are widespread in Western Europe, although their core technologies (various Levallois methods, discoid, core-on-flake, Quina, and similar varieties of alternating platform cores) are certainly more complex than those of earlier times.

Thus, if we want to accommodate the variability documented in the archaeological record of the Middle Pleistocene and still to seek a general explanation, we have, at present, two choices:

(1) If we follow the interpretative principle of Carbonell et al. (based on a one-to-one correlation between stone technologies and human groups), we must conclude that the pattern of human dispersal and adaptation to temperate environments in Europe was much more complicated than the one just suggested. We should think in terms of highly mobile small groups, which were capable of developing strong social networks over wide geographical areas, thus successfully maintaining their separate technical traditions throughout enormously long stretches of time. Interstratification would be the result of discontinuities in occupation, with groups coming and going in and out of an area. This would be the approach of Breuil and Bordes, only couched in evolutionary terms.

(2) Alternatively, we believe that the lithic repertoire of Lower/early Middle Pleistocene hominids in Europe (and in East Africa) included bifaces as well as some basic varieties of core reduction methods for the production of flakes. Different technological responses to particular landscapes and resource settings, adaptations to local raw material sources, and task requirements would be the main cause of assemblage variability and of the presence or absence of bifaces (Clark et al., 1994; Villa, 1983, p. 15; see also Isaac, 1972).

3.5. *What if bifaces do not have a phylogenetic or cultural significance?*

What are the logical consequences of the idea that the absence or presence of bifaces has no phylogenetic or cultural significance?

If we accept the idea that bifaces, after their first appearance at 1.5 Ma in East Africa had become simply a component of a variable technological repertoire, would this imply that only one dispersal event into Eurasia took place? To explain the apparent temporal separation between the first appearances of Mode 1 and 2 industries in Europe, should we think that the early toolmakers were capable of making handaxes but did not put into practice their technical repertoire for adaptive or raw material reasons? Transmission of technical knowledge without actual practice seems difficult to accept. The solution of having separate phyla of culture (i.e., technical traditions), possibly associated with genetically isolated hominid taxa (Foley, 1987; Foley and Lahr, 1997) might seem best. Yet the Middle Pleistocene prehistoric record offers many examples discordant with this model.

For instance, the Yabrudian industry, found in Syria and dated to 270/300 ka (Mercier et al., 1995) is characterized by Quina-like scrapers, and a core technology that has been compared with that of Quina Mousterian sites in France (Bourguignon, 1997). French Quina Mousterian sites are generally dated to OIS 4 (Delpech, 1996), much later than the Yabrudian industry. Production of blanks for Quina-like scrapers has also been described from industries widely separated in space and time, such as the High Lodge in England (OIS 13) and Les Tares in Southwestern France (OIS 6). At both sites flaked flakes (a variety of the Kombewa method) are found. These are interpreted either as removals to make Clactonian notches and/or as a method for producing thin blanks with sharp, cutting edges starting from scrapers or thick flakes (Ashton and McNabb, 1992; Geneste and Plisson, 1993).

Using the separate phyla principle, similarities between the French Quina sites and Yabrud must be the result of group migrations from the Middle East to Western Europe (or vice versa), although it is difficult to account for the vast span of time and space separating the two phenomena, with no evidence of continuity. The reappearance of specific technical habits (flaked flakes) and similarly retouched scrapers across the hundreds of thousands of years separating High Lodge and Les Tares is also difficult to explain, if we believe that stone technologies and cultural or biological boundaries coincide.

There is also the case of the long intervals of time (up to 200 ka) separating French Mousterian assemblages with apparently identical reduction methods such as the use of series of unipolar removals within the Levallois recurrent technique (Soressi, 1999). Assemblages with blade technologies resembling "Upper Paleolithic" techniques are documented in the Near East and Europe. Their dates range from as early as 270 ka down to assemblages dated to OIS 5 or early OIS 4 (Bar Yosef and Kuhn, 1999), again with no evidence of continuity. These huge gaps in temporal and spatial range have no explanation under a biological or cultural affiliation principle.

If, instead, we believe that the repertoire of Paleolithic toolmakers was a broad and flexible base of similar flaking habits influenced by raw material characteristics, the re-occurrence in spatially and temporally distinct sites of similar methods or artifact forms could be explained by the fact that flaking options available to the toolmakers had a broad but not unlimited range, especially when functional purpose and technical objectives were the same (Mellars, 1996, pp. 352–354). In the case of Quina scrapers, their similarity across space and time would be due to a preference for wide and thick blanks that could easily be resharpened (Dibble, 1991). Moreover, detailed technological studies have sometimes shown that there is no need to invoke an extraordinary persistence through time of oral traditions transmitting specific technical habits even when they are not put to practice. Technical habits in temporally and spatially separated assemblages have sometimes been judged superficially similar when in fact there are enough subtle differences corresponding to an expected variability if the explanation is technical convergence. Such would be the case of claimed resemblance between the debitage methods of Les Tares and the Quina Mousterian,[2] (Bourguignon, 1997, pp. 128–129).

In sum, adaptive flexibility and limited range of technical choices in the context of simple technologies may be the reason technical and morphological tool patterns re-appear and alternate in regional sequences without invoking continuous cultural transmission of specific norms or tool patterns.

It should also be clear that the problem with bifaces is, at least in part, an artifact of typology. Paleolithic bifaces are not a morphologically homogeneous class, a single functional category, or a social techno-unit with a symbolic meaning (Kohn and Mithen, 1999), although some bifaces may fall into one or other of these categories. Bifaces are a typological construct based on the coexistence of just two attributes: symmetry of shape, and a bifacial flaking mode to produce a robust edge which can be pointed, rounded or straight (Villa, 1983, pp. 10–11). Yet these two diagnostic attributes are not constant properties of bifaces; there are asymmetrical bifaces, bifaces with almost no bifacially retouched edges, bifaces which were made with a minimum of effort,

[2] The coexistence of the Levallois and Quina modes of debitage in the same assemblage has been suggested for some Mousterian sites in Southern France (at La Combette, Texier et al. (1998); and, tentatively, at Combe Grenal layer 22, Geneste et al. (1997)). These and similar examples of synchronic use by the same groups of a variety of quite different knapping modes are also proof that the repertory of Paleolithic toolmakers consisted of a common base of motor habits put into variable practice under the influence of raw material, technical abilities and functional needs.

bifaces with a lot of secondary thinning, bifaces for a giant hand, bifaces as small as a side scraper, bifaces that are trifaces, and even unifacial "bifaces".

According to Schick (1994), Mode 1 technologies cannot be regarded as traditions with a coherent set of rules of tool-making; they are simply the application of very basic principles of hard-hammer percussion to chunks and cobbles of stone: least-effort strategies for producing sharp edges on flakes or blocks. I would also argue that there is no overall Acheulean tradition covering an area from Africa to Western Europe. I see very little commonality or evidence of shared cultural rules between the bifaces on basalt flakes from Gesher Benot Ya'aqov and those on flint cobbles from Notarchirico, between the Tarn Valley unifaces, partial bifaces, and cleavers on quartzite flakes and the Hoxne or Boxgrove bifaces. In other words, I argue that, like blade technologies, European biface industries cannot be used to infer cultural or biological affiliation. Concepts such as Mode 1–4 technologies may be useful on a planetary scale to describe the technological evolution of the human family in the last 2.5 million years, but they are too vague and generic to fit all the evidence accumulated on Middle Pleistocene Europe. Of course, lumping is for the sake of the Big Picture. Unfortunately, although simple models are useful when you have little data, a lot of information will blow them up.

