C. R. Palevol 17 (2018) 45–60

Contents lists available at ScienceDirect

Comptes Rendus Palevol

www.sciencedirect.com

Human Palaeontology and Prehistory

# The assemblages with bifacial tools in Eurasia (first part). What is going on in the West? Data on western and southern Europe and the Levant

## *Assemblages à outils bifaciaux en Eurasie (première partie). Que se passe-t-il à l'Ouest? Données sur l'Europe occidentale et méridionale ainsi que sur le Levant*

Marie-Hélène Moncel[a,*], Marta Arzarello[b], Éric Boëda[c], Stéphanie Bonilauri[c], Benoît Chevrier[c,f], Claire Gaillard[a], Hubert Forestier[a], Li Yinghua[d], François Sémah[a], Valéry Zeitoun[e]

[a] *UMR 7194, CNRS, Department of Prehistory, National Museum of Natural History, Institut de paléontologie humaine, 1, rue René-Panhard, 75013 Paris, France*
[b] *Dipartimento di Studi Umanistici, LT TekneHub Università degli Studi di Ferrara, C. so Ercole I d'Este 32, 44100 Ferrara, Italy*
[c] *University Paris-Ouest, Nanterre/La Défense, France*
[d] *Université de Wuhan, School of History, Wuhan University, Wuhan 430072, China*
[e] *UMR 7207–CR2P–CNRS–MNHN–Université Paris-6, Sorbonne Universités, Université Pierre-et-Marie-Curie, 75005 Paris, France*
[f] *University of Geneva, Laboratory Archéologie et Peuplement de l'Afrique, rue Gustave-Révilliod, 12, CH-1211, Genève 4, Switzerland*

ARTICLE INFO

*Article history:*
Received 1st June 2015
Accepted after revision 21 September 2015
Available online 10 May 2016

Handled by Amélie Vialet

*Keywords:*
Bifacial tools
Europe
Levant
Technology

ABSTRACT

Assemblages with bifacial tools cover large areas of the Eurasian continent from the Middle Pleistocene to the Upper Pleistocene. These encompass varied technological strategies although the morphological results are often similar. Consequently, bifacial technology is diversified in Eurasia and cannot be correlated to "Acheulean-type behaviour" everywhere, or for all time periods. While early lithic assemblages with bifacial technology appeared in Africa as early as 1.8 Ma, this technology is observed in Eurasia from 1.5 Ma for the earliest evidence, and particularly from 1 Ma onwards. Our purpose here is to focus on Eurasian patterns. This presentation will be divided into three parts in order to describe, clarify and compare the bifacial phenomenon regarding its chronological and geographical extension, based on examples of key sites in diverse Eurasian areas. This first paper presents a review of detailed data from western and southern Europe and the Levant. The second focuses on the East, India, south-eastern Asia and eastern Asia (China). The third and final paper is a comparative analysis of Eurasian areas with occurrences of bifacial technology in relation to paleoanthropological remains in order to clarify the diversity of the bifacial technological phenomenon over time and space. Major European and Levantine sites are described in this first paper. For Europe, the bifacial component is divided into two main currents; before and after the major glacial event of MIS 12. Before MIS 12, sites such as la Noira,

* Corresponding author.
*E-mail address:* moncel@mnhn.fr (M.-H. Moncel).

https://doi.org/10.1016/j.crpv.2015.09.009

Notarchirico, Caune de l'Arago, Galeria II, Cagny-la-Garenne I-II or Boxgrove are taken into consideration. After MIS 12, sites are more numerous and have been widely reviewed (for instance Terra Amata, Guado San Nicolas, Cagny l'Epinette, Soucy. . .). For the Levant, sites such as Ubeidiya, GBY, Nadaouiyeh and El Meirah are presented. Data from the Arabian Peninsula are also taken into account.



*Mots clés :*
Outils bifaciaux
Europe
Levant
Technologie

RÉSUMÉ

Les assemblages à outils bifaciaux couvrent de vastes zones géographiques en Eurasie, du Pléistocène moyen à celui supérieur. Ils s'expriment technologiquement de manière variée, malgré un résultat morphologique similaire. La technologie bifaciale est donc très diversifiée et ne peut donc être assimilée à de l'Acheuléen, quel que soit le lieu et l'âge. L'objectif des trois articles est de décrire et comparer les stratégies bifaciales dans plusieurs zones géographiques de l'Eurasie, au travers d'exemples de sites dans leur contexte chronologique. Les premier et second articles concernent une revue détaillée de chaque zone géographique retenue : Levant, Europe du Sud et de l'Ouest, Inde, Asie du Sud-Est et Asie de l'Est. Des sites majeurs sont pris comme exemples. Le dernier article constitue une analyse comparative des stratégies bifaciales dans leur contexte paléoanthropologique, dans le but de clarifier et de discuter la diversité des technologies bifaciales utilisées en Eurasie au cours du temps. Ce premier article présente un bilan des données au travers d'exemples de sites majeurs européens et levantins. Pour l'Europe, le phénomène bifacial est examiné avant et après le MIS 12, qui marque un seuil dans le développement de la technologie bifaciale dans les régions considérées. Avant le MIS 12, les sites de la Noira, Notarchirico, Caune de l'Arago, Galeria II, Cagny-la-Garenne I–II ou Boxgrove illustrent la période. Après le MIS 12, les sites sont plus nombreux et les données synthétisées (par exemple, Terra Amata, Guado San Nicolas, Cagny l'Epinette, Soucy. . .). Pour le Levant, les sites d'Ubeidiya, GBY, Nadaouiyeh et El Meirah sont détaillés. Les données concernant la péninsule Arabique sont également abordées.



## 1. Introduction

From the Middle Pleistocene to the Upper Pleistocene, assemblages with bifacial tools cover large areas of the Eurasian continent and are absent from others. The earliest phases of bifacial technology were often assimilated to the Acheulean and described using European criteria. Recent discoveries over the past decades in different geographical areas indicate that bifacial technology actually spans a long period of time, from 1.4 Ma to 40 ka, which is much longer than expected in comparison to the European "Acheulean" s.s. or Mousterian evidence. Moreover, it is expressed by varied technological strategies although morphological results can be similar. Bifacial technology is consequently diversified in Eurasia and cannot be assimilated to "Acheulean-type behaviour" everywhere for this extensive timespan.

While early lithic assemblages with bifacial technology appeared in Africa as early as 1.8 Ma, this technology is observed in Eurasia from 1.5 Ma for the earliest evidence and particularly from 1 Ma onwards. This study is divided into three papers. This first paper presents a review of detailed data for western and southern Europe and the Levant. The second focuses on the East, India, south-eastern Asia and eastern Asia (China) (Fig. 1).

The third and final paper is a comparative analysis of the Eurasian areas with occurrences of bifacial technology in relation to paleoanthropological remains, in order to clarify the diversity of the bifacial technology phenomenon throughout time and space.

The purpose of these three papers is to describe, elucidate and compare the bifacial phenomenon based on examples of sites in diverse Eurasian areas. We will define the time span for each region in relation to the characteristics of each area. In the first paper, we will focus on Eurasian patterns.

In order to describe the series, area by area, we will use the general terms of bifacial tools, bifaces or handaxes, rarely "Large Cutting Tools" (LCTs made on large flakes). The bifacial item is defined as a piece with bifacial shaping for managing a pointed, oval or transversal tip, two convergent edges shaped by face-by-face or alternate removals. Shaping reduction sequences are generally characterized by three relatively long steps, depending on the initial morphology of the raw material: peripheral striking platform preparation, bifacial symmetry and bilateral symmetry.

We will consequently use these general terms to define tools types for each area by examining the implemented processing systems.

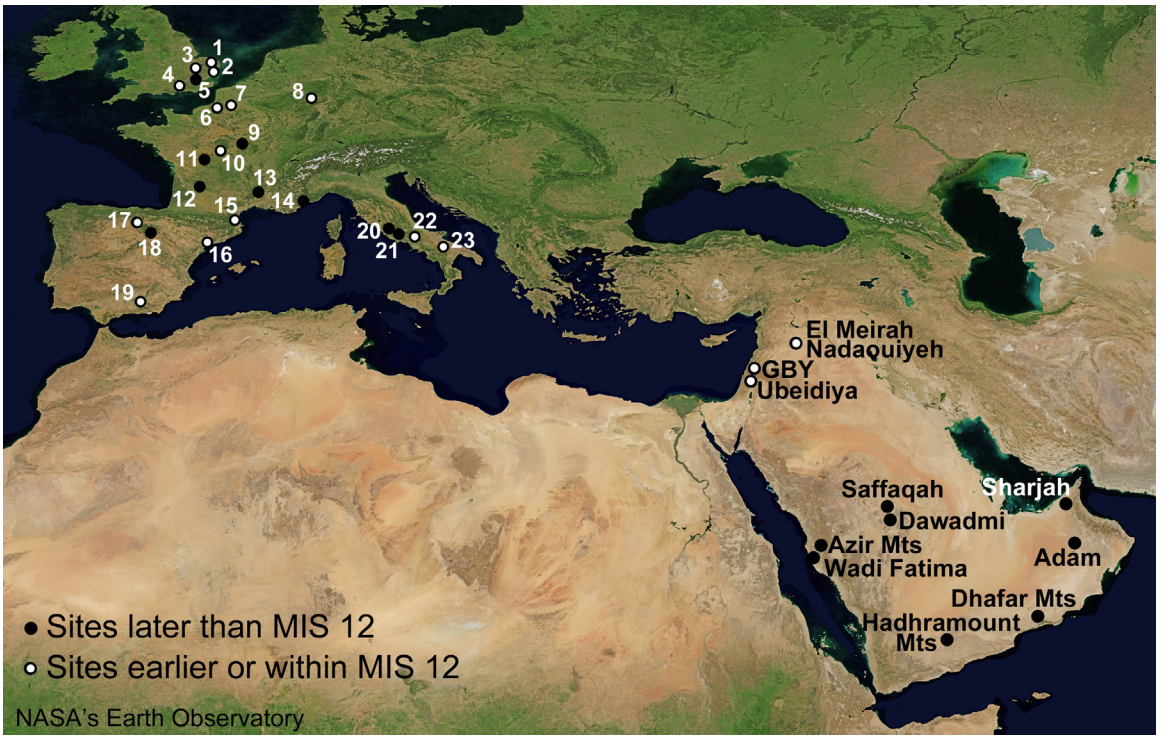


**Fig. 1.** Map of West Eurasia and the Levant showing the location of the sites mentioned in the text. 1, Happisburg; 2, Pakefield; 3, Maidscross Hill, Warren Hill; 4, Boxgrove; 5, Swanscombe; 6, Carpentier Quarry; 7, Cagny-la-Garenne, Saint Acheul; 8, Miesenheim; 9, Soucy; 10, la Noira; 11, La Grande Vallée; 12, Barbas; 13, Orgnac 3; 14, Terra Amata; 15, Caune de l'Arago; 16, la Boella; 17, Galeria (Atapuerca); 18, Ambrona & Torralba; 19, Cueva Negra del Estrecho del Quípar, Solana del Zamborino; 20, Torre in Pietra; 21, Fontana Ranuccio; 22, Guado San Nicolas, Isernia La Pineta; 23, Notarchirico.
**Fig. 1.** Carte de l'Eurasie occidentale et du Levant, avec localisation des sites mentionnés dans le texte. 1, Happisburg, 2 ; Pakefield, 3 ; Maidscross Hill, Warren Hill ; 4, Boxgrove ; 5, Swanscombe ; 6, Carpentier Quarry ; 7, Cagny-la-Garenne, Saint Acheul ; 8, Miesenheim ; 9, Soucy ; 10, la Noira ; 11, La Grande Vallée ; 12, Barbas ; 13, Orgnac 3 ; 14, Terra Amata ; 15, Caune de l'Arago ; 16, la Boella ; 17, Galeria (Atapuerca) ; 18, Ambrona & Torralba ; 19, Cueva Negra del Estrecho del Quípar, Solana del Zamborino ; 20, Torre in Pietra ; 21, Fontana Ranuccio ; 22, Guado San Nicolas, Isernia La Pineta ; 23, Notarchirico.

