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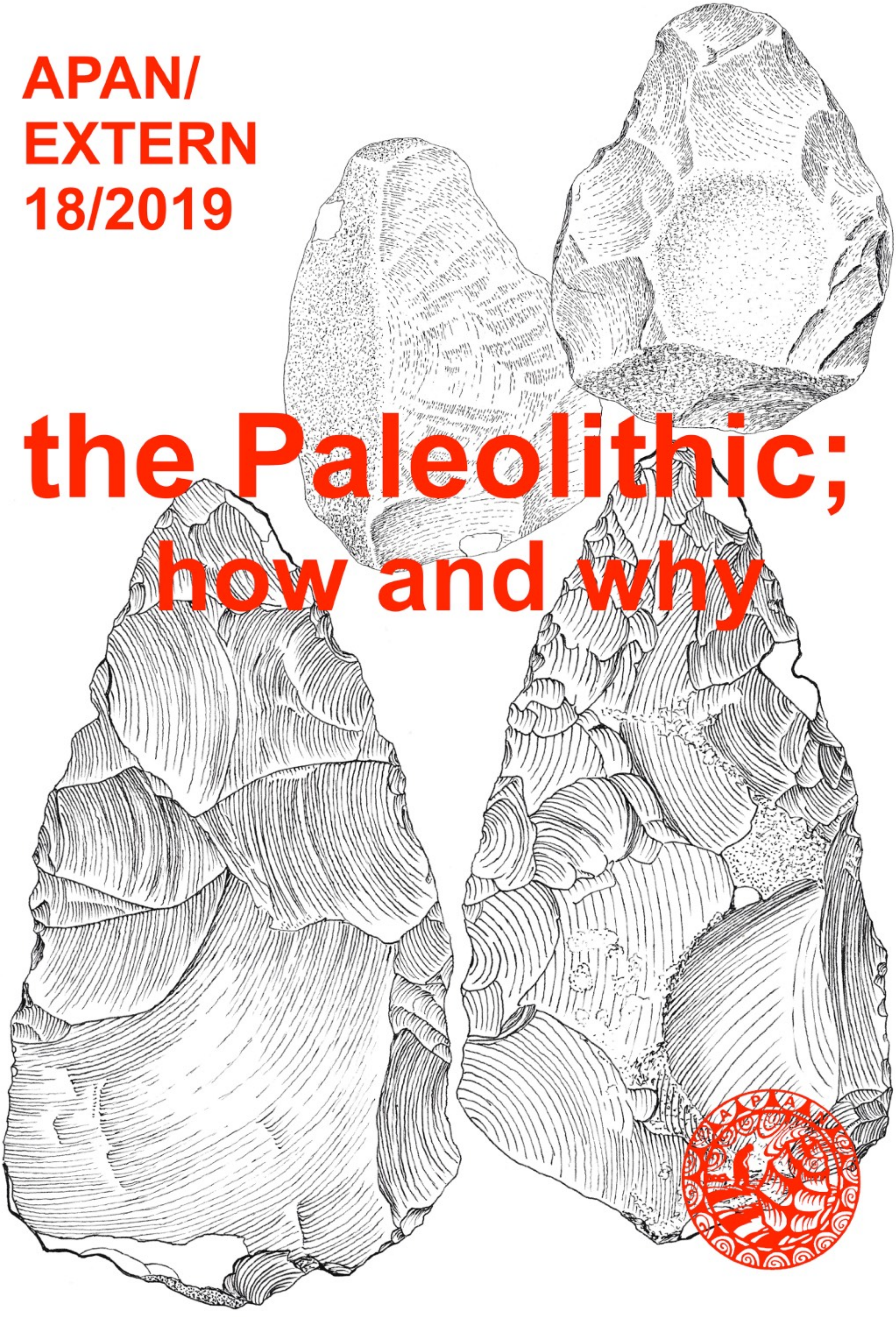
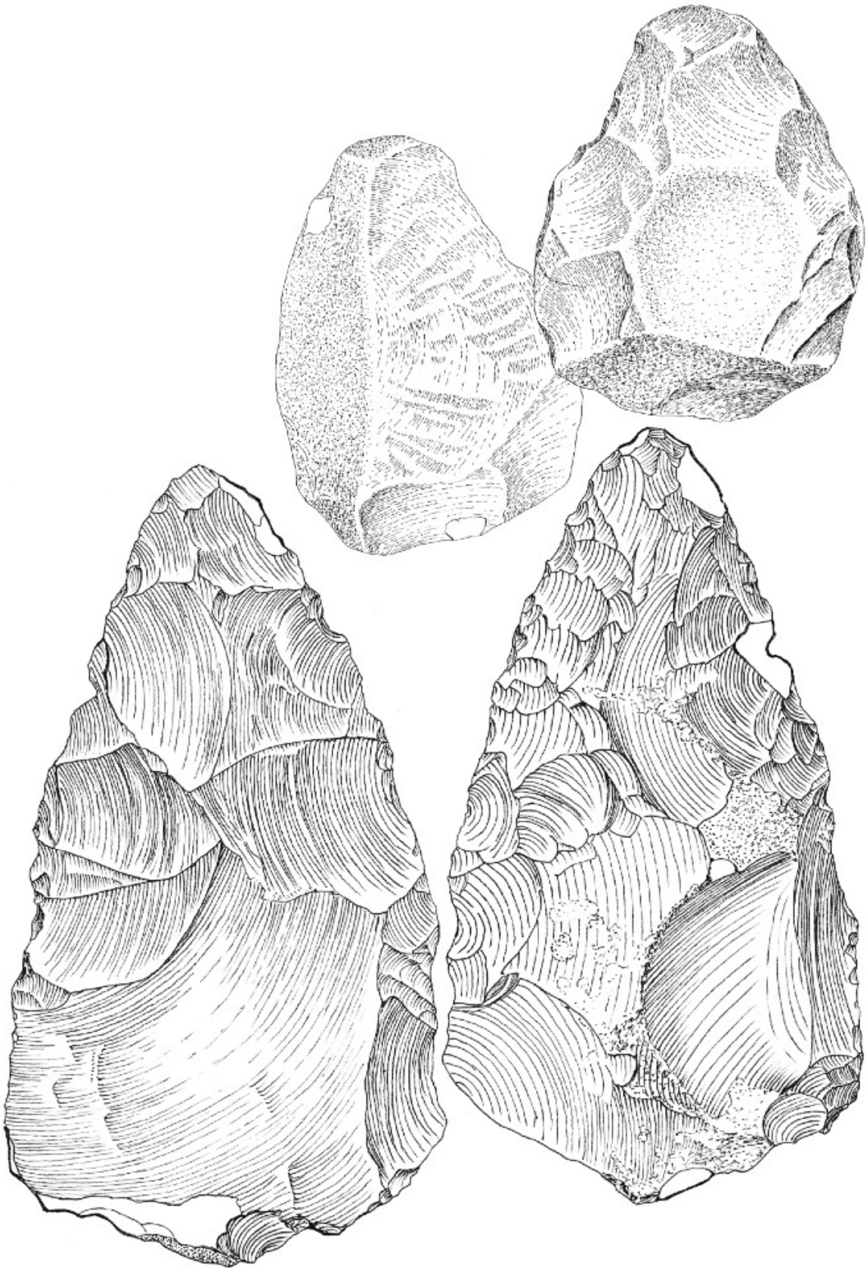
the Paleolithic; how and why



Frontpage:
These forms seem similar but are technically not related. The top drawing shows two views of an oblique bipolar flake with retouched edge, this is a 1.8 Ma Mode-I tool (chapter 4). The drawing below shows two views of a freehand tool, a 0.25 Ma Mode-III plano-convex handaxe (chapter 9).



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THE PALEOLITHIC HOW AND WHY

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contents page

By Jan Willem van der Drift
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Next page, frontpage Chapter 1: On first glance the tools found in Gulpen in 1980 resemble the denticulate Moustérian because both industries lack handaxes and hold small denticulated tools. At the top you can see one page of Bordes' 1968 Le Paléolithique dans le monde combined with actual denticulate Mousterian. At the bottom of the same picture you see one page of my 1988 paper combined with some of the finds from Gulpen. The similar forms may perhaps indicate similar functions but the flaking methods were based on different technologies. The Mousterian flakes (at the top) were struck from the free hand and this group includes Levallois-cores. But the flakes from Gulpen (at the bottom) are bipolar and none of the cores in this group of about 5500 finds shows the use of Mousterian/Levallois-techniques.


1
2
3
4
5
7
8
9
10
11

Chapter 1: Historic events

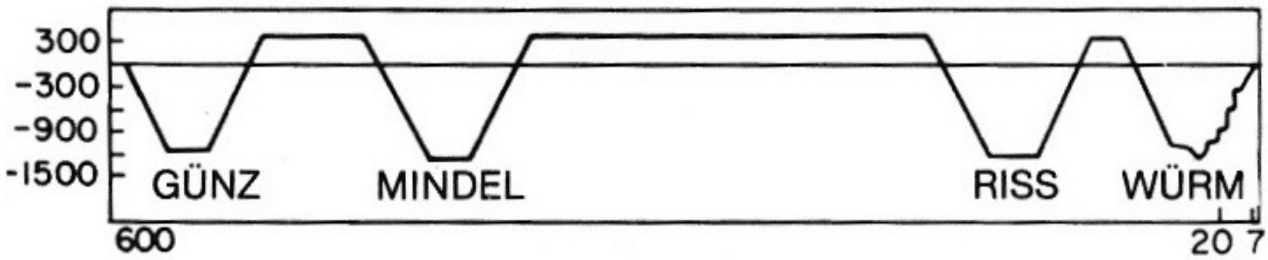
CCC at Gulpen

As a child I collected fossils, but in 1978 when I found a small mesolithic knife (Starr Carr) on a holiday in Yorkshire, I became interested in the stone age. Two years later I found paleolithic tools at Gulpen (Netherlands, 15 kilometers from my house in Maastricht), the group held scrapers and denticulate tools but to my disappointment there were no handaxes. I read in Le paléolithique dans le monde (by professor François Bordes) that Mousterian groups had existed which did not make handaxes, so I hoped that my finds were Mousterian (*frontpage this chapter*). I showed my finds to the archeologist at the museum, but despite being a lithic specialist she couldn't say if I was right. This is understandable, because before 1980 nearly everyone believed that hardly any paleolithic hominids had lived in the Netherlands. We therefor had no Dutch professor in that field and archeology students did not learn a lot about the Paleolithic. The archeologist sent me to an amateur club: the Archeologische Vereniging Limburg (AVL). The chairman of this club knew just as little and sent me to Ad Wouters, an amateur who they believed could know the answer. But Wouters lived in Lent, this was 150 kilometers away and in 1980 we did not yet have the internet. So I wrote Wouters a letter and he answered that I should order the magazine Archaeologische Berichten. But at the time I was a student with no money to spare and feared that this magazine would only bring the next disappointment. Discouraged I let it be.

The impasse ended in 1984, when I visited a temporary exhibition on artefacts from Sprimont (near Liege, Belgium) of 0,5 Ma (million years ago) in the Museum of Natural History in Maastricht. Here I met Piet Kelderman (*figure 1.1*), he told me that I really should buy the Archaeologische Berichten because this magazine had discussed many Paleolithic finds without handaxes from the Netherlands. Wouters called these finds the Chopper-Choppingtool-Complex (CCC). That CCC would have been made before the handaxe became known, if this was true my finds would be far older than the Mousterian! Wouters seemed trustworthy; he knew Bordes personally and had worked with abbot Henri Breuil and with Louis Pradel and many of his conclusions were affirmed by professional specialists. That gave me enough confidence to publish my finds in 1988 in the AVL-magazine as CCC (*figure 1.9*). In that same year Hans Peeters, Johannes Musch and Ad Wouters published an overview of the oldest finds of the Netherlands in the scientific magazine l'Anthropologie (edited by professor Henry de Lumley). That paper had two parts, the first (Les plus anciennes industries des Pays-Bas) presented the CCC; one group was dated to 1 Ma and many others to 400 ka (kilo=thousand years ago). The second part (Les industries Acheuléennes des Pays-Bas) presented the handaxe traditions from 300 to 40 ka.

Figure 1.1: Piet Kelderman (left) and Ad Wouters studying the pebbletools Piet had found at Valkenburg (about 10 km from Maastricht).

Figure 1.2: Penck and Brückner concluded in 1909 that over the last 600 thousand years, the snow-line had four times declined more than 1000 meters below the present level (scale at the left). From: J. Imbrie and K. Palmer-Imbrie: Ice-Ages, solving the mystery, 1979).



Old views
But the archeological theories were changing drastically around 1988. This was mostly the result of improved geological methods: until 1970 the division of the pleistocene was based on research by Penck and Brückner. These geologists concluded in 1909 by studying the terraces of Alpine rivers that the permanent snow-line had four times been at least a kilometer lower than nowadays. They called this the Günz, Mindel, Riss and Würm glacials (*figure 1.2*). But the rivers in France and England did not start in the Alps, so it was unclear if the handaxe bearing terraces from i.e. the Somme should be dated to the Riss or perhaps the Mindel glacial. The dating was so uncertain that archeologists believed they could date the handaxes more securely by studying their forms. When a car-specialist determines the type of a car he can tell you exactly how old it is, so it did seem plausible that a typology-specialist could tell us how old handaxes are by determining their types. Especially because Bordes knew exactly how the shape of the handaxe had developed over time. Bordes showed us that primitive hominids first sharpened a stone by removing a few flakes, producing a chopper (number 1 in *figure 1.3*). When the intelligence and skills of early man improved, the choppers developed a point (number 2). More evolved hominids understood that longer cutting edges were better, this led to numbers 3 and 4. Eventually early man learned to flake the complete edge of the stone: we call this tool a handaxe (number 5). Then finally man discovered that if he used a piece of antler or bone as a hammer (instead of a stone-hammer) he could make thinner and therefor even sharper handaxes. This great latest invention resulted in the classic Acheulean handaxe (number 6 in *figure 1.3*).

Louis Leakey and his wife Mary found two million years old choppers in the Olduvai-gorge (Tanzania), this convinced everyone that the cradle of mankind had stood in East-Africa. The earliest finds in Europe were half as old: professor Henry de Lumley found 1 Ma choppers in the Vallonet-cave in the south of France. So the chopper-makers probably came to Europe in the Günz glacial. The earliest French handaxes were not made until the end of the Mindel glacial. This was later than in Africa, where handaxes were already made in the warm phase between Günz and Mindel. Perhaps the handaxe-makers could not travel from Africa to Europe in that warm phase because they were not adapted to the forested landscape. The French handaxes from the Mindel-phase were still thick and crudely flaked, the typological specialists called this form: biface Abbevillien. The crude form proved that the hominids who made them were still rather clumsy. The English hominids had during the Mindel not yet learned to make Abbevillian handaxes. This was proven by digs in the lower beds at Swanscombe in England. These lower beds were dated to the Holstein-phase (the warm phase between Mindel and Riss) and only held crude flakes and choppers, this primitive tradition was called the Clactonian. Early man in the Netherlands had also not yet learned to make handaxes, instead he worked pebbles into choppers in the CCC, early man in Hungary (at Vértesszöllös) was also still making choppers and choppingtools during the Holstein-phase. *Figure 1.2* shows that the Holstein-phase was very long, in this long phase the Abbevillian gradually developed into the Acheulian with well-made thin classic handaxes. These handaxes were so efficient that the Acheulian now spread to England; well-made mostly pointed handaxes were found in the upper beds at Swanscombe. In the Riss Ante-Neanderthals evolved, these were so intelligent that they could make flakes with a special form (i.e. a triangular point) in just one strike. They did this by shaping the core, we call this the ‘prepared core technique’ or Levallois-technique. The Neanderthals were even cleverer and developed many cultures: Bordes showed Neanderthals made five Mousterian cultures, the most famous is the MTA (with small handaxes with a heart-shaped model). And simultaneous with the Mousterian there even was a fifth culture: the Micoquian. But the handaxes at La Micoque had a stretched point so this was a final-Acheulian rather than a real Mousterian. Finally our own ancestor, the Homo sapiens came to Europe in the Würm-phase. We can see that the Homo sapiens was much cleverer because he based his technology on blades. A blade is a flake that is at least twice as long as its width, creating an efficient cutting edge.

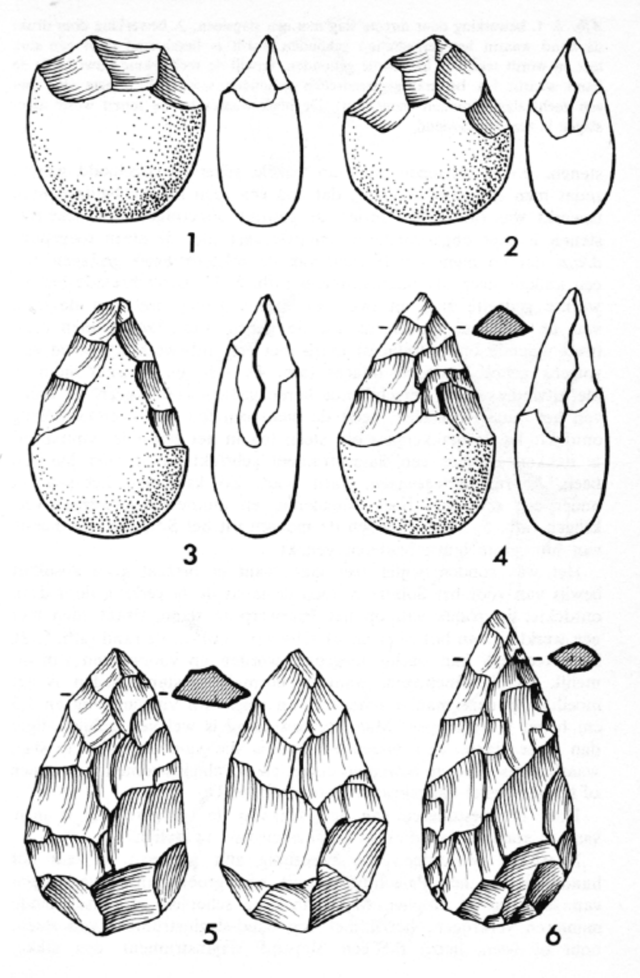


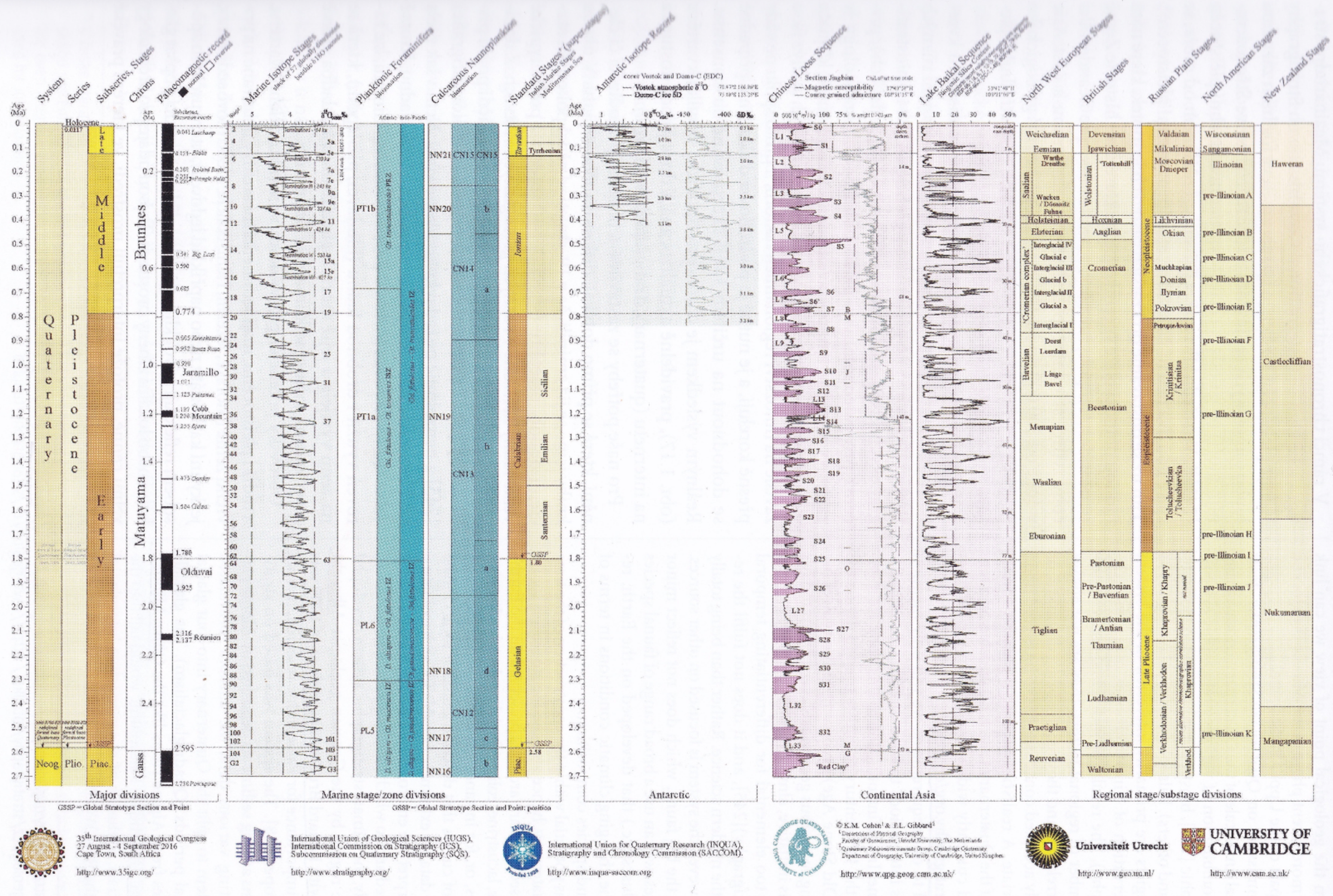
Figure 1.3: Fifty years ago everyone believed that the simple chopper (1) developed into the handaxe by adding a point (2), making longer cutting edges (3-4) until the complete edge was flaked (5). The handaxe was finally made thinner in the classic Acheulian (6). From: F. Bordes: Le paléolithique dans le monde, 1968.

When experimentalists copied the prehistoric tools they measured that a chopper like the Homo habilis in Olduvai made from half a kilo of stone had a cutting edge of only 5 cm. When the Homo erectus used half a kilo of stone, he was able to make a handaxe with two cutting edges of each 10 cm, so 20 cm in total. And from half a kilo of stone Neanderthals were able to make a series of Levallois-flakes with a total cutting length of 100 cm. But this is nothing compared to Modern man: our species turned half a kilo of stone into a series of blades with a total cutting length between 3 and 12 meters. These objective numbers made our evolution tangible: experimental archeology clearly gave us a way to measure the intelligence of our ancestors. Modern man scored 10 times higher than Neanderthals! This impressive result made very clear why only we Moderns were able to make art and conquer the whole world. In 1980 archeologists were convinced this was how Paleolithic hominids and traditions had evolved.

New geology

But around 1980 geologists were developing far better dating-methods. They studied the oxygen-isotopes in the deposits at the bottom of the oceans and this showed that in reality there had been fifty cold and fifty warm stages, instead of only the four glacials in *figure 1.2*. These stages were called Marine Interval Stages (MIS, *figure 1.4*). All stages received a number; for instance the old Holstein-phase turned out to span MIS 11-9 (nowadays the name Holstein is mostly used for MIS 11). Another example is the Riss-phase: this spans MIS 8-6. The absolute dating methods also improved. This enabled geologists to link many river terraces and cave deposits to the MIS stages. After 1990 it became clear that some archeological sites were dated correctly, for instance the Clactonian and the choppers from Vértesszöllös indeed belonged in the Holstein (MIS 11-9) phase. But many thin classic handaxes turned out to be far older than professor Bordes had held possible in 1968. To everyones surprise the well-made handaxes at Boxgrove (England) were dated to MIS 13, so they were over 0,5 Ma. It was great to discover that many Acheulian sites were older than expected but this was also a terrible shock, because it showed that the simple Clactonian choppers from Swanscombe, the Dutch CCC and the choppers from the Vértesszöllös pebble-industry no longer preceded the Acheulian. So either *figure 1.3* was wrong or the evolution had taken a step back. This startled the paleolithic-specialists, both options turned the accepted theories upside down and this was totally unacceptable. The new geology forced researchers around 1990 to reevaluate all of the earlier findings.

Next page figure 1.4: The pleistocene is now divided into over 100 Marine Isotope Stages (MIS) that correspond with river-terraces and loess-deposits. From: P. Neruda: Time of Neanderthals, 2016.



System
Series
Subseries, Stages
Chrons
Palaeomagnetic record
Marine Isotope Stages
Planktonic Foraminifera
Calcareous Nannoplankton
'Standard Stages' (super-stages)
Antarctic Isotope Record
Chinese Loess Sequence
Lake Baikal Sequence
North West European Stages
British Stages
Russian Plain Stages
North American Stages
New Zealand Stages
Age (Ma)
Quaternary
Pleistocene
Holocene
Late
Middle
Early
Neog.
Plio.
Piac.
Brunhes
Matuyama
Gauss
Jaramillo
Cobb Mountain
Olduvai
Réunion
0.774
1.780
2.595
Calabrian
Gelasian
Ionian
Tyrrhenian
Sicilian
Emilian
Santernian
GSSP
Weichselian
Eemian
Holsteinian
Elsterian
Cromerian complex
Bavelian
Menapian
Waalian
Eburonian
Tiglian
Praetiglian
Reuverian
Devensian
Ipswichian
Wolstonian
Hoxnian
Anglian
Cromerian
Beestonian
Pastonian
Pre-Pastonian / Baventian
Bramertonian / Antian
Thurnian
Ludhamian
Pre-Ludhamian
Waltonian
Valdaian
Mikulinian
Moscovian Dnieper
Likhvinian
Okian
Muchkapian
Donian
Ilynian
Pokrovian
Neopleistocene
Eopleistocene
Late Pliocene
Wisconsinan
Sangamonian
Illinoian
pre-Illinoian A
pre-Illinoian B
pre-Illinoian C
pre-Illinoian D
pre-Illinoian E
pre-Illinoian F
pre-Illinoian G
pre-Illinoian H
pre-Illinoian I
pre-Illinoian J
pre-Illinoian K
Haweran
Castlecliffian
Nukumaruan
Mangapanian
'Red Clay'
Major divisions
GSSP = Global Stratotype Section and Point
Marine stage/zone divisions
GSSP = Global Stratotype Section and Point: position
Antarctic
Continental Asia
Regional stage/substage divisions
35th International Geological Congress
27 August - 4 September 2016
Cape Town, South Africa
http://www.35igc.org/
International Union of Geological Sciences (IUGS),
International Commission on Stratigraphy (ICS),
Subcommission on Quaternary Stratigraphy (SQS).
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Stratigraphy and Chronology Commission (SACCOM).
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When the French reevaluated the Abbevillian, they discovered that it simply did not exist. In 1836 Jacques Boucher de Perthes published crude and thick handaxes found near Abbeville. Gabriel de Mortillet called this the Abbevillian in 1882, because he believed these were primitive and thus old forms. This led collectors to select their crudest and thickest finds, they split the finds from the same sites in two groups: one group with the well-made Acheulian handaxes and another group that they believed to be older. So the Abbevillian was merely wishful thinking but all scholars, including the revered professor Bordes had for more than a century believed in this wishful thinking. This was a serious problem, around 1990 it plagued the paleolithic-specialists with doubts; could it be possible that the professors had also been wrong about other things?

Belvédère

Will Roebroeks graduated in the eighties and became the first official Dutch specialist in the paleolithic. He achieved this through self-tuition and of course with some support from Ad Wouters. Immediately after his graduation Roebroeks was put in charge of a prestigious dig in the Belvédère quarry at Maastricht, that was a difficult mission when you consider that there was no senior specialist that could keep his back. So Roebroeks must have been shaken when he heard that the handaxes from Boxgrove were older than the CCC and he must have been shaken to learn that the Abbevillian was no longer accepted. What could all of this mean for his research in the Netherlands? Roebroeks was now the only professional Dutch Paleolithic-specialist so he felt that it was his responsibility to reevaluate the CCC.

Boxgrove proved that the early Europeans around 500 ka were intelligent and skillful enough to make thin symmetrical handaxes. They were not as primitive as was previously thought and Roebroeks his own finds in the Belvédère demonstrated that in MIS 7 our ancestors were able to find good quality flint near Maastricht. From these undeniable facts, Roebroeks concluded that if any hominids lived near Maastricht during MIS 11-9, these were surely able to make handaxes. Why on earth would hominids who had the intelligence and had the flint to make handaxes mess around with choppers made from pebbles? This seemed utterly impossible, so Roebroeks concluded that the CCC simply could not exist: de Mortillet and Bordes had made a mistake so Wouters could also make a mistake. Roebroeks concluded that the CCC consisted of stones broken by natural processes: pseudo-artefacts. The Chopper-Choppingtool-Complex was (just like the Abbevillian) created by wishful thinking; collectors had merely selected series of stones that seemed to have an intentional form. When Roebroeks lost his faith in Wouters he felt this as a personal loss. But he could forgive Wouters and the CCC-collectors because they were amateurs, it was far worse when professionals made such mistakes. Roebroeks was therefor extremely disappointed that the famous professor Henri de Lumley also believed in these choppers and choppingtools and angry that de Lumley backed Wouters. According to Roebroeks all primitive choppers were nonsense so he dismissed the one million years old choppers de Lumley had found in the Vallonet cave. He dismissed the choppers the Italians claimed from Monte Poggiolo and also the choppers the Belgians claimed from Sprimont. According to him all of these finds were pseudo-artefacts just like the CCC. This clean-sweep of the archeological record brought Roebroeks to the conclusion that Europe was not inhabited before the Acheulian handaxe-makers arrived. This was in 1990 believed to have happened in MIS 13, Boxgrove would be one of the oldest European sites. He presented this ‘short chronology hypothesis’ in 1993 at a congress at Tautavel. The short chronology hypothesis went completely against the archeological consensus and against the archeological establishment. I very much respect Roebroeks’ rebellion, because I believe that divergent opinions must always be heard. Just imagine where we would be today, if Darwin had not gone against the establishment in 1859. Science simply cannot exist without respect for divergent opinions and science cannot exist without open discussions.

The core-argument of Roebroeks’ hypothesis is that you do not need to be a professor to see that complex tool-shapes (like handaxes or Levallois-cores) were man-made. But it is difficult to see if a simple flake or chopper is natural or man-made. We therefor need extra proof before we accept simple shapes as man-made objects. Here I have to agree with Roebroeks and I also agree with him that the opinion of a professor cannot be taken as proof. So how can we prove whether or not a simple object was man-made? Roebroeks designed strict rules, scientific criteria that do give us 100% certainty that the stones we find have been worked by hominids. These rules are shown in *figure 1.5*: the finds must come in large numbers from fine-grained deposits, some finds have to fit together (be conjoinable) and it is even better when the finds are accompanied by hominid fossils. If the finds fulfill these criteria they are undoubtedly man-made.

BEFORE 500 Kyr BP	AFTER 500 Kyr BP
small series consisting of isolated pieces collected from a natural pebble background	large collections from excavated knapping floors with conjoinable material
disturbed context (coarse matrix)	primary context sites (finegrained matrix)
contested 'primitive' assemblages	uncontested 'Acheulean' and non-Acheulean industries
no humain remains at all	human remains common

Figure 1.5: Roebroeks his 1993-hypothesis (that Europe had not been settled before 500 ka) was based on his conviction that the criteria in the right column define finds as real artefacts whilst the criteria in the left column reveal that the finds are pseudo-artefacts.

New scientific standard
The short-chronology hypothesis was overthrown in July 1994, when researchers at Atapuerca (Spain) discovered primitive flakes and cores that dated back to 800 ka. The simple artefacts were found in a fine-grained matrix and accompanied by hominid fossils, so they fulfilled the criteria in *figure 1.5*. Atapuerca proved that Europe was settled far earlier than 500 ka but more importantly it also proved that primitive artefacts existed in Europe. There was life before the handaxe but according to Roebroeks this absolutely did not mean that the choppers from Sprimont, le Vallonet and Monte Poggiolo were man-made. To the contrary: according to him Atapuerca demonstrated that good sites do meet the criteria he had set in *figure 1.5*. This proved his criteria really worked and of course redefined what a good site should be like. Good sites had to answer to the criteria in *figure 1.5*, Roebroeks' criteria should be accepted as the new scientific standard. He felt certain that his new standard had lifted the paleolithic archeology to a higher level.

Atapuerca according to Roebroeks furthermore proved that the earliest industries were not about choppers, Atapuerca instead showed cores and well-made flakes. When Roebroeks visited Dmanisi (a 1.8 Ma site in Georgia that had recently been discovered) he had seen this site also presented well-made flakes. Early-man used good flakes as tools and if Wouters and de Lumley still focused on choppers, they were not keeping up with the new discoveries. In the nineties Roebroeks was certainly not the only specialist who considered choppers and choppingtools outdated. Before 1980 all paleolithic-specialists treasured choppers because they believed in *figure 1.3* but after 1990 most specialists lost interest in these so-called primitive forms. Leading specialists instead focused on developed forms, the new careers were built on investigating the earliest thin symmetrical handaxes or the earliest Levallois-technique.

System by Clark
After 1990 researchers continued to classify the European Paleolithic industries according to the development-stages Grahame Clark had designed in 1977. Clark called the stage before the invention of the handaxe Mode-I. In Africa Mode-I was about flakes made by Homo habilis, a species that was not yet clever enough to shape his tools. The Mode-I tools were found in Europe in Atapuerca made by the Homo Antecessor. The next stage was Mode-II; this stage showed deliberately shaped his tools: handaxes cleavers and pics made by Homo erectus. But in Europe Mode-II is linked to Heidelberg-man (in Atapuerca the Sima de los Huesos) and it lasted from 700 ka to 300 ka. In Mode-III the Neanderthals used Levallois-techniques. After 40 ka Modern man came to Europe, Clark called this Mode-IV (blades) and Mode-V (microlithic) tools.