In sum, the hypothesis of two migration events lacks a sound theoretical basis and is not more probable than a hypothesis of one. Nevertheless, I realize that this debate may seem a conflict carrying a philosophical component with no solution in sight. To refute the model of separate phyla, or at least its application to Italy, in its own terms, we should leave aside interpretative arguments and simply prove that its chronology lacks empirical justification. In other words, we should show that in the Italian peninsula, Mode 1 assemblages do not consistently precede Acheulean assemblages.

This brings me to the third part of this paper: the chronology of the earliest sites in Italy and the nature of their faunal and lithic assemblages. I suggest that the purported greater age of Mode 1 industries in Italy (and in Europe) has been evaluated on the basis of chronological data influenced by underlying assumptions of greater archaism with respect to Mode 2.

4. Early sites in Italy

About eight sites have been considered as important occurrences that might be dated to the upper Matuyama or the early part of the Brunhes epoch. They are: Monte Poggiolo, Isernia, Notarchirico, Ceprano, Arce, Fontana Liri, Colle Marino, and Casella di Maida. Six of these, with the exception of Notarchirico, have been classified as core-and-flake or pebble tool industries. Ceprano has yielded a human calvarium identified as late *Homo erectus* or of *Homo sapiens* grade, compared to the Atapuerca Gran Dolina hominids (Ascenzi et al., 1996; Howell, 1999). The fossil has been estimated to date to older than 700 ka from stratigraphic correlations, which need to be published in more detail. No artifacts have been found in association with the cranium, thus the site falls outside the scope of this paper. The often-cited Monte Peglia occurrence is not considered, since of the five artifacts, four were not found in situ and the fifth looks like a geofact (Piperno, 1972; Piperno et al., 1984, pp. 115–119; Mussi, 1995).

What constitutes the evidence that in Italy core-and-flake assemblages are older than biface assemblages?

Arce and Fontana Liri (both in the Latium region, south of Rome) are surface collections of limestone chopper-cores, some flaked with the vertical percussion technique described for Terra Amata (Villa, 1983), and a few flakes with simple retouch. The discovering archaeologist (Biddittu, 1972) thought he had identified the layer of provenience. However, their morphostratigraphic position only tells us that the deposits are Pleistocene in age, overlying sandy clays of the Messinian (end of the Miocene), so their dating to before 700 ka (Piperno et al., 1984, p. 113) is essentially based on typological arguments, namely, the presumed archaism of the industry.

The Colle Marino artifacts (some limestone chopper-cores and flakes from two nearby findspots, Colle Marino and Nocicchio, also southeast of Rome) have been found in layers uncovered by a roadcut and natural erosion. It is argued that the archaeological deposits preceded the first manifestation of volcanic activity of the Latian volcano dated to about 700 ka. However, the regional correlations used for assigning an age are generalized, are not based on detailed mapping, and lack chronostratigraphic details (Biddittu and Segre, 1982; Mussi, 1995). At none of these sites are there associated faunas. Some of the artifacts from Colle Marino appear to be geofacts; the series should be subjected to technological analysis.

At Casella di Maida (Calabria), the industry (hundreds of chopper-cores and retouched flakes on quartz and quartzite cobbles) comes at least in part from an excavation but the artifacts are not associated with fauna. The assignment to an early age (early Brunhes) is tentative and based only on typological arguments, that is, on comparisons with supposedly more archaic industries (Colle Marino, Isernia) and supposedly younger handaxe (i.e., Acheulean), assemblages which contain a core-and-flake component. Casella di Maida contains no handaxes and is thus judged older than Fontana Ranuccio. However, it seems to me that some retouched pieces might easily be assigned to a younger, Middle Paleolithic age (Gambassini and Ronchitelli, 1982, Fig. 7; Piperno et al., 1984, pp. 119–121).

Three sites deserve a closer look: Monte Poggiolo in Northern Italy, Isernia in Central Italy, and Notarchirico in Southern Italy. At all these sites, artifacts are, without a doubt, of human manufacture. The first two sites have provided large core-and-flake assemblages, bifaces have been found at Notarchirico.

4.1. Monte Poggiolo

The Monte Poggiolo site, in the northern Apennines foothills at the southern margin of the Po Plain, is found in fluviatile sandy gravels at 200 m above sea level and about 40 km from the Adriatic coast. The geological sequence in this area is formed by marine clays (Blue Clays) unconformably overlain by littoral sands (Yellow Sands or Imola Sands; Amorosi et al., 1998). The top part of the Yellow Sands, quarried in a locality about 20 km from the archaeological site, has provided *Mammuthus meridionalis* (a Late Villafranchian taxon) and other fauna (such as *Bison schoetensacki*) dated to the early Galerian (1–0.9 Ma, according to Azzaroli et al. (1988), but see van Kolfschoten (1996)). Based on some ESR dates on shell, and paleomagnetism, the marine clays are dated to the lower Matuyama (older than Jaramillo); the Yellow Sands are dated to the interval between Jaramillo and the Brunhes by ESR on quartz crystals; the paleomagnetism indicates reversed polarity. The archaeological deposits of Monte Poggiolo contain no fauna and were first dated by correlation with the Yellow Sands; they are interpreted as a lateral facies of the Yellow Sands, that is, gravel-beach and fan-delta deposits. There are now paleomagnetic measurements of reversed polarity and three ESR dates on quartz from the site. Thus, the site is estimated to be of upper Matuyama age, around 0.8 Ma. (Fig. 4). However, some of the paleomagnetic measurements are inconclusive and the dates have large uncertainties (Gagnepain et al., 1992, 1996; Antoniazzi et al., 1993, 1995; Peretto et al., 1998).

The assemblage is made on small flint pebbles (which are naturally abundant in the deposits) and consists mostly of core-choppers and flakes, with very few retouched pieces (7 denticulates and 5 scrapers). There are many refitted groups, which form about 17% of the excavated sample. The total excavated assemblage is 1310 pieces (1166 flakes and 153 pebbles). Most flakes are smaller than 6 cm and the pebbles are generally 10 cm or smaller.

Not everybody agrees that the deposits are fluviatile. It has been suggested that they are colluvial, based on the general geometry of the deposits and lack of cross-bedding (M. Santonja, pers. comm.), and not necessarily correlative with the Yellow Sands. I believe that the ESR dates on quartz are provisional and that they cannot be relied upon to support a precedence of core-and-flake industries over biface assemblages.