## 2. Bifacial tools in the West, from Europe to the Levant (first part)

### 2.1. North-western and southern Europe

Bifacial technology is observed along a geographical belt covering southern and north-western Europe to the South Caucasus in the form of open-air sites and some well-dated open-air and cave sites. It is lacking in Central Europe, Russia and Central Asia (Doronichev, 2008; Liubin, 2002). The Rhine River acted as a barrier (Bosinski, 2006). In Central Europe, asymmetrical bifacial pieces made on flakes exist in the Micoquian as early as MIS 6, in what is known as the Jung Acheulean. They differ technologically from the classical Acheulean. This also applies to some MIS 4 and 3 series ("Mousterian de Tradition Acheuléenne", Vasconian).

We will focus on what is described as the Acheulean, between 700 and 350 ka (onset of Middle Paleolithic-type behaviour, in southern and north-western Europe, although series with bifaces persist sporadically until 200 ka (i.e., Lazaret Cave dated to MIS 6; Cauche, 2012). Assemblages without bifaces are contemporaneous with series with bifaces throughout Europe after 700 ka. The hypothesis of the coexistence of hominin groups with distinct traditions seems to be unlikely on account of common core technologies and land-use patterns. Only bifacial tools are missing and the presence or absence of bifacial technology could be explained more plausibly in terms of activities or raw materials (Aureli et al., 2015). Sites without bifacial technology include for instance: Happisburg (800 ka) and Pakefield in the UK (700 ka), Miesenheim I in Germany (around 500 ka), Isernia La Pineta in Italy (700–600 ka) and High Lodge in the UK (500 ka) (Coltorti et al., 2005; Parfitt et al., 2005, 2010). The interstratification in some sites (i.e. Notarchirico) is sometimes interpreted as proof of the clear influence of activities on assemblage composition (Piperno ed., 1999).

For the time being, two chronological phases seem to be present, before and after MIS 12 (700–500 ka/MIS 11 to 9), particularly in northwestern Europe (Table 1). Sites were rare before the MIS 12 glacial phase, both in the North (discontinuous occupations) and in the South.

1) The 700–500 ka phase demonstrates that bifacial technology is mastered in north-western and southern Europe from as early as 700 ka, perhaps due to episodic arrivals of new hominin groups during favourable climatic periods. Local onsets seem unlikely since early bifacial technology is already present and any evidence of transitional phases is recorded in the lithic series. The site of la Boella (Spain, 1 Ma ± 0,068), with a schist pick and a cleaver

**Table 1**
Some examples of relevant sites with the bifacial technology in Europe (700 to 350 ka).
**Tableau 1**
Quelques exemples de sites pertinents avec la technologie biface en Europe (de 700 à 350 ka).

| Site and Location | Chronology | Raw material | | Core technology | Percussion | Tools | Type of site |
|---|---|---|---|---|---|---|---|
| | | Type | Distance | | | | |
| La Noira (lower level, stratum a) (Centre, France) (Moncel et al., 2013) | 700 ka (ESR) | Siliceous stones | Local | Centripetal, unifacial, orthogonal, multidirectional | Hard and soft hammers Direct percussion | *Bifaces, cleavers, LCTs, bifacial tools* | Open air site Workshops |
| Notarchiricco (Basilicata, Italy) (Piperno et al., 1990; (Piperno ed., 1999; Lefèvre et al., 2010) | 600–300 ka (TL, ESR) | Flint Limestone Silicified limestone quartzite | Local | Orthogonal, multidirectional | ? | Bifaces, choppers, denticulates, scrapers | Open air site Butchery site |
| Caune de l'Arago - Sol P (Southern France) (Barsky and de Lumley, 2010; Barsky, 2013) | Around 550 ka (biostratigraphy) | Milky and hyaline quartz Quartzite | Local and 15 km | Discoïd | Direct percussion Rare bipolar on anvil | Few pebble-tools and flake-tools Bifaces (n = 71) | Cave Short-term occupations |
| Menez-Dregan (Western France) (Gowlett, 2006) (Monnier et al., 2001) | 500–300 ka (ESR) | Flint and quartz for the small tools Sandstone, gneiss and micro-granite for the pebble tools | Local or on far from the site | Unipolar or bipolar Rare centripetal | Direct percussion | Pebble-tools Flake-tools on various flakes | Marine cave |
| Cagny-la Garenne (Somme, France) (Tuffreau et al., 2008; Tuffreau and Lamotte, 2010) | 400 ka MIS 12 (radiometry, stratigraphy) | Flint | Local | Unipolar unifacial > evidence of Levallois | Direct percussion | 70% bifaces Flake-tools on various flakes | Open air site |
| Boxgrove (UK) (Roberts and Parfitt, 1999) | 500 ka (stratigraphy) | Flint | Local | Unipolar Orthogonal Centripetal | Direct percussion Soft hammer on bifaces | Large quantity of well-worked bifaces *coup de tranchet* | Open air site Workshops |
| Guando San Nicola (Southern Italy) (Muttillo et al., 2014) | 370–400 ka ($^{40}Ar/^{39}Ar$ ESR/U-Th) | Flint, limestone, Middle quality | Local Secondary position | Opportunistic Discoïd-type Levallois | Hard hammer Soft hammer for the final shaping | Preforms, recycled bifaces Distal bifacial shaping and cortical base 3–5% bifaces Scrapers denticulates notches | Open air site *Ursus* sp.; *Palaeoloxondon* sp.; *Stephanorhinus kirchbergensis; Equus ferus* ssp.; *Cervus elaphus acoronatus; Dama sp.; Bos primigenius* |

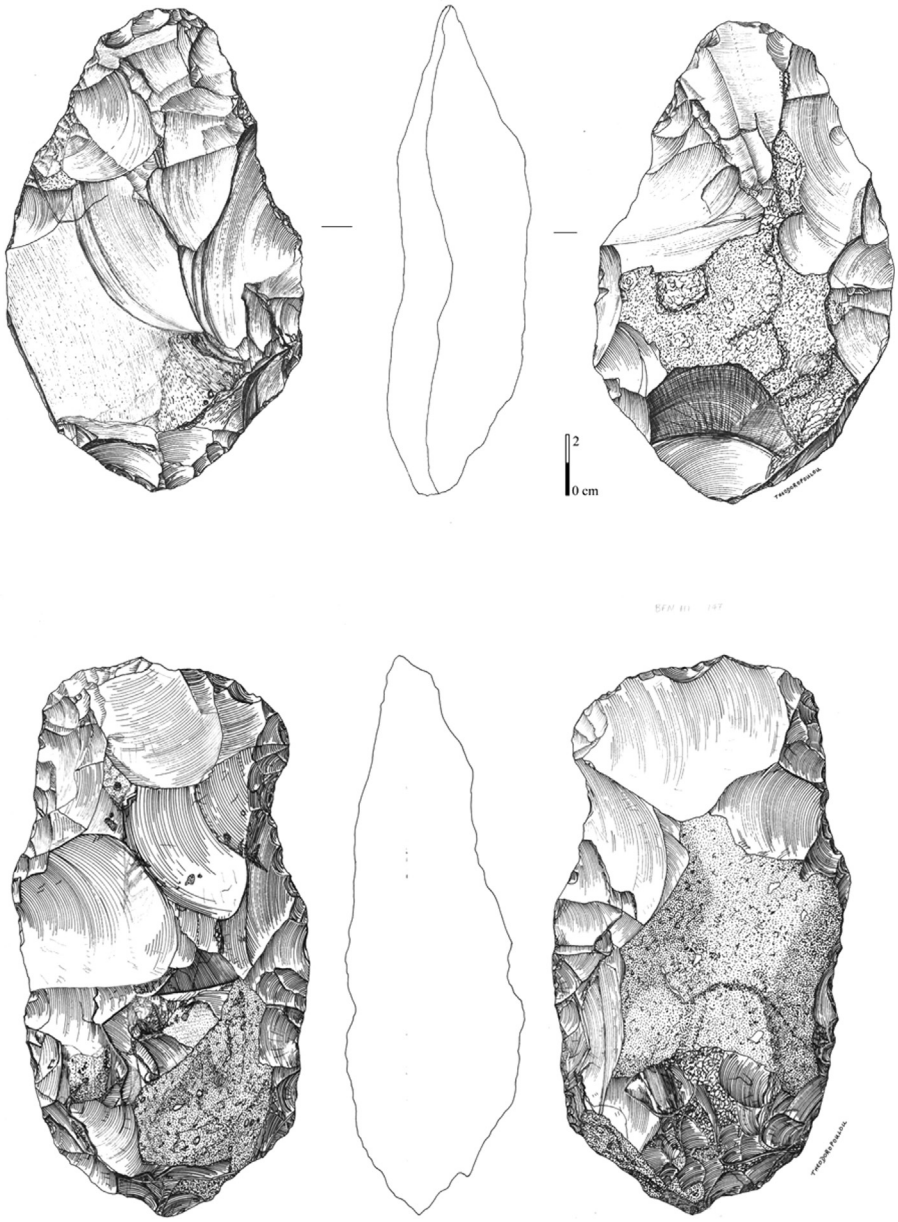


**Fig. 2.** La Noira. Bifaces in millstone from the lower level, dated to 700 ka (drawings A. Theodopoulou).
**Fig. 2.** La Noira. Bifaces en meulière du niveau inférieur, daté de 700 ka (dessins A. Theodopoulou).

discovered in a butchery context (*Mammutus meridionalis*), may record the early advent of this technology (Mosquera et al., in press; Vallverdu et al., 2014).

Cueva Negra del Estrecho del Quípar and Solana del Zamborino (Southern Spain, 900 to ~760 ka) have yielded lithic series with bifacially shaped tools (Scott and Gibert, 2009). However, Jiménez-Arenas et al. (2011) propose a younger Middle Pleistocene age for this site.

The site of la Noira (Centre, France) dated to 700 ka, contains workshops of millstone slabs with diversified large tools, with both bifaces *s.s.* and bifacial tools including bifacial cleavers and cleavers on flakes (Fig. 2). These recent discoveries are among the earliest occurrences of this behaviour beyond the 45th North parallel (Despriée et al., 2011; Moncel et al., 2013).

The Italian Acheulean phenomenon has mainly been described on the basis of the presence/absence of bifaces (Mussi, 2002; Nicoud, 2011). Most of the assemblages are from open-air sites and have been divided into two broad phases: archaic and elaborated (Palma di Cesnola, 1996), linked to the surface aspect of pieces and crude or elaborate biface morphology. In the elaborate Acheulean, several facies have been identified, with elongated, short and small bifaces, with or without Levallois core technology. These different "facies" were associated with regional evolution but also with the geographical location of the

sites (Ceruleo et al., 2015; Palma di Cesnola, 1996). For the earliest Acheulean series, reduction processes are short and uniform, with small products, a high ratio of flake-tools and numerous large tools in open-air sites (Muttillo et al., 2014; Piperno ed., 1999; Radmilli and Boschian, 1996; Segre and Ascenzi, 1984).