Clark his system seems ideal because it creates a direct link between the design of the tool and the hominid evolution. This tells 'the human story' that everyone likes to hear; a story of progress that ultimately leads to Modern-man conquering the universe. But the choppers from the CCC, Vértesszöllös and the Clactonian disturbed Clark's system, they are far too young. Still both Vértesszöllös and the Clactonian do meet the criteria in *figure 1.5* so we cannot dismiss these industries. This anomaly had to be explained, why did man make primitive forms in the Holstein-phase right in the middle of Clark's Mode-II? It was easy to find a reason for Vértesszöllös: the early Hungarians messed with pebbles because they did not have good flints and it is obvious that nobody can turn a small pebble into a large handaxe. But the Clactonian used top quality large flints and still failed to make Mode-II tools. Specialists called this 'the Clactonian question'. They ultimately decided that the makers of the Clactonian were Mode-II-hominids and therefor able to make handaxes but simply didn't. Maybe out of British stubbornness? Roebroeks of course explained the CCC by dismissing it as not man-made. At a meeting of the Belvédère-team I showed him the denticulate scraper in *figure 1.6*, as a clear example of my Holstein-aged non-handaxe group from Gulpen. He immediately held it up in the air and told the complete team to take a good look, because this was a classic example of a typical pseudo-artefact.

Figure 1.6: This flake-based denticulate scraper (denticulé convergent) from Gulpen was called a typical pseudo-artefact.

Theory or practice

My finds from Gulpen were collected on the eroding surface of a slope so they do not have a proper context. So if I base my judgement on the criteria in *figure 1.5*, I have to dismiss the complete groep. I have to agree with Roebroeks that nature does create the most intricate forms. But the scraper in the *figure 1.6* is not a solitary find, it was found together with the worked stones at the lower half of the *frontpage of this chapter* and also with more than five thousand similarly worked stones (see chapter 8) at a surface of only a hundred square meters. Three quarters of all stones at this site were worked, so if a natural geological process had broken all of these stones there would have to be similar sites nearby. Of course I looked for such sites and I did find several locations that showed the same geology, but none of these presented flaked stones. There is no geological process that breaks stones in one selected location and leaves stones in similar places untouched. This creates a dilemma: the fractures cannot be natural but because the stones fail to meet the criteria in *figure 1.5* we should out of scientific scrutiny still dump them in the trash-can. I decided to keep the stones because I have learned to distrust criteria. Like every veterinarian I have cured patients that should according to all criteria have died. So a good veterinarian never adjusts his findings to theoretical rules, instead he uses his practical experience to recalibrate or adjust the theoretical criteria.

I believe that we should also follow this approach in archeological matters: if the simple tools from the Holstein-phase do not fit into Clark's theory, we should not disregard our findings. We should instead adjust Clark's theory. So we must not dismiss non-handaxe-groups and we must not try to find ad hoc arguments to push non-handaxe industries into Mode-II, we must instead improve the theory. Clark's system has good elements that we need to preserve: I want to preserve the name Mode-I for the earliest phase of the Paleolithic, Mode-II for the Acheulian and Mode-III for the Mousterian. We must also preserve the good elements in *figure 1.5*; it remains true that a fine-grained matrix with hominid fossils leads to absolute certainty. But we must not turn this around to dismiss all other finds.

Two basic techniques

In this paper I will give the CCC, Vértesszöllös and the Clactonian their rightful place in the Paleolithic by improving Clark's system. I do this by improving our views on flaking techniques. The first step to a better understanding is acknowledging that there are two ways to break a stone, to there are two basic techniques. In one basic technique you lift a stone up in one hand, then you take a hammer in your other hand and strike flakes from that stone (the core). This technique is called freehand-flaking because you hold the core in your free and unsupported hand. The famous forger Flint Jack demonstrated in Darwin's days that he could reproduce handaxes and other antiquities by freehand-flaking and since then many experimentalists have widely studied the freehand-method. The other basic technique starts by putting the stone on a support; either the floor or an anvil. If you strike flakes from a supported stone the forces come from two opposed sides, this is therefor called bipolar-flaking. I developed an understanding of bipolar-flaking as a child, long before I became interested in archeology. Because I shaped many geological samples and also freed fossils from flint-nodules with the use of a support. So I immediately recognized that my finds from Gulpen showed bipolar fractures.

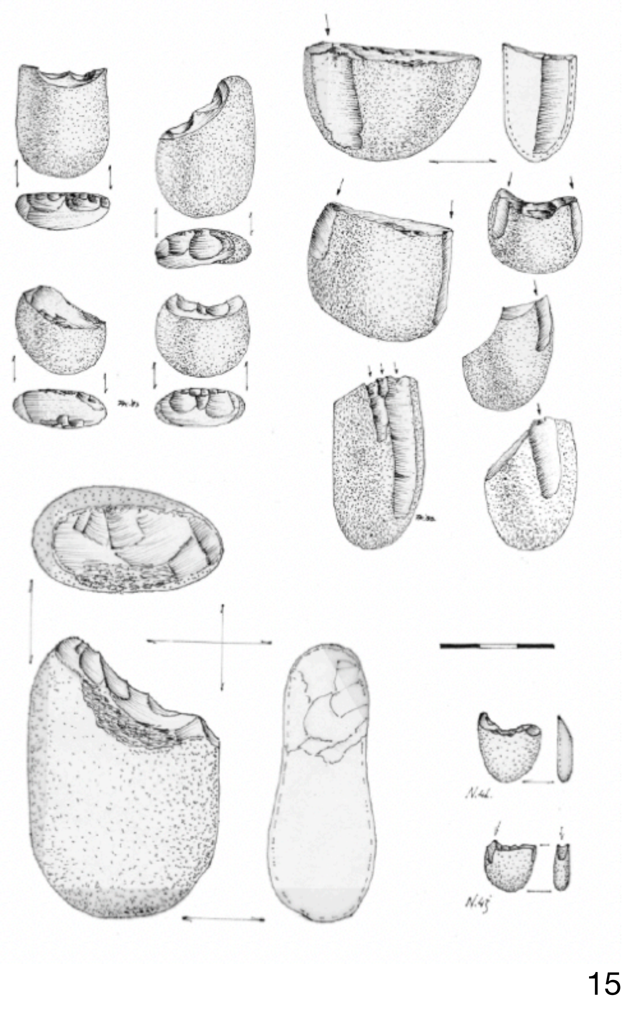
Experimentalists show little interest in bipolar techniques, most experimentalists consider bipolar flaking a clumsy inferior technique. That is understandable because even if you hit a stone that lies on the ground a hundred times, you cannot shape that stone into a handaxe. If you want to make Mode-II tools you have to lift the stone up and work it from the free hand. Experimentalists therefor only work on the floor (or on an anvil) when that is absolutely necessary. For instance when a block is too large to lift; in that case the experimentalist leaves the block lying on the ground whilst he strikes a very large flake. But once that flake is made most experimentalists will immediately pick it up and they will then use freehand technique to shape it into a handaxe. So the experimentalists make structural use of freehand-flaking and the Mode-II traditions also made structural use of freehand-techniques.

But as a child when I collected fossils, I structurally used bipolar methods to free fossils from their matrix. This experience taught me how man-made bipolar fractures look, this enabled me to recognize that the Clactonian, the pebbletools in Vértesszöllös and the CCC used bipolar flaking. I became even more convinced that these industries used bipolar techniques as their main method, when Kelderman demonstrated that he could experimentally reproduce all of the pebbletool-models (models as in *figure 1.7 and 1.8*) with hammer and anvil. In Archaeologische Berichten (1979) Wouters furthermore showed that notches could be made far deeper and in thicker flakes with the combined use of hammer and anvil than from the free hand. Another obvious advantage of the bipolar techniques is that they allow you to break small rounded pebbles. So instead of as 'clumsy and inferior' we must see the bipolar techniques as methods that have specific advantages. But since bipolar techniques do not allow the making of handaxes, they lead to a toolkit-concept (an idea on how tools should look, how they should be made and how they should function) that is structurally based on what these techniques do allow. The Clactonian, the pebbletools at Vértesszöllös and the CCC all show this specific bipolar toolkit-concept. The individuals in these traditions were not handicapped so they may occasionally have struck a stone from the free hand, but structurally everything that these groups made can be reproduced by bipolar-flaking. So their standard methods were bipolar.

The bipolar toolkit concept

According to Wouters I was around 1990 the only person that explained the differences between the Acheulian and non-handaxe industries in this structural and consistent way. He encouraged me to develop these ideas further, this led to a paper in 1991. Ad Wouters died in 2001 and shortly before his death he gave me his ‘type-collections’ of some CCC-sites. In 2007 I filmed these tools (and also some of my own finds) to show them to the members of the APAN on a DVD called: ‘the bipolar toolkit concept’. I preferred this new name over the old name CCC because the old name referred to the old theory that choppers preceded handaxes. And also because freehand-choppers are actually very common in some Acheulian traditions, whilst choppers rare in the Clactonian and several other bipolar industries. Choppers and choppingtools are therefor not at all characteristic of the bipolar industries. The name bipolar toolkit concept does not have a catchy sound or abbreviation (BTC will never catch-on like CCC did), but this name does catch the essence of the non-handaxe industries. In the following chapters I will explain that the bipolar techniques were certainly not limited to the Holstein-phase. Understanding the bipolar techniques helps us to develop new insights in the development of the Paleolithic and even gives us a better understanding of human evolution, starting with the classic question why our ancestors began to make stone cutting-tools.

Figure 1.7 (left) and 1.8 (right): Pebbletools from the terraces of the Geul at Valkenburg (near Maastricht) collection and drawings Piet Kelderman.



Previous page, frontpage Chapter 2: Apart from stone tools, little is left to us from the Paleolithic. We are therefor tempted to use the tools we find as a means to evaluate the skills and intelligence of their makers. But is that correct? In this experiment we see Ton van Grunsven making a harpoon with nothing more than a bone splinter and a simple flake. When this stone flake is all you have it becomes absolutely impossible to reconstruct the complexity of this experiment. Even if we study the microscopic use-wear traces on that flake. So this simple flake certainly does not tell us anything about the intelligence of its maker.

Chapter 2: Man the toolmaker

Survival of the fittest
Charles Darwin wrote in 1859 that the characteristics of all species were formed by the struggle for survival, but how does that struggle work? It seems simple: the struggle is for bears all about strength, because when two bears fight the strongest bear will survive. For a cheetah the struggle for survival is about speed; the fastest cheetah catches the prey and survives. So for humans the struggle for survival must have been about intelligence. That simple interpretation does sound convincing: the evolution of man must have been driven by the growth of our brains. But how did this actually work? Was the growth of intelligence the destiny of our species, was this imprinted in our primate-DNA from the very start? And if so, does that mean that the human brains will keep growing and in another million years become twice the size our brains are now?

This simple interpretation of the evolution may sound appealing, but it is incorrect because the evolution is not at all about becoming the strongest, the fastest, the cleverest or any other kind of champion. If Darwin really believed the evolution worked this way, he would have called it the survival of the champions. Instead Darwin carefully chose the term survival of the fittest: the individuals which are best fit (= adapted) for their lifestyle have the best chances to survive and pass their genes on. In other words: the real drive behind the evolution is finding the most efficient adaptations to differentiated environments and lifestyles (niches). This brings us to the question whether it is efficient to have a larger brain.

When is intelligence efficient?
Intelligence is rarely efficient, this becomes clear when we compare sharks and dolphins. Both are marine predators that hunt more or less similar preys, under more or less similar circumstances. We should therefor expect that their brains would evolve in a more or less similar way, but sharks clearly have far smaller brains than dolphins. It is surprising that these hunters differ so much and this becomes even stranger when you consider that the shark is an older species: the sharks had far more time to evolve than the dolphins. The reason why sharks have such a small brain becomes clear when we consider what would happen if one individual shark (through a genetic mutation) would become so clever that he could spell the word tax-collector. This shark would have a much larger brain but brain-matter consumes a lot of energy; our brains are only 2% of our total body-weight but consume 20% of all our energy. So the clever shark would have to eat far more than other sharks, but his ability to spell would not help him catch more fish. This shows that for the shark, the profits of using a larger brain do not weigh up to the costs of feeding a larger brain. The reason why so many species have a small brain is not that they are 'primitive or lower' life-forms, but that every species has a brain-size that fits its lifestyle.

The brain of the dolphin is larger because his lifestyle is more complex than that of the shark. This begins with the fact that a shark is a fish, this fish is so well-adapted to hunting in the sea that he can even smell his prey under water in stereo. The dolphin is not a fish, his ancestors lived on land and his body is therefor only partially adapted to life in the sea. A dolphin therefor primarily hunts with its eyes and ears, so when the dolphin comes to the surface to breath he can loose contact with his prey. This gives the prey a chance to swim away and escape, dolphins are therefor far better off when they hunt in groups. Dolphins are social hunters in an environment for which their body is not fully adapted. This challenged their brains: the individuals who were able to come up with the best hunting-strategies and able to communicate their strategies with the group caught more fish. So it also costs more energy for dolphins to have a larger brain, but because they have such a challenging lifestyle the profit is worth the expense. Having a larger brain is thus inefficient for the shark, but it is efficient for the dolphin.

Apes in trees
The evolution of our brain followed the same principal; it was efficient for our ancestors to be clever because just like dolphins they lived in a place and niche for which their body was only partially adapted. Our earliest ancestors were apes, so hominids began with a body that was perfectly adapted to a life in the trees. The anatomy of the Ardipithecus shows us that between 7 and 4.4 Ma our ancestors still spent a lot of their time in trees. This species still had grasping feet (somewhat comparable to chimpanzee feet) but the knees and pelvis show that the Ardipithecus had straight legs, so he was able to stand up like us. Standing straight is rather useless in the forest-canopy, a straight-up-tree-ape cannot move through the canopy as efficiently as a normal ape. So in closed forests the Ardipithecus lost the struggle for survival, he preferred areas where the trees stood further apart. In half-open landscapes his straight-up posture enabled him to walk efficiently over the floor from one tree to the next. But in doing so he often found more food on the ground than in the trees, so the Ardipithecus quickly spent more of his time walking on the ground than climbing trees. Grasping-feet are not at all efficient on the ground, so these evolved into walking-feet: the Ardipithecus evolved into the Australopithecus.

Life on the ground was challenging for our ancestors because of the danger of predators and the impressive competition. The Australopithecus ate plants, fruits, insects, eggs and small animal preys but for instance baboons also ate this. Australopithecines were far slower than baboons because they walked on two legs and as primates they also bred much slower than baboons. The competition was so fierce that this forced our ancestors to exploit alternative food sources: some tried scavenging. An old theory claimed scavenging increased the growth of the brain because meat provided important nutrients. But if nutrients really determined the brain-size sharks would be super-intelligent. The real reason why the scavenging Australopithecus developed a larger brain is that his body was not designed for that lifestyle. Typical scavengers have specialized senses: hyenas for example can hear the sounds of dying animals and can smell carcasses over great distances. But the Australopithecus inherited his senses from tree-apes so he was able to see colors, because this allows apes to see from a distance whether or not the fruits are ripe to be eaten. Seeing colors does not really help in finding carcasses. Hyenas rip off meat with their strong teeth and they can even crush bones and partially digest the fragments. Hyenas are so strong that they can claim carcasses, whilst all the Australopithecus could do was run away. And because he ran on only two legs he was not even good at that. So life as a scavenger was extremely challenging for the Australopithecus: only the individuals that invented clever strategies survived. Strategies like finding carcasses by looking where the vultures went. Or eating the highly nutritious bone-marrow by smashing the bones to pieces. It was efficient for the Australopithecus to develop a larger brain because life as a scavenger was so extremely challenging.

A miracle
We know that a few clever people invented the wheel, book-printing, the car and so on. We tend to believe that stone tools were invented in a similar way: by a few clever early-man. But if that was true, stone artefacts could not be much older than 2.6 Ma because the brains of our ancestors only developed a hominid size at the onset of the pleistocene. This explains why i.e. Semaw would not accept that the striations on the 3.4 Ma fossil bones from Dikika (Ethiopia) were cutmarks from stone tools. New discoveries at Lomekwi (see chapter 3) however confirm that stone tools were already made around 3.3 Ma, this proves our ancestors made stone tools before they developed hominid intelligence. Our ancestors at that time still had brains of the same size as an ape; that is why they're called Australopithecus (pithecus means ape). Why did the not-yet-so-clever Australopithecus begin making stone tools? According to the old theory in *figure 2.1* the first flake was made by an individual who picked up a stone with one hand and a hammer-stone with his other hand. It only takes one blow to make a sharp flake that could be used to cut meat. That seems simple, would apes be able to do this without anyone teaching them how?

When we start to think about *figure 2.1*, it quickly becomes clear that this would take a miracle. Let us call the individual Australopithecus that made this first flake Johnny. On a good day Johnny was walking on the savanne looking for food. One day earlier he had found an ostrich-egg, he had tapped the egg with a stone to make a hole and eten the contents. Now he felt hungry again but he was still happy and softly singing 'egg-egg, another egg'. To his regret he only saw stones and he knew the stones were not edible. But one stone looked temptingly like an egg; Johnny picked it up and tapped it with another stone to see if he could make a hole in it. Of course nothing happened, but our Johnny was no quitter. So he hit harder and harder and even took a larger

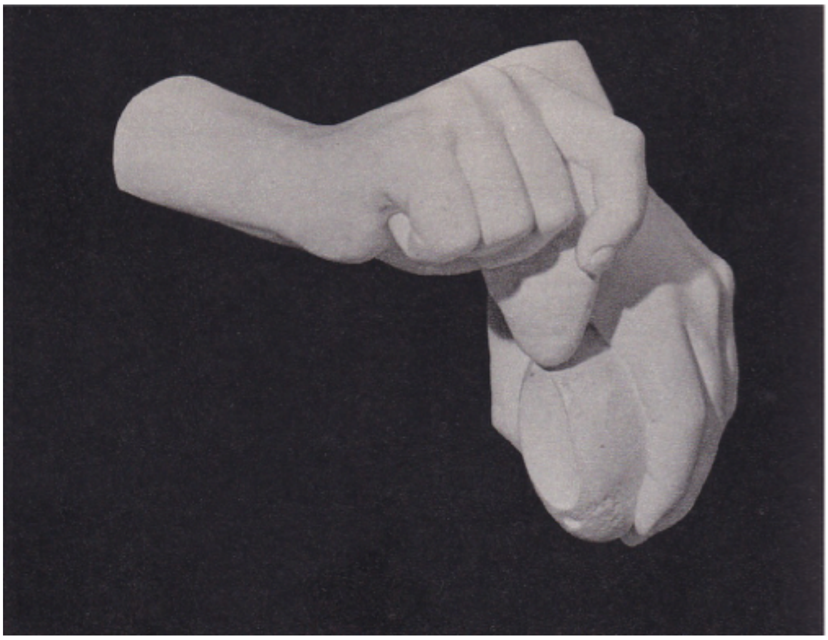


Figure 2.1: According to the old theory the first flakes were made like this. But this is not as simple as it seems, it is very difficult to flake a rounded cobble from the free hand. From: J. Jelinek: Das grosse Bilderlexikon des Menschen in der Vorzeit. Prag 1972.

hammer-stone. He hit straight from above and hit from the side and got more and more fanatical. Finally he must in some way have struck the right platform at the correct angle with enough force: the stone broke. After a brief moment of triumph, Johnny returned to the reality: he had broken his egg-stone but found nothing inside that he could eat. So he dropped the hammer-stone and he dropped the broken egg-stone and walked on, disappointed and still hungry. And so the story ends. Perhaps you expected that Johnny would have shouted: 'Eureka, I invented the knife', but he did not even pick the flake up. Because Johnny had never cut anything: he had no idea that his flake was a useful object, it never occurred to him that if he would carry the flake along for a few days he might find a carcass and then use the flake to cut off meat.

Daily routine
Stone tools were not miraculously invented by a clever Johnny, the reality is far simpler. Stone tools developed as the inevitable result of an almost daily routine! When Australopithecines became scavengers they picked up large stones and used them to smash the bones of a carcass to pieces in order to eat the marrow. That was a simple behavior, more or less comparable to otters smashing shells to eat the shellfish or apes cracking nuts (*figure 10.2*). Every day a few groups found carcasses on the savanne and ate the marrow. When you add everything up, our ancestors must have smashed millions of bones during the pliocene. With so many hammer-strikes, some must have missed and accidentally struck a stone that lay next to the bone. These powerful strikes produced unintended splinters of stone. Whilst unlucky individuals cut their feet open on these splinters, some lucky ones saw how these splinters scraped meat from the bones of the carcass. So Australopithecines got pieces of meat as a reward for breaking stones.

When any action plus reward is repeated, this becomes an effective learning-process. Many researchers use such learning-processes in experiments to train apes (this is how the famous Kanzi was taught to make stone tools). Important is that this also happens in the wild: some chimpanzee groups have for instance learned to choose and even adjust sticks they use to catch small preys that hide in hollow tree trunks. So if trained chimpanzees can work stones and wild chimpanzees work wood, why are there no wild chimpanzees that flake stones? It is not difficult to find the answer: stones are only used by wild chimpanzees to crack nuts, so chimpanzees have no use for the sharp pieces of an accidentally broken stone. Their action has no reward, whilst the scavenging Australopithecines utilized the pieces as knives and learned to make flakes.

Bipolar technique
The Australopithecus invented stone tools by breaking stones that were lying on the ground. This means that the first stone tools were not made from the free hand as *figure 2.1* suggested, the first stone tools were actually made on the ground with the method shown in *figure 2.2*. The stone was supported by the ground when it was hit by the hammer-strike. So the forces which produced the fracture came from two opposed sides: this is clearly a bipolar technique.

Figure 2.2: It is a small step from smashing bones that are lying on the ground to smashing and intentionally working stones that are lying on the ground.

Flaking was invented on the ground. But there is no reason why the Australopithecus would not have been able to switch from bipolar to freehand flaking: our ancestors always had the choice between both basic techniques. So in the next chapters we must constantly and consciously determine which artefacts where made in which technique and why. Step-by-step this enables us to discover the how and why of the Paleolithic techniques.

Next page, frontpage Chapter 3: Mode-I cores and flakes from Bed-I in the Olduvai-gorge, Frida Leakey Korongo (FLK). The artefacts in FLK were made from raw materials that early man found very close to his campsite, mostly lava-cobbles. No handaxes or other standardized formal-tools were made during Mode-I. The hominids used the cutting edges and piercing points of simple cores and flakes. These edges and points were sometimes retouched to improve their function. From: Olduvai Museum.

Chapter 3: Mode-I

Oblique Bipolar Flakes
The Australopithecus experienced that thin flakes were the best cutting-tools. So he did not strike the stones dead-center, but near the edge as we saw in *figure 2.2*. With this method the place where the hammer made contact with the core was not straight above the support, but oblique above the support. And to stop the stone from turning he was held down as we see in *figure 2.2*. This method is far more effective than straight bipolar flaking and enables toolmakers to control the thickness and shape of the flake. I named this method Oblique Bipolar Flaking (OBF) and the resulting flakes Oblique Bipolar Flakes (OBFs).

I have no doubt that the toolmakers also discovered other ways to break stones. Early-man could according to Kathy Schick and Nicholas Toth have used all of the methods in *figure 3.1* during the phase before the invention of the handaxe (Clark named this Mode-I). Schick and Toth therefor called these ‘the major techniques of flaking stone that would have been available to the earliest stone tool-making hominids’. Every technique in *figure 3.1* has its own specific advantages and disadvantages, let me start with the method at the top-right (number 2). In this drawing the toolmaker places the strike straight above the support, this is the straight bipolar technique. The straight bipolar technique is the best method for breaking a round cobble in two equal pieces. This can be done on an anvil but this technique also works on a hard floor. In the drawing this method is used to break flakes from a core at a nearly 90 degrees angle, Fernando Diez Martín found this method was used in Olduvai Bed-II to chip flakes from blocks of Naibor Soit quartz. But this method gives far less control over the shape of the flakes than OBF. At the bottom-right we see that stones can also be broken by throwing them against an anvil (4), but this method totally lacks control and most of the flakes are lost in the vegetation. The method at the bottom-left in *figure 3.1* is called block-on-block (3). This method is handy if you want to test the quality of a stone that you find, but have no hammer-stone at hand. The disadvantage is that control over the exact striking-point is lost and the control over the direction of the fracture is very poor. So the four methods in *figure 3.1* only present one good alternative for OBF: method number 1 at the top-left. This technique is called ‘direct hard-hammer percussion from the free hand’, in this paper I generally shorten this name to freehand flaking.

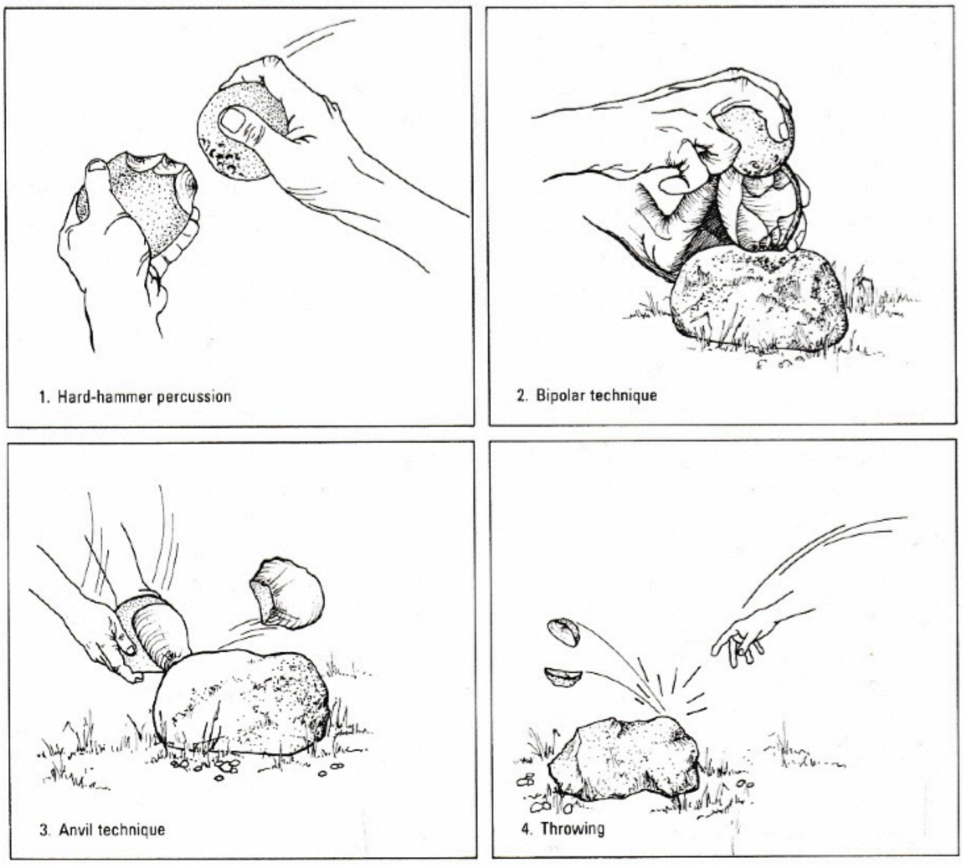


Figure 3.1: Techniques which according to Schick and Toth could have been used during Mode-I. From K. Schick and N. Toth: Making silent stones speak, human evolution and the dawn of technology (1993).

Direct hard-hammer percussion
Mode-I toolmakers had two good alternatives: they could use OBF and freehand flaking. But Schick and Toth do not show OBF in *figure 3.1* and strangely they do not mention OBF at all in their book. This becomes even stranger when you know that several photos in their book do show Schick and Toth using OBF. For instance on page 228, 238, 239 and 247 we see pictures of how stones are not worked from the free hand but whilst they are supported by the floor. These photos also show the strikes are not straight towards the support, so this is no straight bipolar technique but clearly OBF. Schick and Toth used OBF, so did they simply forget to put OBF in *figure 3.1*? No, these researchers are far too clever to simply forget this essential technique. This was done out of principle: most experimentalists believe that OBF is a technique that does not deserve to have its own name! Experimentalists generally name techniques after the tools they use; for instance if an experimentalist makes retouches with a pressure-rod (i.e. a copper point) he calls this pressure-technique. If he uses a punch he calls it punch-technique or indirect percussion. Striking with a piece of bone or antler is called direct soft percussion. Because of this principle the use a stone hammer as flaking-tool is generally called: direct hard percussion (number 1 in *figure 3.1*). This name is used regardless whether this is done from the free hand or with the ground as a support.

It is easy to understand why experimentalists name techniques after their tools when you look at *figure 6.9*. In this picture of the Dutch National Championship Handaxe-making we can see that the competitors have large bags and baskets. The bags contain dozens of hammer-stones, antler-hammers and pressure-rods, because you cannot win the competition without the proper instruments. The competitors first give their handaxe its general shape (stage 5 in *figure 1.3*) using stone hammers with the correct size, shape and hardness. And in the next step they switch to their favorite antler hammers to reach stage 6 in *figure 1.3* by removing thin flakes stretching over the complete dorsal and ventral surfaces.

Test your marbles
The baskets in *figure 6.9* are filled with flat slabs of high-quality flint that Dutch experimentalists import from Denmark. *Figure 6.11* shows that the experimentalists at the Centre Européen de Recherches Préhistoriques in Tautavel (France) also make their handaxes from good quality flat slabs. But the Mode-I-makers did not have such high-quality raw materials, they used the stones they found near their campsites. Some of these stones may have been too big to lift with one hand. Schick and Toth show pictures in which Nick Toth used the support of the ground to make very large OBFs from such blocks.

The extreme size of these OBFs testifies to the fact that a bipolar strike produces a greater force than a similar freehand strike. We can illustrate the difference between working on a support and from the free hand by driving a nail into a wooden board with both techniques. When you put the board on the floor all of the energy of the hammer is effectively used. It is very easy to drive the nail into the wood with this bipolar method. When you lift the board up with one hand it becomes far more difficult to drive the nail in, because the nail now pushes the board away with every strike of the hammer. A lot of the energy of the hammer is now lost, this energy turns into the kinetic energy that moves the board. You loose even more energy when you use a lighter board because this gets pushed away very easily. That explains why it is very difficult to flake small stones from the free hand, you can test this with a glass marble. Glass is a very fragile material but when you try to break a marble by holding it up in one hand and striking it with the hammer, this proves to be impossible. The marble weighs so little that the hammer simply pushes it away and if you hit it harder, you only loose your grip. But if you place the glass marble on a hard floor or an anvil, it only takes a small tap with the hammer to break it.

This is interesting because it shows that when very big stones and also when very small stones were used, the bipolar techniques were far more effective than the freehand techniques.

Round stones
The effectivity of freehand flaking also highly depends on the shape of the stone. This is clearly shown in *figure 3.2*; Schick and Toth explicitly wrote in this drawing that a stone can only be flaked from the free hand if it has a percussion-angle of less than 90 degrees. This is not at all necessary when you use OBF. Please note that the name percussion-angle is used in *figure 3.2* for the angle between the platform of the core and the reduction-face of the core. We must not

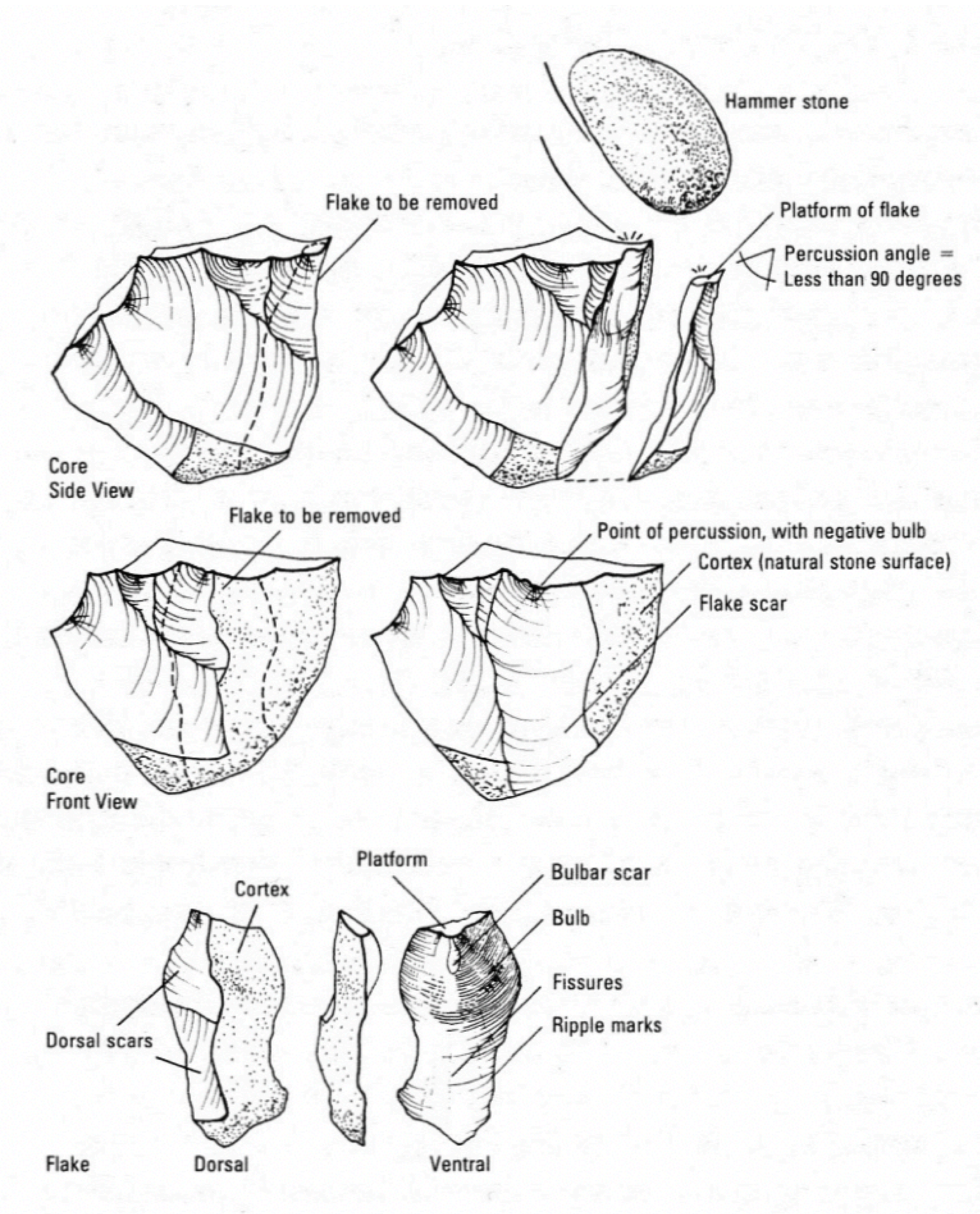


Figure 3.2: The characteristics of a freehand flake and freehand core. From K. Schick and N. Toth: Making silent stones speak, human evolution and the dawn of technology (1993).