4.2. Isernia

The site of Isernia (Peretto, 1994, 1996) contains four core-and-flake assemblages from two different sectors of the site at a total of four different loci. The oldest horizon (level 3c in Sector I) was deposited on a paleo-land

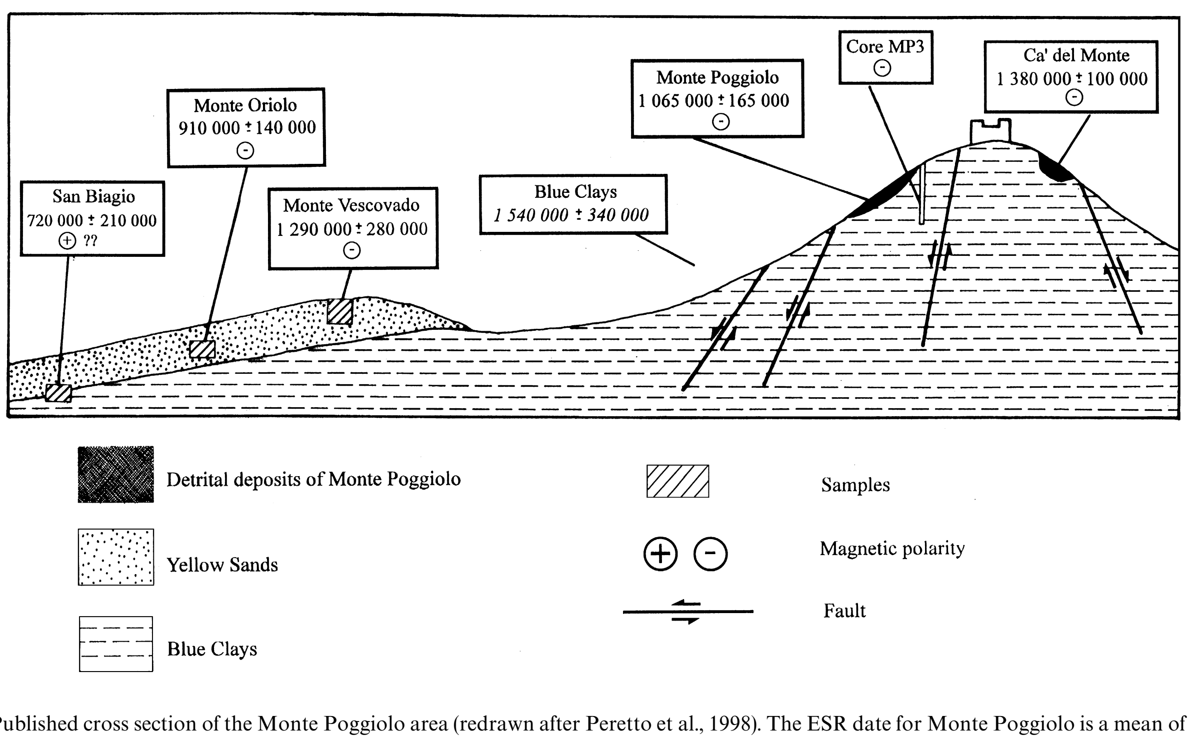

Fig. 4. Published cross section of the Monte Poggiolo area (redrawn after Peretto et al., 1998). The ESR date for Monte Poggiolo is a mean of 3 dates.

surface on top of lacustrine travertine; of this surface about $80\,m^2$ has been excavated, yielding 579 artifacts and about 700 macrofaunal remains. This level was covered by sterile overbank deposits (fluviatile clay-muds), over which a second horizon, level 3a, was found. This horizon, excavated over a surface area of about $130\,m^2$, has yielded 334 artifacts and a spectacular concentration of faunal remains (more than 4000 pieces). Approximately $60\,m^2$ has been left in situ; the remaining area has been completely excavated.

The fluviatile gravels that cover part of level 3a and the debris flow that covered most of it underlie a series of clay-silt sands in which the third horizon (level 3S10) is located, some meters north of the previous area. Explored over an area of $9\,m^2$, this level contains 514 faunal remains and 114 lithic artifacts. Sector II (50 m from sector I) was excavated over about $68\,m^2$ as a salvage operation, since highway work had truncated the archaeological horizon on one side. Artifacts were vertically concentrated in a horizon only a few cm thick and were numerous: 4524 pieces, of which 1600 were debris, but bone remains were few (163) and in a bad state of preservation. The fluviatile muds of this horizon are stratigraphically related to the deposits of level 3S10. A discussion on whether these occurrences qualify as "living floors" (as the excavators claim) falls beyond the scope of this paper. My opinion is presented in Villa (1996).

Fauna is present in three of the loci, especially in level 3a. The most frequent species is *Bison schoetensacki* (estimated MNI = 61 in level 3a), followed by the rhino (*Stephanorhinus hundsheimensis*, formerly *D. hemitoechus*; MNI = 31 in level 3a), and the elephant (*Elephas antiquus*; MNI = 9). Hippos and medium-size ungulates are much less common. Bear (*Ursus deningeri*; MNI = 13) is also found. In all loci the lithic industry is made of flint. There is also a small number of limestone artifacts essentially modified pebbles (with few scars, including some anvils or percussors) and some choppers.

Both raw materials used are local. Flint comes in the form of small angular slabs and blocks generally smaller than 8 cm. Not a particularly good raw material, the flint has planes of weakness and fissures, fractures are a common knapping accident. The mean length of all flint artifacts (including flakes, debris, and cores) is between 2 and 4 cm. The bipolar and direct percussion techniques were used, and the assemblages consist of a very large number of small flakes, a lot of flake fragments and debris, plus a series of thick pieces which would normally be classified as denticulates, notches, becs, and coarse end-scrapers. Based on replicative experiments, it has been shown that these pieces are not tools in the sense of being deliberately produced but are just cores, resulting from intensive reduction of the raw material (Peretto, 1994, 1996).

The age of Isernia is controversial. The excavators published a K–Ar date from volcanic elements in the debris flow covering part of the 3a occurrence (730 ± 40 ka). The date was on sanidine crystals and the excavators rejected the hypothesis that these were reworked volcanics because the crystals had fresh edges. They note that two other K–Ar dates from later strata at the top of the sequence (although in another part of the site), of 550 ± 50 and 470 ± 50 ka, are consistent with the age of level 3a. In addition, reversed polarity was indicated for the archaeological level, thus dating Isernia to below the Matuyama/Brunhes boundary. However, the published paleomagnetic data appeared more suggestive than definitive, since several measurements were inconclusive (Coltorti et al., 1982; Cremaschi and Peretto, 1988). Note that at the time the Matuyama/Brunhes boundary was set at 730 ka, but has since been redated at 788 ka (Tauxe et al., 1992).

A strong challenge to the age of Isernia has come from two researchers, Roebroeks and van Kolfschoten (1994, 1998). They argued that the presence of a rodent, *Arvicola terrestris cantiana*, which in Northwestern Europe replaces *Mimomys savini* at about 500 ka, clearly indicates that Isernia could not be as old as claimed. *Arvicola terrestris cantiana* is a water vole with rootless molars, and is assumed to be the descendant of *M. savini*, which has rooted molars. The Pleistocene *Arvicola* is present during temperate and cold phases in the Mediterranean, as well as in Central and Northwestern Europe. *M. savini* occurs at West Runton (the type site of the Cromerian, sensu stricto) in deposits antedating the Anglian ice advance, which is generally correlated with OIS 12 and the Elsterian glaciation of Germany. The transition from *M. savini* to *A. cantiana* happened before the end of the Cromerian, since *A. cantiana* appears in the Netherlands in the Interglacial IV deposits of the Cromerian Complex before the Elster ice advance, and in the Neuwied basin (Germany) at a slightly earlier date, within the second half of the Cromerian Complex, i.e., between 0.6 and 0.5 Ma (van Koenigswald and van Kolfschoten, 1996). The *Arvicola* from Isernia has been characterized as a primitive population, since a small proportion of the molars show evidence of root formation. Some Italian paleontologists are also of the opinion that the date of 0.73 Ma does not match the macrofaunal evidence (specifically, the presence of *E. antiquus, B. schoetensacki*), and consider Isernia younger, approximately 0.6 Ma (Petronio and Sardella, 1999). It is interesting to note that in a recent paper on paleomagnetic data from Isernia the site is put within the Brunhes epoch (Gagnepain et al., 1996).