The site of Notarchirico (southern Italy, 0.64 Ma; Lefèvre et al., 2010; Piperno ed., 1999) yielded a long sequence of occupations where assemblages (levels B, D, F) with some bifaces and abundant pointed bifacial pebble-tools alternate with assemblages without bifaces (Piperno, 1999; Piperno et al., 1990). The bifacial tools display limited diversity and poor standardization and include some bifaces made on quartzite, limestone and flint pebbles or flakes (Santagata, 2012). The bifaces are made by deep removals, which can be invasive or limited to the periphery, and some of them are rectified by a second series of small removals on the tip.

At the Caune de l'Arago (southern France, MIS 14), elaborate bifaces and cleavers on flakes in various raw materials (blocks and flakes) were discovered in the layers P-Q (Barsky, 2013; Barsky and de Lumley, 2010; de Lumley, 2004; Falguères et al., 2015) in quartz or rock cobbles from up to 15–30 km away (Fig. 3).

Finally, at Galeria II (between 500 and 260 ka, Berger et al., 2008; Falguères et al., 2013; Garcia-Medrano et al., in press; Ollé et al., 2013), the earliest lithic series are on Neogene chert (large blocks), Cretaceous chert (nodules) and quartzite, collected 2–5 km away. Bifacial technology represents 17 tools in GIIa (6%), composed of choppers, cleavers and bifaces. Tools bear large removals and retouch, and are mainly oval with cortical butts and a pointed tip. There is some adaptation to the initial blank and the original shape is visible.

In the North of Europe, several British sites, such as Brandon Field, Maidscross Hill or Warren Hill (Great-Britain) are dated to MIS 15 (Bytham river sediments, Ashton and Lewis, 2012; Ashton et al., 2011). All the assemblages are made on locally available flint nodules from fluvial gravels. These series are made up of two groups of bifaces with varying ratios: 1) crudely fashioned bifaces made with a hard hammer on pebbles, half-pebbles, occasionally flakes (thick with sinuous cutting edges, made face-by-face, with little final retouch), 2) thin ovates and cordiform bifaces (made with a soft-hammer with final retouch, with a symmetrical plan and cross-section, sometimes with a *tranchet* flake removal across the tip.

Happisburgh Site 1 (HSB1, probably MIS 13) (Preece and Parfitt, 2012) yielded a flint assemblage comprising almost 300 pieces and one thin and ovate biface.

At Boxgrove (Great-Britain, end of MIS 13, Roberts and Parfitt, 1999), the numerous bifaces are predominantly thin and ovate in shape and are made with a hard hammer, followed by final shaping and retouch with a soft hammer. They are generally symmetrical in shape and cross-section. The tips are generally rounded or straight due to the frequent use of the *coup de tranchet*, suggesting resharpening.

Several of the Somme Valley terraces in the North of France contain major sites such as Saint Acheul and Cagny-la-Garenne. Recent fieldwork in the Carpentier quarry (Cromerian "white marls") has not revealed archaeological evidence. Cagny-la-Garenne I and II (France, Somme Valley, MIS 12, Antoine et al., 2007) yielded several assemblages in locally available flint nodules (Lamotte and Tuffreau, 2001; Tuffreau and Lamotte, 2010; Tuffreau et al., 2008). The bifaces are abandoned at various shaping stages and worked both by hard and soft hammers. Generally, there is little retouch on biface edges, apart from on the edges and tips of some elongated lanceolate pointed bifaces. Shaping of the tip is part of overall biface shaping. There are also some bifacial cleavers. Cross-sections are mainly plano-convex produced by face-by-face sequences, while some symmetrical bifaces were made by alternate flaking.

2) From around 450 ka, the great northern European plain seems to be largely occupied and bifaces appeared in more assemblages (Antoine et al., 2007; Lamotte and Tuffreau, 2001). Hominins adapted to the "Mammoth steppe" merging at around 500 ka from France to Russia (Bosinski, 2006; Guthrie, 1984).

The hypothesis of the mastery of fire has been advanced for explaining this northern occupation, attested from 0.5–0.4 Ma, for instance at Menez Dregan in western France, Vertesszöllös in Hungary, Stranska Skala in Moravia or Terra Amata in Southeast France (Gowlett, 2006; Kretzoï and Dobosi, 1990; de Lumley, 2006; Monnier et al., 2001).

The variability of bifacial tools (including Large Cutting Tools [LCT]) is still high, both within the same series or between sites and no functional explanations have been proposed up until now. Without any clear chronological links, series yield stone and/or bone bifaces *s.s.* (general management of bifacial volume) or/and bifacial tools (plano-convex cross-section with unifacial retouch on the convex face) with distinct functional or active areas (distinct cutting edges on the periphery): for instance, Fontana Ranuccio (460 ka, Italy), La Grande Vallée (450 ka, France), Torre in Pietra (430 ka, Italy), Guado San Nicola (400 ka, Italy, Fig. 4), Terra Amata (400 ka, France), Cagny l'Epinette (MIS 9, Somme, France), High Lodge (MIS 13, UK) and Swanscombe (MIS 9, UK), Soucy (MIS 9, France), Ambrona-Torralba (MIS 9, Spain), Orgnac 3 (MIS 9-8, France) (i.e. Ashton et al., 1992, 2011; Grimaldi, 1998; Herisson et al., 2012; de Lumley et al., 2015; Malatesta, 1978; Moncel et al., 2012; Muttoni et al., 2009, 2014; Orain et al., 2013). Among these, is what F. Bordes described as the Southern Acheulean with trifacial pieces, both cores and tools (MIS 9 and younger series, for instance Barbas in southwestern France; Boëda, 2001). The ratio of bifaces/bifacial tools is always low; less than 1%, and this ratio, as well as the absence of bifaces, is often related to specific activities such as butchery or scavenging with associated assemblages composed above all of small unretouched flakes or pebble-tools. The mode and intensity of shaping indicate again the selection of adapted blanks (thin blocks and nodules, flakes). In some sites, the morphology of the blank highly influences the morphology of the tool, such as at Cagny l'Epinette (Lamotte and Tuffreau, 2001; Tuffreau et al., 2008). The size of the flint nodules in the North of Europe would explain the scarcity of cleavers on flakes (shaping of bifacial cleavers). However, bifaces are not only associated with the ability to produce large flakes. In some cases, Elephas bone fragments (Italian Latium, MIS 9) are

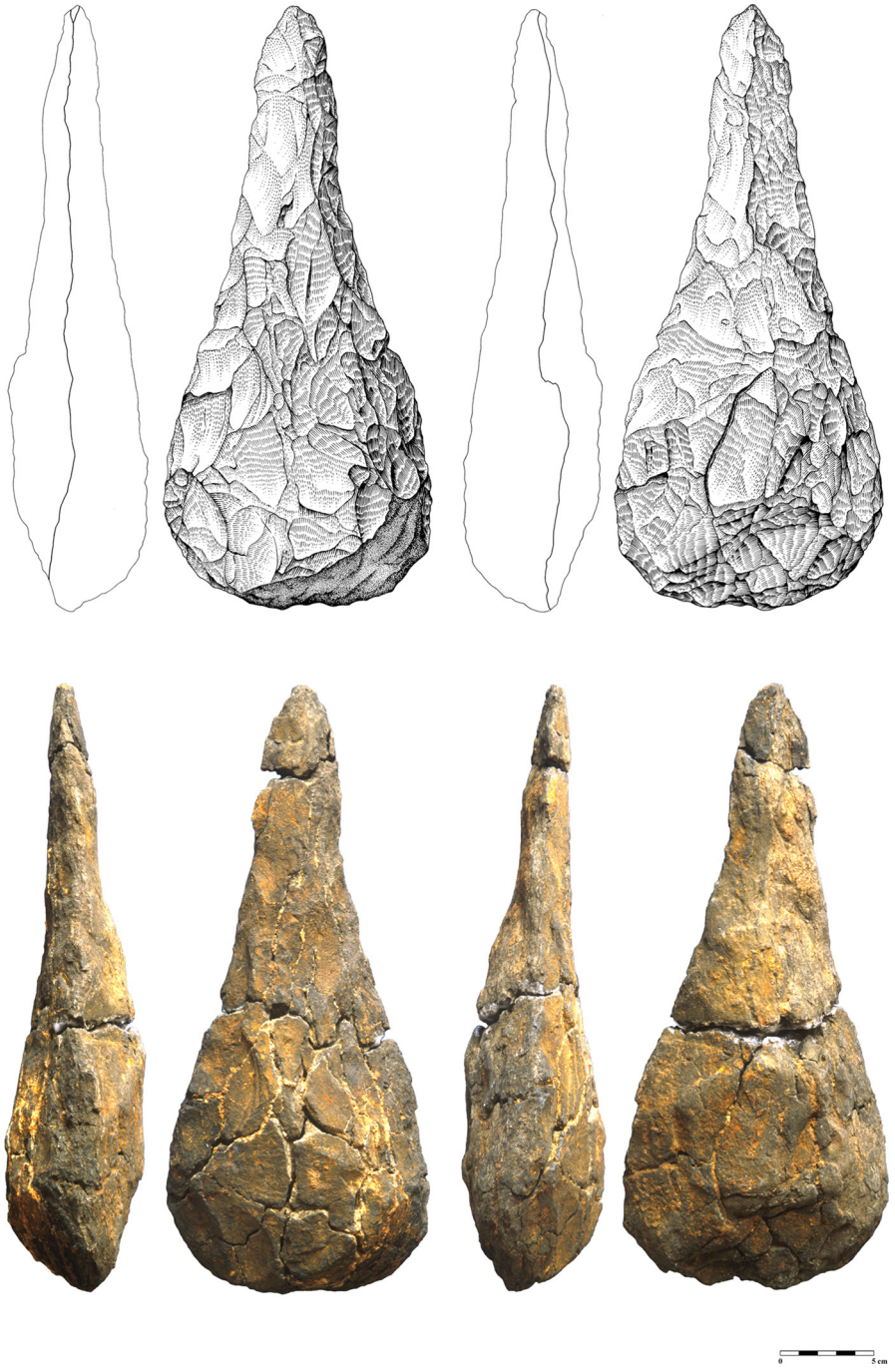

**Fig. 3.** Caune de l'Arago. Biface in metamorphic schist from level P–Q dated to 550 ka (unpublished drawings and photos CERP Tautavel).
**Fig. 3.** Caune de l'Arago. Biface en schiste métamorphique du niveau P–Q daté de 550 ka (dessins inédits et photos CERP Tautavel).

recovered to compensate perhaps for the rarity of large nodules or pebbles and are shaped as bifaces (bifacial tip and additional lateral/proximal unifacial or bifacial scrapers) or large scrapers (Radmilli and Boschian, 1996). Finally, it is important to mention the symbolic value of these objects, such as at Sima de los Huesos in Spain (Atapuerca), where more than 28 hominin skeletons were discovered in association with a single unused pink quartzite biface (Arsuaga et al., 1997; Martinon-Torres et al., 2012).