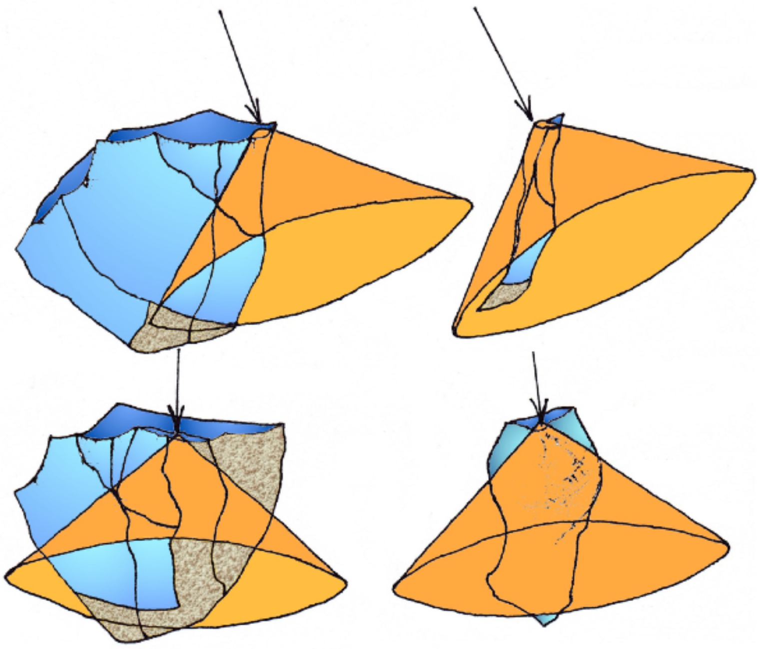


Figure 3.3: The arrow shows the direction of the strike and the orange cone indicates where the compressive force works in the core and flake from figure 3.2.

confuse this name with the name flaking-angle; that is the angle between the platform of the flake and the rupture (or ventral face) of the flake. Freehand-flakes always have a flaking-angle above 90 degrees, the average flaking-angle in handaxe-industries (Mode-II) is 110-120 degrees.

Neolithic cores and flakes look exactly like *figure 3.2* because the farmers 4000 BC mostly flaked from the free hand. But the cores that Jelinek showed in *figure 2.1* and Schick and Toth showed in *figure 3.1* do not at all look like neolithic cores, the cores in these figures are clearly rounded. This is realistic: the use of rounded cobbles as raw material was more or less the standard in Mode-I groups, because most early-hominids lived near rivers and used the stones these rivers provided. Unlike the core in *figure 3.2*, rounded cobbles rarely have percussion-angles less than 90 degrees, this makes it difficult and often totally impossible to flake rounded cobbles from the free hand. So the model in *figure 2.1* is unrealistic despite its highly suggestive and artistic qualities: if you try to flake an egg-shaped cobble from the free hand your hammer will bounce.

Directing the compressed cone
Australopithecus Johnny had already noticed this in the previous chapter. His strikes bounced because there was no striking platform. Freehand-flaking requires an acute angle in order to direct the compressive force to the outside of the stone, *figure 3.3* helps to explain this. At the moment when the hammer hits the platform, the force compresses a small (more or less circular) part of that platform. This now pushes on a somewhat larger circle beneath it, compressing that part of the stone. The deeper the force goes into the stone the larger the compressed circle becomes, so the force spreads in the form of a cone. The compressed-cone grows but the pressure per square mm decreases exponentially. At a depth of 1 cm the radius of the circle is 10 times bigger than at a depth of 1 mm. The surface of a circle is $2\pi r^2$ so at this depth the pressure has decreased 10^2 (a hundred) times! Of course this means that every fracture quickly comes to a dead end because of the exponential reduction of the force, unless you use a trick to keep the pressure per square mm high. *Figure 3.3* reveals that trick; you keep the pressure per square mm high by directing the strike so that most of the cone falls outside the core. Since you only compress the small part of stone that lies inside the cone, the rupture can now continue through the stone. It is important to note that the arrow in *figure 3.3* stands perpendicular to the platform. This perpendicular angle ensures that the core absorbs the full force of the hammer strike: the core in *figure 3.3* shows a deliberate design that is ideal to make freehand flakes.

The left drawing in *figure 3.4* shows what happens when you use the freehand method on a rounded cobble. The toolmaker has no influence on the opening-angle of the cone because this is determined by the material, in most rock-types it is ± 100 degrees. In the small drawing at the bottom-left this opening angle of 100 degrees is shown in orange, you can see that all freehand-strikes must therefor be given at 130 degrees (green angle) to the desired fracture-line. So to make the light-blue flake, the strike must be given in the direction of the red arrow. But now the hammer is no longer perpendicular to the platform like in *figure 3.2*, the strike is now at an acute angle. Most of the energy is now lost, only a very small part of the force enters the cobble: this strike bounces. This explains why Schick and Toth wrote in *figure 3.2* that the percussion angle must always be less than 90 degrees. The slabs in *figure 6.11* clearly show that some rounded stones have a flat surface, that can be used to direct the pressure-cone. In *figure 3.1* (number 1) Schick and Toth used the flat surface of a cobble as platform, so this drawing is realistic but it would have been easier to flake this cobble with bipolar technique. Fully rounded cobbles like in *figure 2.1* or *3.4* have no flat surface and can therefor never be flaked from the free hand.

Plan de rupture imposé
Physicists call the orange cone in *figures 3.3* and *3.4* the neutral cone, because the stone is compressed inside and stretched outside this cone. The word neutral seems to suggest that nothing happens, but the strain (or deformation) is actually at its greatest here at the borderline between compression and stretching. The rupture always follows the line of the greatest strain, in freehand flaking that line is very close to the cone. But the drawing at the right in *figure 3.4* shows that the cone becomes irrelevant when you put the stone on a support (the ground or an anvil). This should not come as a surprise because we all know that if you put a perfectly round stone on the ground and hit it straight from the top, it will break straight through the middle. There is no cone, no angle of 130 degrees and no dead-end fracture. The bipolar technique clearly has other rules than the freehand technique.

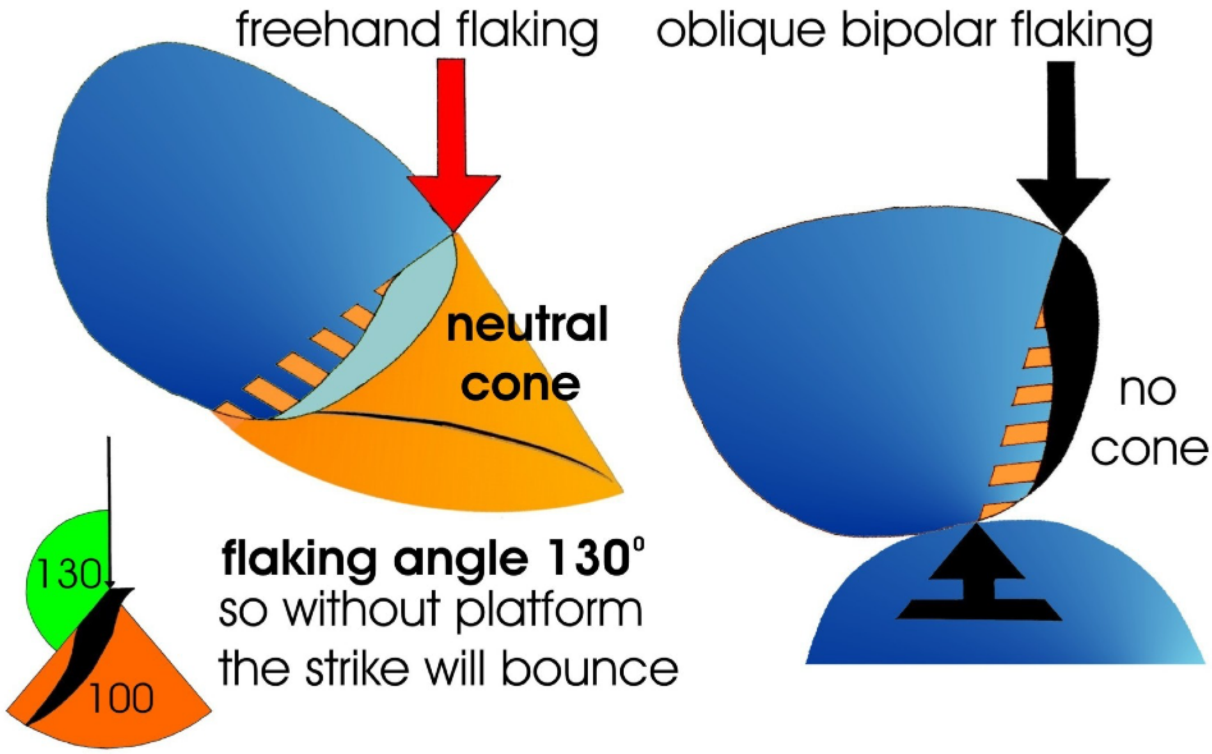


Figure 3.4: In freehand flaking (at the left) the compressive force spreads in the shape of a cone, but in bipolar flaking (at the right) the greatest strain is simply located between the hammer and the support. From: J.W.P. van der Drift: Oblique bipolar flaking, the new interpretation of Mode-I. N.P. 32/2012 https://NP32_159-164_vdDrift_Oblique-bipolar-flaking_111212_600-p.

In bipolar flaking the greatest strain simply follows the line between the hammer and the support. So when you strike straight towards the support, you get a fracture that is in line with the strike. The drawing at the right of *figure 3.4* shows that in OBF the fracture still runs towards the support when the strike has another direction. So you can simply impose your will on the fracture-line by choosing where it begins (the hammer-contact) and where it ends (the anvil-contact), Horace Bertouille therefor called this 'technique avec plan de rupture imposé' (Theories physiques et mathematiques de la taille des outils prehistoriques, Cahiers du Quaternaire 15, Paris 1989). The toolmaker can decide for himself in which direction he wants to hit the cobble because he does not have to strike at a 130 degree angle. So he can choose a direction that ensures his strike will not bounce. We see the result in *figure 3.4*: you cannot break this rounded cobble when you use freehand technique (the strike bounces at the left) but you can break it with bipolar technique (at the right). The oblique bipolar technique enabled early-man to flake every rounded cobble efficiently. Since Mode-I so often used rounded cobbles as raw material this made OBF the ideal flaking-technique for Mode-I.

Accepted method

In the middle of the 19th century Flint Jack demonstrated he could copy prehistoric tools with the freehand flaking method. Since then, experimentalists have always considered this as the 'normal' generally accepted method. So it is understandable that Schick and Toth wanted to copy Mode-I tools in this way. They found that this method does not work on round or egg-shaped stones (in *figure 5.2* these are called spheres) but solved this problem by excluding those cobbles. They were able to flake cobbles with flat surfaces and acute angles from the free hand, this supposedly proved that Mode-I tools were made with this accepted method. Nobody saw any reason to believe that prehistoric man could have used a different method.

It is very difficult to detect the signals which are characteristic for bipolar flaking. Scholars therefor did not find anything out of the ordinary when they inspected Mode-I flakes and cores. Everything appeared to be 'normal' but that does not exclude bipolar methods. Because when you look at *figure 3.4* you see that an OBF looks exactly like a freehand flake: it has just one point-of-percussion, just one bulb and the distal cutting edge is just as sharp as in a freehand flake. In *figure 3.4* you see that the direction of the rupture is not determined by a neutral cone, but the OBF can nevertheless show a flaking-cone because the flaking-cone is the result of shearing. Shearing is the process where the part of the stone that becomes the flake slides down the part that becomes the core, this shearing happens in OBF just as well as in freehand flaking. The great resemblance between freehand and OBF flakes is the second reason why most experimentalists believe that OBF does not deserve to have its own name and the second reason why researchers still believe Mode-I was made from the free hand.

Experimentalists also downplay the importance of OBF because there is no exact line between unsupported (freehand) and supported (bipolar) flaking. For even when you hold a stone in one free unsupported hand, the hand itself already acts as a support. The supporting force increases when you rest that hand on your thigh (as in *figure 6.9*). Your thigh may give even more support than dry sand or a soft forest floor, so when do you begin to call the technique bipolar? An anvil creates maximal support but even the best anvils tend to give a little during the strike. Freehand and OBF clearly do not contrast like black versus white, they only differ like shades of grey.

The fourth reason why scholars find it hard to accept that Mode-I used OBF is that Louis Leakey discovered Mode-I when he searched for the tools early-man made before the handaxe. Mode-I has therefor always been always regarded as the predecessor of Mode-II. Leakey was convinced that Mode-I choppers were the predecessors of Mode-II handaxes and Mode-I flakes were seen as the predecessors of Mode-II flakes. This view implies that there was no technical difference between Mode-I and Mode-II. The only difference was that the Homo erectus made tools with well-defined forms (handaxes, picks, cleavers). In reality the past was never about predecessors, if you try to imagine what the predecessor of i.e. the car would be you will end up with a carriage that has a steering-wheel. Looking back leads to mistakes so we must first start with sites close to the beginning of Mode-I and very slowly work our way towards Mode-II in chapter 5.

Lomekwi
So the first thing we need to work out, is what basic flaking technique was used in Lomekwi-3 in Kenia. Because this is the earliest site known today where stones were deliberately worked to make tools: Mode-I flakes and cores were found here in a Toroto-tuf bed that was dated to 3.3 Ma (late-pliocene). As far as we know Homo had not yet evolved so the tools must have been made by Australopithecines. It might be good if you study the core GaJg1 that is shown in 3-D on africanfossils.org, *figure 3.5* shows a screenshot from the side of this core. This side-view shows that some removals (places where flakes were removed, also called negatives) start from the top and others from the bottom. This proves that these early toolmakers were not just battering: they deliberately turned the core into the best position to produce the desired flakes. GaJg1 is called a

Figure 3.5: Side-view of Mode-I core GaJg1 from Lomekwi-3. From: africanfossils.org.

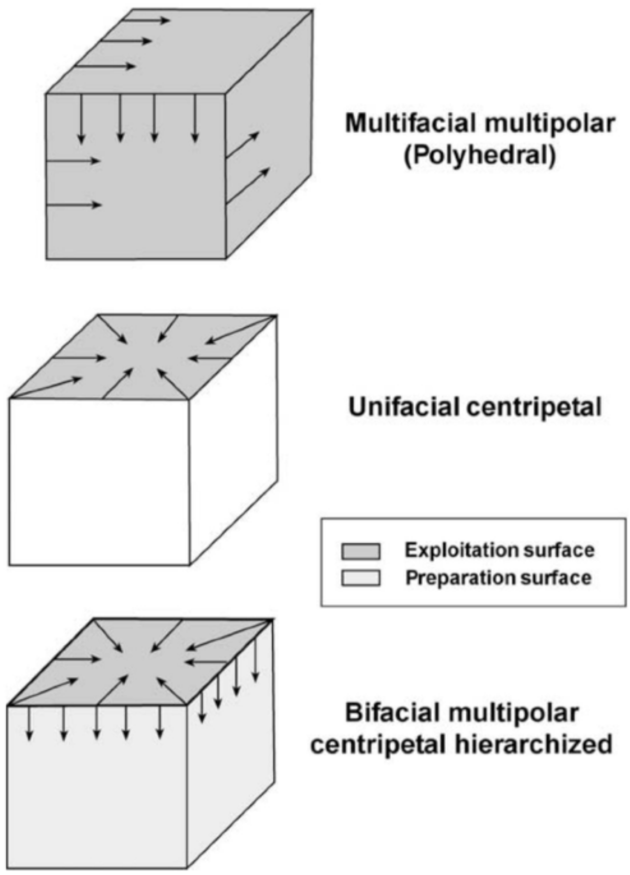


Figure 3.6: Typological names used for the cores in Olduvai-BK (Bed-II). From: F. Diez-Martín et al, J.A.A. 28 (2009).

'bipolar' core on the website, but this doesn't imply that researchers believe it was made using OBF. Because the names that scholars use for cores are not based on the technique, but on the directions of the removals. The examples in *figure 3.6* demonstrate this; the core at the top has been worked in multiple directions and is therefor called a multipolar core. The middle core shows removals pointing towards the centre, so this is called a centripetal core. At the bottom we can see that this method can lead to complex names such as bifacial multipolar centripetal hierarchized. So at Lomekwi core GaJg1 is merely called 'bipolar' because it shows bidirectional flaking; it is therefor still our own task to determine which flaking technique was used 3.3Ma: was this core flaked from the free hand or by using OBF?

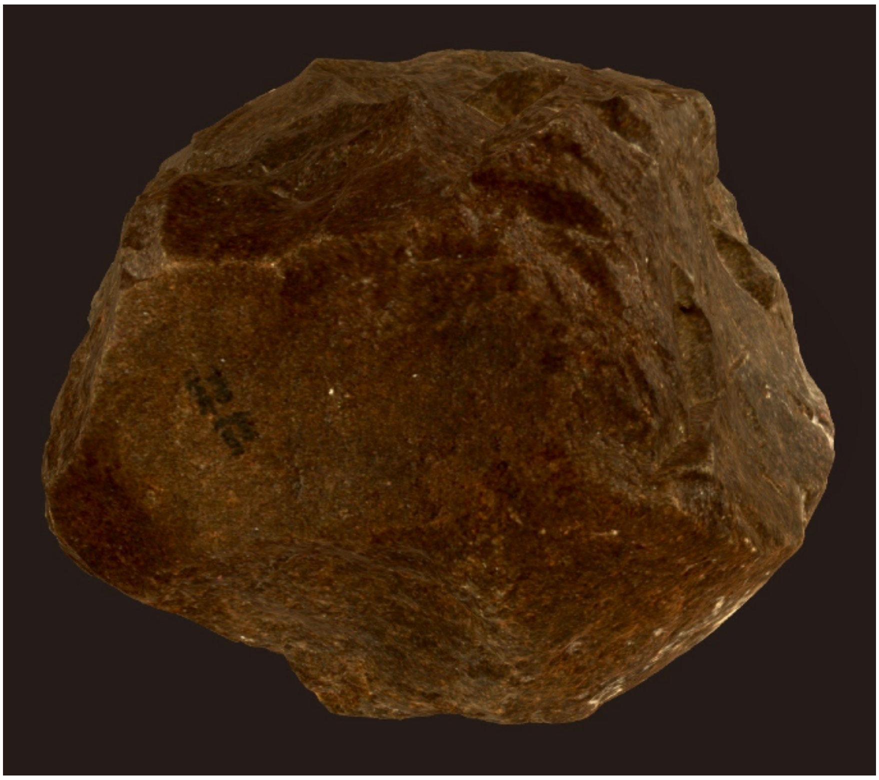


Figure 3.7: Bottom-view of GaJg1 from Lomekwi-3. From: africanfossils.org.

To find the answer we must turn GaJg1 to the position in *figure 3.7*. In this screenshot we see the core from what in *figure 3.5* was the bottom. We now see points of percussion which are close to the centre of the core. But we saw in *figure 3.2-3.3* that all freehand-strikes have to be near to the edge, because a freehand-strike further from the edge comes to a dead end. The strikes in *figure 3.7* produced negatives at percussion angles of more than 90 degrees whilst *figure 3.2* told us that this can absolutely not be done from the free hand. So the core GaJg1 gives us 100% certainty that the Australopithecus at Lomekwi-3 still used the technique that was invented by cracking bones to eat the marrow: 3.3 Ma our ancestors still worked on the floor (OBF).

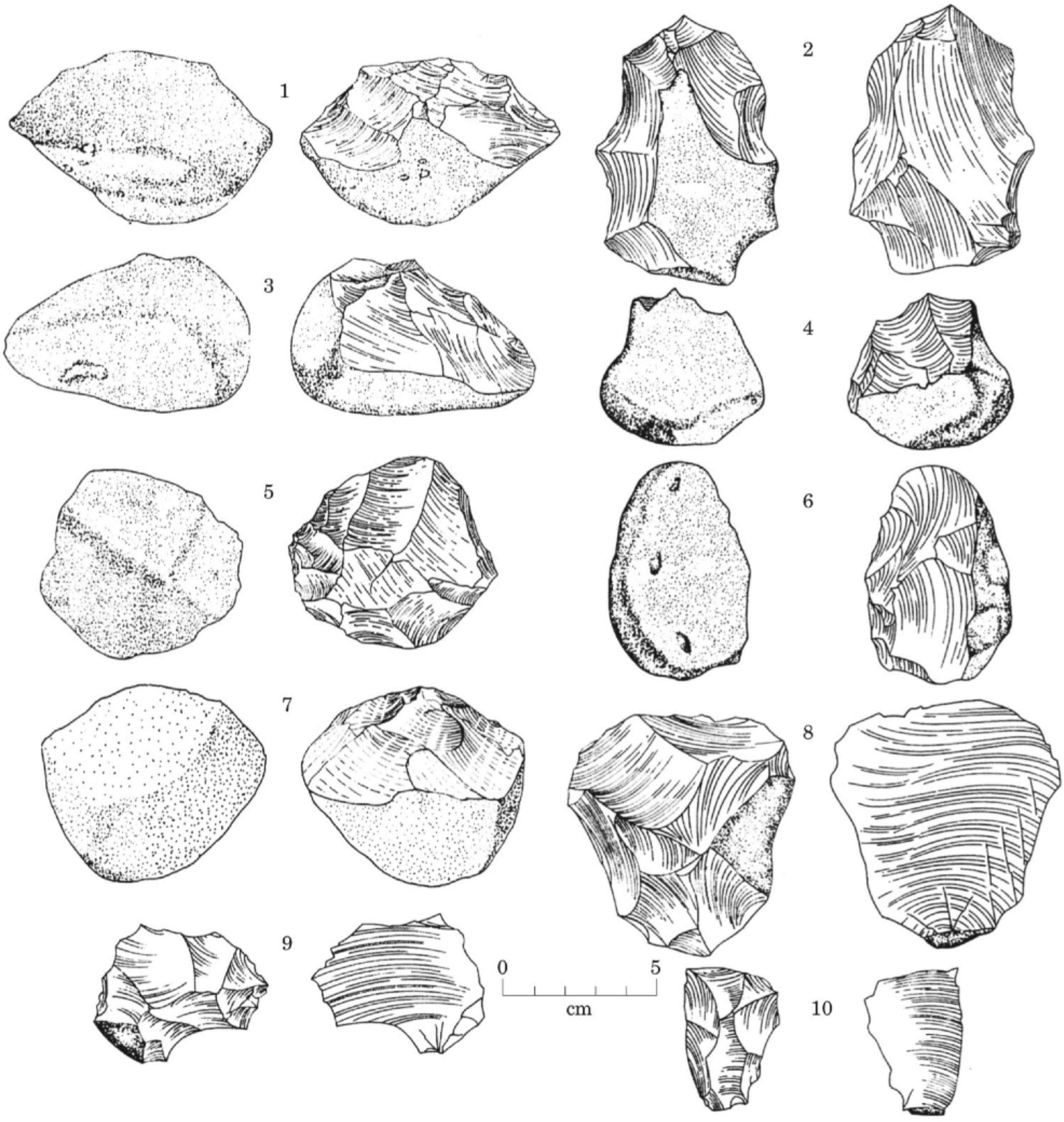
Gona
Stepping forward in time brings us to 2.6 Ma: this is the beginning of the pleistocene, the phase when the Australopithecus evolved into the more intelligent early-Homo. This brings us to the question whether early-Homo still used OBF. Did early-Homo perhaps believe that freehand flaking gave better results? The 2.6 Ma artefacts from Gona can help us answer this question, we are fortunate that Sileshi Semaw published some very good artefact-drawings (*figure 3.8*). These drawings show the exact flaking-signals even clearer than photos. When we understand these flaking-signals we can tell which method was used.

The names of the flaking-signals are shown in *figure 3.2* (drawing by Schick and Toth). I will begin by explaining the ripples. Most people assume that the ripples are shock-waves, because their form resembles the waves which appear when a stone falls into water. But shock-waves are always perfectly circular whilst we often find a ripple pattern that runs parallel to the outer surface of the stone. So clearly the ripples cannot be waves, they are instead a registration of the compression-pattern during the time of the fracture. Stone is very rigid so this material cannot wrinkle in a way that is visible to the naked eye, but the compression does result in an invisible strain-pattern. In transparent materials like glass, physicists can make that strain-pattern visible with the help of the polariscope technique. We can send a beam of monochromatic (= one color) polarized (= waves in just one direction) light through a glass model. When we compress the glass model the microscopic particles deform and this changes the direction of the wave-polarity: the waves spiral. We can make this effect visible by placing a polaroid filter in the light-beam coming from the model. A pattern now appears of light and dark lines, that looks exactly like the ripple-pattern. When the glass (or the stone) breaks the rupture follows the greatest strain, so it follows this pattern. Experiments with the polariscope demonstrate that the lines become weaker (or even disappear altogether) when the pressure is divided over a larger contact-area. This is interesting because it explains why a soft (antler) hammer produces a weaker ripple-pattern. And when you work on the floor, the pressure from the ground is normally divided over a wide contact-area; this explains why we hardly ever see any ripples starting from the floor-contact in OBF.

It is important to understand that the strained material has a similar effect on the rupture as on the polarized light-waves. The polariscope image forms because the light-waves spiral when they pass through strained material and the rupture-front tends to spiral in the same way. But there is one big difference: whilst the light can spiral freely through the transparent glass model, the rupture cannot spiral like it wants to do. Because the rupture has to follow a predetermined path; it must always stay in the plane with the greatest strain. So when the rupture tries to spiral away from this obligatory route, it comes to an abrupt stop. Then it immediately restarts within the plane of the greatest strain; this corrective process causes the bulbar scar and the fissures. In freehand-strikes the compressive strain reaches its maximum on the bulb, immediately below the point of percussion. So this is the first place where the rupture spirals away, stops and restarts: this forms an abrupt narrow ridge on the bulb. This ridge tears a splinter away as the flake shears down the core; this tear is called the bulbar scar. As the rupture spreads the compressive-strain decreases. But when the rupture comes closer to the outside of the stone, it becomes easier for the material to stretch to the sides. This stretching increases the deformation (= strain) so when the rupture comes close to the edges of the flake, the effects of spiraling-stopping-restarting reappear. The narrow ridges which form here are called fissures. The spiraling explains why each fissure on close inspection looks like an overstretched S running in the direction of propulsion of the rupture.

We can now use this understanding of the flaking-signals to interpret the ruptures in *figure 3.8*. Flake number 8 shows a peculiar pattern: the point of percussion is at the bottom so we expect the ripples to run from the bottom to the top. But the ripples on the left side are running in the opposite direction: this flake is one of the very rare OBFs with a bipolar ripple-pattern! If you fear that the ripples may have been drawn incorrectly, please look at the fissures. Freehand-fissures always point towards the hammer struck, but these fissures indicate that a second force came from the opposite side. So the flaking-signals prove beyond any doubt that flake number 8 is an OBF. Number 8 clearly has a well-developed model with a functional cutting edge and the dorsal negatives are almost like in a Levallois (Mode-III) flake. So this confirms that bipolar flaking is not at all a primitive-clumsy method; the experienced OBF-makers at Gona produced well-developed flakes. Number 9 is another example; the three very small negatives at the right side look like a Levallois-prepared platform. But these negatives were not used as platform, the real point of percussion lies just to the left of these negatives. So the hammer actually struck on the cortex that we see in the left drawing. This means that the percussion-angle was larger than 90 degrees, so number 9 also is an OBF. The top of number 7 is formed by a large cone, so the stone was not struck near its edge but almost from the middle. It is impossible to flake a cobble from the middle without the support of the ground (or on an anvil) so number 7 was also made with OBF. The signals in this drawing prove that at least 3 out of the 10 objects were made with bipolar technique. OBFs look so much like freehand flakes that experimentalists call both hard-hammer percussion (page 27-28). So if we are able to recognize 3 out of 10 artefacts, it is statistically highly likely that all other artefacts in this drawing were also made with bipolar technique.

Figure 3.8: Flakes and cores (or choppers) from Gona. From: Semaw, J.A.S. 27 (2000) pg 1206.



Olduvai Bed-I
Our next step forward in time brings us to the 2.4 and 1.8 Ma sites in the famous Olduvai-gorge (Tanzania). The early Homo (habilis or rudolfensis) at FLK (a 1.8 Ma site, photos at the frontpage of chapter 3) was on the brink of becoming Homo erectus. Did this nearly-erectus stil use OBF or did he flake from the free hand? The drawing (from Schick and Toth) in *figure 3.9* lays in a show-case at the Olduvai-museum; it shows how a freehand-chopper is made. The experimentalist uses the

flat part of a cobble in drawing number 1 as platform to remove the first flake. Because the edge of the cobble is rounded, he has to strike further from the edge than in *figure 3.2* so he has to hit with far more force. The experimentalist has to swing his hammer as fast as is humanly possible so of course he tries to make the second flake in an easier way. He does this by turning the cobble over as we see in drawing 2. This enables him to strike much closer to the edge, by using the first negative as platform. The second flake now takes a far less vigorous strike. In drawing 3 the cobble is again turned to make a third flake and drawing number 4 shows the final result: three flakes and a core with bifacial removals. Experimentalists use this freehand-method to make choppers and the Acheulean handaxe-makers in Europe used this method around 0.5 Ma to make Mode-II choppers. But did the Mode-I toolmakers in FLK 1.8 Ma also use this freehand-method, or did they still make tools with OBF just like their ancestors at Gona 2.6 Ma?

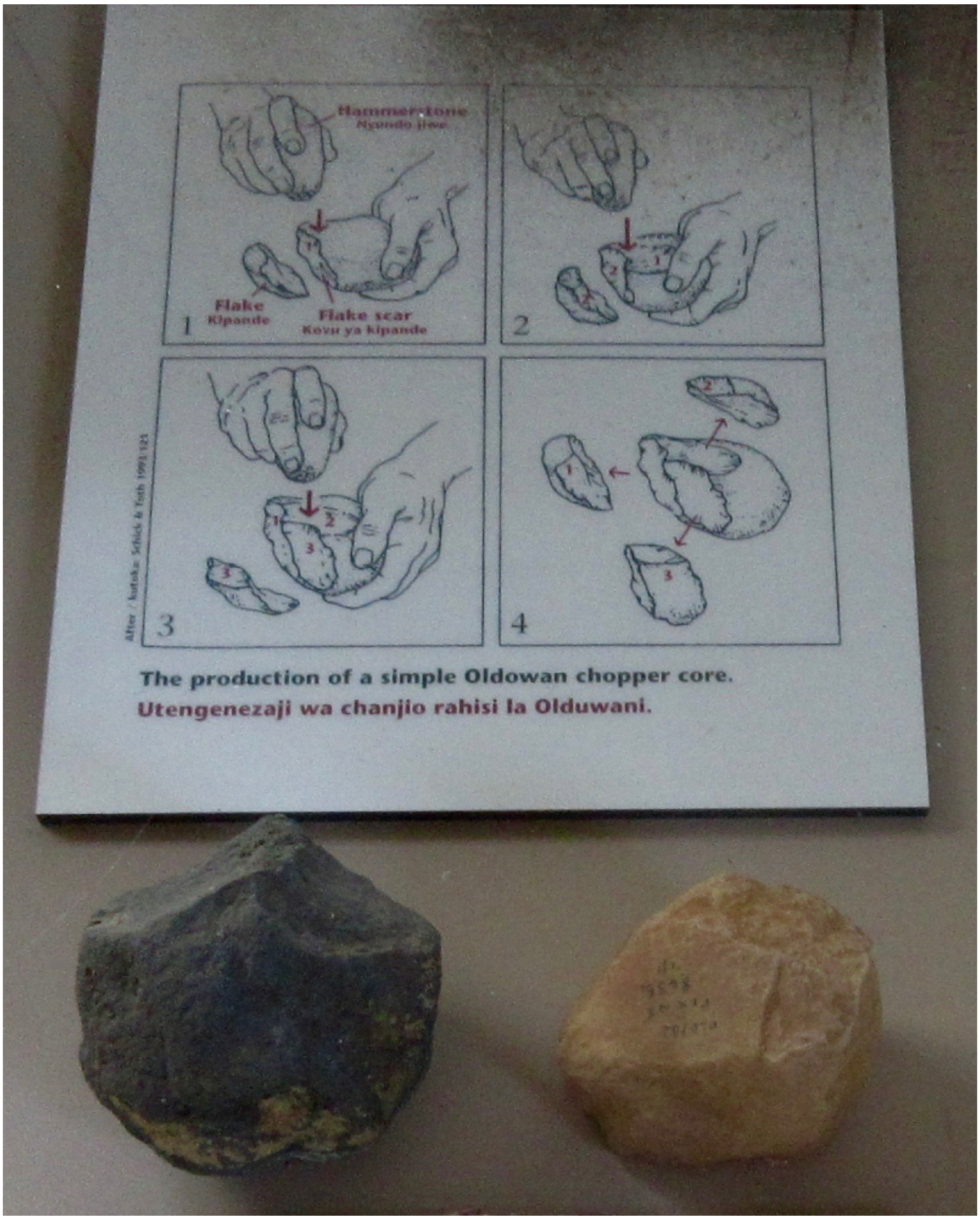


Figure 3.9: Show-case in the Olduvai museum with a drawing from Schick and Toth and two Mode-I choppers or cores from Bed-I.