4.3. Notarchirico

The archaeological occurrences at Venosa (Piperno, 1999) are found in fluviatile deposits, rich in volcanic materials, which fill a paleovalley 2–4 km wide. The

Venosa basin is part of a tectonic depression (Fossa Bradanica, i.e., Bradanic foredeep), which underwent uplift in the Lower Pleistocene. Throughout the Middle Pleistocene the basin was occupied by a wide, meandering river and witnessed several volcanic eruptions by the Vulture volcano, which lies 23 km to the East. The explosive and effusive activity of Monte Vulture occurred from the Middle Pleistocene (about 730 ka) until the Upper Pleistocene (about 132 ka). The volcanism induced changes in fluvial sedimentation, with formation of shallow lakes and progressive filling of the paleovalley. In the Upper Pleistocene, tectonic movements reverse the direction of the drainage pattern exposing the Middle Pleistocene deposits (Lefèvre et al., 1999).

The deposits at Notarchirico are about 6 m thick and comprise four stratigraphic units (1–4, in descending order); archaeological materials are found in all units, but those in the lowest unit have been only tested over small surfaces. They form an alternating sequence of fluviatile sediments filling paleo-channels, volcanic ashes concentrated and reworked in water, and stone pavements formed by detrital slope deposits set in motion by volcanic activity. The fines have subsequently been washed out, leaving the pebbles as a lag deposit; thus the stone pavements (particularly in levels B and F) form old land surfaces and represent an interruption in deposition, with bones and stones forming part of the pavements or resting on top of them. Some assemblages contain bifaces (Raynal et al., 1999a).

The archaeological sequence consists of nine levels: (descending) level Alpha, A, A1, B, C, D, E, E1, and F excavated, to date, over variable surfaces from a minimum of 20 to a maximum of 133 m^2. Four more levels at the base of the sequence have only been tested. The assemblages with bifaces, made on limestone, flint and, more rarely, quartzite cobbles (ascending: F, D, B, A1, A) alternate with assemblages with only choppers, cores (single and multiple debitage surfaces, some discoid), and flakes/flake tools (levels E1, E, C, Alpha). At least one assemblage without bifaces is rather large (level Alpha at the top of the sequence, with 950 stone artifacts), thus the absence of bifaces is not dependent on sample size.

In level A1, consisting of sands and gravels preserved in a slight depression of 6×4 m^2 above the stone pavement B, an elephant skull was found in close proximity to 41 stone artifacts including choppers, five small tools and nine bifaces (two of which are in contact with the elephant mandible). The materials had been partly disturbed by low-energy water flow which deposited the sandy gravels and may have removed small- to medium-sized lithic elements.

In the biface assemblages, we note the absence of flake cleavers, pics, trihedrals, double-pointed bifaces, and spheroids. These characteristic tool types occur (though not all the time) in the Acheulean assemblages of North Africa, e.g., Thomas Quarry, unit L, dated to 1 Ma (Raynal and Texier, 1989; Raynal et al., 1999b; Raynal et al., this volume), and in Israel at 'Ubeidiya and Gesher Benot Ya'aqov (Bar Yosef and Goren-Inbar, 1993; Goren-Inbar and Saragusti, 1996; Saragusti and Goren-Inbar, this volume). Most of the Notarchirico bifaces are amygdaloids with twisted edges and a low degree of standardization.

In level Alpha, a human femur was found and dated by U-series to 359 ka, but with a large margin of uncertainty (+ 154 and − 97 ka). TL dating on quartz has yielded contradictory dates, since the oldest date is above a younger one. However, in stratigraphic unit 2, layers 2.1–2.4, which underlie archaeological level E1 and occur above level F, represent a volcanic ash fall in primary context, deposited in still water. The chemical composition of level 2.4 (a trachytic cinerite called Notarchirico tephra) has been compared with tephras in the stratigraphic succession of the Vulture. In that sequence, one tephra with similar composition, defined as exotic and considered as a fall from a more distant source (Latium or Campania), has been dated by Ar–Ar on sanidine crystals (Raynal, pers. comm.) to about 654 ± 11 ka. This date corresponds to the TL date obtained for layer 2.1, i.e., 640 ± 70 ka. The Notarchirico archaeological sequence complex occurs at the top of the Piano Regio Formation, which is overlain by other volcanic-sedimentary deposits called the Tufarelle Formation where the non-biface assemblage of Venosa Loreto is found. Based on correlations with the various volcanic episodes of the Vulture, both formations are thought to represent a rather short interval of time within the early part of the Middle Pleistocene (Raynal et al., 1999a; Vernet et al., 1999).

The microfaunal assemblage contains species that are also found at Isernia, such as *Arvicola cantiana* and *Pliomys episcopalis*; the macrofauna of levels A and Alpha includes *E. antiquus, Dama clactoniana, Bos primigenius,* and *Bison schoetensacki*, but the lower levels remain to be studied (Cassoli et al., 1999; Sala, 1999).

5. Conclusions

As it stands, the dating evidence from Italy is not strong enough to prove a precedence of core-and-flake industry over biface assemblages and the existence of two separate migration events. The early core-and-flake assemblages have problematic dates, and there is clear evidence of the limitations imposed by the size of raw material for key sites such as Monte Poggiolo and Isernia. The biface assemblages from Notarchirico appear to be only slightly younger than those without bifaces from Isernia. Certainly, if one scans the published literature, there seem to be many core-and-flake assemblages hypothetically dated to early times. But is a large number of unverified, doubtful cases sufficient to argue for a priority of non-biface industries? Not only is the evidence for a greater antiquity of core-and-flake industries ambiguous, the interpretation of these industries as designating different groups of hominids lacks a sound archaeological basis.

Hominid presence in Italy is documented at the beginning of the Middle Pleistocene, and Sicily does not seem to be on their route of entry. Certain aspects of the record should be emphasized:

(a) In contrast to the 'Ubeidiya and Gesher Benot Ya'aqov assemblages in Israel (Bar Yosef and Goren-Inbar, 1993; Goren-Inbar and Saragusti, 1996), the earliest-dated biface assemblages in Italy show no specific characteristics that would tie them to the African Acheulean (whether from East or North Africa).
(b) There seems to be a very low density of sites for the first part of the Middle Pleistocene. Taking the dating of the major sites at face value, there are four sites for the time span between 0.8 and 0.5 Ma (Ceprano, Monte Poggiolo, Isernia, Notarchirico), i.e., on average 1 site every 100 ka. Even if we concede that sites such as Arce and Liri might be this old, we are still dealing with a mostly clean slate. The picture would change if instead of 0.8 one takes 0.7–0.6 Ma as the date of the first appearance of hominids in the peninsula, but not too dramatically, since the density of sites only increases in the second half of the Middle Pleistocene, after 450 ka.
(c) There are few elements of similarity between the early Italian assemblages, and they are essentially features related to the use of a simple technology. There is a lack of standardized design, all assemblages show a strong influence of raw material properties on the manufacture method and the morphology of the artifacts, and all indicate a low degree of internal differentiation and only limited evidence of distinct tool patterns.

These kinds of data would fit an ad hoc interpretation of multiple, sporadic, and discontinuous episodes of settlement into the peninsula until higher densities of population allowed the formation of a more stable prehistoric record and more distinct tool-making patterns. It is often suggested that the great mobility of several mammalian groups such as carnivores or elephants is a key to understanding human dispersal (e.g., Turner, 1999). Since no complete barriers ever existed to stop faunal exchanges with continental Europe, the hypothesis of multiple episodes of migration into the peninsula should be entertained, although we can neither support it nor refute it because the archaeological assemblages do not inform us on specific migration events.