The variability of shaping and morphological results may be both structural and cyclical, and the resharpening of some biface cutting edges (multi-functional tools) may be the cause, for instance, of the wide morphological variability of tools in some sites and some areas. In Europe,


**Fig. 4.** Guado San Nicola, handaxe made on local flint, from US B dated to 368,000 years B.P. by ESR/U–Th.
**Fig. 4.** Guado San Nicola, biface en silex local de l'unité US B datée de 368 000 ans B.P. par ESR/U–Th.

and in the Levant, the biface did not progressively become more carefully worked or thinner over time and examples show that residual crude pieces persisted during MIS 9-8 (cf. Arago, unit I, and Orgnac 3; Moncel et al., 2012).

As for core technology, local raw materials, and in some cases, semi-local stones were gathered (from up to 30 km at Arago, Barsky, 2013). Some methods are new, some previously existed. In some cases, centripetal cores show that debitage methods are not linked to stone shape (for instance at la Noira). Some of the flakes from these assemblages are microlithic and derive from bipolar debitage on an anvil, as at Isernia or Quarto delle Cinfonare in Italy. From 450 ka, in the terraces of the Somme Valley (Cagny-la-Garenne) or in Italy (Guado San Nicola; Muttillo et al., 2014) Levallois core technology appeared, which could derive from biface thinning. Whatever the flaking mode, flake shapes are poorly controlled. At the same time, flake tools multiplied, but few of them are standardized.

### 2.2. Near East

#### 2.2.1. 'Ubeidiya

The site of Ubeidiya is located in Israel on the western bank of the Jordan River in the rift valley of the Dead Sea. It was extensively excavated in the 1960s and 1970s by M. Stekelis, O. Bar-Yosef and E. Tchernov, and is attached to the formation of the same name, composed of a thick succession of limnic and fluvial formations deposited in a freshwater lake context (Bar-Yosef and Goren-Inbar, 1993). Several intense folding episodes then ensued, tilting the sedimentary strata. Most of the 65 archaeological levels are found in the "Lower Fluvial" member or 20–30 m thick "Intraconglomerate and Clay Member". They are located on either side of an anticline and stratigraphic correlations are complex to establish. Different dating methods have been applied (potassium/argon, argon/argon, paleomagnetism and biochronology) and chronologically place the sequence between 1.6 and 1.0 Ma, or even 1.6 and 1.2 Ma (Bar-Yosef and Goren-Inbar, 1993; Belmaker, 2006; Sagi, 2005).

Despite an attribution of the entire sequence to the Early Acheulean (Bar-Yosef and Goren-Inbar, 1993), the composition of the lithic assemblages in the levels under consideration is highly variable. Only 16 out of the 30 levels with more than 50 artefacts have bifaces (Fig. 5). There are thus, on one hand, many assemblages without bifaces and, on the other hand, assemblages with biface proportions varying between 0.1 to more than 30%. While geomorphological and spatial explanations have sometimes been advanced, these require further analysis and other factors must also be considered. Bifaces were shaped using hard hammer percussion, and the toolkit generally consists of choppers, polyhedrons/spheroids and flake tools. A preferential distribution of lithic raw materials emerges: bifaces on basalt, sometimes on flint and limestone, choppers essentially on flint, polyhedrons and spheroids mostly on limestone and sometimes flint (Bar-Yosef and Goren-Inbar, 1993). For levels K-30 and I-15, for example, bifacial shaping, whether limited or extensive, is most often applied to blocks, but also to large flakes. Volume (bifacial, trihedral or even tetrahedral, commonly with convergent edges), intended tool types and their numbers (single or multifunctional tools) are technologically and morphologically varied and relatively simply made by adding on functional zones (Chevrier, 2012) (Fig. 6). Although the concepts of choppers, polyhedrons and spheroids are commonly associated with tools, it appears that many of these artefacts are related to debitage and provide blanks for smaller tools.

#### 2.2.2. Gesher Benot Ya'aqov (GBY)

Located in the Dead Sea Rift in Israel, the site of Gesher Benot Ya'aqov is composed of several localities excavated by M. Stekelis, I. Gilead, N. Goren-Inbar and G. Sharon. The main site and the zone called "North of Bridge Acheulean" (GBY-NBA) have yielded detailed and reliable data. In addition, due to the immersion of the site, remains are exceptionally preserved, particularly organic materials (Goren-Inbar et al., 2002; Sharon, 2007; Sharon et al., 2002). A 34 m-thick stratigraphic sequence established in the southern part demonstrates that the archaeological levels occur in the Benot Ya'aqov formation, composed of limestone and conglomerate deposits, deformed and folded by the rift valley faults. Basalt analysis and the calculation of

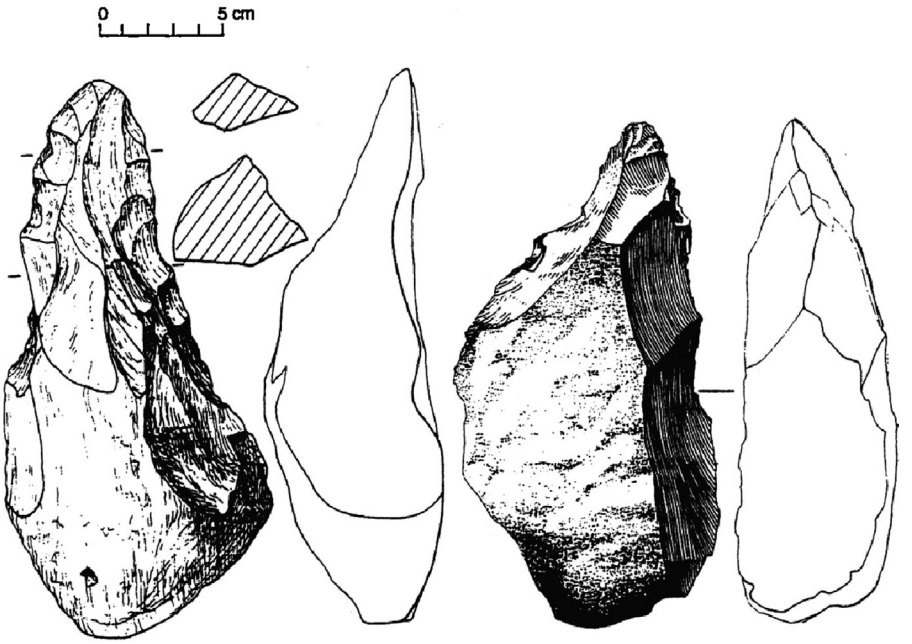


**Fig. 5.** Bifaces of 'Ubeidiya (Bar-Yosef, Goren-Inbar, 1993). Left layer I-15 (basalt), right layer K-30 (flint).
**Fig. 5.** Bifaces de 'Ubeidiya (Bar-Yosef, Goren-Inbar, 1993). À gauche, niveau I-15 (basalte), à droite, niveau K-30 (silex).

paleomagnetic polarities identify the Brunhes-Matuyama limit in the lower part of the sequence: the archaeological occupations are attributed to the lower Middle Pleistocene between 800 and 650 ka.

Typologically, the assemblages contain a large number of bifaces and cleavers associated with cores, mainly for the production of large flakes. Smaller retouched tools are also present, as well as massive scrapers. Raw materials were differentially exploited: bifaces and cleavers are mainly on basalt, small debitage and tools generally on flint with chopping-tools on limestone (Goren-Inbar, rarely on flint, and Saragusti, 1996; Sharon, 2007). Production modes vary with large tools shaped at times on blocks, but with the predominant use of large flake blanks. Biface shaping can be limited or extensive, whereas flakes with a transverse edge (cleaver-type) were largely unretouched apart from the removal of the platform and bulb and possible regularization of the edges. Hard and soft hammer percussion were both used. While bifacial volumes are largely dominant, morphological and functional diversity are present and, at least for GBY-NBA, shaping does not seem to have been constantly guided by the creation of preconceived forms, but rather by the addition of functional zones, made on volumes that were generally produced by knapping (Chevrier, 2012) (Fig. 7).

### 2.2.3. *Nadaouiyeh Aïn Askar*

The site of Nadaouiyeh Aïn Askar is located in the El Kowm Basin in central Syria. It was excavated in the 1990s by J.-M. Le Tensorer, S. Muhesen and F. Hours, and has yielded a sedimentary sequence several dozen meters thick, partially destroyed by several significant phases of erosion (Jahger and Le Tensorer, 1996; Jagher et al., 1997; Le Tensorer, 2006). The deposits are mainly lacustrine, limnic: loams and travertines. Detritic levels, faults and the morphology of the strata indicate successive and asymmetric episodes of karstic collapse (of doline type), in addition to common erosion processes. These episodes significantly modified the sequence and make stratigraphic correlations difficult. From an archaeological viewpoint, more than 30 Acheulean levels have been documented in sedimentary units IV, V and VII, as well as Yabrudian, Hummalian and Levallois Mousterian occupations in the upper part and a final Acheulean horizon in Unit II. Unfortunately, no radiometric elements define the chronology of the Nadaouiyeh Aïn Askar sequence. Nonetheless, cultural comparison with other Near Eastern sites leads the authors to propose a chronological range between 600 and 350 ka.

Several thousand bifacial tools were collected from the sequence. These were systematically made on flint and many of them display a long technical life (rejuvenation, multiple patinas, etc.). Most of them are cordiform, oval or amygdaloid types. The high quality of shaping, mainly by soft hammer percussion for some of the bifaces, corroborates an attribution of the assemblages to the Late Acheulean. Seven technocultural facies have been distinguished (Nad-G to Nad-A, from the earliest to the most recent) and several general trends emerge (Jahger and Le Tensorer, 1996; Jahger et al., 1997; Le Tensorer, 2006). In the early phases (up to Nad-D), standardization is extremely marked, particularly for relatively short cordiform types, with a near-absence of flake tools and flake production. The *coup de tranchet* technique is also used. Volumetric and typological variants are, however, observed (Fig. 8). In the recent facies (Nad-C/B), volumetric variability is more visible, with less standardized bifacial shaping and thicker tools. Debitage is present, but remains uncommon. Small tools (microbifaces and,