It is very clear that the Mode-I choppers in *figure 3.9* don't look like the freehand-chopper in the drawing. I am sure that Leakey also saw the differences, but he probably explained them away by assuming that their makers were too unintelligent and too unskillful to create the form in the drawing. The flaking-signals however tell a very different story; what really happened becomes clear when we look at the depth of the flaking-negatives in the dark-grey chopper. You have to be extremely skillful and need tremendous strength to strike freehand-flakes this far from the edge, but it is very easy to copy this form when you put the cobble of the floor and use OBF. The dark-grey chopper is not an unskillful attempt to make a freehand-chopper, it shows the clever and skillful use of bipolar technique. This toolmaker did not need to turn the cobble because he did not need to use the first negative as platform; he used OBF so it was very easy for him to make the second deep negative next to the first. This is not a bad freehand-chopper but a good bipolar-chopper. This toolmaker did not need to turn the cobble over because he was a 'habitual' OBF-user, working on the ground was his standard-method. The form of the light-grey core in *figure 3.9* also indicates bipolar technique because 'habitual' freehand-flakers always use the flattest part of a cobble as platform. We already saw this in drawing 1 and also at the top-left in *figure 3.1*. The light-grey stone was instead repeatedly struck on its rounded side, exactly where you can expect a freehand strike to bounce. This artefact is presented as a chopper but in my opinion the centripetal flakes may have been the toolmaker's primary objective, I would therefor prefer to call this a core. There are very few cores in Mode-I that resemble the neolithic model in *figure 3.2*, most Mode-I cores have odd shapes. The most recognizable Mode-I core-type is the polyhedron, examples can be seen in *figure 3.10* and at the top-right of the frontpage of this chapter. You can make a polyhedron-core from the free hand but that is difficult and very inefficient, so there are very few polyhedron-cores in freehand (Acheulean and in neolithic) sites. But when you flake cobbles on the ground rounded polyhedrons occur spontaneously. The smaller negatives along the main edge of the core in *figure 3.10* may represent deliberate retouches, made with the objective to use this stone as a heavy-duty scraper.

Figure 3.10: The large negative on the left picture of this polyhedron was a we see in the center repeatedly used as platform for smaller removals. The right picture shows that the edge this created may very well have been used as heavy-duty scraper. Olduvai Mode-I.

Bipolar toolkit concept

Our experiments confirm that OBF is the easiest and most reliable technique to flake rounded cobbles. The forms and the flaking-signals of Mode-I tools confirm that these were made with bipolar techniques. All Mode-I tools can experimentally be reproduced with bipolar methods; Mode-I-types which require the use of freehand flaking methods do not exist. Of course it is possible that some Mode-I flakes were struck from the free hand, but these are incidents. The 'habitual' technique of Mode-I was bipolar, Mode-I is therefor part of the bipolar toolkit concept.

This conclusion is not limited to the three sites in East-Africa we just discussed. Bipolar flaking was for instance also used in the North-African Mode-I-sites Ain Boucherit (*figure 3.11*) and Ain Hanech. Bipolar flaking was the leading technique for all hominids during a period of one and a half million years, from 3.3 Ma (Lomekwi-3) to 1.8 Ma (i.e. FLK). Early-man has in this long period undoubtedly tried how it would be to flake from the free hand, but he was never fully satisfied with the results. The first problem was that he had to hit harder when he struck from the free hand. The use of predominantly rounded cobbles led to the second problem: when early-man struck from the free hand frustratingly many strikes bounced. The third problem was that our Mode-I ancestors had learned to control the direction on the rupture by choosing the point of percussion and the point of support, this is a very effective directional-control method. It is much harder to develop directional-control with the freehand method, this takes a lot of practice. Most incidental freehand strikes were therefor disappointing and the bipolar technique was guaranteed an easy production of all the tool-types Mode-I hominids wanted. The Mode-I tool-types may look clumsy to the untrained eye because there are no standardized forms, but on closer inspection you see very functional points and cutting edges.

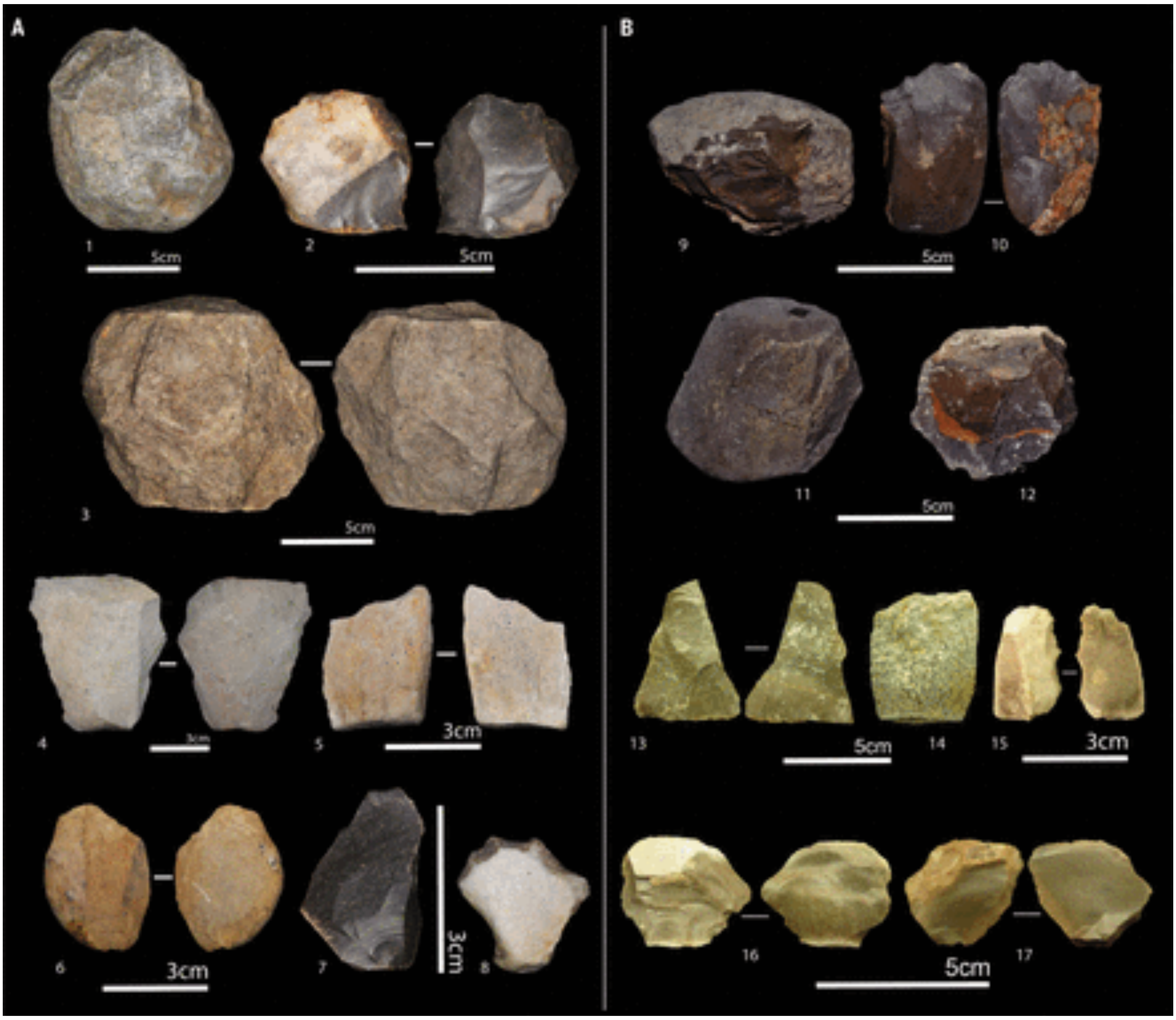


Figure 3.11: Mode-I artefacts from Ain Boucherit, Algeria. From: M Sahnouni et al, DOI: 10.1126/ science.aau0008.

When you understand that Mode-I was based on bipolar flaking and Mode-II on freehand flaking it becomes clear that transitional industries between Mode-I and Mode-II cannot exist. For anyone who does not know that Mode-I is bipolar, it seems perfectly plausible that the Mode-I choppers would over time have developed into handaxes. We saw in *figure 1.3* that Bordes was trapped by this idea and so were Louis and Mary Leakey. They believed this happened through the development of the intermediate form of the proto-biface or proto-handaxe. They tried to find support for this theory by calculating the percentages of choppers, proto-bifaces and handaxes in every site, but ultimately had to admit that there were no transitional industries in their research-area (Olduvai and adjoining parts of Tanzania and Kenia). It was undeniable that the Acheulean succeeded Mode-I very abruptly. Even then they still believed so strongly in their theory that they concluded this meant the gradual development from chopper via proto-biface to handaxe must have taken place somewhere outside of the investigated area.

Today we know that the Acheulean did not only have an abrupt beginning in Olduvai; Mode-I was suddenly replaced by Mode-II all over Africa. It almost seems as if the same persons who on Monday made Mode-I tools on the ground, for some mysterious reason changed to freehand flaking on Tuesday and to everybody's surprise learned to make flat handaxes on that same day. So what was this mysterious reason? Some researchers believe that it was the sudden evolution of a more intelligent hominid-type: the Homo erectus (some scholars prefer to use the name Homo ergaster for African hominids). I do not deny that our ancestors were around the same time gradually developing a larger brain but that is not the reason. The real cause of the transition from Mode-I to Mode-II was a rather simple, inevitable and logical process. I will explain in chapter 5 when, why and how this happened. But first we should in chapter 4 look at how our Mode-I ancestors spread out of Africa.

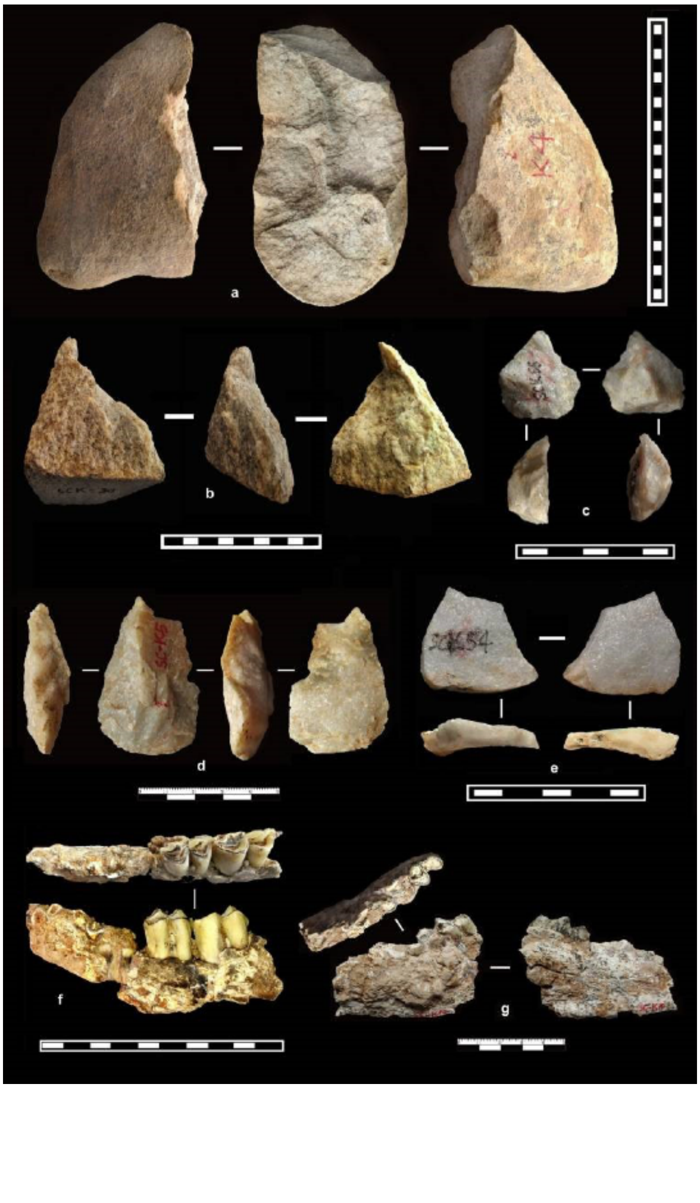
Next page, frontpage Chapter 4: At the end of the 20th century the APAN group-west investigated Mode-I sites at West-Runton (England) that were exposed by the coastal erosion. The continuing erosion has now destroyed most of the beds, only a few hard-ground parts remained. This photo shows hard-grounds above the sand, with at the left a polyhedron and a large flake with dorsal negatives near the tip of the hammer.


Estwing

Chapter 4: The pioneers

Out of Africa
If we want to understand how the Mode-I toolmakers spread from Africa into Eurasia, we should first study how the horse spread from Asia to Europe at the beginning of the pleistocene. The global temperatures dropped and the oceans cooled down around 2.6 Ma, this led to decreasing rainfall because the ocean became colder and therefor evaporated less water. The result of the drought was that many of the forests that covered Eurasia at the end of the pliocene disappeared. These forests were replaced by grasslands: at the beginning of the pleistocene a great steppe reached from Asia all the way to Europe. Horses found plenty of food on these grasslands so they could simply eat their way from Asia into Europe, by following this grassland-corridor. This is what paleontologists call a migration-event. A popular theory claims that early-man migrated from Africa to Eurasia in a similar migration-event. It is obvious that early-man found most of his food in open landscapes, many sites have been found on the African savanne. So it seems plausible that Mode-I hominids just like the horses could have followed the grassland-corridors. But a man is not a horse: horses can get a large part of the water their body needs from the grass they eat and hominids cannot do this. The Mode-I hominids needed drinking-water, they went into the open landscape to find carcasses and other food but always had to return to places with water. Early man was therefor not a grassland-species like the horse, but a river-valley species.

There has never been one unbroken river-corridor from Africa to Eurasia, so it is unlikely that the out-of-Africa took place in one migration-event. Instead the migration must have gone step-by-step: settling one valley at a time. When the population in one valley grew, the next generations had to walk further in search of food. The search for food ultimately drove individuals to a next valley. They formed a new group and under the right conditions that new group also grew. So the climate obviously had a great influence on the step-by-step migration. Large parts of the Middle-East were often so dry that they formed a bottleneck or even completely stopped the process.



The Yellow River
We have no idea when our ancestors first left Africa or when he arrived in India. But we do know that early-man already lived in China before 2 Ma. Mode-I tools dated to 2.1 Ma have been found at Shangchen (East-Chinese province Lantian, near the Yellow River). *Figure 4.1* shows simple flakes and a core that may have been used as a chopper. These stones were found in loess, this is an aeolian (wind-carried) sediment so early-man must have carried the stones to the site. So they are artefacts according to the criteria in *figure 1.5* and we can also be sure that the finds are correctly dated because the Chinese loess stratigraphy has been well-studied (see *figure 1.4*).

Figure 4.1: Mode-I from the loess plateaus near the Yellow River. From: Zhaoyu Zhu, https://natureecoevocommunity.nature.com/users/115195-zhaoyu-zhu/posts/36721-hominin-may-have-left-africa-much-earlier-than-than-previously-envisaged

This brings us to the question why early-man spread out-of-Africa, whilst his close relative the chimpanzee stayed behind. There is no doubt that early-man's growing intelligence was his most distinguishing characteristic, so it seems plausible that early-man conquered Eurasia as the result of his growing brain. Until recently many scholars believed that the large-brained clever Homo erectus became curious to see what lay beyond the horizon and ventured into the unknown. But China was settled before the Homo erectus evolved. Should we therefor conclude that the Homo habilis was more intelligent than we thought? That is a romantic theory, but we know that all other species simply migrated to the places where they found food. Food was the reason why the horse walked to Europe around 2.6 Ma and the lack of food is the reason why chimpanzees stayed in Africa; they only find food in a limited territory. That brings us to the question what sort of food our ancestors ate at Shangchen. The site lies at 35 degrees north, so nearly at the same latitude as Ain Boucherit. But the winters at Shangchen are colder due to the monsoon-winds that blow from the northwest on the Chinese loess-plateaus. So a chimpanzee could not survive in Shangchen because he cannot find the fruits he needs, but our ancestors were less picky about their food. At the end of the pliocene our African ancestors had become scavengers to survive the competition. Scavenging must have provided the Mode-I hominids at Shangchen with the calories that they needed to survive the winters on the Chinese loess-plateaus. Our ancestors ate a lot of fat and proteins from carcasses, this food-source enabled early-man to leave Africa. Whilst chimpanzees only ate a few small preys; they depended on fruits and this forced them to stay behind.

Dmanisi
The survival of the fittest adapted all species to their environments. Early man had to adapt to a wide range of climates and landscapes for hundreds of thousands of years, so the survival of the fittest over time resulted in many hominid-types with a wide range of adaptations. For instance skull KNM-ER 1470 differs so much from the Homo habilis OH 24 and KNM-ER 1813, that some paleontologists consider 1470 to be a different species: the Homo rudolfensis. They believe that this rudolfensis must have been our true ancestor whilst the habilis went extinct. Others believe both types belonged to the same species, so who is right? A biologist tell if two individuals belong to the same species by testing if these individuals will interbreed. For instance a chihuahua looks far more different from a poodle than 1470 differs from 1813 and OH 24, but a chihuahua and poodle can interbreed and produce fertile offspring. This proves both belong to the same species: canis familiaris. Sadly we cannot test if fossils interbred, a paleontologist must therefor rely on how they look: every paleontologist would therefor define the chihuahua and poodle as separate species. The hominid fossils from Dmanisi forced paleontologists to become more flexible; the first finds were called Homo georgicus as if they represented yet another new species. As more fossils were discovered, it became clear that some looked like Homo habilis and others like Homo erectus. But we know that they all lived at the same place at the same time so it is very likely that they lived together, had children together and therefor were one species. This proves that a group of early hominids could contain far more diverse individuals than we see in any group of Modern man. This is an important finding that also makes us rethink the differences between hominids elsewhere. I will explain in chapter 10 why Moderns have lost so much of the genetic biodiversity of the hominid species and ended up with such a strictly uniform anatomy.

Around 1.8 Ma the environment of Dmanisi was very attractive to the early hominids. The site lay in a halfopen landscape, where two rivers came together and formed a lake. But there were also open grasslands and forests nearby, the diverse landscape gave provided a various food-sources and the rivers brought ample raw materials to make stone tools. If someone wanted to make a stone tool he only needed to walk for say two hundred meters to the riverbed, pick up a cobble and strike it once or twice with another cobble. In economic terminology you could therefor say that new clean and sharp tools were very cheap. Archeologists call such cheap disposable tools expedient technology; Mode-I tools are predominantly expedient. Archeologists call the more expensive tools (in the sense that they cost more time and effort to make) curated technology; retouched scrapers and Mode-II handaxes are examples of curated technology.

Dmanisi was visited many times by hominids around 1.8 Ma because it was such an attractive site. All of these hominids made many disposable tools so when I visited the site in 2011, more than 20.000 artefacts had already been excavated. This great number made Dmanisi the ideal site where I could test if the hypothesis in chapter 2 (my claim that OBF was the main technique during Mode-I) is also valid outside Africa.

Figure 4.2: A blade-like basalt flake from Dmanisi (8 cm long, drawings are not to scale), compared to an experimental bipolar flake. From: https://NP32_159-164_vdDrift_Oblique-bipolar-flaking_111212_600-p

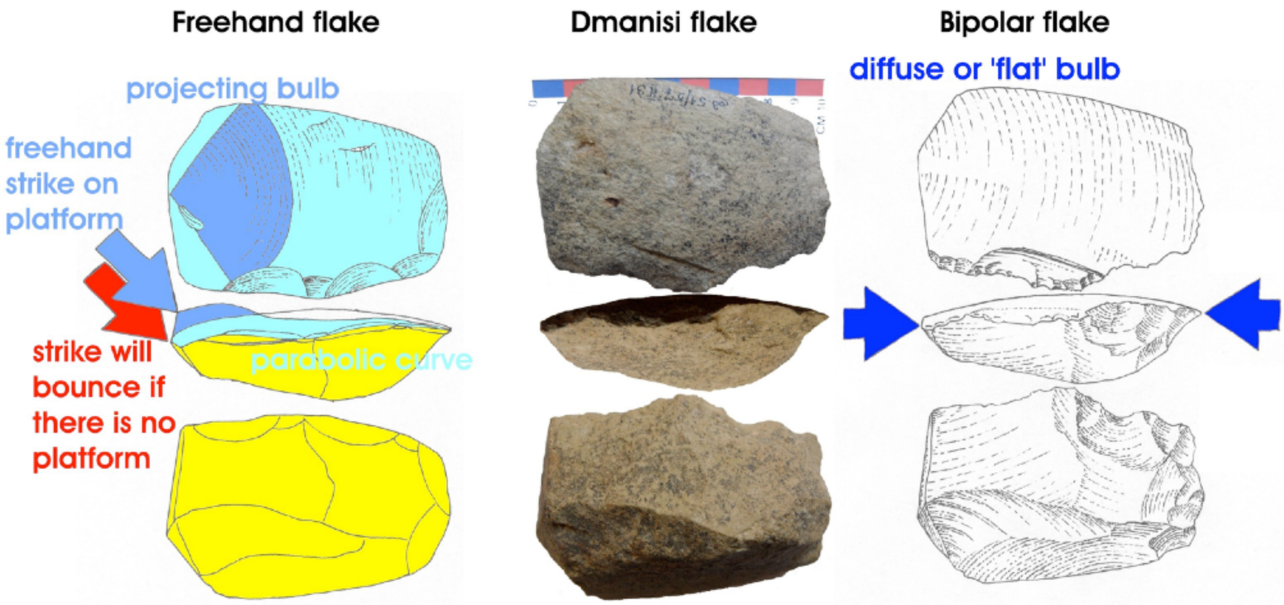


Figure 4.3: Flake with dorsal negatives from Dmanisi. From: https://NP32_159-164_vdDrift_Oblique-bipolar-flaking_111212_600-p

Bipolar signals in Dmanisi

Some flakes from Dmanisi are rather large, for instance the flakes in *figure 4.2* and *4.3* are 8 cm and 10 cm long. These flakes are impressive and well-developed tools: *figure 4.2* resembles a blade and even has a lip instead of a bulb. Such a lip is considered typical for blades that were struck from the free hand with a soft (antler) hammer. Horace Bertouille explained that these lips are caused by the very wide contact-area between the flexible hammer and the platform. But the very large scar (= central ‘fissure’) on the ventral surface proves that a tremendous force made this flake, so this cannot be the result of a soft-hammer strike. This scar even reaches beyond the middle of the flake so it must be a bipolar flake. We tested in an experiment if it is possible to make such a lip with bipolar technique. Ton van Grunsven put a basalt core on an anvil; when he hit the top of the core a flake started from the anvil-contact. By positioning the core carefully on the anvil van Grunsven had created a wide contact-area, so this test produced a basalt flake with a lip. In chapter 7-8 we see that this inversed-bipolar-technique (where flakes start at the anvil) was often used by far younger industries.

The flake in *figure 4.3* has dorsal negatives that create a resemblance to Levallois-flakes, much like what we saw in Gona. But this cannot be a freehand-flake because it would then look like the drawing at the left: a freehand flake would have a platform (dark-blue) because freehand flaking requires a percussion-angle below 90 degrees (*figure 3.2*), a bulb (also dark-blue) and a parabolic fracture (light blue). A freehand strike (always at 130 degrees to the direction of the fracture, so directed like the red arrow) would have bounced. The complete ventral face of this flake forms one diffuse curvature, this sort of all-inclusive curvature is called a diffuse or ‘flat’ bulb. Bipolar fractures very often show such flat bulbs, but I must emphasize that most OBFs closely resemble freehand flakes. *Figure 4.4* shows an example of a flake that in most aspects looks as if it was struck from the free hand, but here the very large scar tells us that this must also be an OBF. The flaking-signals of bipolar fractures show a far greater variability in form and size than the signals of freehand fractures.

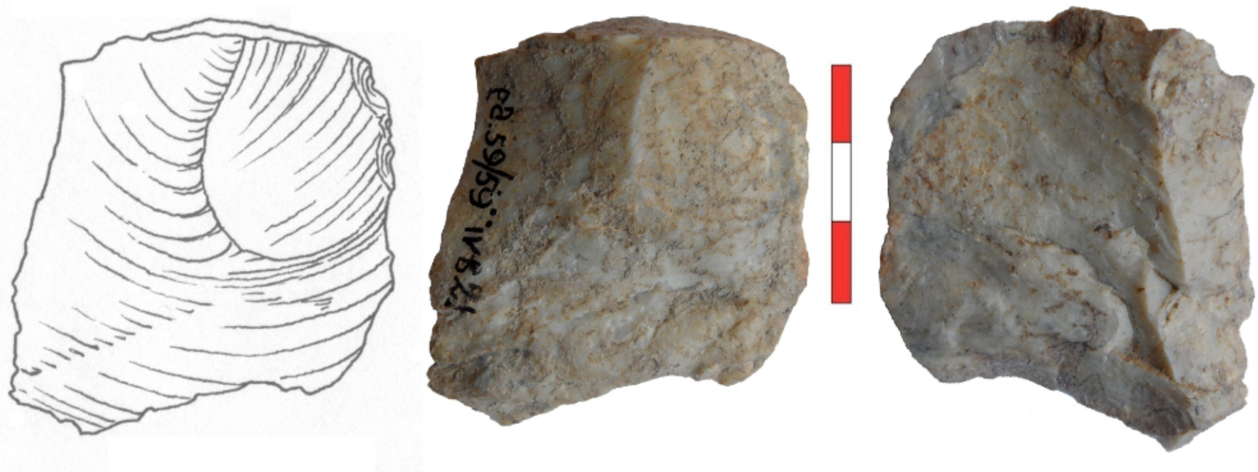


Figure 4.4: OBF from Dmanisi with a large scar. Georgian National Museum.

Figure 3.8 shows that 3 out of 10 artefacts from Gona have obvious bipolar flaking-signals. To reach the same ratio in Dmanisi I would need to show that 6000 of the 20.000 artefacts have obvious bipolar flaking-signals; this would take unrealistic amounts of time and space. But the ‘general habitus’ of the Dmanisi-toolkit does convincingly support my claim that OBF was the standard technique. Thew term ‘general habitus’ is often used by veterinarians to express the health of a patient without using exact numbers; is the patient generally well-groomed, well-fed, active, happy or not. The flakes in *figures 4.2-4.3-4.4* are some of the most beautiful show-pieces from Dmanisi, these are exclusive museum-exhibits. If we instead just grab a few objects in the depot of the Georgian National Museum we get *figure 4.5*. This is the real deal if we do not select pieces for aesthetics or other reasons, you could therefor call *figure 4.5* a random sample that shows the ‘general habitus’ of the Dmanisi-toolkit. We know that these stones were carried from the banks of the river to the site and they all clearly show fractures, so they are all undoubtedly Mode-I artefacts. But they are hard to classify, specialists therefor use the rule that artefacts with a large positive surface are classified as flakes and the artefacts in which the negative surfaces prevail are classified as cores. So the stones in *figure 4.5* are all classified as flakes and cores but are not at all like Acheulean or neolithic flakes and cores. When you remove all handaxes from an Acheulean site the remaining flakes and cores still look highly standardized, but the forms in *figure 4.5* (or those on the frontpage of chapter 3 from Olduvai) are not at all standardized. This ‘general habitus’ is typical for bipolar industries: we know that these objects are man-made because they were found in fine-grained beds with hominid fossils (see *figure 1.5*) but without that context (if they were found in a random field) we would assume these stones were natural fragments. This can only mean one thing: the hominids who made these artefacts did not use the same flaking methods as the Acheulean or neolithic hominids. These stones look like natural forms because the hominids who made them used the same method as nature: they used bipolar forces! We can forgive Louis and Mary Leakey for not recognizing this in 1959 and blaming that 'general habitus' on a lack of skills because in 1959 people still thought the evolution was a continuous process of improvement. People for instance believed that the brains of big dinosaurs were too far from their legs and this made them so slow they went extinct, today we know that evolution is not about improvement but about adaptation (chapter 2). Our early ancestors had smaller brains so they did not have our intelligence but our experiments show that highly skilled experimentalists make cores and flakes with exactly the same 'general habitus' if they only flake on the floor. So there is no reason to think that the makers of Mode-I were primitive and lacked the necessary skills.

Figure 4.5: These artefacts from Dmanisi look just like natural fragments because nature also breaks stones with bipolar techniques. Georgian National Museum.

Northwest-Europe

Mode-I toolmakers did not build houses and it is very unlikely that they could make fire, most researchers therefor believe that Dmanisi (at the latitude of 42 degrees north) must have been the furthest north that hominids were able to survive around 1.8 Ma. I strongly disagree because right at that moment in time, the Netherlands had the same subtropical climate as in Dmanisi. We find fossils from the same animal species at 51 degrees north in the clay from Tegelen (the town from which the name Tiglian-stage was derived) as are found in Dmanisi. Including the hippopotamus; I consider the hippo a very important indicator because just like hominids this animal stayed close to water. Just like hominids he did nor cross large dry areas and did not climb high mountains and just like hominids the hippopotamus looked for food in halfopen or open landscapes. So if the hippo could reach the Netherlands 1.8 Ma, early man must also have been able to get here.

Did early-man visit Northwest-Europe? Early-man and prehistoric animals were extremely popular topics in the Victorian times; we know that many collectors fanatically tried to find the tools early-man used before he invented the handaxe. Sadly the collectors that lived around 1900 had no idea what to look for. Most of them assumed that early-man had already existed since the end of the Cretaceous-period. They believed this tertiary-man was too primitive to make good handaxes and scrapers but nevertheless needed such tools. Tertiary-man compensated his lack of skills by searching for natural flints that already had the shape of a handaxe or a scraper. So when tertiary-man found the correct natural forms, he only had to sharpen their edges with a few retouches. We now understand this is nonsense, it is far easier to break a stone than to look for a desired natural shape. But the collectors around 1900 gathered bruised natural forms and called these 'eoliths'. *Figure 4.6* shows three examples found in gravel of the river Meuse; these more or less have the form of a scraper, a blade and a partially flaked handaxe. Today everybody understands that these are pseudo-artefacts, natural-shapes with damaged-edges. But around 1900 many scholars still believed the eolith-theory and these scholars felt cheated when it became clear that the collectors had unknowingly made a great mistake. It is understandable that some scientists are even today, a century after this happened still disappointed and suspicious of all primitive forms. So we saw in chapter 1 that *figure 1.5* was the result of the developments in the eighties. But the historic events also contributed to the mindset, especially in the Northwest of Europe (where the eolith-collectors had been most active). Whist scholars in Southern-Europe kept their faith in the primitive forms from le Vallonet and other early pleistocene sites.

Figure 4.6: Pseudo-artefacts; flints shaped by natural pressure. The damaged edge makes the natural flake at the top resemble a scraper. Bottom left we see a natural blade and right a form that resembles a small handaxe. Meuse gravel.