Acknowledgements

I thank Lawrence Straus and Ofer Bar Yosef for inviting me to participate in the symposium "Out of Africa: once, twice or continuously in the Pleistocene" of the XVth INQUA Congress of August 1999 in Durban, South Africa. A short version of this paper was presented at the workshop organized in conjunction with the symposium. I also thank the NRC/NAS, the American Geophysical Union, and NSF, which provided travel money to attend the conference. Laura Bonfiglio, Francesco d'Errico, Marie Soressi, and Antonio Minoldo made very useful comments on an earlier draft of this paper. I am very grateful to Marcello Piperno and Jean-Paul Raynal, who kindly provided the Notarchirico monograph and to Laura Bonfiglio who sent me her publications relevant to this topic.

References

Agustí, J., Oms, O., Parés, J.M., 1999. Magnetofaunal dating and correlation of early human occupation in the Baza Formation (Guadix-Baza Basin, SE Spain). Abstracts of the XV INQUA Congress, August 3–11, Durban, South Africa, p. 3.

Aïfa, T., Feinberg, H., Pozzi, J.P., 1988. Pliocene–Pleistocene evolution of the Tyrrhenian arc: paleomagnetic determination of uplift and rotational deformation. Earth and Planetary Science Letters 87, 438–452.

Alexander, D., 1988. A review of the physical geography of Malta and its significance for tectonic geomorphology. Quaternary Science Review 7, 41–43.

Alimen, M.H., 1975. Les isthmes hispano-marocain et siculo-tunisien aux temps acheuléens. L'Anthropologie 79, 399–436.

Amorosi, A., Caporale, L., Cibin, U., Colalongo, M.L., Pasini, G., Lucchi, F.R., Severi, P., Vaiani, S.C., 1998. The Pleistocene littoral deposits (Imola Sands) of the Northern Apennines foothills. Giornale di Geologia 60, 83–118.

Antoniazzi, A., Antoniazzi, Al., Peretto, C., 1995. Ca' Belvedere di Monte Poggiolo. In: Guerreschi, A., Peretto, C., Prati, L. (Eds.), Guide archeologiche, Preistoria e Protostoria in Italia, Vol. 3. A.B.A.C.O. Edizioni, Forlí, pp. 379–387.

Antoniazzi, A., Ferrari, M., Peretto, C., 1993. Il giacimento di Ca'Belvedere di Monte Poggiolo del Pleistocene inferiore con industria litica (Forlí). Bullettino di Paletnologia Italiana 84, 1–56.

Anzidei, A.P., Arnoldus Huyzendveld, A., 1992. The Lower Paleolithic site of La Polledrara di Cecanibbio (Rome). In: Herring, E., Whitehouse, R., Wilkins, J. (Eds.), Papers of the Fourth Conference of Italian Archaeology. Accordia Research Center, London, pp. 141–153.

Ascenzi, A., Biddittu, I., Cassoli, P.F., Segre, A.G., Segre-Naldini, E., 1996. A calvarium of late Homo erectus from Ceprano Italy. Journal of Human Evolution 31, 409–423.

Ascenzi, A., Segre, A.G., 1971. A new Neandertal child mandible from an Upper Pleistocene site in Southern Italy. Nature 233, 280–283.

Ashton, N.M., McNabb, J., 1992. The interpretation and context of the High Lodge industries. In: Ashton, N.M., Lewis, J., Cook, S.G., Rose, J. (Eds.), High Lodge. Excavations by G. de G. Sieveking 1962–68 and J. Cook 1988. British Museum Press, London, pp. 164–168.

Ashton, N., McNabb, J., 1994. Bifaces in perspective. In: Ashton, N., David, A. (Eds.), Stories in Stone. Lithics Studies Society, Occasional Paper Vol. 4, pp. 182–191.

Ashton, N., McNabb, J., 1996. The flint industries from the Waechter excavations. In: Conway, B., McNabb, J., Ashton, N. (Eds.), Excavations at Barnfield Pit, Swanscombe, 1968–1972. British Museum Occasional Papers, Vol. 94, London, pp. 201–236.

Ashton, N.M., McNabb, J., Irving, B., Lewis, S., Parfitt, S., 1994. Contemporaneity of Clactonian and Acheulean flint industries at Barnham, Suffolk. Antiquity 68, 585–589.

Azzaroli, A., 1999. Biogeography of Early and Early-Middle Pleistocene mammalian faunas of Italy. In: Gibert, J., Sanchez, F., Gibert, L., Ribot, F. (Eds.), The Hominids and their Environment During the Lower and Middle Pleistocene of Eurasia. Proceedings of the International Conference of Human Paleontology, Orce, 1995. Museo de Prehistoria y Paleontologia, Orce, pp. 549–555.

Azzaroli, A., De Giuli, C., Ficcarelli, G., Torre, D., 1982. Table of the stratigraphic distribution of terrestrial mammalian faunas in Italy from the Pliocene to the early Middle Pleistocene. Geografia Fisica e Dinamica del Quaternario 5, 55–58.

Azzaroli, A., De Giuli, C., Ficcarelli, G., Torre, D., 1988. Late Pliocene to early mid-Pleistocene mammals in Eurasia: faunal succession and dispersal events. Palaeogeography, Palaeoclimatology, Palaeoecology 66, 77–100.

Bar Yosef, O., Goren-Inbar, N., 1993. The lithic assemblages of 'Ubeidiya. Qedem, Monographs of the Institute of Archaeology, Jerusalem.

Bar Yosef, O., Kuhn, S.L., 1999. The big deal about blades: laminar technology and human evolution. American Anthropologist 101, 322–338.

Bianchini, G., 1973. Gli "hachereaux" nei giacimenti paleolitici della Sicilia sud-occidentale. Atti della XV Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria, ottobre 1972, 11–25.

Biddittu, I., 1972. Pleistocene e industrie litiche pre-acheuliane ad Arce e Fontana Liri (Frosinone). Quaternaria 16, 35–52.

Biddittu, I., Segre, A.G., 1982. Pleistocene medio-inferiore con industria arcaica su ciottolo nel bacino di Anagni (Lazio). Atti della XXIII Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria, Firenze, pp. 567–576.

Binford, L.R., 1972. Contemporary model building: paradigms and the current state of Palaeolithic research. In: Clarke, D.L. (Ed.), Models in Archaeology. Methuen, London, pp. 109–165.

Boëda, E., Kervazo, B., Mercier, N., Valladas, H., 1996. Barbas C 3 base (Dordogne). Une industrie bifaciale contemporaine des industries du Moustérien ancien: une variabilité attendue. Qauternaria Nova VI, 465–504.

Bonfiglio, L., 1992. Middle and Upper Pleistocene mammal-bearing deposits in South-Eastern Sicily: new stratigraphic records from Coste di Gigia (Syracuse). Geobios 14, 189–199.

Bonfiglio, L., Berdar, A., 1979. Gli elefanti delle ghiaie pleistoceniche di Messina. Quaternaria 21, 139–177.

Bonfiglio, L., Cassoli, P.F., Mallegni, F., Piperno, M., 1986. Neanderthal parietal, vertebrate fauna and stone artifacts from the Upper Pleistocene deposits of Contrada Ianní di San Calogero (Catanzaro, Calabria, Italy). American Journal of Physical Anthropology 70, 241–250.

Bonfiglio, L., Insacco, G., 1992. Paleoenvironmental, paleontologic and stratigraphic significance of vertebrate remains in Pleistocene limnic and alluvial deposits from southeastern Sicily. Palaeogeography, Palaeoclimatology, Palaeoecology 95, 193–208.