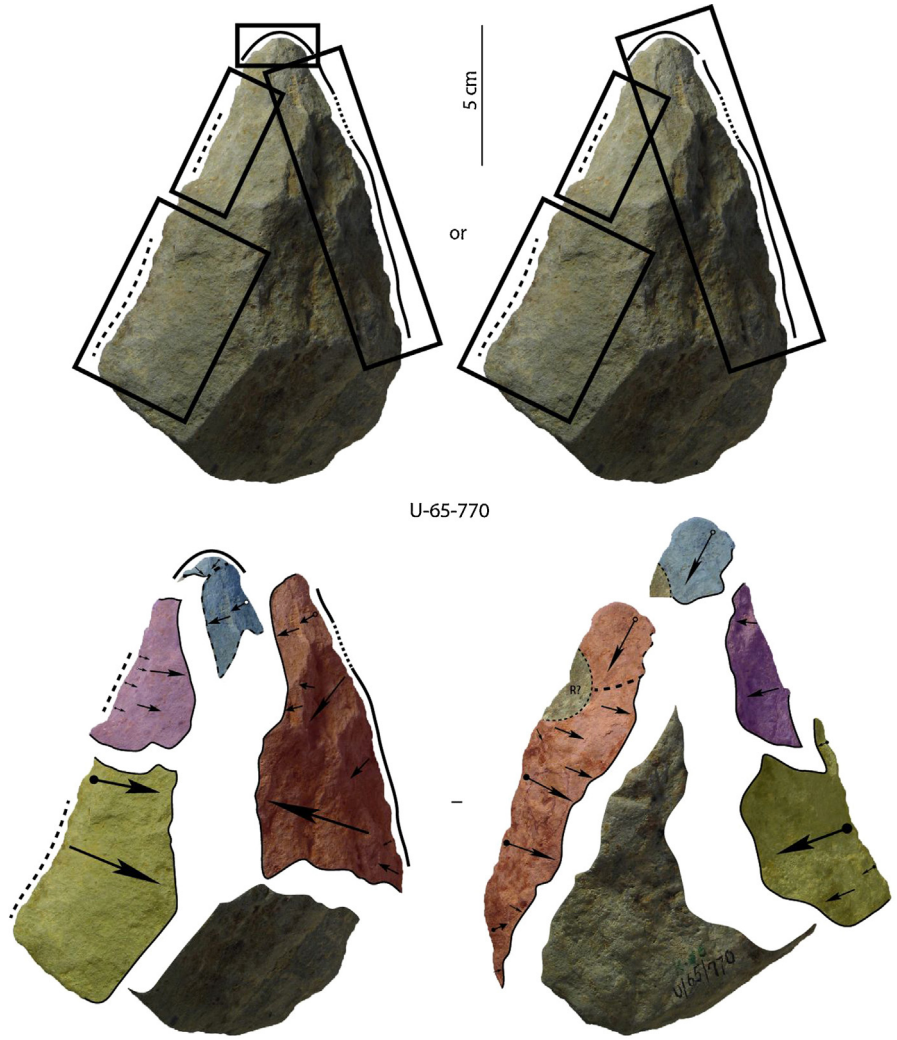


**Fig. 6.** Ubeidiya, K-30 layer. Example of the addition of several functional zones on a basalt block. The different colors relate to the removals creating each functional area.
**Fig. 6.** Ubeidiya, niveau K-30. Exemple de l'association de plusieurs zones fonctionnelles sur un bloc de basalte. Les différentes couleurs indiquent les enlèvements de chaque zone fonctionnelle.

more rarely, retouched flakes) and the functionalization of blocks complete the toolkits. After transition levels, facies Nad-A, attributed to the Final Acheulean, contains small bifaces and simple knapped products.

While the authors generally underline a phenomenon of paradoxical evolution, with highly standardized bifaces at the beginning of the sequence, it should be recalled that in comparison to other Near Eastern Acheulean sites, in particular those attributed to the Early and Middle Acheulean, the bifacial tools at Nadaouiyeh Aïn Askar present exceptionally high shaping standards, regardless of the facies. Indeed, although further techno-functional analysis is required to confirm this hypothesis, it would appear that the vast majority of these tools are indicative of standardized forms, enabling simple management of multi-functional tools, and thus an advanced stage of technological evolution. This entire Acheulean sequence has also been described, in a more contracted sequence, in the fluvial levels at the site of Umm el Tlel (Boëda, 2011).

### 2.2.4. El Meirah

The site of El Meirah is located in central Syria in the El Kowm Basin. It was discovered in 1993 and excavated over an area of 7 $m^2$ (Boëda and Muhesen, 1993; Boëda et al., 2004). The stratigraphic sequence is over 15 m thick and is composed of a several-meter-thick gypsum crust containing elements of the Geometric Kebaran, overlying limestone and clay lacustrine layers with a Mousterian assemblage and the Acheulean level of interest here. The latter is stratigraphically well localized, and presents a relatively undisturbed occupation. The dating of the sequence by paleomagnetism indicates an age around the Matuyama-Brunhes reversal of around 780 ka, or perhaps earlier, since the level is located below this limit. The lithic assemblage of 268 artefacts is composed of 185 bifacial

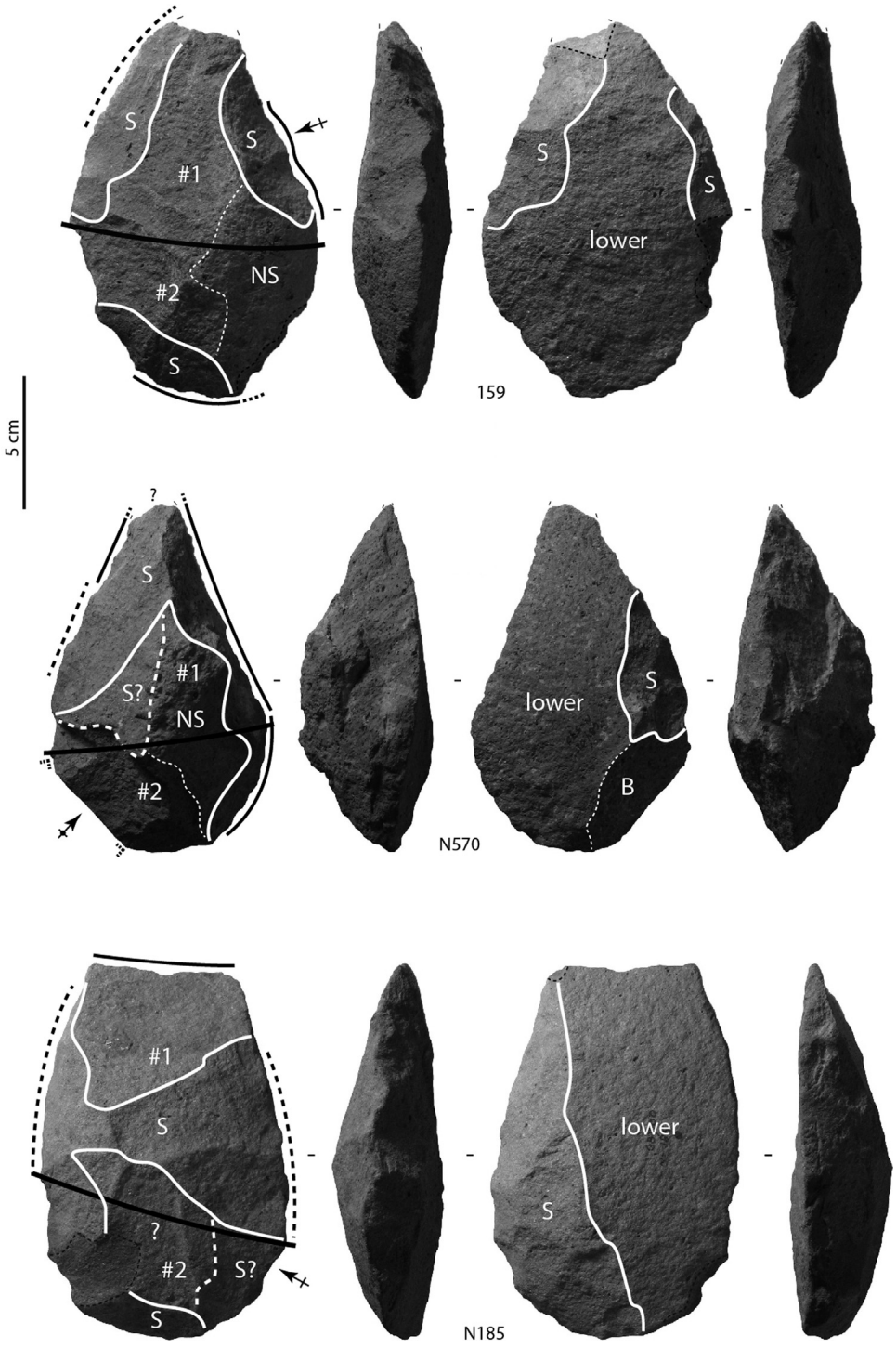


**Fig. 7.** Gesher Benot Ya'aqov–North of Bridge Acheulean. Techno-functional analysis of two bifacial tools and a cleaver on a flake (from Chevrier, 2012). Black lines: transformative edges, #1/#2: subvolumes, S: shaped, NS: natural surface, B: butt, lower: lower face of the flake blank.
**Fig. 7.** Site acheuléen de Gesher Benot Ya'aqov – North of Bridge. Analyses techno-fonctionnelle de deux outils bifaciaux et un hachereau sur éclat (Chevrier, 2012). Traits noirs : bords façonnés, #1/#2 : sous-volumes, S : façonné, NS : surface naturelle, B : talon, *lower* : face inférieure de l'éclat-support.

shaping flakes (some of which could be refitted), 83 bifacial tools on Tertiary flint cobbles (except for one made on limestone) and five spherical blocks with a diameter of around 20 cm on brecciated limestone. The lithics are associated with rare fauna (*Cervidae, Proboscidea*, hippopotamus and herbivores). Debitage is entirely absent. Bifacially shaped tools are generally made by hard percussion on selected cobbles. The intended volumes are varied,

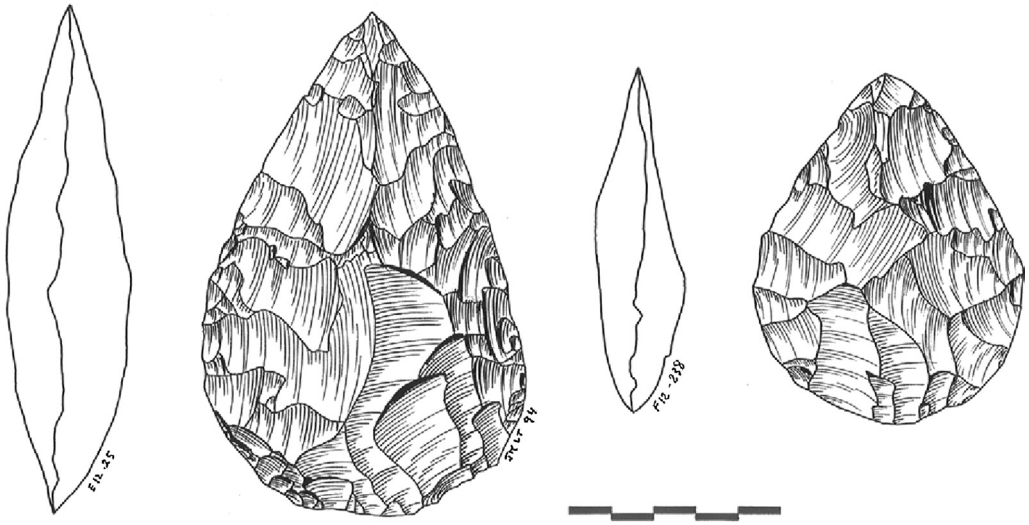

**Fig. 8.** Nadaouiyeh Aïn Askar. Bifaces, stratum 9, facies Nad-E (Le Tensorer, 2006).
**Fig. 8.** Nadaouiyeh Aïn Askar. Bifaces, strate 9, faciès Nad-E (Le Tensorer, 2006).

but all have convergent edges. Eleven techno-types have been defined in two technological groups: the tetrahedral (Fig. 9) and the trihedral groups. The transformative parts, found on the apical ends which can be transverse or pointed, or on the lateral edges, are also varied. These tool preforms were designed to support either multi-functional tools (around 75% of the bifaces) for which it is possible to distinguish distinct added and unrelated subvolumes, or to support single-use tools (around 25%). Several interesting observations can be made. This site, now situated in the steppe zone, is in an extremely rich region where more than 20 sites with stratigraphic sequences spanning the entire Middle and Late Pleistocene have been discovered. All of the chronological periods are represented, evidencing a near-perennial occupation of this geographic zone since at least the Acheulean to the Neolithic, or even well before the Acheulean. And yet this region is outside the coastal zone where many authors have placed the diffusion path of African Acheulean populations. The near exclusive choice of bifaces as bases for tools is also present in all of the Acheulean industries in the region. Evolutionary technological analysis combined with stratigraphic analysis demonstrates that all of the evolutionary technological stages are present, with El Meirah being one of the first. This evolutionary sequence is preceded by cobble industries (sites of Hummal [Le Tensorer, 2009; Le Tensorer et al.,