West-Runton

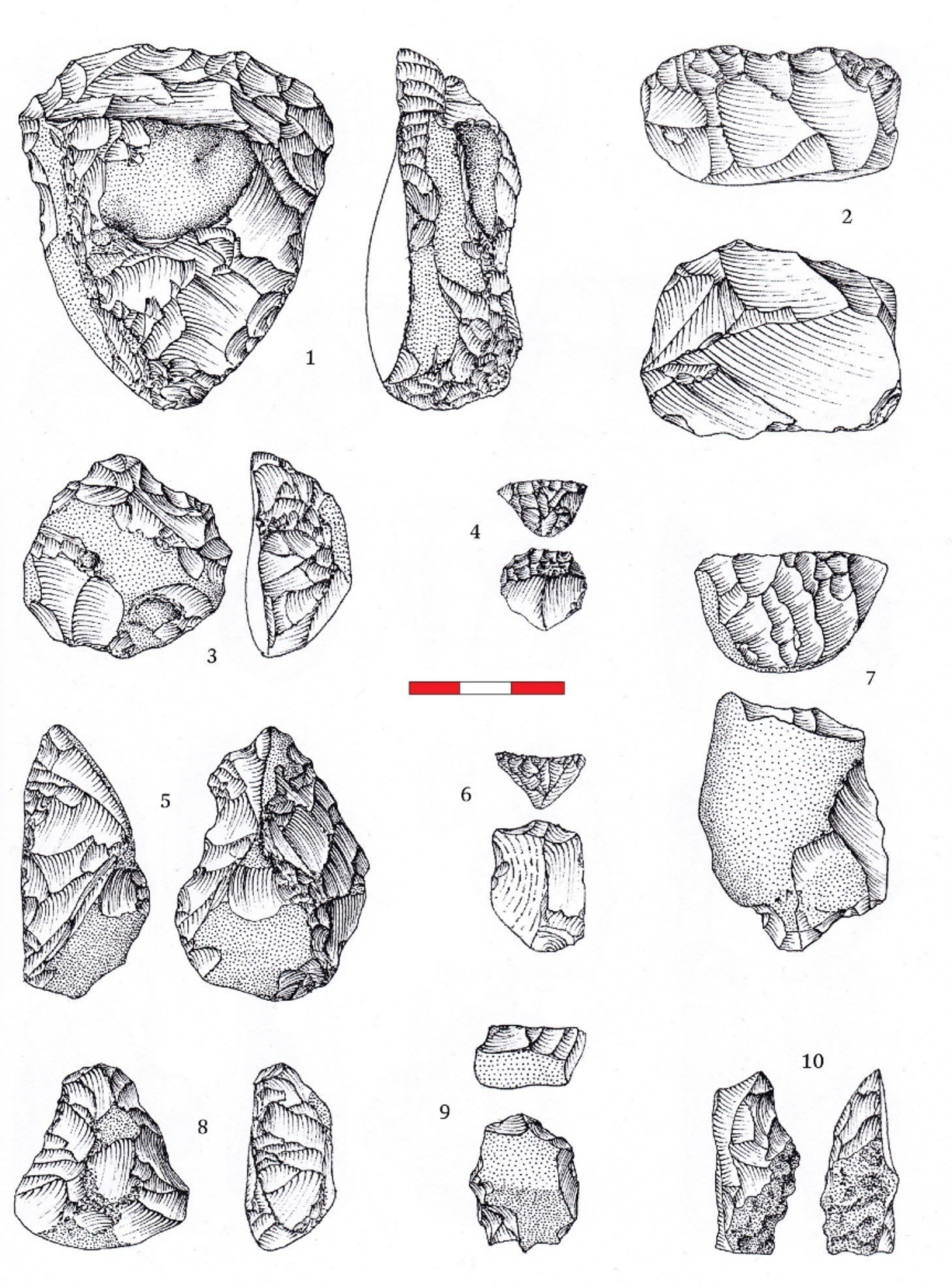
Dutch collectors became very interested in pebbletools during the eighties. Many collected tools in sands that had been dredged from the sea-floor off-shore Great-Yarmouth. Around 1990 they saw that Roebroeks rejected these pebbletools, they therefor decided to take the research into their own hands. One group of collectors went to England, in an effort to link the dredged pebbletools to similar artefacts on land. They hoped to find pebbletools in the Cromer forest-beds, but instead found Mode-I tools at West-Runton in a bed called the stone-bed. To their surprise this bed dated back to the end of the Tiglian (1.8 Ma). Sadly they did not find hominid fossils and the tools are made from flint that naturally occurs in the stone-bed, so we cannot prove that stones were carried to the site. West-Runton can therefor not meet the criteria in *figure 1.5*. To make matters even worse, the Mode-I tools from West-Runton are harder to recognize for the untrained eye than the Mode-I tools that we saw in the previous chapter. Because many of the African Mode-I tools were made from cobbles with a naturally rounded outer side. This makes it very easy to recognize the difference between the natural surface and the flaked surfaces; you do not need to be an expert to see that the sharp edges and the point of the dark-grey chopper in *figure 3.9* contrast with the rounded natural shape. West-Runton is certainly not the only Mode-I site that used flint, flint was also used i.e. in Pirro Nord (*figure 4.12*). But the fact that flint-nodules have irregular forms and break into irregular natural fragments severely complicates the interpretation of the forms; when a flint shows sharp edges or points it can therefor be difficult to distinguish whether these are man-made forms, or pseudo-artefacts like in *figure 4.6*.

So we should not be surprised that even professors have completely opposed opinions. Professor Wil Roebroeks dismissed the finds from West-Runton because they do not meet his criteria in *figure 1.5*, but professor Henry de Lumley and professor Gerhard Bosinski approved the finds. The greatest controversy is about the flakes in *figure 4.7*. These flakes show diffuse or flat bulbs and some lack a platform, so the flaking-signals are not in accordance with ‘the diagnostic signals of conchoidal flaking’. Roebroeks believes that this confirms the pseudo-artefact status. But we have already seen that many flakes from Gona and Dmanisi show the exact same non-conchoidal flaking-signals. This only tells us that these are bipolar flakes, it does not tell us if these flakes are man-made or natural. When I told researchers in the Dmanisi-team that many of their Mode-I-flakes showed non-conchoidal signals, they shrugged their shoulders and said ‘but they are always like that’. Bosinski has also participated in the dig at Dmanisi, so it does not surprise me that disagreed with Roebroeks. Bosinski even stood so positive to the flakes from West-Runton that he insisted on personally opening the temporary exposition with the finds from West-Runton at Enschede (in 2014).

Figure 4.7: Flakes from West-Runton. From: the exposition at Twentse-Welle museum, Enschede 2014.

Selective choices
What strikes me most when I look at these flakes from West-Runton, is that their acute edges do not show any acute retouches. Interestingly we also see this in all other Mode-I sites (i.e. in Gona and Dmanisi). But our attention is especially drawn to these intact edges in the toolkit from West-Runton because this contrasts so clearly with the often intensively retouched edges of the thick flakes and fragments. We see this in *figure 4.8*; these retouches are mostly steep and somewhat irregular. The eoliths in *figure 4.6* show steep and irregular natural retouches, so we must wonder if the retouches in *figure 4.8* could perhaps also be natural.

Figure 4.8: Retouched tools (heavy-duty scrapers and pointed tools) on bipolar flakes and fragments found in the Stone-Bed at West-Runton. Drawings from:
Lagerweij et al: Werktuigen uit het Stone Bed van East Anglia 1,8 miljoen jaar BP. APAN/Extern 13, 2009.



But the thin and very fragile flakes in *figure 4.7* do not show any natural damages and these came from exactly the same spot in the same bed. There is no natural-geological process that is able to damage such thick flakes and fragments, whilst selectively leaving the thinnest edges of the most vulnerable flakes intact. The Stone-Bed has preserved even the smallest production waste and has protected the thinnest edges from any damages so there was no destructive geological force. The retouches in *figure 4.8* can therefor only be man-made. But that seems completely counter-intuitive, why would early-man put so much effort in resharpening the steep edges of thick flakes and fragments instead of resharpening the acute edges of thin flakes. In Acheulean and neolithic sites the thick fragments were discarded and nice thin edges resharpened, why would early man at West-Runton do the exact opposite? Tools like the heavy-duty scraper from Olduvai in *figure 3.10* show us that other Mode-I sites also did this; thick objects like this scraper show intense retouches whilst thin flakes were discarded. That is odd: the Mode-I hominids did retouche thick flakes or fragments, but failed to resharpen their best flakes (expedient technology). Does this indicate their brains were primitive or had they all gone mad? No, this was not a matter of lunacy or a lack of intelligence. Discarding thin flakes without first resharpening them was a direct consequence of the predominant use of bipolar techniques.

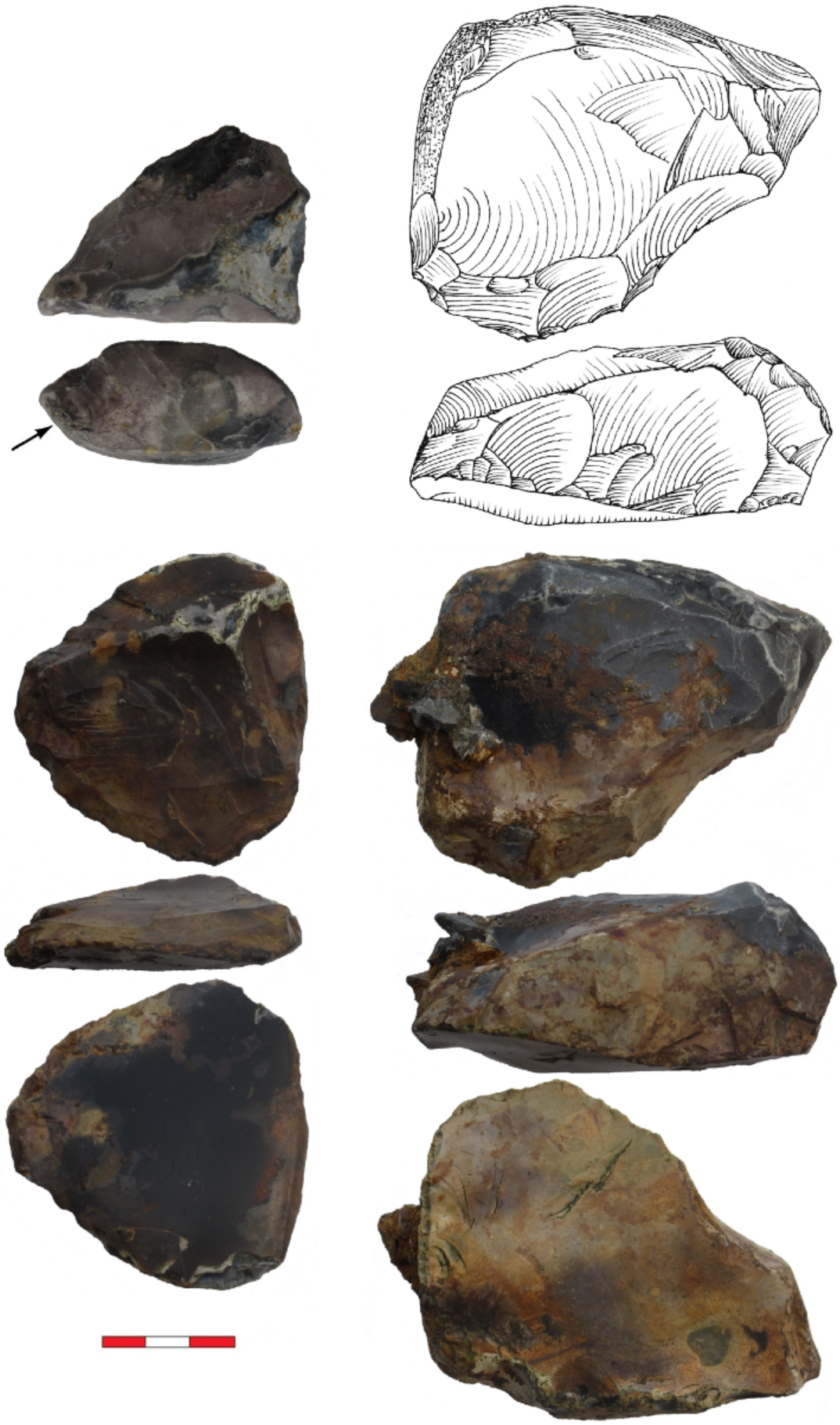


Figure 4.9: The acute edge of the thin Mode-I flake at the left could not be resharpened on the ground, it only shows use-wear retouche. In contrast it was very easy to flake thick fragments or flakes on the ground. The tip of the top-left fragment was resharpened with a burin-strike. The thick flake at the right became a heavy-duty scraper (some of the production waste that was present in the iron-infused matrix still sticks to the scraper). From: the Stone-Bed at West-Runton.

It is easy to understand why the bipolar techniques led to this peculiar phenomenon. The Mode-I hominids were used to work on the ground. So if a nice thin flake with an acute edge became blunt, they could put that flake on the ground and hammer on that blunted edge. But this crushes and totally destroys the edge, the early-hominids were intelligent enough to see that this had no use. It was absolutely impossible to resharpen an acute edge with the Mode-I flaking-method. The Mode-I toolmakers understood this, so they simply discarded the blunted flakes and replaced them by making new flakes. But when the Mode-I toolmakers put thick flakes or fragments on the floor and struck the edge, they could successfully shape and resharpen these thick edges. So whilst the Mode-I toolmakers discarded thin flakes, they skillfully made retouched heavy-duty scrapers. Of course very fine retouches were only possible in good quality raw material. So the lava-cobbles at Olduvai were only suitable for choppers and heavy-duty scrapers, but the flint at West-Runton encouraged the making of very fine retouches and even resharpening of points by burin-like spalls. The difference in the intensity of retouche between Olduvai and West-Runton should therefor not be taken as representing a different evolutionary stage. These differences are primarily related to the different raw materials and to lifestyle requirements.

Rhenen
I believe that Mode-I may have reached West-Runton by following the same route into Northwest-Europe as the hippopotamus, but exactly which route was this? It is not likely that hippos from Northwest-Africa crossed the Gibraltar strait: it is unlikely that the hominids at West-Runton came from Ain Hanech. They probably came over land from the Middle-East. The most likely route through Europe for the hippo was by following the Danube river-valley, this quickly brought him to the south of Germany. The route from the Danube-Altmühl to the Rhine-Main river-system stays below 500 meters so this was an easy walk for the hippopotamus and the Rhine-valley brought him straight to Tegelen where his 1.8 Ma fossils were found. We know that around 40 ka the first Moderns followed the same Danube-Rhine route through Europe and that the neolithic farmers also followed this route into Europe. So it is very likely that the Homo erectus 1.8 Ma also came to Northwest-Europe through this fast and easy Danube-Rhine corridor. England was at 1.8 Ma still connected to the continent, so when Homo erectus arrived in the Rhine-delta he only needed to explore the coastline over a very short distance to reach West-Runton. Early-man could in theory also have travelled to Southwest-Europe by following a southern route along the Mediterranean coastline and then have travelled in a second phase along the Atlantic coast to Northwest-Europe. But this is a far more difficult and thus far slower route into Europe. Especially along the eastern part of the Mediterranean, because here early-man would need to step by step and often in difficult terrain settle a great number of river-valleys.

If early-man came to West-Runton following the Danube-Rhine route, there could also be 1.8 Ma sites in the Netherlands along the Rhine. But will never find any sites in the Rhine-delta near Amsterdam because the ground-level in the northwest of the Netherlands subsided more than a kilometer from 1.8 Ma to today. The only reason why the northwestern-Netherlands are still more or less at sea-level, is that the Rhine (and other rivers) deposited more than a kilometer thick bed of sands, clay and gravels just as fast as the earth sank. The ground-level has subsided far less in the middle of the Netherlands and the old beds were sometimes even pushed upwards by glaciers (which covered the northern half of the Netherlands during MIS 6 = the Drenthe glacial, 180-130 ka, see *figure 1.4*). Ice-pushed ridges formed in the middle of the Netherlands, large sand and gravel quarries in these ridges cut deep into old beds and in one pit at Rhenen Rhine gravel was dredged up from 18-20 meters below the groundwater-table that held 1.8 Ma fossils. Together with these fossils Mode-I artefacts also came to light; we believe these artefacts are similar in age to those from West-Runton. But early-man had to work with the local raw materials, in this case rounded Rhine-cobbles. Due to this raw material the tools cannot resemble the flint artefacts from West-Runton, instead they look more like the African cobble-based Mode-I. *Figure 4.10* shows some examples of the artefacts from Rhenen which Max Franssen discovered.

Eastmeuse
Due to the Alps-Ardennes upheaval, the ground-level in the south of the Netherlands has actually risen during the pleistocene. Rising landscapes are always subjected to erosion, the rising land produces the sand and gravel that is deposited by the rivers in subsiding landscapes. The erosion by the river Meuse created a large valley in the south of the Netherlands, near Maastricht. As the pleistocene progressed the Meuse-valley cut deeper, at an average of 66 mm per thousand years. In this valley river-deposits (gravels) form a terraces-landscape, of course the highest terraces are

Figure 4.10: Artefacts from Rhenen 1.8 Ma. The fragment of mammoth-bone may be artificial and may have been used as a chopper, the loamy matrix still adheres to the scraper at the bottom-right.

Figure 4.11: Artefacts from the 1.8 Ma Eastmeuse terrace at Gulpen. The large quartzite flake in the middle at the left slightly resembles a handaxe because it was flaked along both sides (a drawing is shown on the cover of this paper). So you might call it a Large Cutting Tool (LCT) but certainly not a Mode-II handaxe because this is an incidental form and not the result of a repeated pattern. The clearly bipolar production technique also places it in Mode-I together with the other finds from this site.

the earliest and the lowest terraces are the youngest deposits. The Meuse runs from France through Belgium (past Liege) and enters the Netherlands at the small village Eijsden. At Eijsden the Meuse turned to the east in the beginning of the pleistocene, towards the German city of Aachen and the Meuse flowed into the Rhine near Jülich. Geologists call this the Eastmeuse. The Eastmeuse stagnated around 1.8 Ma, because the ground-level near Aachen was rising faster than near Eijsden. The stagnating Eastmeuse formed marshlands and eventually the water had to find a new route: from 1.8 Ma to 0.9 Ma the Meuse could no langer flow to the east to Aachen, instead it ran from Eijsden northeast to Heinsberg where it flowed into the Rhine. The Meuse changed its course again around 0,9 Ma, this time because the ground-level in the Netherlands was subsiding between Roermond and Eindhoven (the Ruhr-valley graben). The water found a way into this Ruhr-valley graben, so after 0,9 Ma the Meuse flowed north through this graben towards Nijmegen. Today the water from the Meuse still follows that route and from Nijmegen the Meuse runs west towards the sea (alongside the Rhine and parallel to the ice-pushed ridges).

The Eastmeuse was a tributary of the Rhine so it is logical that 1.8 Ma Mode-I groups also lived along the Eastmeuse. The forms and the wear and patina suggest that the tools found at the 1.8 Ma terrace at Gulpen (*figure 4.11*) can be the same age as the terrace on which they were found. There are also two additional arguments against a younger date. The first argument is the climate; immediately after 1.8 Ma it became so cold that the biological activity above the latitude of 50 degrees north greatly decreased (see the Lake Baikal sequence in *figure 1.4*). This climate-change drove all Mode-I hominids to the south. It took until 1.4 Ma before the climate became warm enough for hominids to return this far north and we have a strong argument against dating the finds to 1.4 Ma or a later warm-phase. This second argument is that at 1.4 Ma when the climate improved the Meuse already ran more than 8 kilometers from the site. In the Netherlands it frequently rained in moderate-to-warm climate phases, so 1.4 Ma the landscape was covered with vegetation and humus. There were no mountains cliffs or volcanos and the plant-cover made the cobbles from the older terraces completely inaccessible. So the riverbanks were the only reliable source of raw materials. The river was vital to the Mode-I groups, it provided everything they needed: drinking water, wildlife and the raw materials for Mode-I tools. It is therefor unlikely that this Mode-I group had made its camp at a distance of more than 8 kilometers from their river.

Climate migrants
After 1.8 Ma the climate became cooler, plants and animals retreated to the south. The biological activity decreased so drastically at 50 degrees north (*figure 1.4*) that the hominids found too few preys and carcasses to survive the winters. Without food they could no longer stay at this latitude; when the warm Tiglian phase ended the pioneers at West-Runton and in the Rhine-Meuse valleys had to migrate to the south. Perhaps they reached the Saône-Rhône valleys or other rivers and perhaps they were able to follow these to the south. In that case the inhabitants of Pirro Nord (southern Italy, 1.6-1.3 Ma see *figure 4.12*) Atapuerca (north Spain, 1,5-1,4 Ma) Barranco Léon and Fuente Nueva (south Spain 1.2 Ma) may have descended from these pioneers. Or at least in part, because probably new migrants also came to Western-Europe along the slower and more

Figure 4.12: Mode-I core (perhaps used as a chopper) and flake from Pirro Nord, 1.6-1.3 Ma. From World heritage papers no. 29 Unesco.

difficult southern route. Along that southern route Mode-I tools were found at Bogatyri/Sinyaya Balka and Rodniki (sites on the Taman peninsula, dated between 1.6 and 1.2 Ma) and in Peshtera Kozarnika (Bulgaria, between 1.6 and 1.4 Ma). It is likely the northwestern pioneers and the southern newcomers crossbred and mixed their DNA, because if small isolated populations did not mix their DNA with newcomers they would over time develop a fatal inbreeding depression. So there must have been several mechanisms encouraging gene flows, one mechanism was perhaps that young men left their group in search of a partner. But migration was probably the most important mechanism in Europe, because this drove groups (predominantly) to the north and the south throughout the complete pleistocene. To separate this type of migration from the population-growth-driven migration, I call this the climate-change-driven migration.

Figure 4.13: Geological profile in the Kwintelooijen quarry at Rhenen (ice-pushed ridges, the Netherlands). At the top of the grey loam at the level of the standing man we see a black discoloration (near the man's head) due to a concentration of fossil peat and wood. This bed was formed in the Waalian phase and held Mode-I tools. The bed 2.5 meters higher (and also another bed 6 meters higher that is not in the picture) produced Clactonian tools. From Archaeologische Berichten 6, 1979).

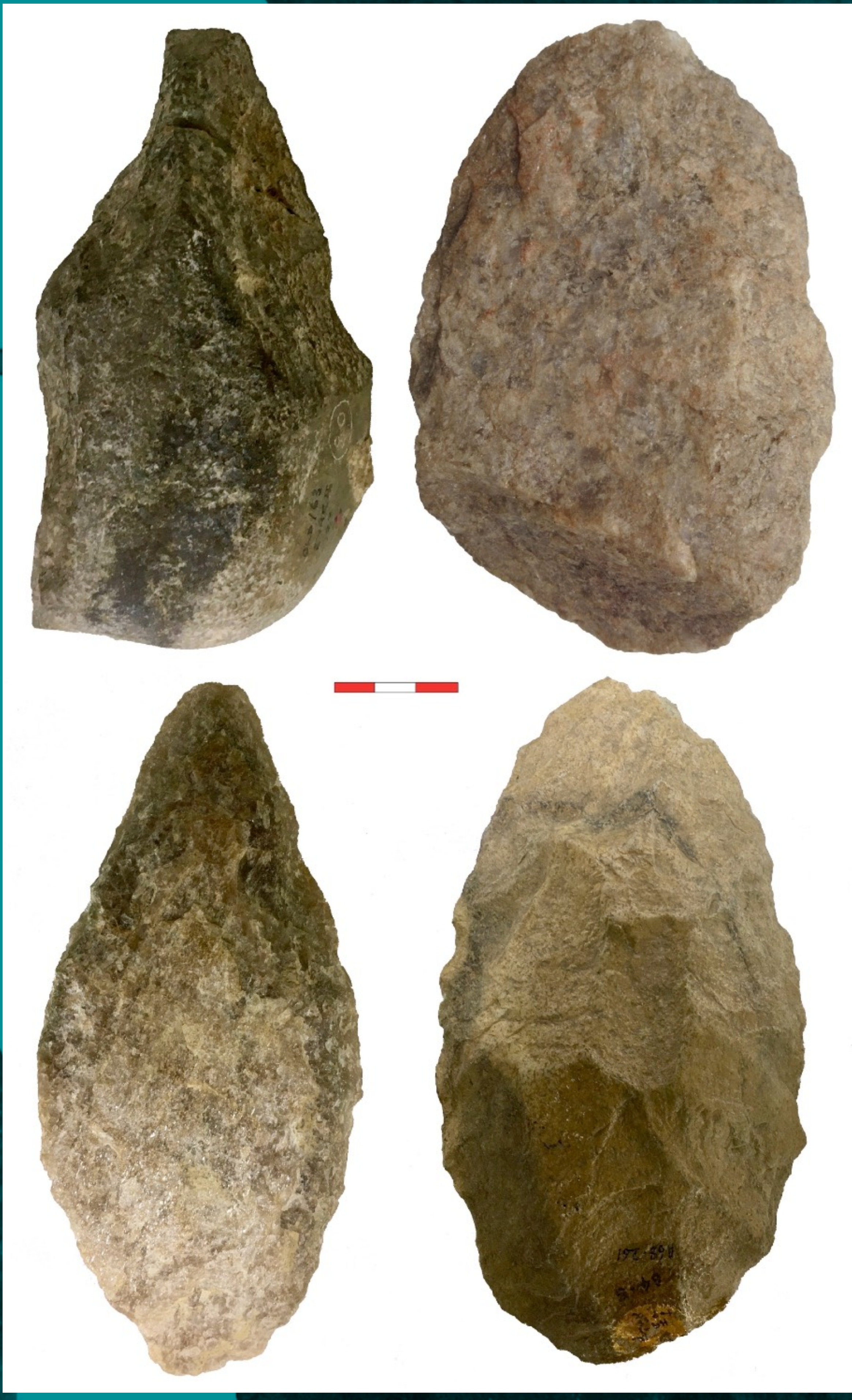
Hominids always selected the best places to make their camp. For instance a cave, a hill that offered hunters a good view over the river-valley, a source of water on a slope or a doline (a karst erosion pit) that offered protection against the wind. Today we discover multiple-layered archeological sites at preferential locations, because they were visited many times by our ancestors. Before 1990 the researchers often interpreted these sites as places with a local or regional development. These sites supposedly showed how the local tribes had slowly evolved over hundreds of thousands of years and how these locals had adapted to changing conditions. The impression that tribes had developed locally was often strengthened by the fact that the groups had used the same local raw materials in different layers (we have already seen in this chapter that specific raw materials lead to specific tool-forms). But in reality hunter-gatherer societies were always traveling through the landscape in search of food. Their bond with the plants and animals that kept them alive, was far stronger than their bond with a cave or their bond with a hill with a view. So the real evolutionary developments took place in a climate-belt rather than in a multiple-layered site. The climate-belts were always moving so the climate-change-driven migration really determined the bigger picture of the development of the European

Paleolithic. We can only understand the human story of Europe if we integrate all findings within the complete area. Let me remind you how small the distances in Europe are; for instance the distance from the Mediterranean to Rhenen (Netherlands) is merely one thousand kilometers. This it is just 10% from the distance from Africa to Shangchen. So it is not at all surprising that hominids in the Waalian-C warm phase were again able to reach Rhenen, in *figure 4.13* we see the bed (black from the organic content) that produced Mode-I choppers and flakes. Most artefacts were small due to the size of the raw materials, but *figure 4.14* shows that when these hominids found larger stones they also made large OBFs just like we saw in Dmanisi.

Figure 4.14: 12 cm long flake from the Waalian bed at Rhenen. The absence of a bulb standing in contrast to a parabolic ventral face demonstrates that this flake is an OBF. It seems as if there is a technical continuity between the artefacts from Rhenen in figure 4.10 and figure 4.14 but this cannot be the consequence of a local development because the Netherlands were uninhabited in cold climate phases. Collection: Joost Thoe Schwartzenberg.

Migration determined all developments; the major step from Mode-I to Mode-II did not even take place in Europe. So in Chapter 5 we have to return to Africa to learn how and why our ancestors took this major step.

Next page, frontpage Chapter 5: Mode-II artefacts from the Olduvai-gorge. Top-left: pic, top-right cleaver, at the bottom two handaxes. All of these Acheulean tools were made from materials that early-man imported over several kilometers. Olduvai museum.



Chapter 5: The earliest handaxes

From flake to handaxe
How did our ancestors invent the handaxe? Bordes believed that handaxes had developed gradually from bifacial choppers (*figure 1.3*), from which the flaking-negatives served as platforms for the next freehand-removals (*figure 3.9*). The essence of this development was that early-man evolved to a state in which he was able to improve the form, by making the cutting edges longer and giving them a more acute edge. But the earliest handaxes that archeologists found were not made from cobbles or flint-nodules like in *figure 1.3*, instead they were made from large flakes (according to Kleindienst a flake must be called large when it is over 10 cm in length). The African Acheulean is Large Flake Based and therefor generally called the LFB-Acheulean (i.e. Gonen Sharon, 2007). So the handaxe was invented in Africa as a flake-based tool.

Most scholars refused to accept this during the 20th century, because in Europe flakes that were large enough to be shaped into Acheulean handaxes were only made after 300 ka (Mode-III, Middle-Paleolithic, chapter 9). The scholars believed it was absolutely impossible that in Africa the Homo erectus would have been able to make flakes of this large size 1.5 million years earlier than in Europe. But in 2012 a large dig at Konso (Ethiopia) silenced all critics, by showing that the African handaxes were made on giant flakes from their very beginning. *Figure 5.1* summarizes the results in a visually overpowering way. To understand this photo, you have to know that these eight handaxes do not all come from the same level; instead they represent finds that came from four consecutive beds.

The top row shows the dorsal faces of each handaxe and the bottom row the ventral faces. We give all of the handaxes in this picture a number, starting at the left with number 1 to number 8 at the right. The numbers 1 and 2 were made 1.75 Ma. Numbers 3 and 4 are 1.6 Ma, 5 and 6 are 1.25 Ma and finally 7 and 8 are 0.85 Ma. It is first of all clearly visible that all of these handaxes are very big: they measure around 25 cm in length. Interestingly all of them are also remarkably thin. So the earliest handaxes were not made on smaller flakes and they did not have thick clumsy Abbevillian forms. Konso has proven beyond any doubt that the earliest handaxe-makers were clearly capable of making thin handaxes from flat flakes that were about 30 cm in length.

Figure 5.1: The development of the LFB-handaxe in the Konso-Beds over time from 1.75 Ma (at the left) to 0.85 Ma (at the right). From: Y. Beyene et al: The characteristics and chronology of the earliest Acheulean at Konso Ethiopia. PNAS 2012.

Not freehand but OBF
Experimentalist in Europe prefer flint as raw material, but in when Schick and Toth experimented in Africa they decided to use the local materials. These experiments showed them, as we can clearly see in the table in *figure 5.2* that handaxes in Africa had to be made from flakes. *Figure 5.2* shows that the African handaxes could not be made from spheres or wedges or hemi-spheres or rollers. Schick and Toth made very clear that large flakes were the only option, but they did not describe exactly how these large flakes were experimentally made. Thankfully their photos solve this riddle: they made the large flakes that were used as the basis for handaxes from large blocks and whilst these blocks were supported by the ground. So these large flakes were no freehand-flakes (as in Europe in Mode-III) but large OBFs! Knowing this makes it far easier to understand the transition from Mode-I to Mode-II: the earliest handaxe-makers still used exactly the same OBF-technique that was used by Mode-I in Gona 2.6 Ma and by Mode-I in Dmanisi 1.8 Ma.

The critical difference between the Mode-I making Homo erectus in Dmanisi and the Mode-II making Homo erectus in Konso is that in Dmanisi the OBFs were discarded after use (expedient technology) whilst in Konso the OBFs became flaked from the free hand (curated technology). What the hominids in Konso did was a huge trend break, so they must have had a very good reason to change their behavior. Early man at Konso must have had a very good reason to choose freehand-flaking and to make his OBFs three times as big as in Dmanisi. This reason becomes clear when we study the effects of climate-change in Africa between 1.8 and 1.75 Ma.

Temporary watercourses
We already saw what happened in Europe at that time: the cold climate drove plants, animals and hominids to the south. In Africa the lower temperatures were not a great problem, but the lower ocean temperatures did create a problem. The oceans evaporated less water so there was less rain. This reduced the African forests and the savannes expanded. It may surprise some people that glacials resulted in droughts, because at the moment we see droughts and expanding

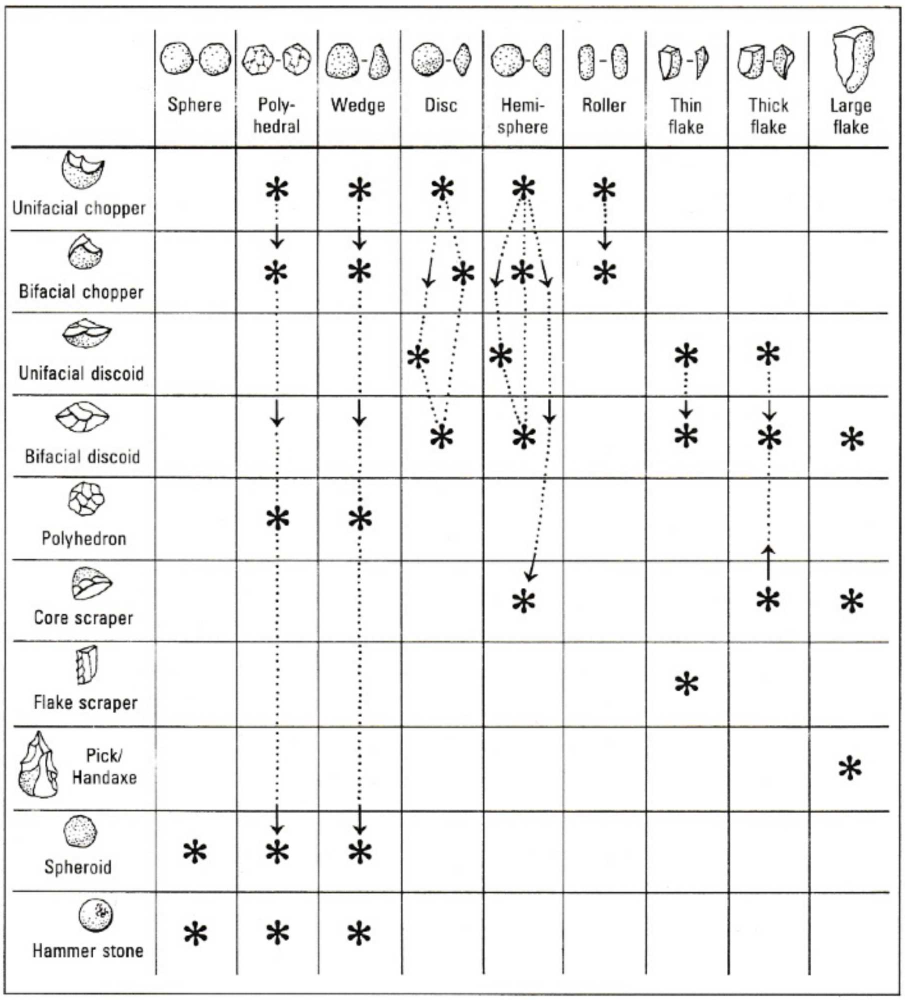


Figure 5.2: You cannot make a handaxe from a spherical or roller-shaped cobble. The experiments by Schick and Toth showed that in Africa large flakes are the only suitable basis for handaxes. From: Making silent stones speak, human evolution and the dawn of technology. 1993.