Bonfiglio, L., Insacco, G., Marra, A.C., Masini, F., 1997. Large and small mammals, amphibians and reptiles from a new late Pleistocene fissure filling deposit of the Hyblean Plateau (South-Eastern Sicily). Bollettino della Società Paleontologica Italiana 36, 97–122.

Bonfiglio, L., Piperno, M., 1996. Early faunal and human populations. In: Leighton, R. (Ed.), Early Societies in Sicily. Accordia Research Centre, University of London, pp. 21–30.

Bonifay, E., Vandermeersch, B., 1989. Vue d'ensemble sur le très ancien Paléolithique de l'Europe. In: Bonifay, E., Vandermeersch, B. (Eds.), Les premiers Européens. Editions du C.T.H.S., Paris, pp. 309–319.

Boschian, G., Mallegni, F., Tozzi, C., 1999. The homo erectus site of Visogliano shelter (Trieste, NE Italy). In: Gibert, J., Sanchez, F., Gibert, L., Ribot, F. (Eds.), The Hominids and their Environment During the Lower and Middle Pleistocene of Eurasia. Proceedings of the International Conference of Human Paleontology, Orce, 1995. Museo de Prehistoria y Paleontologia, Orce, pp. 437–442.

Bosinski, G., 1995. The earliest occupation of Europe: Western Central Europe. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 103–128.

Bourguignon, L., 1997. Le Moustérien de type Quina. Nouvelle définition d'une entité technique. Doctoral Thesis, Université Paris X.

Breuil, H., 1932. Les industries à éclat du paléolithique ancien, I, Le Clactonien. Préhistoire 1 (2), 125–190.

Butzer, K.W., 1977. Environment, culture and human evolution. American Scientist 65, 572–584.

Callow, P., Cornford, J.M., 1986. La Cotte de St. Brelade, 1961–1978. Geo Books, Norwich.

Caloi, L., Kotsakis, T., Palombo, M.R., Petronio, C., 1996. The Pleistocene dwarf elephants of Mediterranean islands. In: Shoshani, J., Tassy, P. (Eds.), The Proboscidea. Evolution and Palaeoecology of Elephants and their Relatives. Oxford University Press, New York, pp. 234–239.

Caloi, L., Palombo, M.R., Zarlenga, F., 1998. Late-Middle Pleistocene mammal faunas of Latium (central Italy): stratigraphy and environment. Quaternary International 47–48, 77–86.

Carbonell, E., García-Antón, M.D., Mallol, C., Mosquera, M., Ollé, A., Rodrígues, P., Sahnouni, M., Sala, R., Vergés, J.M., 1999a. The TD6 level lithic industry from Gran Dolina, Atapuerca (Burgos, Spain): production and use. Journal of Human Evolution 37, 653–693.

Carbonell, E., Mosquera, M., Rodriguez, X.P., Sala, R., van der Made, J., 1999b. Out of Africa: the dispersal of the earliest technical systems reconsidered. Journal of Anthropological Archaeology 18, 119–136.

Cassoli, P.F., Di Stefano, G., Tagliacozzo, A., 1999. I vertebrati dei livelli superiori A ed Alfa della serie stratigrafica di Notarchirico. In: Piperno, M. (Ed.), Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa, pp. 361–438.

Clark, G., 1969. World Prehistory: A New Outline, 2nd Edition. Cambridge University Press, London.

Clark, G.A., 1989. Alternative models of Pleistocene biocultural evolution: a response to Foley. Antiquity 63, 153–162.

Clark, J.D., 1970. The Prehistory of Africa. Praeger, New York.

Clark, J.D., 1975. The Late Acheulian industries of Africa and the Middle East. In: Butzer, K.W., Isaac, G.Ll. (Eds.), After the Australopithecines. Mouton, The Hague, pp. 605–660.

Clark, J.D., 1987. Transitions: Homo erectus and the Acheulian: the Ethiopian sites of Gadeb and the Middle Awash. Journal of Human Evolution 16, 809–826.

Clark, J.D., Haynes, C.V., 1969. An elephant butchery site at Mwanganda's village, Karonga, Malawi, and its relevance for Palaeolithic archaeology. World Archaeology 1, 390–411.

Clark, J.D., de Heinzelin, J., Schick, K.D., Hart, W.K., White, T.D., Wolde-Gabriel, G., Walter, R.C., Suwa, G., Asfaw, B., Vrba, E., Selassie, Y.H., 1994. African Homo erectus: old radiometric ages and young Oldowan assemblages in the Middle Awash valley, Ethiopia. Science 264, 1907–1910.

Clark, J.D., Schick, K.D., 2000. Biface technological development and variability in the Acheulean Industrial Complex in the Middle Awash Region of the Afar Rift, Ethiopia. Paper presented at the 65th Annual Meeting of the Society for American Archaeology, April 5–9, Philadelphia.

Collins, D., 1969. Culture traditions and environment of early man. Current Anthropology 10, 267–316.

Coltorti, M. et al., 1982. Reversed magnetic polarity at an early Lower Paleolithic site in Central Italy. Nature 300 (5888), 173–176.

Conway, B., McNabb, J., Ashton, N. (Eds.), 1996. Excavations at Barnfield Pit, Swanscombe, 1968–1972. British Museum Occasional Papers, Vol. 94, London.

Cremaschi, M., Peretto, C., 1988. Paleolithique inferieur de la plaine orientale du Po. Anthropologie 92 (2), 643–681.

Delpech, F., 1996. L'environnement animal des Moustériens Quina du Perigord. Paléo 8, 31–46.

d'Errico, F., Zilhao, J., Julien, M., Baffier, D., Pelegrin, J., 1998. Neanderthal acculturation in Western Europe? A critical review of the evidence and its interpretation. Current Anthropology 39, 1–44.

Dibble, H.L., 1991. Mousterian assemblage variability on an inter-regional scale. Journal of Anthropological Research 47, 239–258.

Foley, R., 1987. Hominid species and stone-tool assemblages: how are they related? Antiquity 61, 380–392.

Foley, R., Lahr, M.M., 1997. Mode 3 technologies and the evolution of modern humans. Cambridge Archaeological Journal 7, 3–36.

Freudenthal, M., 1971. Neogene vertebrates from the Gargano Peninsula, Italy. Scripta Geologica 3, 1–10.

Gagnepain, J., Hedley, I., Bahain, J.J., Falguères, C., Laurent, M., Peretto, C., Wagner, J.J., Yokohama, Y., 1996. Synthèse des données radiochronologiques et paléomagnetiques du site de Ca' Belvedere di Monte Poggiolo (Romagna, Italie) et de son environnement géologique. Abstracts of the XIII U.I.S.P.P. Congress, Forlí, Italia, Vol. 2, The Workshops. A.B.A.C.O., Forlí, pp. 129–130.

Gagnepain, J., Hedley, I., Bahain, J.J., Wagner, J.J., 1992. Etude magnétostratigraphique du site de Ca' Belvedere di Monte Poggiolo (Forlí, Italie) et de son contexte stratigraphique. Premiers résultats. In: Peretto, C. (Ed.), I primi abitanti della valle Padana: Monte Poggiolo nel quadro delle conoscenze europee. Jaca Book, Milan, pp. 319–329.

Gambassini, P., Ronchitelli, A.M., 1982. L'industria arcaica su ciottolo di Casella di Maida (Catanzaro). Rivista di Scienze Preistoriche 37, 3–30.

Geneste, J.M., 1999. Réexamen du concept du faciès Moustérien de Tradition acheuléenne (a) de F. Bordes à la faveur de l'analyse technoéconomique (Périgord-France). Paper presented at the Table Ronde "Les industries à outils bifaciaux du Paléolithique moyen d'Europe occidentale" Caen, Service Régional de l'Archéologie, 14–15 Octobre 1999.