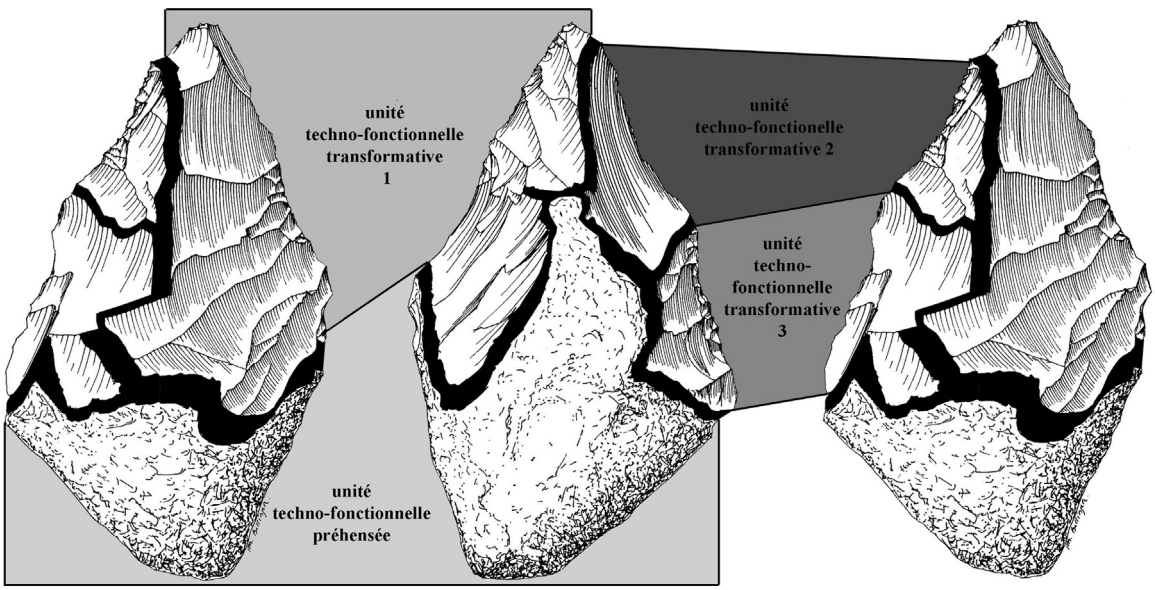


**Fig. 9.** El Meirah. Example of a tetrahedral bearing several tools (Boëda, 2004).
**Fig. 9.** El Meirah. Exemple d'un tétraèdre portant plusieurs outils (Boëda, 2004).

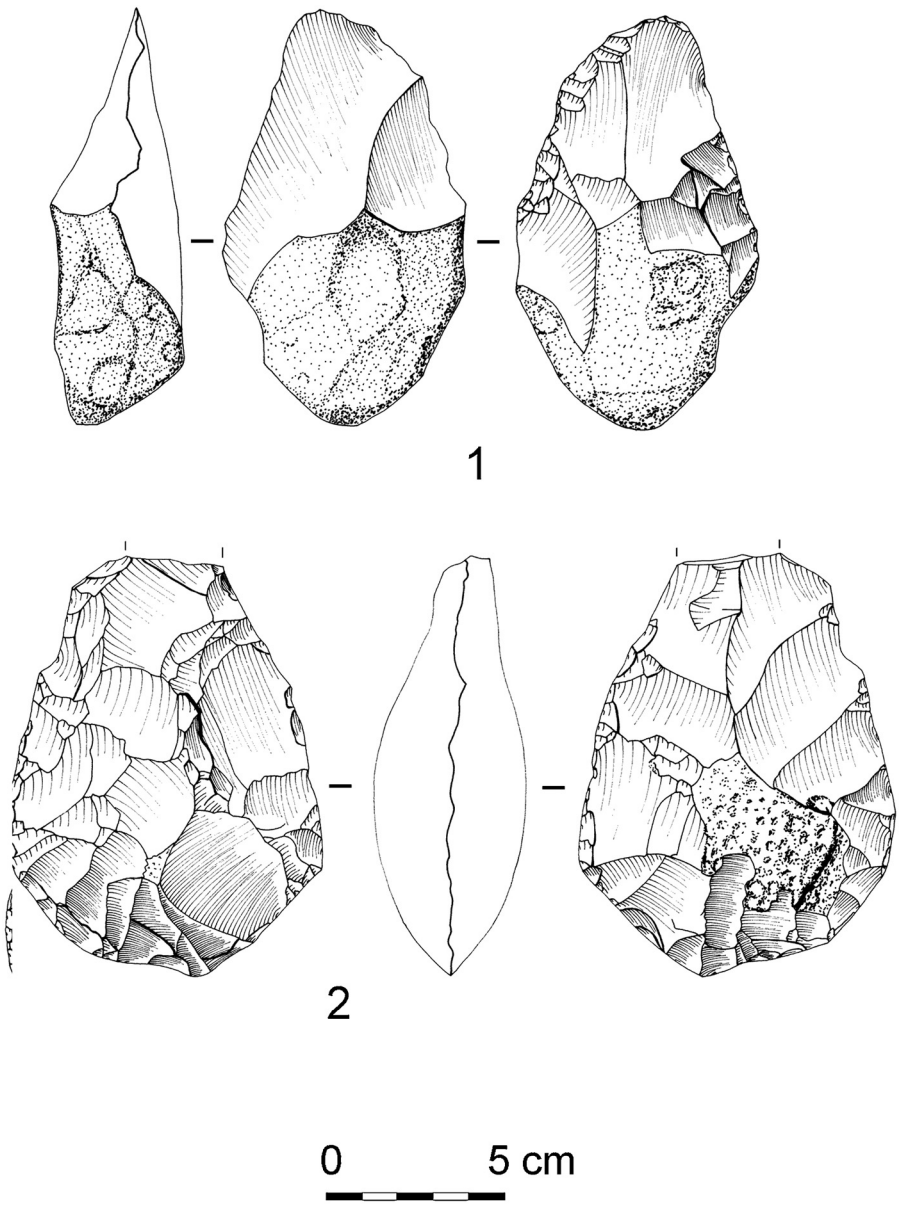


**Fig. 10.** Bifaces from the Sufrat Valley, Adam region, Sultanate of Oman.
**Fig. 10.** Bifaces de la Vallée du Sufrat, Région Adam, Sultanat d'Oman.

2011], Aïn al Fil [Le Tensorer, 2009] and Umm el Tlel [Boëda, 2011]), providing evidence of settlement in inland zones. The latter are currently steppe landscapes but formerly contained large lakes, including those in the El Kowm and Palmyra region.

*2.2.5. Arabian Peninsula (primarily the southern part of the peninsula)*

In the southern part of the Arabian Peninsula, sites attributable to the Acheulean are mainly located in mountainous and coastal zones. Indeed, research in this region since the 1930s has led to the discovery of many Acheulean lithic assemblages, for the most part in the Asir Mountains and the coastal zones of the Red Sea in Saudi Arabia and Yemen (Groucutt and Petraglia, 2012; Petraglia et al., 2009; Whalen et al., 1988; Zarins et al., 1980, 1981), the Hadhramaut Mountains and the coastal zones of the Gulf of Aden and the Oman Sea in Yemen (Amirkhanov, 1994; Whalen and Pease, 1991; Whalen and Schatte, 1997), the Dhofar Mountains and the Sea of Oman in the Sultanate of Oman (Rose and Hilbert, 2014; Whalen, 2003; Whalen et al., 2002). It should be noted that the low number of artefacts collected, the recent discovery of bifaces in northeastern Oman in the Adam region (Bonilauri et al., in press) (Fig. 10) and in the central region of Sharjah in the United Arab Emirates (Bretzke, 2015), and the easternmost "Acheulean" sites in the Arabian Peninsula, relate directly to the question of the Acheulean phenomenon and its diffusion path.

Apart from a few stratified sites, such as Saffaqah (excavated but undated; Saudi Arabia) (Whalen et al., 1984), most of the occurrences are from surface sites with no chronostratigraphic context. However, typo-technological analyses attribute the lithic industries (most with bifaces) to the East African and Levantine Acheulean, or for some assemblages, such as that from Dawadmi, to the Indian Acheulean (like Isampur Quarry, Hunsgi-Baichbal Valley) (Petraglia et al., 2009; Whalen et al., 1983, 1984; Zarins et al., 1980).

The affiliation of a certain number of inventoried lithic assemblages to the Acheulean culture is based in many cases on the sole presence of different kinds of bifaces (oval, amygdaloid, etc.), some of which are associated with cleavers and other well-defined types such as trihedrals, polyhedrals and even scrapers, like the assemblages found for example in the Wadi Fatimah (western Saudi Arabia, along the Red Sea coast) (Petraglia, 2003, 2005; Petraglia et al., 2009; Wahlen et al., 1988) or at Dawadmi and Saffaqah (inland Saudi Arabia) (Petraglia et al., 2009; Whalen et al., 1983, 1984; Zarins et al., 1980). In Yemen, sites considered to be Acheulean discovered near the Red Sea and the Bab-el-Mandeb Strait, for example, also appear to be contain characteristic tools, such as bifaces associated with rare cleavers, scrapers and undetermined tools (Whalen and Schatte, 1997; Petraglia, 2003). Likewise, in Oman, the Acheulean sites found in the southwest in the Dhofar region (Whalen et al., 2002; Whalen, 2003; Rose and Hilbert, 2014) also appear to be based on this readily identifiable tool, the biface.

## 3. Conclusion

From a historical perspective, the Acheulean was invented in Europe, where it was defined at the end of the 19th century in the Somme Valley, in northern France, by Gabriel de Mortillet, in 1872, then Vayson de Pradennes in 1920. However, it occurs much earlier in Africa, at 1.8 Ma (i.e., Lepre et al., 2011). The earlier start and intensity of research in Europe explain the quantity of sites in this part of the world. In other areas, discoveries are now beginning to increase. Assemblages with bifacial technology are less known in Asia, where recent discoveries have triggered debate as to how to define them: Acheulean or not? This question will be examined in the second paper.

## Acknowledgements

This analysis is part of an “Action thématique du Muséum” (ATM), Paris, France, focusing on “Acheulean” behaviour. The English version was edited by Louise Byrne, official translator.

We would like to thank the two reviewers and Amélie Vialet, the editor, for their relevant and constructive comments, which helped us to really improve the papers.

## References

Amirkhanov, K.A., 1994. Research on the Palaeolithic and Neolithic of Hadramaut and Mahra. Arab. Archaeol. Epigr. 5, 217–228.

Antoine, P., Limondin-Lozouet, N., Chaussé, C., Lautridou, J.P., Pastre, J.F., Auguste, P., Bahain, J.J., Falguères, C., Galheb, B., 2007. Pleistocene fluvial terraces from northern France (Seine, Yonne, Somme): synthesis and new results. Quat. Sci. Rev. 26, 2701–2723.