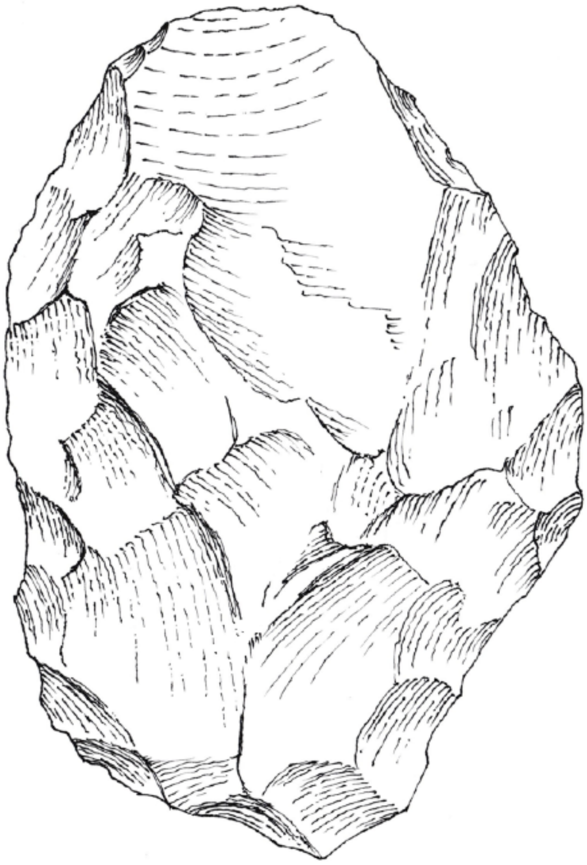
deserts whilst the global temperatures are rising. But this present climate-change is not a natural process; our droughts and desertification are primarily the effect of large scale deforestation by man. The expanding savanne of 1.75 Ma was far less capable of preserving water than the 1.8 Ma forests. So all of the water that fell in the rainy season immediately flowed away through many temporary (seasonal) watercourses. This greatly increased the number of temporary watercourses and also their length between 1.8 Ma and 1.75 Ma. Early man followed these watercourses ever deeper into the open savanne landscape, in search of carcasses and other foods. This changed the pattern of where early man made his camps; research in Ethiopia has shown that before 1.8 Ma most camps were close to permanent rivers, but after 1.75 the camps were often kilometers away from the rivers and close to a temporary watercourse.

In camps so far from the river the hominids had to change their raw material procurement strategy. Toolmakers at Dmanisi only needed to walk two hundred meters to get the raw materials for new flakes, the expedient Mode-I-technology was economically viable thanks to these ample raw materials. But 1.75 Ma groups moved away from the river so they left the area that was littered with cobbles. They often camped beside seasonal waterways, in places where raw materials were very hard to find. So when a person discarded his used OBF, he had to walk many kilometers (to the next river or to the next hill) to find the necessary replacement materials. That created a huge problem, especially when the OBFs were used to butcher. Our ancestors couldn't walk away in the middle of the butchering process, because then the vultures and hyenas would eat everything before they returned. So the groups that moved away from the rivers had to make sure that they had all necessary raw materials at hand; where ever they went, they always carried an OBF in one hand. That OBF had to be thin so that it could be comfortably carried, but as big as possible to be prepared for even the biggest job. But even a giant OBF will ultimately become blunt, so what could they do without any raw materials to replace their tool? Instead of discarding the blunted OBF, they used this as raw material for the production of new flakes.

This brought a critical change in their flaking technique. Before 1.8 Ma our ancestors mostly used rounded cobbles as raw material, we saw in chapter 3 that they therefor kept using OBF as their basic flaking method: Mode-I flaked on the ground. But (as we saw in West-Runton) the bipolar technique is certainly not the best method when you use large thin OBFs as raw material. A few individuals must have experienced that it worked far better if they struck the edge of these flakes from the free hand. This produced many new and very sharp flakes. They shared this experience with others, so everyone quickly learned to flake OBFs from the free hand. There really is just one direction in which a large OBF can be flaked: from the edge towards the centre. So freehand-flaking OBFs inevitably leads to centripetal cores; in *figure 5.1* number 1 is a unifacial centripetal core and number 2 is a bifacial centripetal core. These centripetal cores have sharp edges and points that were used to cut. We call such cutting-cores: handaxes, cleavers and pics. The researchers at Konso concluded that the handaxes, cleavers and pics which dated to 1.75 Ma already showed consistent forms, so we can call number 1 and 2 formal handaxes.

Olduvai FLK-West

Olduvai clearly shows how us the raw material strategy changed. *Figure 5.3* presents a view from the museum over the gorge. The Olduvai-river runs behind the red rock (called the castle) in a wide arch from left to right through the deepest part of the valley. The river is not visible because the photo was taken in the dry season: the bed is almost dry. The horizon is mostly flat, because the complete area is covered by many layers of volcanic ash and lava cobbles. Only one hill was too high to get covered by the ashes, this is the Naibor Soit Inselberg (Inselberg is German for island-mountain: the hill rises above the savanne like an island). The Mode-I groups in FLK (at the bottom of the hill below the castle) lived by the side of a large lake (to the left of the photo). The frontpage of chapter 3 shows that they used local lava cobbles as raw material and discarded their tools when these became blunt. Directly above FLK in the grey ash (called Bed-II) lies the 1.7 Ma site FLK-West. The lake had become much smaller as result of the dryer climate, so FLK-West was nowhere near the lake. The camp was instead beside a temporary watercourse and *figure 5.4* shows that the hominids now made their tools from quartz or as we see in *figure 5.5* from basalt, Mode-II tools were also made from granites (frontpage of this chapter). These raw materials cannot be found in the volcanic ashes, they could only be accessed at the Naibor Soit Inselberg. The hominids made OBFs at Naibor Soit and carried them over 3 kilometers in their hands, until they arrived at FLK-West where the OBFs were flaked into handaxes, cleavers and picks.



Top previous page, figure 5.3: Classic view over the Olduvai gorge from the museum.

Bottom previous page, figure 5.4: Large Cutting Tool (in this case a Mode-II cleaver) made from Naibor Soit quartz by flaking a large OBF form the free hand.

Figure 5.5: Basalt handaxe from FLK-West. From: F. Diez-Martín et al: The origin of the Acheulean: The 1.7 million-year-old site of FLK-west, Olduvai Gorge (Tanzania) Nature scientific reports, 2015.

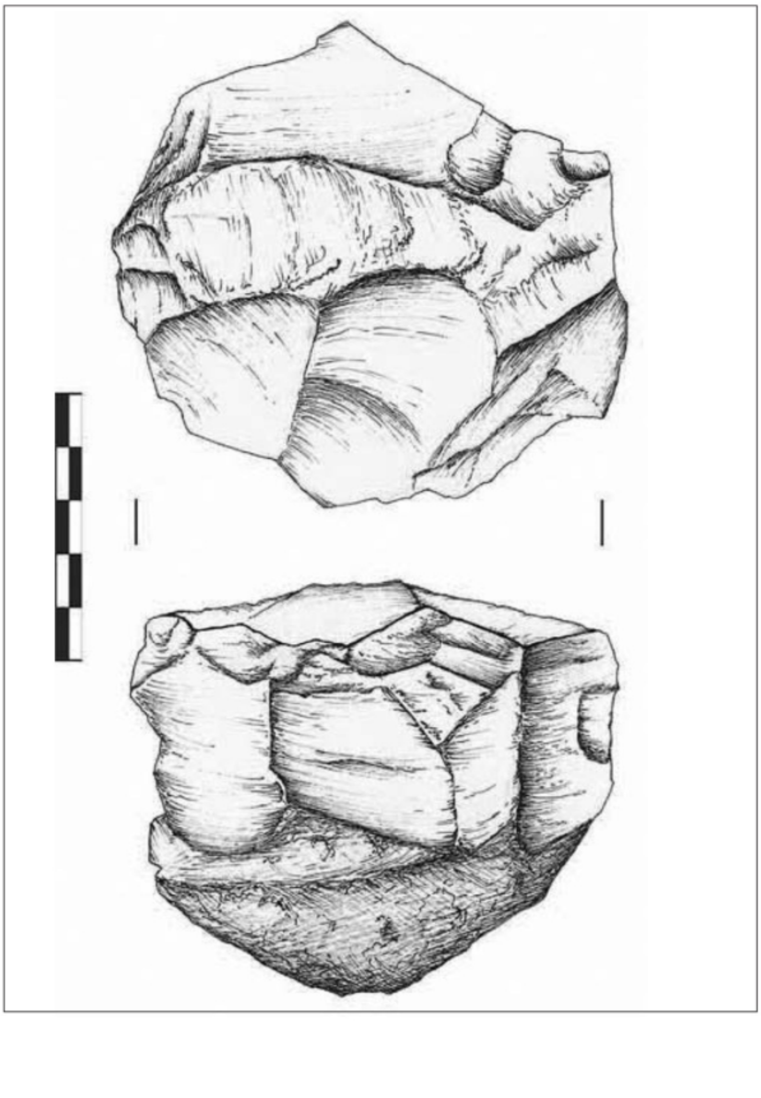
We tend to believe that the early-hominids where nomads and would (just like the San-nomads today) stay in one and the same camp for weeks or months. From their camp San-men go hunting and their wives search for fruits or nuts and firewood. But if our ancestors really lived for weeks in FLK-West they had to walk three kilometers to Naibor Soit and another three kilometers back to the camp, just to make one LCT. That would have been very uneconomical. We must understand that early-hominids were no nomads and made no huts. Instead they lived in mobile groups, always on the move through the landscape to find food. So what really happened was that mobile groups planned a route towards FLK-West to spend the night beside the seasonal watercourse. On their way to FLK-West these foraging groups also went past the Inselberg to get some OBFs. So for nomads getting raw materials was a separate task, but for the Mode-II groups it was part of the everyday foraging. So getting OBFs took only very little time; this system gave Mode-II the benefit of better raw materials and the benefit of Large Cutting Tools that enabled the group to dissect carcasses faster than Mode-I groups. Without the disadvantage of needing to walk for hours to get these raw materials. This made the Mode-II system so efficient that it rapidly replaced Mode-I all over Africa. The butchering with LCTs was so much faster that the expedient Mode-I technology was even replaced on riverbanks that were littered with cobbles.

The form of the handaxe

In Darwin's days the public became fascinated by the highly recognizable symmetrical forms of handaxes. Handaxe-models were romanticized and even compared to works of art. This raised the status of handaxes from merely tools to 'the beginnings of culture'. Today we still put fine handaxes on display just like famous paintings. It is therefor no wonder that we are inclined to put handaxe-makers on a much higher evolutionary level than Mode-I-makers. Of course that is true when we compare the 1 Ma handaxe-making Homo erectus to the 3 Ma Mode-I-making Australopithecus; the 1 Ma erectus had twice the cranial capacity of the 3 Ma Australopithecus. But there is no reason at all to believe that the handaxe-makers who lived 1.75 Ma differed in any way from the 1.75 Ma Mode-I-makers; both were exactly the same. You can never classify hominids on the basis of their technology; the theory that you can is really a shameful remnant of the colonial era, when white men with guns believed that they were technically, morally and also evolutionary superior over colored men with bows and arrows.

Handaxes were not made to be sacred objects or revered museum exhibits, they were just tools. We can very clearly see this in *figure 5.1*. The flake removals in numbers 1 and 2 are very invasive (in French envahissante, they reach to the middle or even beyond the middle of the large OBFs). This is remarkable because it proves that the first handaxe-makers were highly skilled. It takes a lot of practice to learn this, skilled experimentalists are able to make such invasive removals but beginners cannot. Whilst any beginner can create a regular outline after an hour of training. So the makers of numbers 1 and 2 were certainly able to give their tools a regular outline, the fact that they didn't proves that they were simply not interested in making a creative-design. They cared about the functionality of their tools but not at all about the formal aspects; the earliest handaxes were therefor not the result of a creative-design process. The earliest handaxes were clearly the result of technical change and they became a success because of their efficiency.

Social motivation
But the outlines of the numbers 3-4 (1.6 Ma) and certainly of the numbers 5-6 (1.25 Ma) do show an increasing intent towards symmetry and design. When we look at the changes over time in *figure 5.1* we might even feel tempted to compare this to how a child's drawings develop over time. When you give a toddler a pencil he cannot draw a straight line, so if a toddler drew a handaxe it would look like numbers 1 and 2. A six year old would draw the numbers 3-4 and a 10 year old would have developed the skill to draw numbers 5-6. But the handaxes in *figure 5.1* were all made by adults and the invasive removals verify that these adults were highly skilled. So the changes are not the effect of improving skills, instead they indicate changing social motivation. In social groups, the individuals always try to raise their social status by outperforming others. We try to impress our friends by showing our weirdest tricks on you-tube and hope for likes when we put our best pictures on social media. Behavioral studies in apes and monkeys show these animals are also socially motivated to outperform others in order to gain self-respect, status and sexual partners. So there can be no doubt that our ancestors also tried to outperform and impress their friends, it is very likely they raised their social status when they made aesthetic handaxes.



When we measure the performance of handaxe-makers from a million years ago against the performance of our best experimentalists, it is obvious that both had similar skills. So if we take physical skill as a measurement for the evolution, we have not evolved at all. That should not come as a surprise, because the survival of the fittest ensured that all species were highly skilled at what they did. The extinct dinosaurs were extremely good at what they did, the extinct trilobites were extremely good at what they did and our extinct ancestors were also extremely good at what they did. Our human intelligence has evolved, but all hominids were always highly skilled.

Figure 5.6: Recurrent centripetal core from Peninj dated to 1.3 Ma. From R. Mora et al: The archeology of the Peninj 'ST-complex' (Lake Natron Tanzania). Treballs d'Arqueologia, 2003.

Peninj
Around 1.3 Ma a Mode-II-group camped along the lower Peninj River (at Maritanane, Natron Lake, one hundred kilometers northeast of

Olduvai). At 1.3 Ma African hominids were already making handaxes for nearly half a million years. But the chunks of basalt by the side of the Peninj river only measured 5 to 10 cm, so they were far too small to make LFB-handaxes. The hominids could therefor only make small flakes. Of course they flaked the chunks with the same method that they would have used on large OBFs, so they flaked them from the free hand. They repeatedly turned the cores just like they would have done with a OBF in order to use the previous negative as platform for the next flake (alternating bifacial flaking as in *figure 3.9*). If you flake an OBF this way you get a handaxe, but if you flake a chunk this way this leads to cores like in *figure 5.6*. At the top of this core you see invasive centripetal flaking just like we see in a handaxe. But the removals in the alternating direction run vertically down the side of the core. Other researchers found similar cores in a slightly younger site: Olduvai-BK, 1.2 Ma. At the bottom of *figure 3.6*, they made a schematic drawing of this bifacial method. They called such cores bifacial multipolar centripetal hierarchized.

An important aspect of alternating bifacial flaking is that it creates an edge that can be flaked repeatedly. You can i.e. repeatedly flake (and resharpen) the edge of a handaxe. The bifacial multipolar centripetal cores in Peninj and BK could also be flaked repeatedly, not to sharpen the edge but simply to produce more flakes. That is very convenient when you have a limited supply of raw materials. To get more raw materials the hominids at Olduvai-BK needed to walk 3 kilometers to Naibor Soit and 3 kilometers back to their camp. So it was far more economical to use the same cores over and over again; this way one core could produce many flakes with an average size of 4 cm. The cores were reduced until they had to be discarded because the percussion-angle (the angle between the platform and reduction-face, *figure 3.2*) had reached 90 degrees. This is very noteworthy because this means that the hominids at Peninj 1.3 Ma and BK 1.2 Ma had already found a method to make large series of flakes, with a predictable size and form (centripetal flakes tend to have a wide basis and narrow top just like the slices of a pizza) from one core. Making large series of uniform flakes from one core is the definition of recurrent Levallois-flaking. This makes Peninj 1.3 Ma the earliest known site with Levallois-technique.

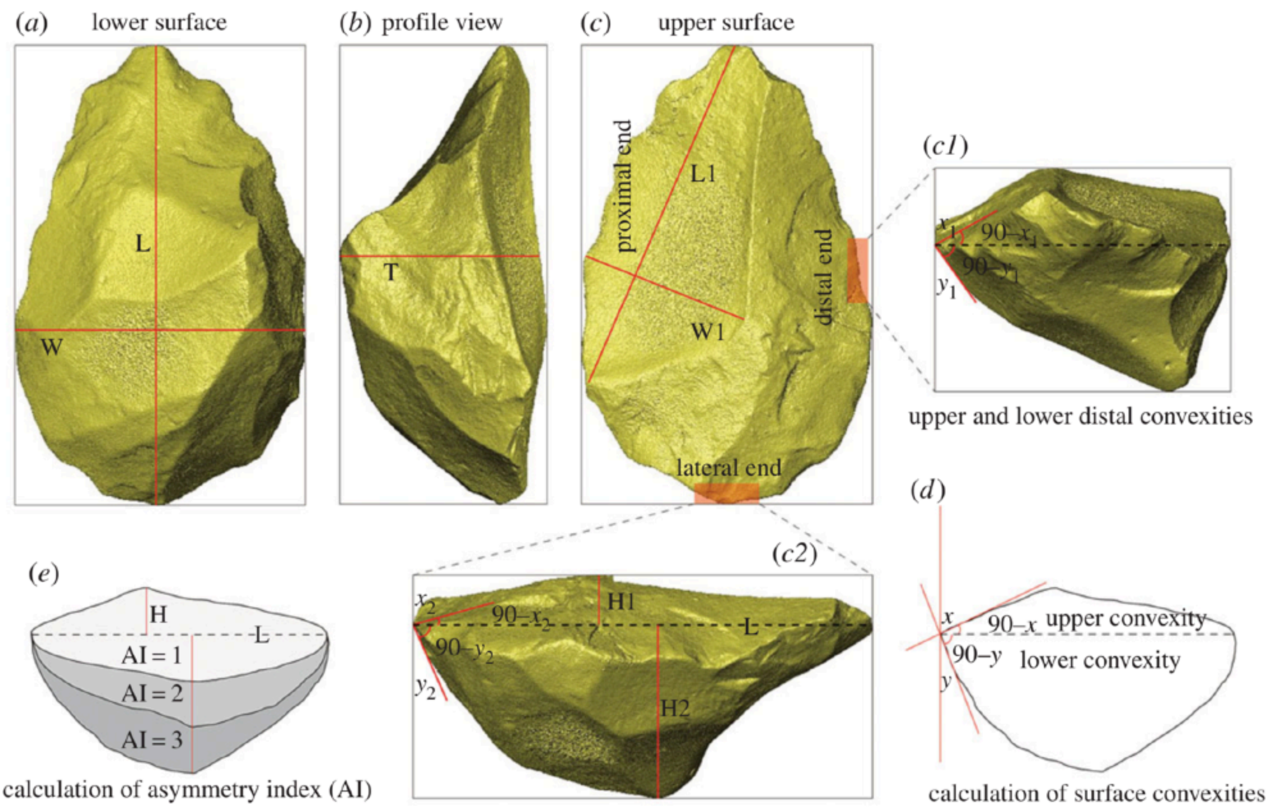


Figure 5.7: Victoria-West technique. From H. Li et al: The Victoria West: earliest prepared core technology in the Acheulean at Canteen Kopje and implications for the cognitive evolution of early hominids. 2017. http://dx.doi.org/10.1098/rsos.170288

Victoria-West
Large flat LFB-handaxes were made all over Africa around 1 Ma so the groups that lived at Canteen Kopje near the Vaal river (South-Africa) also wanted these tools. But if you want to make LFB-handaxes you need large flat OBFs as blanks (the French use the word tool-carrier: porte d'outil) and the raw materials that the Vaal river brought were simply not suitable to make these. There were some very large rounded andesite boulders, but this material is so hard and tough that making 30 cm large flat OBFs proved to be impossible. So the handaxe-makers of the Vaal had to use smaller andesite cobbles as blanks. Thick blanks of course lead to disappointingly lumpy thick handaxe-forms similar to *figure 5.7*. You can use these objects as tools but they simply can't compete with the LFB-handaxes in *figure 5.1*, the hominids wanted thin tools with efficient acute cutting edges. They came up with a trick: they did not use the lumpy form in *figure 5.7* as a tool but instead as a core.

The core in *figure 5.7* has (as view b and c1 show) the ideal form to strike one large thin flake from the free hand: the angle between the two faces is perfect for this. This type of core was especially made for the production of one large thin freehand-flake. We therefor call this flake the target-flake (and since it was struck from one side it is a side-struck target-flake). Such cores were first found at Victoria-West and they are therefor called Victoria-West-cores. The Victoria-West technique produced very thin large flakes with sharp acute edges. These flakes already had the outline-form of a handaxe. These side-struck target-flakes could be used as tools without further alteration, or used as blanks for thin handaxes (instead of the OBFs). The residual-core in *figure 5.7* was simply discarded. Preparing a core to make one target-flake with a predictable size and shape is called the preferential Levallois-technique. The development of the Victoria-West method around 1 Ma was just like the development of recurrent-cores in Peninj 1.3 Ma a technical milestone because this represents the earliest known preferential Levallois-technique.

Intelligent techniques
In France and England the Levallois-techniques dominated the lithic industries between 300 ka and 40 ka. Bordes called this phase the Middle-Paleolithic because it lies between the classic-Acheulean (still part of the Lower-Paleolithic) and the arrival of Modern man in Europe (the Upper-Paleolithic). Bordes believed this Middle-Paleolithic was not just a technical stage but also a stage of hominid evolution because the Levallois-technique proved that the middle-paleolithic-man was able to think ahead. The brain of lower-paleolithic-man was only involved with what he was doing at the time: when he was making a handaxe he thought of the handaxe. But the brain of middle-paleolithic-man had already decided how the Levallois-flakes should look before he began to make the Levallois-cores. Bordes regarded the recurrent and preferential Levallois methods as intelligent techniques.

But everybody understands that the Homo erectus at Peninj 1.3 Ma or Canteen Kopje 1 Ma was far less intelligent than the late Heidelberg-man and Neanderthals between 300 and 40 ka. So especially the complex Victoria-West techniques presented a great problem for Bordes' theory. He solved that problem by claiming that the Victoria-West technique was no real Levallois-technique, he decided to instead call it proto-Levallois-technique. We can forgive Bordes for thinking that he could measure the intelligence of hominids by their tools, after all this professor grew up in what was still the colonial era. But today some scholars still hold on to that old theory, of course they still struggle with the same problem. S. Lycett et al (A comparative 3D geometric morphometric analysis of Victoria West cores: implications for the origins of Levallois technology doi:10.1016/j.jas.2009.12.011) therefor decided to compare the form of the Victoria-West cores to the form of the European Levallois cores. With state-of-the-art modern 3-D measuring they confirmed what everyone can see with his naked eyes: most European Levallois-cores are oval (tortoise cores, *figure 9.1*) but Victoria-West cores resemble handaxes. According to Lycett et al this means that the form of the Victoria-West cores fits Mode-II, that would confirm Bordes his theory. But they confuse the form with technique; it is certainly true that a Harley Davidson rides on two wheels and thus has the form of a bicycle but that is no reason to claim that a Harley is not a motorized vehicle or merely represents the proto-engine-technique. The Levallois-technique was used from 1.3 Ma at Peninj and 1 Ma at Canteen Kopje up to 40 ka in Europe by hominids with a cranial capacity varying from under 900 to over 1500 cc. This wide variety shows us that the Levallois-method is not typical for a specific evolutionary stage. The reason why the Levallois-technique was so frequently used in Europe between 300 and 40 ka is explained in chapter 9.

Mode-II out of Africa
The earliest LFB-Acheulean Acheulean at Konso is dated to 1.75 Ma, by 1.7 Ma the technique had already spread not just to Olduvai but over large parts of Africa. The LFB-Acheulean strategy quickly reached the Middle-East (Ubeidyia 1.4 Ma) and from here it spread to South-Asia. It had reached Attirampakkan near Madras in India 1.5 Ma (*figure 5.8-5.9*) and Isampur (dated to to 1.2 Ma). These sites crearly show us that the LFB-concept was used in India in exactly the same way as in Africa. Here also we see that the mobile groups made very large OBFs in the places that provided raw materials whilst they were foraging. These OBFs were then carried as intact blanks from the raw-material-source to the butchering-or-camp-sites. This was confirmed by studies of the production waste at Attirampakkan; nearly all formal-tools were made in the campsites and only very few handaxes were already shaped at the raw-material-sites before transportation. The very quick dispersal of Mode-II shows us how incredibly efficient the Mode-II tools and certainly the Mode-II production-system were.

It is therefor absolutely remarkable that the spread of the Acheulean came to a sudden halt around 1.5 Ma. The handaxe-technology was unable to spread from the Middle-East to Europe and it was unable to spread from India to East-Asia for more than half a million years. Some scientists believe this was a cultural choice; even today people in China do things differently from people in Africa. But whilst it is true that people want to keep their own cultural practices (like their clothes, religious beliefs, specific foods and how to prepare them, their partner choices and the arrangement of marriages), all people want the very best tools. They all for instance want the best transportation tools and for many people this means they want a car. Cars were first developed in the western world but people in Africa and China with a non-western-culture nevertheless want to own and drive a car. We have seen that many handaxes do show socially motivated forms, this sometimes led to handaxe-forms which were specific for certain areas and timespans. But that does not change the fact that they are just tools; handaxes are not cultural objects. So every cultural group that lived between 1.5 and 1 million years ago would have embraced those tools. That is why other scientists believe that people simply could not travel from the Middle-East to Europe or from India to Indonesia and China during this period. You could say the roads were blocked: perhaps by deserts, by impenetrable forests, wide wild rivers, swamps or glaciers. But it is impossible that every passage was blocked for more than half a million years, because we know that hominids were living everywhere; i.e. on the Taman peninsula, in the Kozarnika cave, all over Spain and all over China. More importantly the few hominid fossils we have indicate that all of them were evolving in a similar direction so we have to accept that there was migration or that groups (at least sometimes) made contact and exchanged DNA (gene-flows).

So why did they not also learn how to make the best tools? Why were the hominids that lived on the Taman peninsula or in the Kozarnika cave around 1.5 Ma still making Mode-I tools? Why did the hominids in Spain and France still make Mode-I tools until 0.8 Ma? Why did the early Homo erectus on Java not make handaxes?

Available materials
The answer is that the spread of the Mode-II technology was blocked by the lack of raw materials. At first glance you may think this answer cannot be right, because there are plenty raw materials in Europe and in East-Asia. That is proven by the fact that around 0.5 Ma the hominids in Europe and the hominids in East-Asia were making lots of handaxes. But the problem is that the materials were not available in the right place at the right time. The reason becomes clear when we first look at the process that made raw materials available for the hominids in Africa and India.

Let us for instance look what happened in the relatively well-studied Middle-Awash valley in Ethiopia. It hardly rained in the Awash-region during the dry season; due to the seasonal drought only very few trees grew in the Awash valley. But during the wet season, there were often heavy rains. With no forests to absorb the precipitation, the water had devastating effects on the landscape. Because all of the water ran towards the river at once. These floods took lots of earth and stones with them because these were not held in place by tree-roots. Even large boulders disappeared into the whirling streams and the swollen river. Then as soon as the rain stopped the Awash-river retreated. It returned to its narrow bed, whilst the water had left a wide trail behind of cobbles and boulders in a wide dry riverbed. The LFB-Acheulean groups that walked on these dry beds used these large stones to make 30 cm large OBFs. When the groups walked further away from river they could make large OBFs from materials in the hills because the rain had stripped the hills barren (like we saw at the Naibor Soit Inselberg in Tanzania). This shows us that the raw materials were abundantly available in Ethiopia as the result of erosion, that was caused by the alternation of dry and wet seasons. The same happened in large parts of Africa and India: both had dry and wet seasons. The erosion in Africa and India therefor provided the LFB-handaxe-makers with all the stones they needed. But the rain in Europe fell all year round, so most of Europe was covered by trees around 1.5 Ma, forests dominated the European landscape all through the early pleistocene. The tree-roots held loose-earth and the humus-soil in place, the great forests absorbed the rain and stopped the erosion. In Europe there were almost no flash-floods, no boulders or large cobbles lying close to the rivers and there were no barren hills, the complete landscape was covered with vegetation. So the hominids in Europe only found small rounded cobbles on the riverbanks, we saw in chapter 3 that small rounded cobbles could best be flaked on the ground.

Lowlands

In the lowlands there were even less raw materials because lowland-rivers flow so slow that they bring hardly anything but mud. This made the lowlands into a critical barrier for migrating early-hominids. The groups that migrated from the Middle-East to Europe had to cross the Ponto-Caspian lowlands. As far as food goes these lowlands were able to provide a good life, because most of the time the landscape was half-open or open: steppe landscape filled with large herbivores. But in contrast to what we saw in the Middle-Awash valley there was not one boulder that could be used to make a 30 cm large OBF. So the Ponto-Caspian lowlands completely blocked the LFB-Acheulean from entering Europe. The road from the Middle-East to Europe was open for hominids, but only if they left their LFB-Acheulean-technology behind. That explains why the groups on the Taman peninsula (in Bogatyri/Sinyaya Balka, Rodniki) did not use the handaxe-technology. So the migrants further down the road, for instance in the Peshtera Kozornika never learned how handaxes were made.

Figure 5.8: This 17 cm. long handaxe from Attirampakkan (India) was made on a large flat OBF and just like number 1 in figure 5.1 centripetally flaked over one side. From: collection Arend Bosscher.

Figure 5.9: Developed 14 cm long stretched handaxe and cleaver from Attirampakkan. From: collection Arend Bosscher.

When the LFB-Acheulean tried to migrate from India (Attirampakkan, *figure 5.8-5.9*) to East-Asia the groups ran into a similar problem: the lowlands of the Ganges-Brahmaputra delta. This was also a very fertile area with plenty of water and wildlife, but there was not one boulder that could be used to make a 30 cm large OBF. So nobody could make LFB-handaxes in the Ganges-Brahmaputra lowlands. The road to East-Asia was open for hominids, but only if they left their LFB-Acheulean-technology behind. The lack of raw materials in the lowlands explains why the Indonesian and Chinese hominids (just like the Europeans) did not make handaxes before the beginning of the middle pleistocene (0,9 Ma).

Next page, frontpage Chapter 6: Mode-II in the south of Europe was mostly made from cobbles, the French call this the Acheuléen meridional to distinguish it from the flint-based Acheulean further north. The missing part of the bifacial cleaver (in grey) has broken off prehistorically.

Chapter 6: Mode-II in Europe

Río Quípar
In the previous chapter we saw that the Ponto-Caspian lowlands blocked the LFB-technology. The handaxe could not travel from the Middle-East to Europe and the earliest European handaxes are actually found at the opposite end of Europe. The earliest securely dated handaxe was found in a cave in Spain: la Cueva Negra del Estrecho del Río Quípar (the Black Cave in the Gorge of the River Quípar). The bed in which it was found is securely dated (flora and fauna, paleomagnetism and thermoluminescence) to MIS 21 (0,9 Ma). Finding the first handaxe so far from the Middle-East almost suggests that the Europeans reinvented the handaxe on their own, independent from Africa. But there were no materials for giant OBFs in Europe nor any groups following seasonal watercourses, so the handaxe could not have developed here as it did in Africa. We also know the handaxe did not develop like in *figure 1.3*, so there was simply no way in which the Europeans could have reinvented the handaxe. This leaves only one option: the handaxe-makers migrated directly from North-Africa to Western-Europe, they must have crossed the Gibraltar-Strait from Morocco to Spain. Two other findings in the black cave confirm that the hominids at the Quípar-site had African roots: recurrent centripetal Levallois-flaking and a controlled fire. Both recurrent centripetal flaking and the use of fire are elsewhere in Europe only seen during the Middle-Paleolithic. But in Africa recurrent centripetal flaking began 1.3 Ma in Peninj and controlled fires are known from 1.0 Ma in the South-African Wonderwerk cave.

We do not know how early-man managed to cross the Gibraltar-Strait, because the Strait is 27 kilometers wide and the strong current makes it impossible to simply swim to the other side and the current pushes rafts into the open sea. We do know that the sea-level dropped during glacials because a lot of water was stored as ice in the polar ice-covers and glaciers; *figure 1.4* shows us that in MIS 22 the sea-level dropped over 80 meters. But even then the Gibraltar-Strait still was at its narrowest point 12 kilometers wide and over 200 meter deep. So instead of crossing here, early man may have crossed just a bit further west by island-hopping across shallower waters.

Negative balance
The pollen from the Quípar cave shows that the area was forested in MIS 21. Forests are very bad for handaxe-makers because trees reduce erosion, this makes it harder to find raw materials. The artefacts from the cave illustrate how scarce the raw materials were. An analysis of the minerals in the cherts enabled the researchers to trace their origins: some of the chert was brought to the cave over a distance of 30 kilometers. This clearly explains why chert-cores were used in the most economical way: by recurrent centripetal flaking. The pieces of chert were far too small to make handaxes, the handaxe was instead made from limestone. We learned in chapter 5 that the Mode-II-technology was successful in Africa because the groups did not waste time or effort on gathering raw materials (the groups that camped in FLK-West lost perhaps twenty minutes during a quick stop at Naibor Soit). But in the Spanish forests it took lots of time and energy to find raw materials. The hominids that lived in the Quípar cave won perhaps 15 minutes time when they butchered a carcass thanks to the cutting-efficiency of their handaxes, but they lost at least an hour and maybe far more time searching for raw materials. So when we look at the complete tool-sequence (gathering the raw material, making the tool and finally using the tool) this Mode-II group lost at least 45 minutes in comparison to a group that would have butchered the carcass with only simple Mode-I flakes. So the final balance of the complete sequence was negative.

The hominids at the Quípar cave made handaxes, Levallois-flakes and they could maintain a fire; they undoubtedly had the best technology of their time. But their Mode-II-technology simply did not fit in forested landscapes with rivers that only carried small rounded cobbles. And we learned in chapter 2 that survival of the fittest is not about being the best, but about fitting into the niche. In MIS 21 it was simply more efficient to use the old Mode-I technology, because OBF was the best way to use small rounded cobbles. So probably archeologists will in the future find a few more handaxes in Spain that date back to MIS 21, but generally speaking the highly developed Quípar-technology was not a success. The negative balance of the complete sequence prevented Mode-II from spreading to other groups in Europe. We know that Mode-I persisted because the Homo antecessor in Atapuerca was still making Mode-I tools between 0.9 Ma and 0.8 Ma. Simple Mode-I choppers found on old terraces like in *figure 6.1* also confirm the persistence of Mode-I.