Geneste, J.M., Jaubert, J., Lenoir, M., Meignen, L., Turq, A., 1997. Approche technologique des Moustériens Charentiens du Sud-Ouest de la France et du Languedoc oriental. Paléo 9, 101–142.

Geneste, J.M., Plisson, H., 1993. Hunting technologies and human behavior: lithic analysis of Solutrean Shouldered Points. In: Knecht, H., Pike-Tay, A., White, R. (Eds.), Before Lascaux: The Complete Record of the Early Upper Paleolithic. CRC Press, Boca Raton, pp. 117–136.

Gilead, I., 1993. The assemblage of layer I–15. In: Bar Yosef, O., Goren-Inbar, N. (Eds.), The Lithic Assemblages of 'Ubeidiya, Qedem. Monographs of the Institute of Archaeology, Jerusalem, pp. 94–120.

Gliozzi, E., Malatesta, A., Scalone, E., 1993. Revision of Cervus elaphus siciliae, Pohlig 1893, Late Pleistocene endemic deer of the siculo-maltese district. Geologica Romana 29, 307–354.

Goren-Inbar, N., Saragusti, I., 1996. An Acheulian biface assemblage from Gesher Benot Ya'aqov, Israel: indications of African affinities. Journal of Field Archaeology 23 (1), 15–30.

Howell, F.C., 1999. Paleo-demes, species clades and extinctions in the Pleistocene hominin record. Journal of Anthropological Research 55 (2), 191–243.

Isaac, G.Ll., 1969. Studies of early cultures in East Africa. World Archeology 2, 278–298.

Isaac, G.Ll., 1972. Early phases of human behavior: models in Lower Palaeolithic archaeology. In: Clarke, D.L. (Ed.), Models in Archaeology. Methuen, London, pp. 167–199.

Isaac, G.Ll., 1975. Stratigraphy and cultural patterns in East Africa. In: Butzer, K.W., Isaac, G.Ll. (Eds.), After the Australopithecines. Mouton, The Hague, pp. 495–542.

Isaac, G.Ll., 1984. The archaeology of human origins: studies of the Lower Pleistocene in East Africa 1971–1981. Advances in World Archaeology 3, 1–87.

Jones, P.R., 1980. Experimental butchery with modern stone tools and its relevance for Palaeolithic archaeology. World Prehistory 12, 153–165.

Jones, P.R., 1994. Results of experimental work in relation to the stone industries of Olduvai Gorge. In: Leakey, M.D., Roe, D.A. (Eds.), Olduvai Gorge, Vol. 5. Cambridge University Press, Cambridge, pp. 254–298.

Keeley, L.H., 1980. Experimental Determination of Stone Tool Uses. University of Chicago Press, Chicago.

Keeley, L.H., 1993. The utilization of lithic artifacts. In: Singer, R., Gladfelter, B.C., Wymer, J.J. (Eds.), The Lower Paleolithic Site at Hoxne, England. University of Chicago Press, Chicago, pp. 129–137.

van Kolfschoten, T., 1996. Mammalian remains in a Palaeolithic context. In: Milliken, S., Peretto, C. (Eds.), Archaeology, Methodology and the Organisation of Research. A.B.A.C.O. Edizioni, Forlí, pp. 19–36.

van Koenigswald, W., van Kolfschoten, T., 1996. The Mimomys-Arvicola boundary and the enamel thickness quotient (SDQ) of Arvicola as stratigraphic markers in the Middle Pleistocene. In: Turner, C. (Ed.), The Early Middle Pleistocene in Europe. Balkema, Rotterdam, pp. 211–226.

Kohn, M., Mithen, S., 1999. Handaxes: products of sexual selection? Antiquity 73, 518–526.

Kotsakis, T., 1979. Sulle mammalofaune quaternarie siciliane. Bolletino del Servizio Geologico Italiano 99, 263–276.

Kuman, K., 1998. The earliest South African industries. In: Petraglia, M.D., Korisettar, R. (Eds.), Early Human Behaviour in Global Context. Routledge, London, pp. 151–186.

Leakey, M.D., 1971. Olduvai Gorge. Excavations in Bed I and II, 1960–1963. Cambridge University Press, Cambridge.

Leakey, M.D., 1975. Cultural patterns in the Olduvai sequence. In: Butzer, K.W., Isaac, G.Ll. (Eds.), After the Australopithecines. Mouton, The Hague, pp. 477–494.

Lebel, S., 1984. La Caune de l'Arago. Etude des assemblages lithiques d'une grotte du Pléistocène moyen en France. Thèse 3ème cycle, Université Paris 6, 2 Vols. 917pp., annexes.

Lefèvre, D., Raynal, J.P., Vernet, G., 1999. Enregistrements pléistocènes dans le bassin de Venosa. In: Piperno, M. (Ed.), Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa. pp. 139–174.

Mallol, C., 1999. The selection of lithic raw materials in the Lower and Middle Pleistocene levels TD6 and TD10A of Gran Dolina (Sierra de Atapuerca. Burgos, Spain). Journal of Anthropological Research 55, 385–407.

Mania, D., 1995. The earliest occupation of Europe: the Elbe-Saale region (Germany). In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 85–102.

Marra, A.C., Bonfiglio, L., 1998. Resti di Hippopotamus pentlandi dalla valle del Simeto (Sicilia Sud-Orientale). Naturalista siciliano S.IV 22 (3–4), 393–404.

McBrearty, S., 2000. Identifying the Acheulian to Middle Stone Age transition in the Kapthurin Formation, Baringo, Kenya. Abstracts of the Paleoanthropological Society Annual Meeting, Philadelphia, April 2–4.

McBrearty, S., Bishop, L., Kingston, J., 1996. Variability in traces of Middle Pleistocene hominid behavior in the Kapthurin Formation. Baringo, Kenya. Journal of Human Evolution 30, 563–580.

McPherron, S., 1994. A reduction model for variability in Acheulian biface morphology. Ph.D. Dissertation, University of Pennsylvania.

Mellars, P., 1996. The Neanderthal Legacy. Princeton University Press, Princeton.

Mercier, N., Valladas, H., Valladas, G., 1995. Flint Thermoluminescence Dates form the CFR laboratory at Gif: contributions to the study of the chronology of the Middle Paleolithic. Quaternary Science Reviews 14 (4), 351–364.

Morwood, M.J., O'Sullivan, P.B., Aziz, F., Raza, A., 1998. Fission-track ages of stone tools and fossils on the east Indonesian island of Flores. Nature 393, 173–179.

Mussi, M., 1992. Popoli e civiltà dell'Italia antica. Biblioteca di Storia Patria, Bologna.

Mussi, M., 1995. The earliest occupation of Europe: Italy. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 27–51.

Nicoletti, F., 1996. Le industrie litiche oloceniche: forme, materie prime e aspetti economici. In: Leighton, R. (Ed.), Early Societies in Sicily. Accordia Research Centre, University of London, pp. 57–70.

Peretto, C. (Ed.), 1994. Le industrie litiche del giacimento paleolitico di Isernia la Pineta. Cosmo Iannone, Isernia.

Peretto, C. (Ed.), 1996. I reperti paleontologici del giacimento paleolitico di Isernia la Pineta. Cosmo Iannone, Isernia.