Arsuaga, J.L., Bermudez-de Castro, J.M., Carbonell, E., 1997. Special Issue «The Sima de los Huesos Homind Site». J. Hum. Evol. 33 (2/3).

Ashton, N., Lewis, S.G., 2012. The environmental contexts of early human occupation of northwest Europe: The British Lower Palaeolithic record. Quatern. Int. 271, 50–64.

Ashton, N.M., Cook, J., Lewis, S.G., Rose, J., 1992. High Lodge, Excavations by G. de G. Sieveking, 1962–8, and J. Cook 1988. British Museum Press.

Ashton, N., Lewis, J.E., Hosfield, R., 2011. Mapping the Human Record: Population Change in Britain during the Early Palaeolithic. In: Ashton, N., Lewis, J.E., Stringer, C. (Eds.), The Ancient Human occupation of Britain. Quat. Sci., pp. 39–53.

Aureli, D., Contardi, A., Giaccio, B., Jicha, B., Lemorini, C., Madonna, S., 2015. Palaeoloxodon and Human Interaction: Depositional Setting, Chronology and Archaeology at the Middle Pleistocene Ficoncella Site (Tarquinia, Italy). PlosOne, http://dx.doi.org/10.1371/journal.pone.0124498.

Barsky, D., 2013. The Caune de l'Arago stone industries in their stratigraphical context. C. R. Palevol. 1, 305–325.

Barsky, D., de Lumley, H., 2010. Early European Mode 2 and the stone industry from the Caune de l'Arago's archeostratigraphical levels “P”. Quatern. Int. 223–224, 71–86.

Bar-Yosef, O., Goren-Inbar, N., 1993. The Lithic Assemblages of ‘Ubeidiya, a Lower Paleolithic Site in the Jordan Valley, 34. Institute of Archaeology, Hebrew University of Jerusalem, Jerusalem.

Belmaker, M., 2006. Community Structure through Time: ‘Ubeidiya, a Lower Pleistocene Site as a Case Study. Hebrew University of Jerusalem (Doctoral thesis).

Berger, G.W., Pérez-González, A., Carbonell, E., Arsuaga, J.L., Bermúdez de Castro, J.M., Ku, T.L., 2008. Luminescence chronology of cave sediments at the Atapuerca paleoanthropological site, Spain. J. Hum. Evol. 55 (2), 300–311.

Boëda, E., 2001. Détermination des unités techno-fonctionnelles de pièces bifaciales provenant de la couche acheuléenne C'3 base du site de Barbas I. In: Cliquet, D. (Ed.), Les industries à outils bifaciaux du Paléolithique moyen d'Europe occidentale. ERAUL, Liège, pp. 51–77.

Boëda, E., 2011. Rapport mission Umm el Tlel 2010. Ministère des Affaires Étrangères.

Boëda, E., Muhesen, S., 1993. Umm et Tlel (El Kowm, Syrie) : étude préliminaire des industries lithiques du Paléolithique moyen et supérieur, 1991–1992. Cahiers de l'Euphrate 7, 47–90.

Boëda, É., Courty, M.-A., Fedoroff, N., Griggo, C., Hedley, I.G., Muhesen, S., 2004. Le site acheuléen d'El Meirah, Syrie. In: Aurenche, O., Le Mière, M., Sanlaville, P. (Eds.), From the River to the Sea. The Paleolithic and the Neolithic on the Euphrates and in the Northern Levant. Studies in honour of Lorraine Copeland. BAR International Series, 1263. Archaeopress–Maison de l'Orient et de la Méditerranée, Oxford–Lyon, pp. 165–201.

Bonilauri, S., Beuzen-Waller, T., Giraud, J., Lemée, M., Gernez, G., Fouache, E., in press. Occupation during the Lower and Middle Palaeolithic period in the Sufrat Valley (Adam region, Sultanate of Oman), Proceedings of the Seminar for Arabian Studies.

Bosinski, G., 2006. Les premiers peuplements de l'Europe centrale et de l'Est, Colloque « Climats–Cultures–Sociétés aux temps préhistoriques. De l'apparition des Hominidés jusqu'au Néolithique ». C. R. Palevol. 5, 311–319.

Bretzke, K., 2015. Paleolithic assemblages from the central region of the Emirate of Sharjah (UAE) and implications for human settlements dynamics in southern Arabia. In: Conard, N.J., Delagnes, A. (Eds.), Settlement Dynamics of the Middle Paleolithic and Middle Stone Age. Tübingen Publications in Prehistory, pp. 105–125.

Cauche, D., 2012. Productions lithiques et comportements techno-économiques de groupes humains acheuléens et moustériens en région liguro-provençale. C. R. Palevol. 11 (7), 519–527.

Ceruleo, P., Marra, F., Pandolfi, L., Petronio, C., Salari, L., 2015. The archaic Acheulean lithic industry of the Cretone basin (Latium, central Italy). J. Archaeol. Sci., Reports 3, 480–492.

Chevrier, B., 2012. Les assemblages à pièces bifaciales au Pléistocène inférieur et moyen en Afrique de l'Est et au Proche-Orient. Nouvelle approche du phénomène bifacial appliqué aux problématiques de migration, de diffusion et d'évolution locale. Univ. Paris Ouest-Nanterre La Défense (Thèse).

Coltorti, M., Feraud, G., Marzoli, A., Peretto, C., Ton-Thate, T., Voinchet, P., Bahain, J.J., Minelli, A., Thun Hohenstain, U., 2005. New $^{40}Ar/^{39}Ar$, stratigraphic and paleoclimatic data on the Isernia La Pineta Lower Palaeolithic site, Molise, Italy. Quatern. Int. 131, 11–22.

Despriée, J., Voinchet, P., Tissoux, H., Bahain, J.-J., Falguères, C., Courcimault, G., Dépont, J., Moncel, M.-H., Robin, S., Arzarello, M., Sala, R.,