Both choppers at the top come of *figure 6.1* from a 1.2 Ma and at the bottom from a 1 Ma terrace, the use of Mode-I (not alternating but bipolar) flaking makes it very likely that all four were made during the early pleistocene.

Figure 6.1: Mode-I choppers, made in OBF technique (at the top from a 1.2 Ma terrace and at the bottom from a 1 Ma terrace, bottom collection Herman van der Made).

Middle-pleistocene

Figure 1.4 shows that the climate-development changed at the start of the middle-pleistocene. There were obviously cool phases (glacials) during the early-pleistocene, but the glacials clearly became colder during the middle-pleistocene (from 780 ka to 130 ka) and the cold-phases also became longer. This had a dramatic effect on the landscape. During the early-pleistocene forests dominated the European landscape, paleontologists call the animals that lived in these forests the Villafrancian-fauna. The forests disappeared in the middle-pleistocene because the cooler oceans produced less rain. Instead the landscape became dominated by open-grasslands, this is called the European mammoth-steppe. The winters on the steppe were cool and sometimes it snowed, but in general the mammoth-steppe was certainly not a snow-covered frozen landscape. The land was mostly fertile and full of steppe-fauna; a frozen landscape would not provide the calories that the mammoths and other large herbivores needed. The fertility of the landscape at 50 degrees north is shown by the Lake Baikal sequence in *figure 1.4*; the biogene activity was even in Siberia actually rather high i.e. during MIS 17-16.

The evolution of the mammoth illustrates how much the middle-pleistocene differs from the early-pleistocene climate. The early-pleistocene mammoth (M. meridionalis or southern-mammoth) had molars with each only 10-12 scales (= the enamel ridges that enabled them to grind plants); this shows that the meridionalis mostly ate soft leafs from trees and bushes. The number of molar-scales increased to 15-20 in the middle-pleistocene mammoth (M. trogontherii or steppe-mammoth); this shows that the steppe-mammoth did not find enough soft leafs to fill his stomach. He clearly had to chew hard steppe-grasses to obtain the necessary calories. There also were forest-elephants (Elephas antiquus) in the middle-pleistocene. But do not get fooled by this name: the forest-elephant had the same number of scales as the steppe-mammoth so he clearly also ate the hard steppe-grasses, this elephant must have lived in halfopen landscapes.

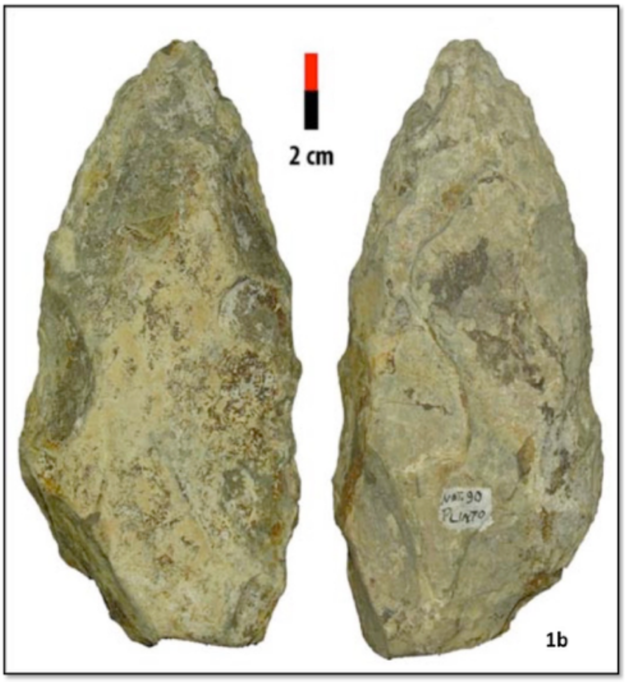
In the middle-pleistocene the decline of the forests led to increased erosion and this exposed the raw materials. More and larger stones now became accessible and this made Western-Europe very attractive for handaxe-makers, so now Mode-II became the most efficient technology. The changing fauna was equally important for early-man; the halfopen and open mammoth-steppe landscape produced large herds of horses, bisons and aurochs. With plenty of food and raw materials for handaxes on many dry riverbanks and barren hills, the hominid population increased notably in Europe after 700 ka (MIS 16, Don-glacial).

Cobble-Acheulean choppers

Mode-II in Western-Europe came from Africa, but the handaxes were nevertheless very different. The European Mode-II groups could not make LFB-handaxes because most stones on the dry riverbanks were far too smal to make the 30 cm large OBFs. So instead of OBFs, toolmakers had to use complete cobbles as blanks. We must therefor call this tradition the cobble-Acheulean. The cobble-Acheulean was not a European invention; it did already exist in Africa (i.e. in Morocco in the Thomas quarry, 1 Ma). So the migrants who came from Morocco to Spain in MIS 18 and MIS 16 did not need to change their raw material strategy.

On some dry riverbanks there were only very few large flat cobbles, for example on the banks of the Tarn (a tributary of the Garonne in Southern-France). The Mode-II-groups in the Tarn-valley therefor suffered from a handaxe-shortage so they also made cutting-tools from smaller cobbles; this led to choppers like in *figure 6.2*. The backside of the chopper at the left is very flat, this provided an easy platform so this cobble was only flaked from one side (unifacial chopper). In the choppers in the middle and on the right, the negatives of the earlier removals were used as platform for the next removals (like in the drawing from Schick and Toth in *figure 3.9*) so these became bifacial tools. Viewed from the top, both show alternating cutting-edges. The industry in the Tarn-valley holds twice as many choppers as handaxes (60% of the curated tools are choppers and 25-30% handaxes). In 1970 scholars still believed that these typical Mode-II-freehand-choppers were more primitive than handaxes (*figure 1.3*). This led them to believe that the Tarn-valley showed a stage that was older than the classic Acheulean (in which 60% of the curated tools are handaxes) but younger than the Abbevillian. The industry was therefor called the middle-Acheulean (in Fench Acheuléen-moyen). Today we know that it is in part just as old as the classic Acheulean and many Acheuléen-moyen choppers must even be younger because they are found in a Mode-III context.

Figure 6.2: Three Acheulean choppers from middle-pleistocene terraces. All were flaked from the free hand, the middle and right choppers show alternate bifacial flaking. (collection Herman van der Made).



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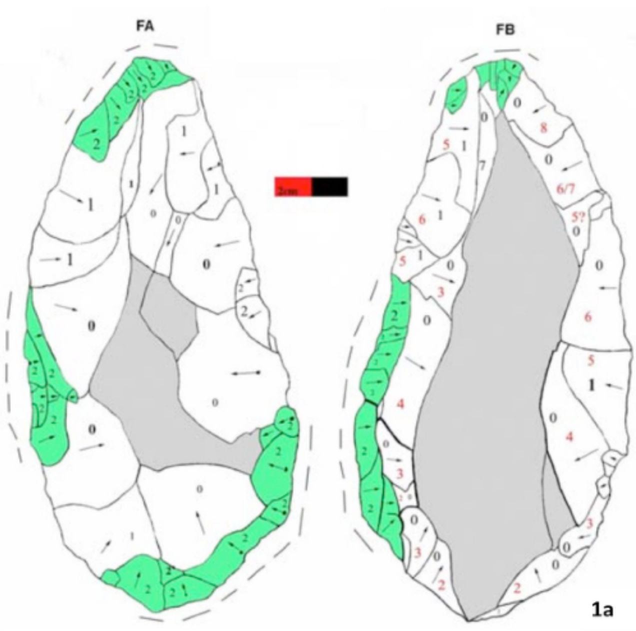

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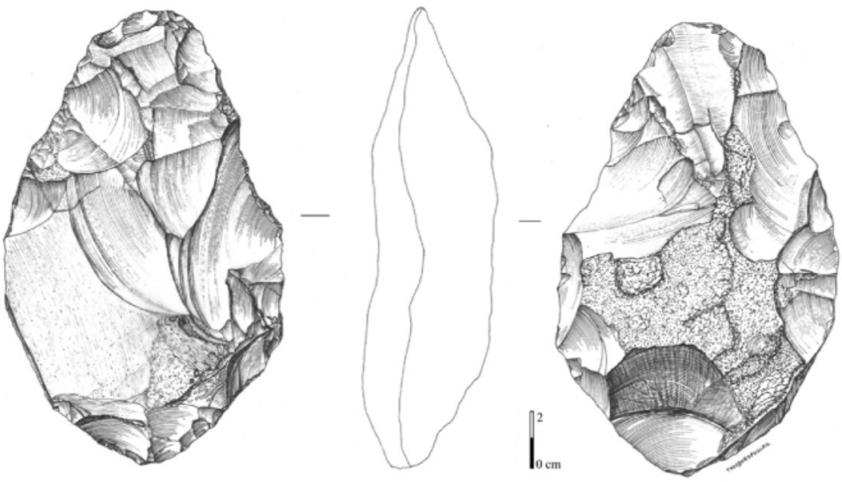
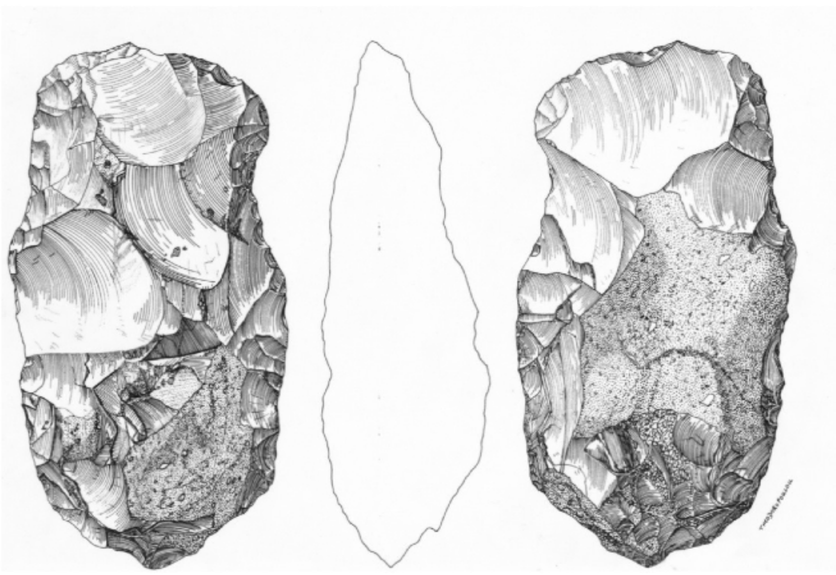


Above, figure 6.3: Two handaxes from Notarchirico made around 700 ka from large flat cobbles. From: C. Santagata: l'Utilisation de roches autres que le silex au paléolithique ancien et moyen. 2012.



Left, figuur 6.4: Flint handaxe and cleaver from La Noira 700 ka. From: M.H. Moncel et al: Early Evidence of Acheulean Settlement in Northwestern Europe - La Noira Site, a 700 000 Year-Old Occupation in the Center of France. PLoS ONE 8(11): e75529. doi:10.1371/journal.pone.0075529. 2013.

Migration

Along the steppe-rivers, the cobble-Acheulean quickly spread during MIS 16 through Southwest-Europe. Large handaxes from large flat cobbles were i.e. made at Notarchirico (Italy 700 ka, *figure 6.3*). Mode-II also spread north: i.e. to La Noira (in the middle of France, *figure 6.4*) and Pakefield (in England). This seems remarkable because MIS 16 was a cold climate-phase. This shows us that early-man (thanks to his higher metabolism, see chapter 10) was far less susceptible to the cold than Modern-man. Surviving cold winters was for these hominids primarily about finding enough food; their caloric intake mostly came from meat and fat from the large herbivores on the mammoth-steppe. La Noira and Pakefield are situated in the French-English chalk or karst area, in this area the riverbanks offered flat slabs of flint instead of flat cobbles. So here the hominids used these flat flints as blanks for their handaxes (*figure 6.4*).

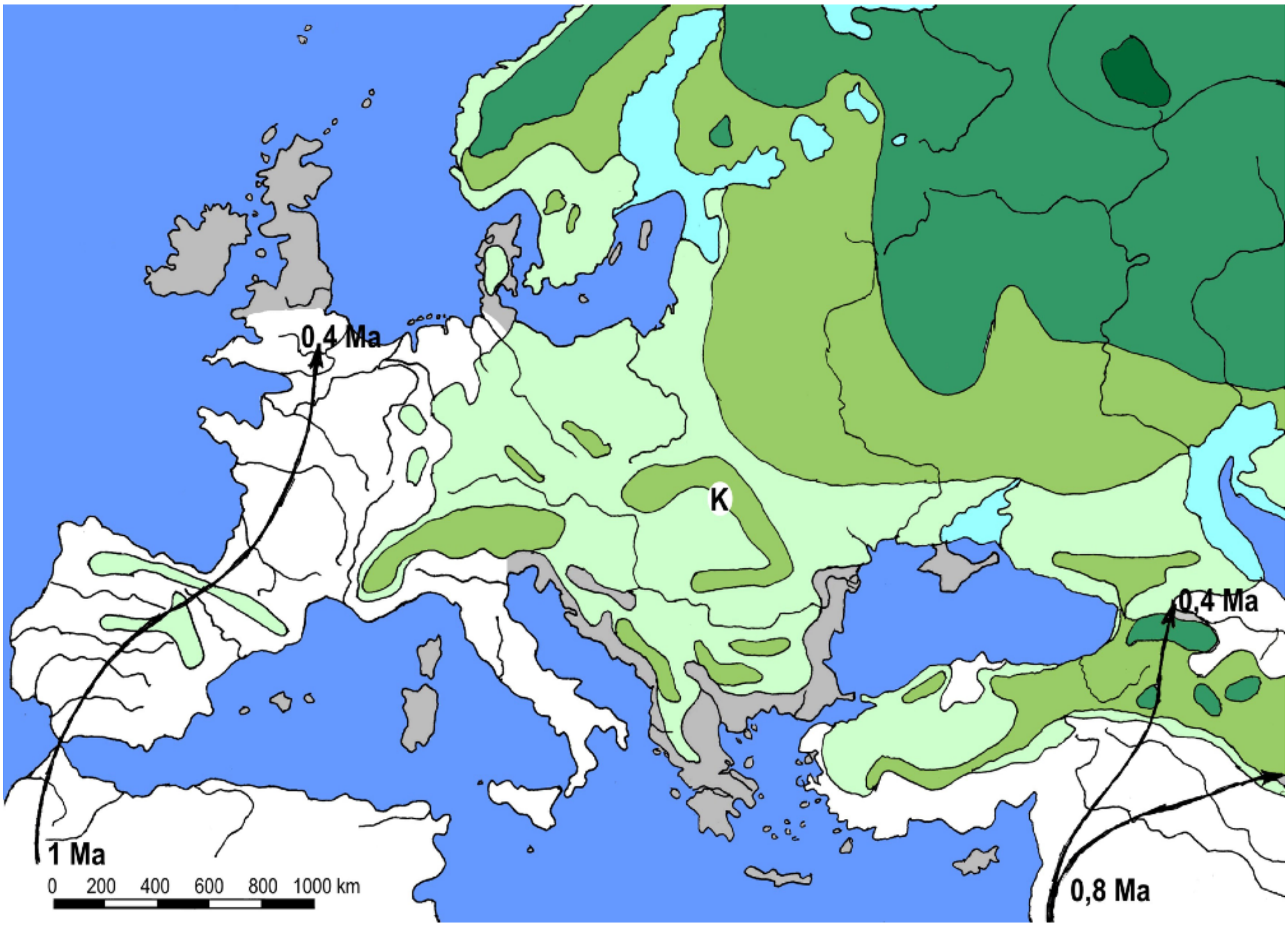


Figure 6.5: The old concept of the Movius-line. It was believed the climate in the green areas was too cold for the Acheulean. And it was believed the handaxe could not have reached England and the southern Caucasus before 0.4 Ma.

Movius-line or climate dynamics

The green zones in *figure 6.5* are the current januari isotherms; in the light-green areas the average januari temperature is just below 0 degrees Celsius and the darker zones are colder. Interestingly Acheulean handaxes are nearly always found in the white zones of *figure 6.5*, so in the areas with relatively warm winters. Hallam Movius wrote therefor in 1948 that the northern border of the Acheulean ran from England to the southeast to Turkey and ended further east in India. This became known as the Movius-line. It seemed obvious that the Acheulean in Europe did not migrate further because early man was unable to withstand the cold winters and that our ancestors later migrated further to the north and east because they learned to make fire and huts. The handaxe-makers would have lived in Africa up to 1 Ma and slowly progressed north along the arrows in *figure 6.5* to finally around 400 ka reach the Movius-line. This slow-expansion-theory is now completely outdated; we know today that early-man was less bothered by the cold due to his high metabolism. And we understand that he followed the climate-induced migration of plants and animals (chapter 4). So the paleomigration was a fast and dynamic process. In MIS 16 the northern limits of the Acheulean (the Movius-line) already reached England but when the climate became colder hominids were pushed back again into southern refugia (places with still enough food). The Movius-line was at the cold-peak probably pushed south to Bordeaux. The climate-belts shifted north again in MIS 15 and 13. Now handaxe-makers even reached the Bytham-river in England (a river at 53 degrees north that was destroyed by the MIS 12 glaciers). There was hardly any flint on the banks of the Bytham so (just like in the south of Europe) cobbles were used as blanks. Then the Anglian or Elster glacial (MIS 12) pushed the Movius-line far south again.

The arrow at the left in *figure 6.5* suggests that our ancestors followed the autoroute-du-soleil. But that road did not yet exist and there were no restaurants or gas-stations. The migrating groups needed food, water and raw materials. So they followed the river-valleys; big rivers were the highways of the mammoth-steppe. Changing from one highway to the other often means passing a bottleneck. Of course it also was a great challenge to go from one river-system to the next. So the distribution-pattern of the rivers had a decisive influence on the spread of the Acheulean.

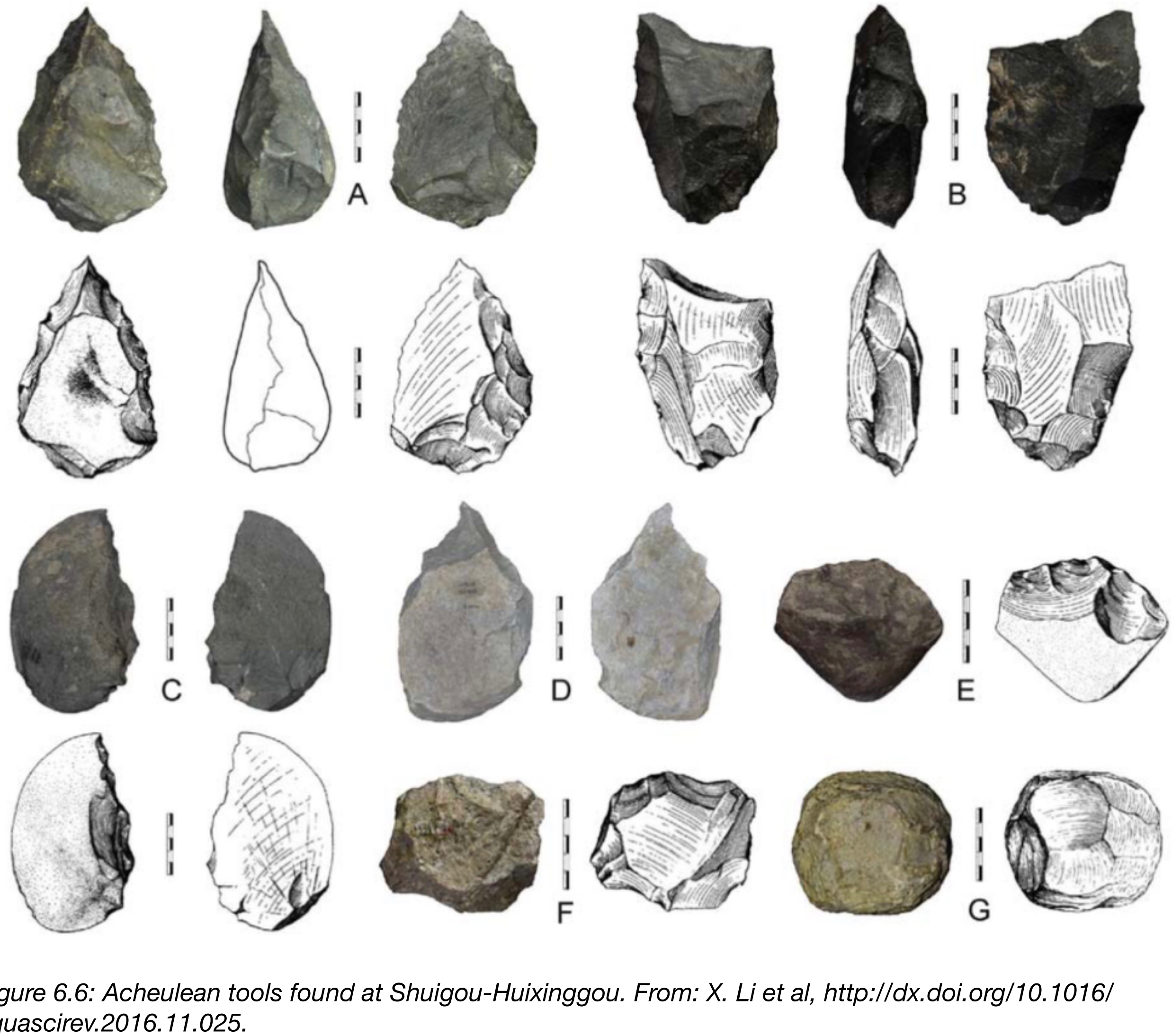


Figure 6.6: Acheulean tools found at Shuigou-Huixinggou. From: X. Li et al, http://dx.doi.org/10.1016/j.quascirev.2016.11.025.

Chinese Acheulean
Pei described the Zhoukoudian (named after Choukoutien, Beijing) pebbletool-industry in 1939, so in 1948 Movius knew the early-Chinese made flakes and choppers. Movius thought there were no handaxes in East-Asia, scholars believed the spread of the Acheulean had ended in India. But the winters in South-China and also Indonesia were warm so they could not blame the absence of handaxes in this area on low winter-temperatures. There had to be another reason: the Asian-Movius-line was perhaps a cultural borderline just like the border between the Roman-civilization and the barbarians? This theory pushed the Asian Homo erectus into the role of the barbarian with primitive tools whilst early-man in Europe and Africa already made civilized handaxes.

This old theory was completely wrong: nowadays many handaxe industries have been discovered in Indonesia and China. The LFB-Acheulean was indeed unable to reach East-Asia during the early-pleistocene, because the Ganges-Brahmaputra lowlands blocked the road to the east just like the Ponto-Caspian lowlands blocked the road to Europe (previous chapter). But the climate changed in the middle-pleistocene; the forests in the foothills of the Himalaya were replaced by grasslands. The rivers also brought more and larger boulders further downstream into these foothills. So a lanscape formed between the mountains and the coast, that allowed the Acheulean to migrate to the east. Handaxe-makers progressed step by step, valley by valley and managed to reach Shuigou-Huixinggou on the East-Chinese loess-plateaus (near the Yellow-River, *figure 6.6*) at 900 ka. This is when the Acheulean also reached the Cueva Negra del Estrecho del Río Quípar. The famous site from Bose (Fengshudao, South-China, *figure 6.7*) was dated to 803 ka and the handaxes at Sangiran (Java, Indonesia) also date back around 800 ka.

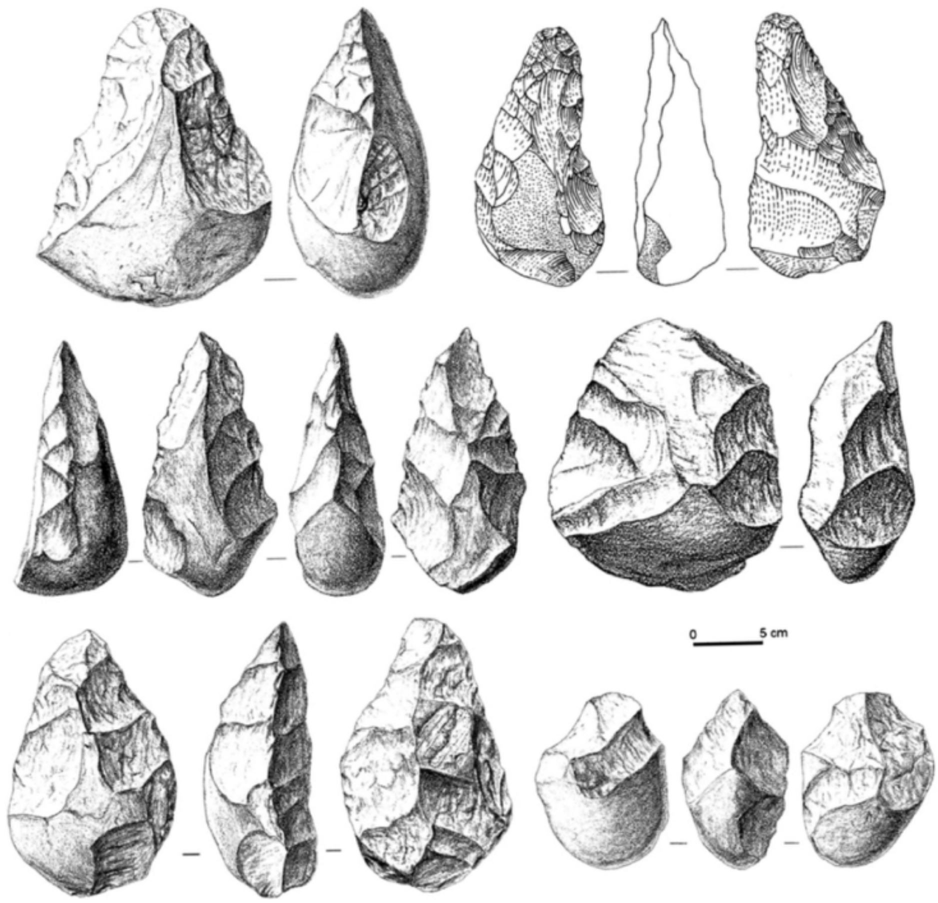


Figure 6.7: Chinese handaxes made from cobbles, found at Bose (top), Lantian (middle row) and Liangshan (bottom row). From M. Otte: Before Levallois. doi: 10.1016/j.quaint. 2009.11.033.

The discovery of the Chinese Acheulean caused a lot of commotion. Some scholars were so convinced that a cultural borderline did exist, that they claimed the tools in *figure 6.7* were no real Acheulian. They believed every culture was based on pebbletools and the forms in *figure 6.7* were merely large sized pointed-choppers. Because just like the types 2-4 in *figure 1.3* these tools are not flaked along their complete edges. Wang et al (2012) also struggled with the form of the Chinese handaxes; they decided to compare the tools from Bose with the classic handaxes from Saint-Acheul and from Elveden. At the same time they also compared the handaxes with tools from non-handaxe-sites. Wang et al did this with the same 3D-method that Lycett et al used to claim the Victoria-West technique was not Levallois.

The results are shown in *figure 6.8*; in this diagram Wang et al put the non-handaxe-sites (with tools that have no standardized forms) at the top. Wang et al call this group Mode-I. Sites with thin handaxes with overall retouche are at the bottom of the diagram. Wang et al call this the group with Western-handaxes. The handaxes from Bose are only partially flaked, so naturally they ended up in the middle of the diagram. This suggests that the Chinese were in Bose proudly developing their own Eastern-handaxes, independent from any Western influences.

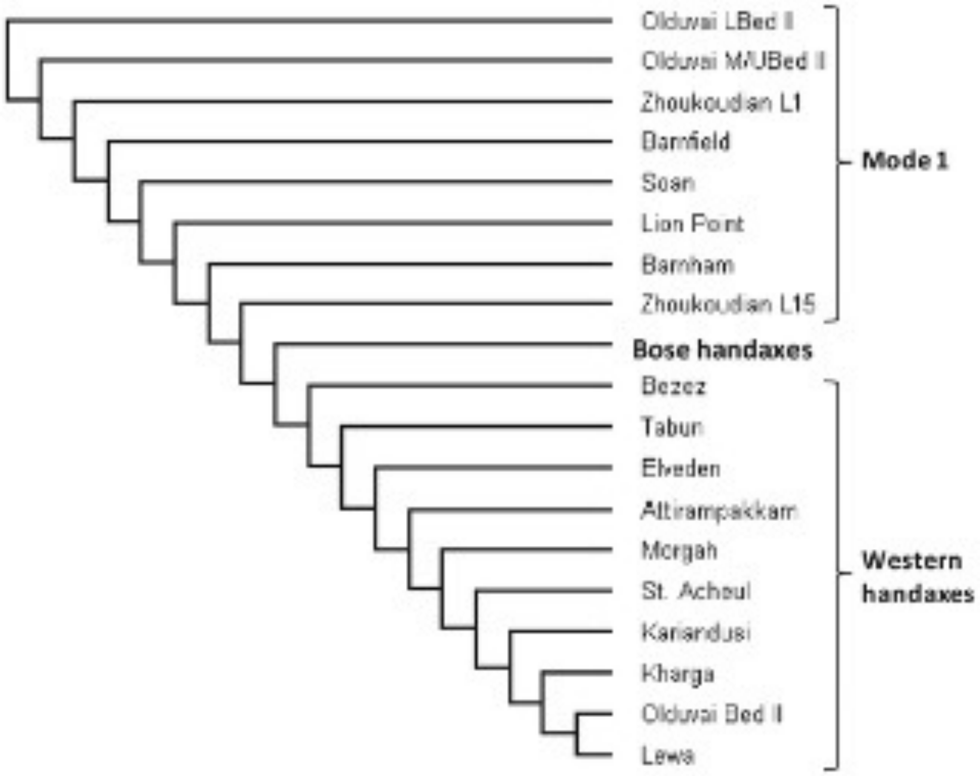


Figure 6.8: Comparison of tools based on the form. From: Wang et al: Comparison of Handaxes from Bose Basin (China) and the Western Acheulean Indicates Convergence of Form, Not Cognitive Differences. 2012.

But this suggestion turns out to be false when we add dates to the sites in the diagram. Then we see that the handaxes in Attirampakkan were already fully developed at 1.5 Ma; Bose is younger. The Zhoukoudian tools from Beijing are 400 ka so these are even younger than Bose. So the developments over time actually suggests that China was on a downward line, the Chinese had already lost the finest forms in Bose and they complete lost the ability to shape handaxes in the Zhoukoudian. Clearly both suggestions are nonsense, this story merely confirms that you can distill whatever you want from the 3-D comparison of forms. If we want to understand why many Chinese handaxes are so thick and incompletely flaked, we have to take a better look at the Acheulean in Europe. The handaxes which Wang et al call 'Western' are far less typical for our Acheulean than many people think.

Core-area of the European Acheulean

In the eyes of the general public, handaxes must look like they do at Saint-Acheul and Elveden. This stereotype exists as the result of historical and aesthetic reasons. Historically John Frère and Jacques Boucher de Crèvecoeur de Perthes created the foundation for our understanding of the paleolithic by convincing the public that thin flat flints with a teardrop-like outline were man-made weapons or tools. Aesthetically this classic form was already considered socially important when the handaxes were made (social motivation chapter 5). Today this aesthetic form still motivates collectors, musea, researchers and experimentalists. So for historical and aesthetic reasons it makes sense that Wang et al presented this archetypical form as the typical Western handaxe. In the Netherlands experimentalists try to promote the interest in the paleolithic and draw the public to the museum by organizing the Dutch National Championship Handaxe-making. *Figure 6.9* shows experimentalists reproducing classic handaxes at the championship. Thick and partially flaked Bose-type handaxes do not make you a champion; the experimentalists need good quality flint to make their archetypical forms. So months before the competition the experimentalists drive to Denmark, where they gather flat slabs of good quality flint.

I tell this story to bring everyone back to reality: Homo erectus and Heidelberg-man did not have cars! So paleolithic man could not drive to Denmark for flint, he had to work with locally available raw materials. Mode-II groups in the south of England and the northwest of France found enough good flint on the dry riverbanks, but groups further south mostly worked with poorer materials. The Acheulean in the Iberian peninsula, the south of France and Italy mostly used cobbles. That European cobble-Acheulean holds choppers (*figure 6.2*) just like in China and it also holds incompletely flaked handaxes (frontpage of this chapter) just like in China. When you compare the

Chinese Acheulean to the European cobble-Acheulean the forms show no significant differences. *Figure 6.8* is based on a misrepresentation: western handaxes include thin flint forms, large flat LFB-forms but also thick and opportunistically flaked cobble-forms.

Figure 6.9: Competing at the Dutch National Championship Handaxe-making. The experimentalists bring bags with tools (hard and soft hammers, retouchers) and baskets with excellent raw materials.

I want to emphasize that from the technical and demographic-paleomigration perspective, the cobble-Acheulean is actually far more important than the classic-flint-Acheulean. The hominids who first brought the Acheulean from North-Africa to Europe used cobbles as blanks, so this was the 'original method'. Using cobbles also remained the 'dominant method' in the south of Europe for as long as our ancestors made large handaxes (from MIS 16 to MIS 6). Handaxe-makers spread north into the French-English flint-area during warm, moderate and even fairly cool climate phases but when it really became cold they were all forced back south. The French-English flint-area must have been nearly completely deserted during the cold-maximum of i.e. MIS 12. The south was therefor demographically the core-area of Europe. So the southern cobble-Acheulean was the 'stem method' from which not only the earliest flint-Acheulean branched but also the 'stem method' from which later phases of the flint-Acheulean branched. The public may focus on the flint forms for historical, aesthetic and perhaps also chauvinistic and even commercial reasons, but from the archeological perspective the cobble-Acheulean holds the central position. *Figure 6.10* illustrates that handaxes made from cobbles are often thicker and often not flaked along the complete edge or over the complete surface, but technically they are nevertheless at the same level as the classic flint forms.