Peretto, C., Ornella Amore, F., Antoniazzi, A., Antoniazzi, Al., Bahain, J.-J., Cattani, L., Cavallini, E., Esposito, P., Falgueres, C., Gagnepain, J., Hedley, I., Laurent, M., Lebreton, V., Longo, L., Milliken, S., Monegatti, P., Olle, A., Pugliese, N., Renault-Miskovsky, J., Sozzi, M., Ungaro, S., Vannucci, S., Verges, J.M., Wagner, J.-J., Yokoyama, Y., 1998. L'industrie lithique de Ca' Belvedere di Monte Poggiolo: stratigraphie, matière première, typologie, remontages et traces d'utilisation. L'Anthropologie 102 (4), 343–365.

Petronio, C., Sardella, R., 1999. Biochronology of the Pleistocene mammal fauna from Ponte Galeria (Rome) and remarks on the Middle Galerian faunas. Rivista Italiana di Paleontologia e Stratigrafia 105, 155–164.

Piperno, M., 1972. The Monte Peglia lithic industry. Quaternaria 16, 53–65.

Piperno, M. (Ed.), 1999. Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa.

Piperno, M., Bulgarelli, M.G., Zevi, F. (Eds.), 1984. I primi abitanti d'Europa. De Luca, Roma.

Piperno, M., Cassoli, P.F., Tagliacozzo, A., Fiore, I., 1999a. I livelli della serie di Notarchirico. In: Piperno, M. (Ed.), Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa, pp. 75–135.

Piperno, M., Lefèvre, D., Raynal, J.P., Tagliacozzo, A., 1999b. Considerazioni conclusive. In: Piperno, M. (Ed.), Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa, pp. 537–540.

Raynal, J.P., Lefèvre, D., Vernet, G., avec la collaboration de G. Papy, 1999a. Lithostratigraphie du site acheuléen de Notarchirico. In: Piperno, M. (Ed.), Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa, pp. 175–206.

Raynal, J.P., Sbihi Alaoui, F., Geraads, D., Magoga, L., Mohib, A., 1999b. The earliest occupation of North Africa: the Moroccan perspective. Abstracts of the XV INQUA Congress, August 3–11, Durban, South Africa, pp. 147–148.

Raynal, J.P., Texier, J.P., 1989. Découverte d'Acheuléen ancien dans la carrière Thomas 1 à Casablanca et problème de l'ancienneté de la présence humaine au Maroc. Comptes Rendus de l'Académie des Sciences, Paris, Série II 308, 1743–1749.

Roberts, M.B., Gamble, C.S., Bridgland, D.R., 1995. The earliest occupation of Europe: the British Isles. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 165–192.

Roche, H., Delagnes, A., Brugal, J.P., Feibel, C., Kibunja, M., Mourre, V., Texier, P.J., 1999. Early hominid stone tool production and technical skill 2.34 Myr ago in West Turkana, Kenya. Nature 399, 57–60.

Roebroeks, W., van Kolfschoten, T., 1994. The earliest occupation of Europe: a short chronology. Antiquity 68 (260), 489–503.

Roebroeks, W., van Kolfschoten, T., 1998. The earliest occupation of Europe: a view from the north. In: Aguirre, E. (Ed.), Atapuerca y la evolución humana. Fundación Areces, Madrid, pp. 153–168.

Roth, V.L., 1990. Insular dwarf elephants: a case study. In: Damuth, J., MacFadden, B.J. (Eds.), Body Size in Mammalian Paleobiology. Cambridge University Press, Cambridge, pp. 151–179.

Sala, B., 1999. Nuovi dati sulla microteriofauna di Notarchirico. In: Piperno, M. (Ed.), Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa, pp. 439–441.

Schick, K.D., 1994. The Movius line reconsidered. In: Corruccini, R.S., Ciochon, R.L. (Eds.), Integrative Paths to the Past. Prentice-Hall, New Jersey, pp. 569–596.

Schick, K., Toth, N., 1993. Making Silent Stones Speak. Simon & Schuster, New York.

Semaw, S., Renne, P., Harris, J.W.K., Feibel, C.S., Bernor, R.L., Fesseha, N., Mowbray, K., 1997. 2.5-million-year-old stone tools from Gona, Ethiopia. Nature 385, 333–336.

Shackleton, J., van Andel, T.H., Runnels, C.N., 1984. Coastal palaeogeography of the central and western Mediterranean during the last 125,000 years and its archaeological implications. Journal of Field Archaeology 11, 307–314.

Soressi, M., 1999. Variabilité technologique au Moustérien. Analyse comparée du débitage Levallois du Mta A du Moustier (Dordogne, France). Paléo 11, 111–134.

Stringer, C.B., Hublin, J.J., 1999. New age estimates for the Swanscombe hominid, and their significance for human evolution. Journal of Human Evolution 37, 873–877.

Svoboda, J., 1987. Lithic industries of the Arago, Vértesszöllös and Bilzingsleben Hominids: comparison and evolutionary interpretation. Current Anthropology 28, 219–227.

Tauxe, L., Deino, A.D., Behrensmeyer, A.K., Potts, R., 1992. Pinning down the Brunhes/Matuyama and upper Jaramillo Boundaries: a reconciliation of orbital and isotopic time scales. Earth and Planetary Science Letters 109, 561–572.

Texier, P.J., Brugal, J.P., Lemorini, C., Wilson, L., 1998. Fonction d'un site du Paléolithique moyen en marge d'un territoire: l'abri de La Combette (Bonnieux, Vaucluse). In: Brugal, J.P., Meignen, L., Patou-Mathis, M. (Eds.), Economie préhistorique: les comportements de subsistance au Paléolithique, Actes des XVIII Rencontres Internationales d'Archéologie et d'Histoire d'Antibes. Editions APDCA, Sophia Antipolis, pp. 325–348.

Thaler, L., 1972. Les rongeurs (Rodentia et Lagomorpha) du Monte Pellegrino et la question des anciens isthmes de la Sicile. Comptes Rendus de l'Académie des Sciences de Paris. Série D 274, 188–190.

Toth, N., Schick, K., 1993. Early stone industries and inferences regarding language and cognition. In: Gibson, K.R., Ingold, T. (Eds.), Tools, Language and Cognition in Human Evolution. Cambridge University Press, Cambridge, pp. 346–362.

Turner, A., 1999. Assessing earliest human settlement of Eurasia. Late Pliocene dispersions from Africa. Antiquity 73 (281), 563–569.

Turq, A., Martinez-Navarro, B., Palmquist, P., Arribas, A., Agusti, J., Rodriguez-Vidal, J., 1996. Le Plio-Pléistocène de la région d'Orce, province de Grenade, Espagne: bilan et perspectives de recherche. Paléo 8, 161–204.

Valoch, K., 1995. The earliest occupation of Europe: Eastern Central and Southeastern Europe. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 67–84.
Vaufrey, R., 1929. Les Eléphants Nains dans les Iles Méditerranéennes et la Question des Isthmes Pleistocène. Archives de l'Institut de Paléontologie Humaine, Paris, 6.
Vernet, G., Raynal, J.P., Lefèvre, D., Kieffer, G., 1999. Téphras distales dans les dépôts du Pléistocène moyen de Venosa. In: Piperno, M. (Ed.), Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna, Venosa, pp. 235–244.
Villa, P., 1983. Terra Amata and the Middle Pleistocene Archaeological Record of Southern France. University of California Press, Berkeley.
Villa, P., 1990. Torralba and Aridos: elephant exploitation in Middle Pleistocene Spain. Journal of Human Evolution 19, 299–309.
Villa, P., 1996. The First Italians (book review). Lithic Technology 21, 71–79.