Marquer, L., Messager, E., Puaud, S., Abdessadok, S., 2011. Lower and Middle Pleistocene human settlements recorded in fluvial deposits of the middle Loire River Basin, Centre Region, France. Quat. Sci. Rev. 30 (11–12), 1474–1485.
Doronichev, V.R., 2008. The Lower Paleolithic in Eastern Europe and the Caucasus: A Reappraisal of the Data and New Approaches. PaleoAnthropology, 107–157.
Falguères, C., Bahain, J.-J., Bischoff, J.L., Perez-Gonzalez, A., Ortega, A.I., Ollé, A., Quiles, A., Ghaleb, B., Moreno, D., Dolo, J.-M., Shao, Q., Vallverdu, J., Carbonell, E., Bermudez de Castro, J.M., Arsuaga, J.L., 2013. Combined ESR/U-series chronology of Acheulean hominid-bearing layers at Trinchera Galeria site, Atapuerca, Spain. J. Hum. Evol. 65, 168–184.
Falguères, C., Shao, Q., Han, F., Bahain, J.J., Richard, M., Perrenoud, C., Moigne, A.M., Lumley de, H., 2015. New ESR and U-series dating at Caune de l'Arago, France: a key-site for European Middle Pleistocene. Quatern. Geochronol. 30, 547–553.
Garcia-Medrano, P., Ollé, A., Mosquera, M., Caceres, I., Diez, C., Carbonell, E. in press. The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galeria site (GII Unit). Quatern. Int.
Goren-Inbar, N., Saragusti, I., 1996. An Acheulian Biface Assemblage from Gesher Benot Ya'aqov, Israel: Indications of African Affinities. J. Field Archaeol. 23 (1), 15–30.
Goren-Inbar, N., Werker, E., Feibel, C.S., 2002. The Acheulian Site of Gesher Benot Ya'aqov, Israel: The Wood Assemblage 1. Oxbow Books, Oxford.
Gowlett, J.A.J., 2006. The early settlement of northern Europe: Fire history in the context of climate change and the social brain, Colloque: Climats-Cultures-Sociétés aux temps préhistoriques. De l'apparition des Hominidés jusqu'au Néolithique. C. R. Palevol 5 (1–2), 299–311.
Grimaldi, S., 1998. Analyse technologique, chaîne opératoire et objectifs techniques. Torre in Pietra (Rome, Italie). Paleo 10, 109–122.
Groucutt, H.S., Petraglia, M., 2012. The Prehistory of the Arabian Peninsula: deserts, dispersals and demography. Evol. Anthropol. 21, 113–125.
Guthrie, R.D., 1984. Mosaics, allelochemics and nutrients: an ecological theory of Late Pleistocene megafaunal extinctions. In: Martin, P.S., Klein, P.S. (Eds.), Quaternary extinctions: a prehistoric revolution. University of Arizona Press, pp. 259–298.
Herisson, D., Airvaux, J., Lenoble, A., Richter, D., Claud, E., Primault, J., 2012. Le gisement acheuléen de La Grande-Vallée à Colombiers (Vienne, France) : stratigraphie, processus de formation, datations préliminaires et industries lithiques. Paleo 23, 1–18.
Jahger, R., Le Tensorer, J.-M., 1996. Nadaouiyeh Aïn Askar. Rapport 1995. Rapport de fouille. Fonds National Suisse de la Recherche Scientifique.
Jagher, R., Le Tensorer, J.-M., Morel, P., Muhesen, S., Renault-Miskovsky, J., Rentzel, P., Schmid, P., 1997. Découvertes de restes humains dans les niveaux acheuléens de Nadaouiyeh Aïn Askar (El Kowm, Syrie Centrale). Paleorient 23, 87–93.
Jiménez-Arenas, J.M., Santonja, M., Botella, M., Palmqvist, P., 2011. The oldest handaxes in Europe: fact or artefact? J. Archaeol. Sci. 38, 3340–3349.
Kretzoï, M., Dobosi, V., 1990. Vertesszölös. Man, site and culture. Akademio kiado, Budapest.
Lamotte, A., Tuffreau, A., 2001. Les industries lithiques de Cagny-la-Garenne II (Somme). In: Truffreau, A. (Ed.), L'Acheuléen dans la vallée de la Somme et Paléolithique moyen dans le Nord de la France : données récentes, 6. CERP, pp. 59–91.
Lefèvre, D., Raynal, J.-P., Vernet, G., Kieffer, G., Piperno, M., 2010. Tephrostratigraphy and the age of ancient Southern Italian Acheulean settlements: The sites of Loreto and No, tarchirico (Venosa, Basilicata, Italy). Quatern. Int. 223–224, 360–368.
Lepre, C.J., Roche, H., Kent, D.V., Harmand, S., Quinn, R.L., Brugal, J.-P., Texier, P.-J., Lenoble, A., Feibel, C.S., 2011. An earlier origin for the Acheulian. Nature 477, 82–85.
Le Tensorer, J.-M., 2006. Les cultures acheuléennes et la question de l'émergence de la pensée symbolique chez *Homo erectus* à partir des données relatives à la forme symétrique et harmonique des bifaces. C. R. Palevol. 5, 127–135.
Le Tensorer, J.-M., 2009. Le paléolithique ancien de Syrie et l'importance du Golan comme voie de passage lors de l'expansion des premiers hommes hors d'Afrique. In: Abdel Rahman, A. (Ed.), International Colloquium History and Antiquities of Al-Golan 2007–2008. The Press of the Ministry of Culture, Damascus-Syria, pp. 37–56.
Le Tensorer, J.-M., von Falkenstein, V., Le Tensorer, H., Schmid, P., Muhesen, S., 2011. Étude préliminaire des industries archaïques de faciès Oldowayen du site de Hummal (El Kowm, Syrie centrale) Preliminary study of archaic lithic industry (Oldowan), site of Hummal (El Kowm, Central Syria). L'Anthropologie 115, 247–266.
Liubin, V.P., 2002. L'Acheuléen du Caucase. Université de Liège, ERAUL.
de Lumley, H. (Ed.), 2004. Habitat et mode de vie des chasseurs paléolithiques de la Caune de l'Arago (600 000–400 000 ans). L'Anthropologie Paris, 108, pp. 159–184.
de Lumley, H., 2006. Il y a 2,5 millions d'années, un seuil majeur de l'hominisation. L'émergence de la pensée conceptuelle et des stratégies maîtrisées du débitage de la pierre. Actes du Congrès de l'Académie des Sciences: Climats, Cultures, Sociétés aux temps préhistoriques, de l'apparition des Hominidés jusqu'au Néolithique. C. R. Palevol. 5 (1–2), 149–154.
de Lumley, H., Cauche, D., El Guennouni, K., Fournier, R.-A., Grégoire, S., Lecervoisier, B., Notter, O., Pollet, G., Rossoni-Notter, E., Roussel, B., Viallet, C., Roger, T., 2015. Terra Amata: Nice, Alpes-Maritimes, France. Tome IV. Fascicule 1. Les industries acheuléennes. CNRS Ed, 806 p.
Malatesta, A., 1978. Torre in Pietra. Quaternaria XX, 205–580.
Martinon-Torres, M., Bermudez de Castro, J.-M., Gomez-Robles, A., Prado-Simon, L., Arsuaga, J.-L., 2012. Morphological description and comparison of the dental remains from Atapuerca-Sima de los Huesos site (Spain). J. Hum. Evol. 62, 7–58.
Moncel, M.-H., Moigne, A.-M., Combier, J., 2012. Towards the Middle Paleolithic in Western Europe: The case of Orgnac 3 (South-Eastern France). J. Hum. Evol. 63, 653–666.
Moncel, M.-H., Despriée, J., Voinchet, P., Tissoux, H., Moreno, D., Bahain, J.-J., Courcimault, G., Falguères, C., 2013. Early evidence of Acheulean settlement in north-western Europe - la Noira site, a 700 000 year-old occupation in the Center of France. PlosOne 8 (11), e75529.
Monnier, J.-L., Hallégouet, B., Hinguant, S.N.M., 2001. La datation de l'habitat Paléolithique inférieur de Menez-Drégan 1 (Plouhinec, Finistère, France). In: Barrandon, J.N., et al. (Eds.), APDCA. CNRS, Antibes, Datation, pp. 261–277.
Mosquera, M, Ollé, A, Saladié, P, Cáceres, I, Huguet, R, Rosas, A et al., in press. The Early Acheulean technology of Barranc de la Boella (Catalonia, Spain). Quatern. Int.
Mussi, M., 2002. Earliest Italy - an Overview of the Italian Paleolithic and Mesolithic. Kluwer Academic/Plenum Publishers, New York, Bostono, Dordrechtmì, London, Moscow.
Muttillo, B., Lembo, G., Peretto, C., 2014. L'insediamento a bifacciali di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, Ferrara.
Muttoni, G., Scardia, G., Kent, D.V., Swisher, C.C., Manzi, G., 2009. Pleistocene magnetochronology of early hominin sites at Ceprano and Fontana Ranuccio. Italy. Earth Planet. Sci. Lett. 286, 255–268.
Nicoud, E., 2011. Le phénomène acheuléen en Europe occidentale : approche chronologique, technologie lithique et implications culturelles. Thèse, Université de Provence, France.
Ollé, A., Mosquera, M., Rodríguez, X.P., de Lombera-Hermida, A., García-Antón, M.D., García-Medrano, P., Peña, L., Menéndez, L., Navazo, M., Terradillos, M., Bargalló, A., Márquez, B., Sala, R., Carbonell, E., 2013. The Early and Middle Pleistocene technological record from Sierra de Atapuerca (Burgos, Spain). Quatern. Int. 295, 138–167.
Orain, R., Lebreton, V., Russo Ermolli, E., Sémah, A.-M., Nomade, S., Shao, Q., Bahain, J.-J., Thun Hohenstein, U., Peretto, C., 2013. Hominin responses to environmental changes during the Middle Pleistocene in central and southern Italy. Climate Past 9, 687–697.
Palma di Cesnola, A., 1996. Le Paléolithique inférieur et moyen en Italie. Préhistoire d'Europe. Editions Jérome Millon, Grenoble.
Parfitt, S.A., et al., 2005. The earliest record of human activity in northern Europe. Nature 438 (15), 1008–1012.
Parfitt, S.A., Ashton, N., Lewis, S.G., Abel, R.L., Coope, G.R., Mike, H.F., Gale, R., Hoare, P.G., Larkin, N.R., Lewis, M.D., Karloukovski, V., Maher, B.A., Peglar, S.M., Preece, R.C., Whittaker, J.E., Stringer, C.B., 2010. Early Pleistocene human occupation at the edge of the boreal zone in Northwest Europe. Nature 466, 229–233.
Petraglia, M.D., 2003. The Lower Paleolithic of the Arabian Peninsula: occupations, adaptations, and dispersals. J. World Prehist. 17, 141–179.
Petraglia, M.D., 2005. Hominin responses to Pleistocene environnemental change in Arabia and South Asia. In: Head, M.J., Gibbard, P.L. (Eds.), Early-Middle Pleistocene Transition: the Land-Ocean Evidence, 247. Geol. Soc. London, Spec. Publ, London, pp. 305–319.
Petraglia, M.D., Drake, N., Alsharekh, A., 2009. Acheulean landscapes and large cutting tool assemblages in the Arabian Peninsula. In: Petraglia, M.D., Rose, J.J. (Eds.), The Evolution of Human Populations in Arabia. Paleoenvironnments, Prehistory and Genetics. Springer, The Netherlands, pp. 197–219.
Piperno, M. (Ed.), 1999. Notarchirico. Un sito del Pleistocene medio iniziale nel bacino di Venosa. Edizioni Osanna.
Piperno, M., Mallegni, F., Yokoyama, Y., 1990. Découverte d'un fémur humain dans les niveaux acheuléens de Notarchirico (Venosa. Basilicate, Italie). C. R. Acad. Sci. Paris, Ser. II 311, 1097–1102.

Preece, R.C., Parfitt, S.A., 2012. The Early and early Middle Pleistocene context of human occupation and lowland glaciation in Britain and northern Europe. Quatern. Int. 271, 6–28.
Radmilli, A.M., Boschian, G., 1996. Gli scavi a Caste di Guido: Il Più Antico Giacimeno di Cacciatori del paleolitico inferiore nell'Agro Romano. Istituto Italiano di Preistoria e Protostoria, Firenze.
Roberts, M., Parfitt, S., 1999. Boxgrove: A Middle Pleistocene Hominid site at Eartham Quarry. English Heritage, West Sussex, England.
Rose, J., Hilbert, Y.H., 2014. New prehistoric sites in the southern Rub' al-Khali desert. Antiquity Project Gallery, Oman.
Sagi, A., 2005. Magnetostratigraphy of Ubeidiya Formation, Northern Dead Sea Transform, Israel. M. Phil. thesis, Hebrew University of Jerusalem.
Santagata, C., (PhD) 2012. L'utilisation de roches autres que le silex au Paléolithique ancien et moyen. Choix économiques, techniques et fonctionnels sur la base de l'étude des gisements de Saint-Anne I (Haute-Loire, France) (MIS 5 et 6) et de Notarchirico (Basilicata, Italia) (MIS 14 à 17). Université de Bordeaux I, Bordeaux.
Scott, G.R., Gibert, L., 2009. The oldest hand-axes in Europe. Nature 461, 82–85.
Segre, A., Ascenzi, A., 1984. Fontana Ranuccio: Italy's Earliest Middle Pleistocene Hominid Site. Curr. Anthropol. 25, 230–233.
Sharon, G., 2007. Acheulian Large Flake Industries: Technology, Chronology, and Significance. BAR International Series, 1701. Archaeopress, Oxford.
Sharon, G., Feibel, C.S., Belitzky, S., Marder, O., Khalaily, H., Rabinovich, R., 2002. 1999 Jordan river drainage project damages Gesher Benot Ya'aqov: a preliminary study of the archaeological and geological implications. In: Gal, Z. (Ed.), Eretz Zafon–Studies in Galilean Archaeology. Israel Antiquities Authority, Jerusalem, pp. 1–19.
Tuffreau, A., Lamotte, A., Goval, E., 2008. Les industries acheuléennes de la France septentrionale. Anthropol. 112, 104–139.
Tuffreau, A., Lamotte, A., 2010. Oldest Acheulean Settlements in Northern France. Quatern. Int. 223–224, 455.
Vallverdu, J., Saladié, P.S., Rosas, A., Huguet, R., Caceres, I., Mosquera, M., Garcia-Tabernero, A., Estalrrich, A., Lozano-Fernandez, I., Pineda-Alcala, A., Carrancho, A., Villalaın, J.-J., Bourle, D., Braucher, R., Lebatard, A., Vilalta Montserrat Esteban-Nadal, J., Lluc Benna, M., Bastir, M., Lopez-Polın, L., Olle, A., Verge, J.-M., Ros-Montoya, S., Martınez-Navarro, B., Garcıa, A., Martinell, J., Exposito, I., Burjachs, F., Agustı, J., Carbonell, E., 2014. Age and Date for Early Arrival of the Acheulean in Europe (Barranc de la Boella, la Canonja, Spain). PlosOne 9 (7), e103634.
Whalen, N.M., 2003. Lower Palaeolithic Sites in the Huqf area of Central Oman. J. Oman Stud. 13, 175–182.
Whalen, N.M., Pease, D.W., 1991. Archaeological Survey in Southwest Yemen, 1990. Paleorient 17, 127–131.
Whalen, N.M., Schatte, K.E., 1997. Pleistocene sites in southern Yemen. Arab. Archaeol. Epigr. 8, 1–10.
Whalen, N.M., Sindi, H., Wahida, G., Siraj-ali, J.S., 1983. Excavation of Acheulean sites near Saffaqah in ad-Dawadmi 1402–1982. Atlal 7, 9–21.
Whalen, N.M., Siraj-Ali, J.S., Davis, W., 1984. Excavation of Acheulean sites near Saffaqah, Saudi Arabia, 1403 AH 1983. Atlal 8, 9–24.
Whalen, N.M., Siraj-Ali, J., Sindi, H.O., Pease, D.W., Badein, M.A., 1988. A complex of sites in the Jeddah-Wadi Fatimah area. Atlal 11, 77–85.
Whalen, N.M., Zoboroski, M., Schubert, K., 2002. The Lower Palaeolithic in southwestern Oman. Adumatu 5, 27–34.
Zarins, J., Whalen, N., Ibrahim, M., Jawad Mursi, A.A., Khan, M., 1980. Comprehensive archaeological survey program, preliminary report on the Central and Southwestern Provinces survey: 1979. Atlal 4, 9–36.
Zarins, J.A., Murad, A., Al-Yish, K., 1981. Comprehensive archaeological survey program: the second preliminary report on the Southwestern Province. Atlal 5, 9–42.