Figure 6.10: Mode-II cobble-Acheulean (estimated to MIS 13, around 500 ka). Due to the character of the blanks these handaxes are not as thin and less symmetrical than their flint counterparts. But the way each strike of the hammer was aimed, dosed and positioned demonstrates expert skills.

Tautavel

One of the most famous sites in the core-area of the European Acheulean is the cave in Tautavel (Caune de l'Arago, near Perpignan in the south of France). The handaxe-makers that visited this cave used cobbles, mostly brought by the stream near the entrance of the cave. The stream also brought very unusual flat grey cobbles, shown at the left in *figure 6.11*. This is limestone that was turned into a very hard rock as the result of geological metamorphic compression. These flat cobbles were gathered at the Centre Européen de Récherches Préhistoriques (CERP) because they can experimentally be flaked just as well as the flat flint slabs our experimentalists gather in Denmark. At the right in *figure 6.11* you see the most famous handaxe Heidelberg-man made from this raw material: the Durandal. This thin symmetrical handaxe is dated to 600 ka, 32 cm long and has a long stretched tip. The unusual brittle appearance is due to the fact that limestone dissolves in water. Most of the limestone handaxes that were made in the middle-pleistocene have therefor completely dissolved, we only know they existed because they left behind cavities in the beds of the cave. Archeologists carefully made casts from some of these cavities and the Durandal is a cast of one of the largest cavities.

Above, figure 6.11: The flat stones at the left are used at Tautavel in experiments as blanks for handaxes. The Durandal at the right is a cast from a handaxe that was made 600 ka from this limestone.

Left, figure 6.12: Handaxe made from a cobble in the CERP depot, Tautavel.

Early-man groups frequently visited the cave. Scholars in the seventies believed that some of these groups did not make handaxes. This non-handaxe-tradition was called the Tautavelian or Tayacian. But that turned out to be a mistake, because further research showed that handaxes are present in every bed from 600 ka to 200 ka (and in almost every drawer of the depot, *figure 6.12*). This proven longterm presence of handaxes makes Tautavel a key site for our understanding of the development of the Acheuléen-meridional (the southern or cobble-Acheulean), just like Konso is a key site for the development of the LFB-Acheulean from 1.75-0.85 Ma.

Typological differences
For handaxe-makers cobbles are not the easiest raw material; it is far easier to make a flat symmetrical handaxe from a flat flint blank. It is thus understandable that many cobble-handaxes are thick and incompletely flaked, but typology-specialists also noted other differences between the flint-Acheulean and cobble-Acheulean. The most striking difference is that flake-based cleavers are very common in the cobble-Acheulean and very rare in the French-English flint-area. In 1970 these typological characteristics were seen as cultural markers. There are many flake-based-cleavers in Africa (some of which show very special designs). Many specialists therefor thought that the cleavers in the south of Europe signaled a cultural connection to Africa. This automatically suggests that the lack of such cleavers further north indicates a cultural borderline. A border between the wild and rough African sphere in the south and the true European cultural identity in the English-French flint-area. But *figure 1.4* proves that the frequent climate-changes pushed one group after the other across that supposed borderline, so the middle and the south of France were not culturally separated. It is also clear the classic Acheulean would have ended in MIS 12 if its forms had been culturally defined, because so few hominids (or perhaps none at all) survived in the flint-area during the glacial-maximum of MIS 12. The classic typology, including the lack of flake-based cleavers must basically be the effect of using flint as raw material, because the handaxe-makers who returned from the cobble-area to the flint-area in MIS 11 redeveloped the same classic typology.

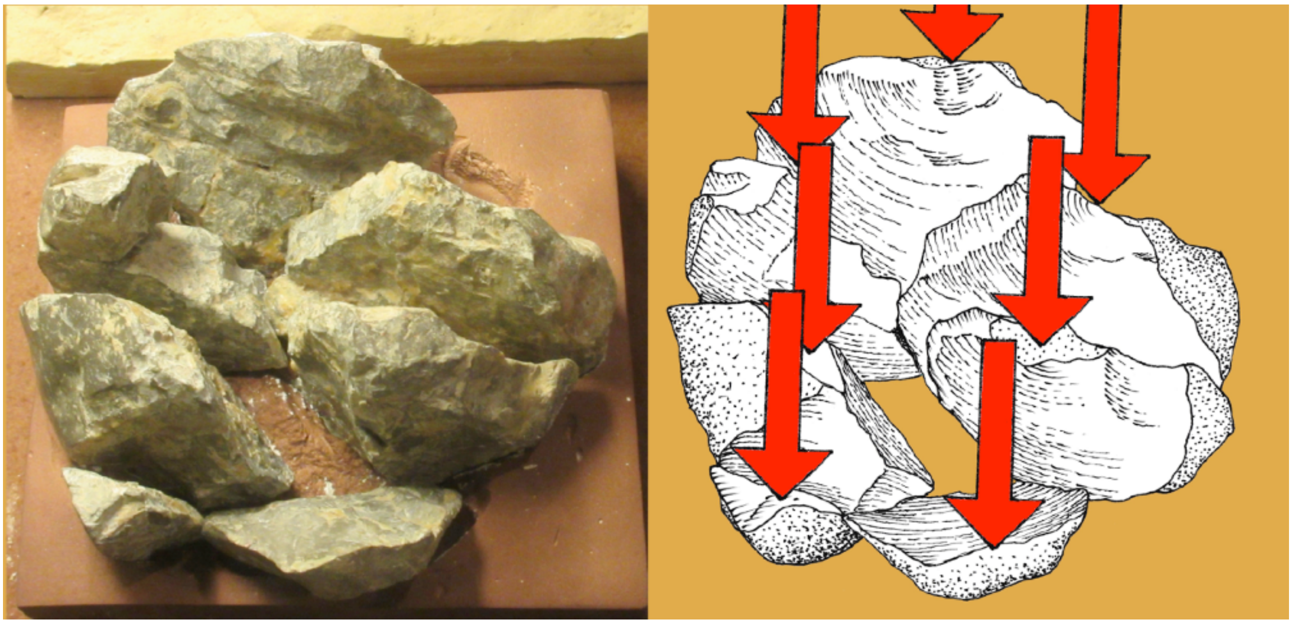


Figure 6.13: This large quartzite cobble was flaked into a series of flat slices (OBFs). Tautavel museum.

Figure 6.13 helps us understand the technique that links the flake-based cleavers to the LFB- and cobble-Acheulean. This photo shows a series of flakes which were made from one large cobble. It is important to know that these flakes were not selected by archeologists and then placed next to each-other (they are not refitted ‘conjoinable’ flakes). This series of flakes was actually found in the Tautavel cave exactly in this position, the flakes really stood next to each-other. This was an absolutely unique discovery that surprised the researchers. At first they thought this group had to be an anvil that accidentally broke in pieces, when it was struck too hard. But in that case all of the fractures would start from the same point, all fractures would then radiate from the place of the destructive impact to the edges of the anvil. Instead the drawing makes very clear that this cobble was divided into flat slices by at least seven separate strikes (red arrows). So this is no accident but a series of OBFs, made exactly at that spot in the Tautavel cave. For some reason the toolmaker simply abandoned the complete series. Perhaps he did not like the quality of the stone, because some OBFs showed transverse fractures. After he left, the still standing OBFs slowly (in the course of centuries) became covered by sediments. I show *figure 6.13* because it illustrates the use of OBF as reduction-method in a unique way and as a reminder of the quintessential importance of OBFs for the LFB-Acheulean and cobble-Acheulean. Large OBFs were in both traditions used as blanks for handaxes, pics and cleavers.

Figure 6.14: The Acheulean flake-based cleavers from the south of Europe are mostly made on flakes that were struck whilst the cobble was supported by the ground (OBFs).

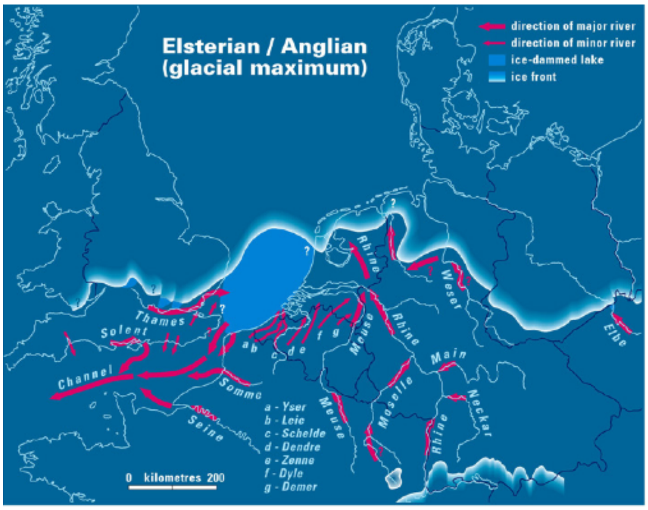
The use of OBF is also confirmed by the flaking-signals. For instance in the two cobble-Acheulean cleavers in *figure 6.14*. The top-right view shows a large scar that runs past the centre of the flake (even further than the 'central fissure' in *figure 4.2*). The dorsal side (top-left view) shows the large side-struck negative of a previous removal on the ground. The side-view in the middle photo shows that the blank finally became zig-zag flaked from the free hand. The broad and wide platform of the side-struck flake at the bottom proves this blank also is an OBF. The ventral face (left) also shows a flat bulb without scar. Again the side-view shows that the grip was shaped by zig-zag freehand retouches. In contrast to what we see in the cobble-area, OBFs are very rare the flint-area. The reason is that nearly every flint-nodule has at least one irregularity that can serve as platform. So the toolmakers did not need OBF and they also found that flaking flint-nodules on the ground was uneconomical. When you flake an average flint-nodule from the free hand it can produce a few dozen thin and sharp flakes, but when you flake it on the ground you only get about seven OBFs (just like in the cobble in *figure 6.13*). This explains why large OBFs that could be used as blanks for cleavers (and thus also the cleavers themselves) are so rare in the flint-Acheulean. The raw materials clearly had an impact on the production techniques and thereby determined the typological specifics of both Acheulean-varieties.

Previous page, frontpage Chapter 7: Pebbletools from Neer (in the south of the Netherlands), from the Broeksberg quarry. Collection J. Beeren. This display measures 40 by 35 cm.

Chapter 7: Without handaxes

The channel river

The greatest pleistocene glacial expansion in England was in MIS 12 (*figure 7.1*, Anglian or Elster glacial). The glaciers became three kilometers thick and completely destroyed the Bytham river, covered East-Anglia and pushed the Thames more than a hundred kilometers to the south. A wall of ice ran from East-Anglia across the North-Sea-plains (which today are about 30 meters below sea-level) to the north of the Netherlands. This great wall of ice functioned as a dam that stopped rivers like the Rhine from running to the north. The North-Sea-plains were dry land before the ice came, but this ice-dam turned them into a huge sweet-water-lake (*figure 7.1*). Ultimately the water rose so high that it eroded and submerged the Weald-Artois anticline (= the land-bridge that connected England to France). The waters of the ice-dammed lake then suddenly flowed to the southwest, washing the land away between Dover and Calais and forming a kilometers wide valley. *Figure 7.11* shows that where the rivers like the Thames and Schelde came together, a lake may have formed. From here the water ran southwest through the deepest part of the new valley, we call this the Channel-river.



Above, figure 7.1: In MIS 12 the glaciers created an ice-dammed lake. Drawing by Phil Gibbard.

Figure 7.2: Mode-II survived the cold-maximum in southern Europe and still made its classic flint handaxes in MIS 11. This nice example was found in Ambrona (Spain). From M. Santonja Gomez et al: Ambrona y Torralba hace 400.000 años. 2005.

The glaciers melted at the end of MIS 12 and the sea level rose. But the North-Sea-plains themselves rose even more, because the earth was no longer pushed down by the weight of the glaciers (on a surface that has the size of your hand, three kilometers of ice weigh 50.000 kilos!). So in MIS 11 the North-Sea-plains were dry land, Heidelberg-man could walk across the North-Sea-plains from the continent to England without getting his feet wet. Because of this connection, you might expect that the handaxe-makers would simply walk back from their southern refugia (see *figure 7.2*) to England and recolonize the Thames-valley. This was after all not extremely far; in medieval times many pilgrims walked from Northwest-Europe to Santiago de Compostela (Spain) and back.

An unexpected journey
But the paleolithic hunter-gatherers were not alt all like pilgrims: the hunter-gatherers did not walk towards a goal. They travelled very slowly because they could not move faster than the climate-belt in which they lived and felt comfortable. The groups simply followed the migration of plants and animals so the journey took many generations. During this climate-change-driven enterprise Heidelberg-man had to cope with unexpected situations. We can discover what happened, by following the unexpected journey of a group that started its migration at the upper Ariège and Garonne rivers. This starting point is very close to Tautavel, so our group surely made the same Acheuléen-meridional (= cobble-Acheulean) type handaxes and cleavers. The group made tools from boulders and cobbles and to understand this chapter it is very important that you know exactly what boulders and cobbles are: W.C. Krumbein defined boulders as stones larger than 256 millimeters and cobbles measure in-between 64 and 256 mm.

The global warming at the end of MIS 12 and beginning of MIS 11 pushed the climate-belts north. Our group saw that their beloved prey-animals migrated downstream so they followed the animals from the upper course of the rivers to the Middle-Garonne area. The group now lived in a much flatter landscape; here the river carried fewer large boulders because its fall had declined. The handaxes now had to be made from smaller cobbles. Some cobbles were so small that they were only fit as blanks for choppers (as in *figure 6.2*); by traveling downstream our group had reached the point where they made Acheuléen-moyen instead of Acheuléen-meridional. Several centuries and generations later our group had followed the animals downstream into the lowlands. But the lowland-Garonne was in MIS 11 not like it was in MIS 13-12. During MIS 13-12 the Garonne was a narrow stream on the mammoth-steppe that (when it rained) swoll enormously into sudden flash-floods. These flash-floods carried many cobbles downstream into the lowlands, so in MIS 13-12 the handaxe-makers found raw materials along the lowland-Garonne. But at the beginning of MIS 11 evaporation from the warmer oceans made the rainfall so frequent that bushes and trees began to grow. The steppe changed into a forest and the tree-roots held the earth in its place. The trees evaporated a part of the water and the rest sank down into the earth. This groundwater was slowly released through small sources into the Garonne. This changed the Garonne from a narrow steppe-river with huge flash-floods into a calm wide stream, that ran far too slow to carry any cobbles into the lowland. The banks of the lowland-Garonne became covered with fertile mud and overgrown by vegetation. So when our group reached the lowlands around 400 ka, the hominids could not find raw materials for handaxes. They considered themselves lucky if they found some pebbles; W.C. Krumbein defined pebbles as stones measuring from 4 to 64 millimeters.

Techniques
By testing our marbles we learned in chapter 3 that you can't flake round pebbles from the free hand; you must combine hammer and anvil. This can be done in many ways; in APAN/Extern 9 (2001) I showed seven different bipolar techniques in one drawing. But most readers found this somewhat confusing, so professor Fernando Diez-Martín decided that it was better to make a drawing with only the primary flaking methods: *figure 7.3*. The name primary expresses that these three bipolar methods are used to break intact stones into pieces. Diez-Martín called the first method vertical-axial because the fracture runs along the long axis of the stone. The second option is called horizontal-axial. And the third bipolar flaking option is non-axial = oblique (OBF).

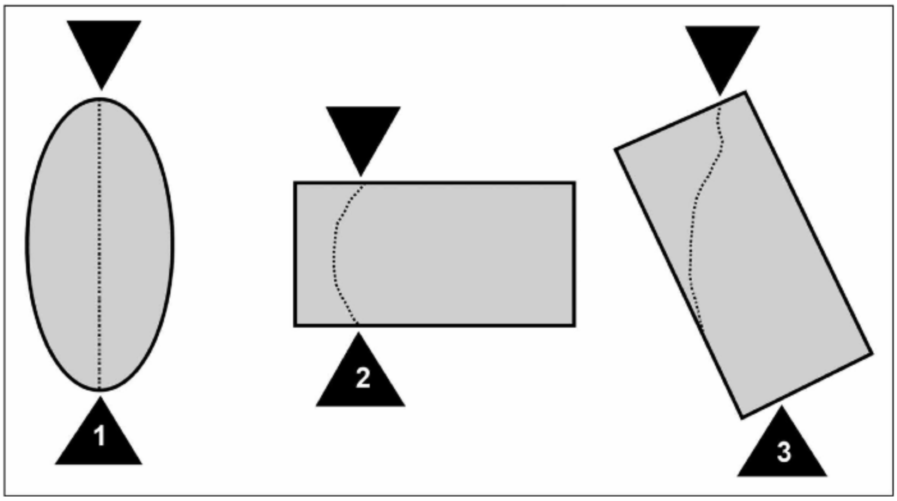


Figure 7.3: Experimental bipolar-knapping at Olduvai was done by: 1 vertical-axial, 2 horizontal-axial and 3 non-axial or oblique bipolar flaking. From: F. Diez-Martín et al; American Antiquity 76 (4), pp. 690-7-8, 2011.

The pebble-OBFs made on anvils are obviously far smaller than the cobble-OBFs (like in *figure 6.13* in Tautavel). *Figure 7.4* shows a typical example of these small size pebble-OBFs from Vértesszöllös (Hungary, MIS 11-9). A flake from the same site that was carefully retouched is shown in *figure 7.5*. *Figure 6.14* clearly shows that the large cobble-OBFs were flaked from the free hand, so you may expect that the small pebble-OBFs were flaked in the same way. You can indeed hond a very small flake between your fingers and hit it with a hammer-stone, but that is far more difficult than retouching a large blank from the free hand. If you try to make an experimental copy of the quartz-OBF in *figure 7.4*, you will notice this weighs too light to absorb the energy of the strike. It is also far too small to provide a good grip. Finally its thick edge also makes the use of freehand-retouches or even pressure-technique extremely difficult. But Heidelberg-hominids routinely worked on anvils quickly discovered a far easier method to retouche these small and often thick objects. They retouched the pebble-OBFs on their anvils with a bipolar method that is called contre-coupe.

Figure 7.4: Pebble-OBF from Vértesszöllös, in the depot of the Hungarian National Museum Budapest.

At the right figure 7.5: Finely retouched quartz pebble-OBF from Vértesszöllös, HNM Budapest.

Contre-coupe
Only very few experimentalists ever combine hammer and anvil. And I certainly do not know any who put (at least) the same amount of time and effort into working with bipolar methods as into copying aesthetic forms with freehand and pressure methods. The contre-coupe technique is therefor not widely practiced, many people do not even how this method works or what is does. But for the pebbletool-makers contre-coupe was their daily routine. To give you an understanding of how the principle works I start by showing the contre-coupe method on a large OBF in *figure 7.6*. You can see that the toolmaker first carefully and deliberately positions the edge of the OBF on the edge of his anvil. Then he strikes the OBF, more or less at its center. The energy of the strike compresses the material. But this strain does not initiate a fracture in the hammer-contact, because fractures always starts in the weakest spot. The anvil-contact is far closer to the edge so this is the weakest spot, the rupture therefor starts here. The small removal (the retouche) in the drawing shows that the contre-coupe fracture began in the anvil-contact and then ran towards the hammer-contact. So it almost seems as if the removal was caused by a force that came from the anvil; a force that 'countered the coup' of the hammer, hence the name contre-coupe.

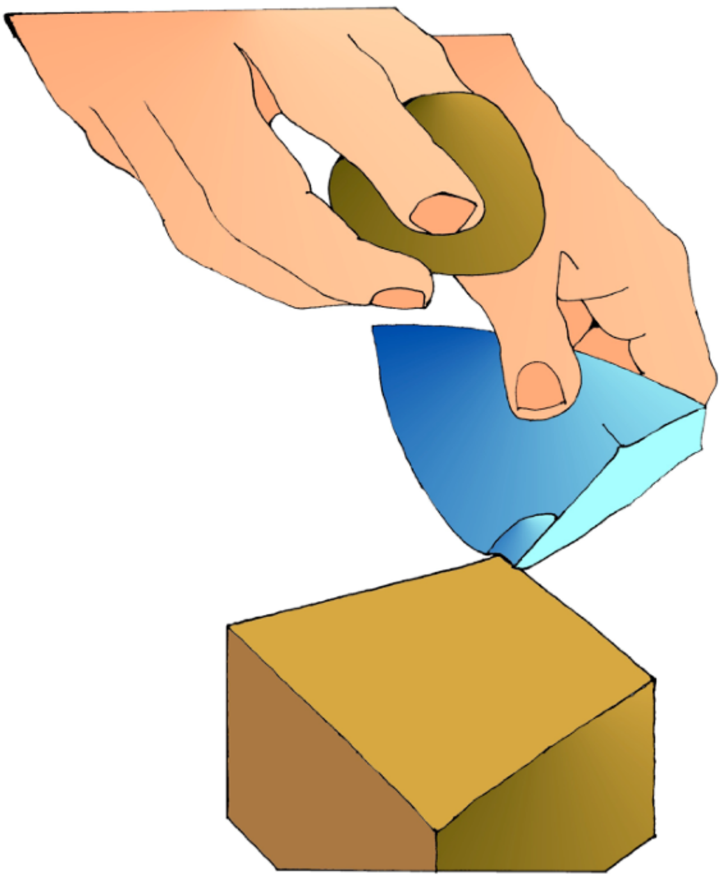
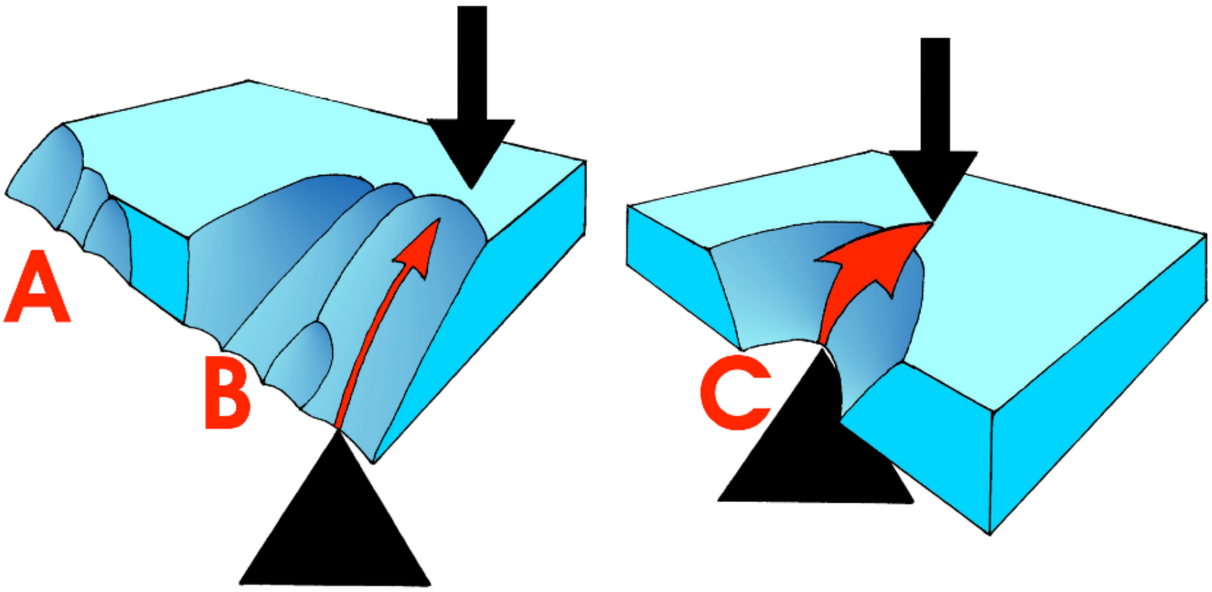


Figure 7.6: The contre-coup principle, demonstrated on a large OBF.

When you understand this, we can go to *figure 7.7*. This schematic drawing shows how the direction of the contre-coupe fracture was controlled. *Figure 7A* shows that very steep contre-coupe retouche are produced by hitting the blank close to its edge. We saw in *figure 3.2* that freehand removals can not be made at an angle larger than 90 degrees. But *figure 7.7A* illustrates that you can make retouches at an angle larger than 90 degrees in contre-coupe, simply because the rupture always runs from one contact-point towards the next contact-point. *Figure 7.7B* shows we can simply make the angle flatter by hitting the blank further from the edge.

Below, figure 7.7: Schematic drawing of the options contre-coupe offers. A: steep retouche, B: flat retouche, C: denticulate retouche or notch.



Three special aspects

Contre-coupe has three special aspects that made it the ideal method for small objects. The first is that the method offers great precision. In contre-coupe retouching you control the point where the fracture begins to the millimeter, simply by positioning the blank carefully onto the anvil. This gives far more control than aiming with the hammer. It is so hard to hit exactly where you want that the Mode-III Neanderthals sought a way to raise the designated impact-point above the rest of the platform (this platform-preparation is called the ‘chapeau de gendarme’). Contre-coupe gives the same amount of control without platform-preparation and even in the smallest objects. We already saw in *figure 7A-B* that contre-coupe also gives perfect control over the flaking angle.

The second special aspect is shown in *figure 7C*: it enables the toolmaker to make very deep removals by simply pushing the edge of the blank slightly over the anvil-contact (symbolized by the black triangle). The rupture starts in the anvil-contact so already in the first moment it removes a part of the edge of the blank. From this point the rupture follows the red arrow towards the hammer-contact (black arrow). This produces a removal with an extremely hollow model, called a notch (in French encoche, in German Buchten). A series of adjoining notches makes denticulate retouche. Experiments show that you can also make notches and denticulate retouche from the free hand using a hammer with a sharp edge that cuts into the thin edge of a flake. But from the free hand you cannot make a deep notch in a thick edge (when you look back at *figure 7.3* you can see that axial fractures often lead to segments with thick edges).

The third special aspect of contre-coupe retouche is also demonstrated in *figures 7.6-7.7*: the negatives always form on the visible side of the blank. Contrary to in freehand flaking, where all negatives form on the bottom-side. This direct visibility had important consequences for the way objects were shaped. The Mode-II toolmakers had two compelling reasons to turn the object over: they wanted to inspect how the depth and size of the negative had changed the form of the blank and they needed to use the previous negative as a platform for the next strike. Turning the blank led to alternating bifacial retouche. But in contre-coupe the toolmaker sees the removals without turning the object so turning is no longer an automatism. Of course he is always free to turn the object at will, but the use of contre-coupe greatly reduced the bifacial flaking in bipolar traditions. So in the Acheulean the great majority of modified tools are bifacially flaked (handaxes pics and cleavers) but pebbletool-traditions show far less bifacial flaking. In 1970 the typology-specialists thought this proved that pebbletools were more primitive and older than the Acheulean but today we know that contre-coupe was not at all primitive. Horace Bertouille even signaled that in upper-paleolithic Modern man made his best burins (with a perfectly straight cutting edge) in contre-coupe. And Wouters showed the upper-paleolithic Hamburg-tradition used contre-coupe to make scrapers with extremely flat retouches. Experimentalists confirmed this in experiments.

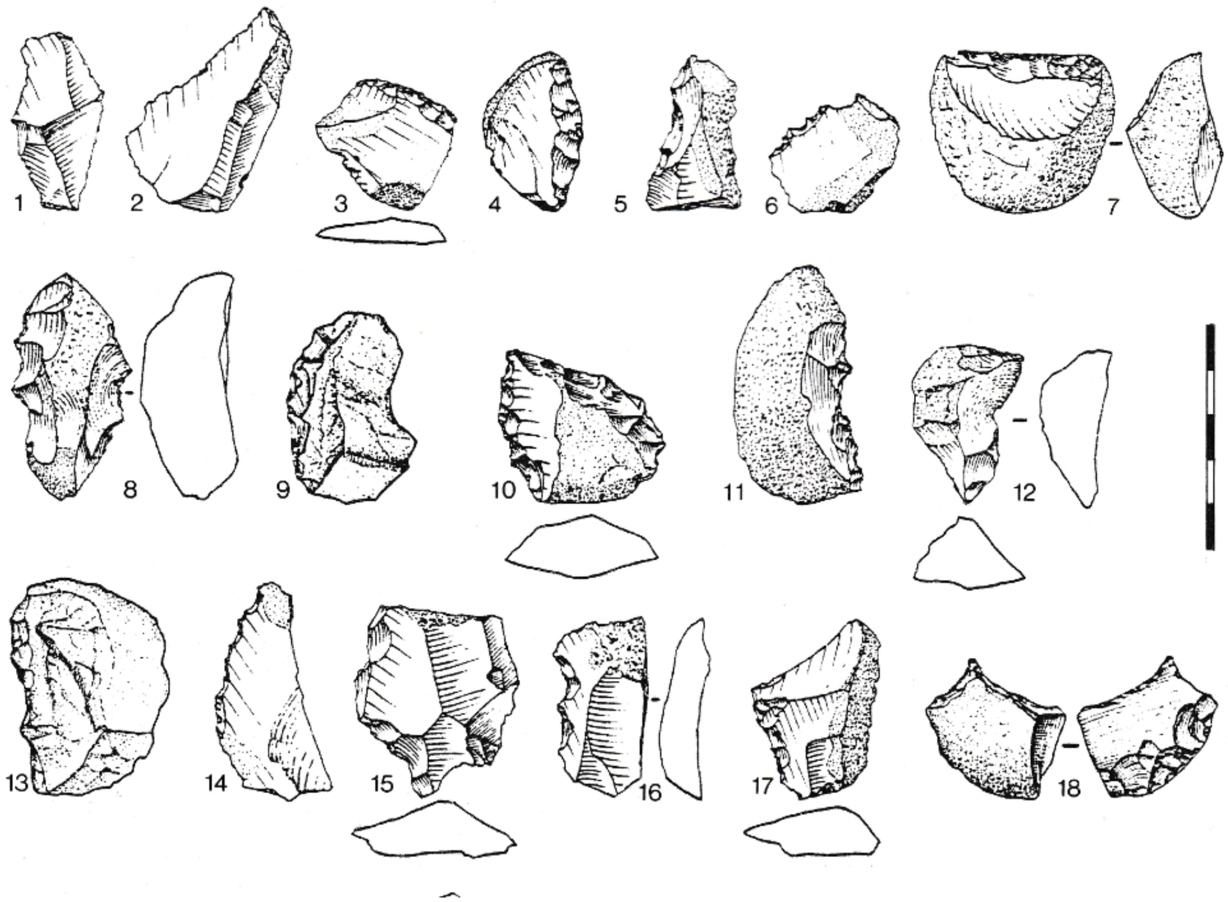


Figure 7.8: Contre-coupe retouched tools from Saint-Colomban. From: Le gisement Paléolithique inférieur de la Pointe de Saint-Colomban à Carnac (Morbihan), Gallia-Préhistoire 28, 7-36, 1985.

Back to the flint-area

We can now continue our story of the unexpected journey at the beginning of MIS 11. The group already followed the Garonne into the lowlands, where they were forced to use pebbles as raw material for their tools. The next generations grew up as expert pebbletool-makers: the children learned at a very young age how to break the pebbles with the primary axial and oblique methods shown in *figure 7.3*. The best pebble-fragments were selected and used immediately, or modified with contre-coupe to become retouched tools. For the next generations living in the lowlands, the bipolar methods were the normal modus operandi. Then the global warming pushed the climate-belts even further north so the next generations of our group travelled to the north along the Atlantic coastline and arrived in Saint-Colomban (near Carnac, Brittany). *Figure 7.8* shows some tools found in this famous site; all were made on blanks produced with the primary methods from *figure 7.3* and retouched with contre-coupe. It is i.e. nearly impossible to make the large removal in drawing number 12 from the free hand because (although it is not a deep notch) it is at a steep angle on a small object. The side-view shows that segment number 8 is very thick, the denticulate retouche in this segment is therefor even harder to make from the free hand, but this is very easy in contre-coupe. Such irregular denticulate retouches even appear spontaneously when you work on an anvil. Very fine points like in number 15 and 18 can also be made far easier with contre-coupe. Saint-Colomban shows the trademarks of hominids specialized in bipolar flaking.

The climate-belts continued to the north, so the next generations followed the valley of the Channel-river to the river Thames. That is where our story of the unexpected journey ends, what technology would the group use in the Thames-valley? The group left the upper-Garonne area as handaxe-makers and was now in an area with a lot of very good flint. These hominids clearly had the brains, the physical control and also the raw materials needed to make handaxes. But they simply lacked the knowhow because their grandparents and parents had only taught them bipolar techniques. So perhaps some of them may have struck a few flakes from the free hand, but that is not the same as making a handaxe. To make a proper classic handaxe you i.e. need to know how to scour a thin edge to keep it from splintering. Platform-preparation is essential in freehand flaking; the famous experimentalist Ginelli at Les Eyzies (Dordogne) always told his students: 'Préparez messieurs, préparez! But this was never taught to the hominids who arrived at the Thames. These guys did not even know what a handaxe was. So they were of course glad that they found better raw materials but also perfectly happy with their forms and function of their bipolar tools. So why would they even try to make a handaxe? Instead of this, they simply used the the large good quality flints from the Thames-valley to make large good quality bipolar tools. Instead of small pebble-OBFs they now made very large flint OBFs, sometimes with deep notches and other retouches. This MIS 11 industry is called the Clactonian tradition.

Clactonian

Everyone thought the Clactonian was older than the Acheulean until (at Boxgrove, chapter 1) the geologists falsified this theory. So in 1990 it seemed inexplicable why the Clactonian did not make handaxes; this was called 'the Clactonian question'. We now solved that riddle and can also solve all other riddles of the Clactonian. Such as the large platforms; abbot Henri Breuil believed the platforms were so large because primitive early-man had not yet developed the skill to strike closer to the edge of the core. This primitive creature also struck so terribly hard that the bulbs often covered the complete ventral face; Bordes, de Heinzelin and Alimen even believed that the bulbs were so large because Clacton-cores were (as in *figure 3.1* bottom left) struck with both hands against an anvil. After the discovery of Boxgrove everybody knew these old theories made no sense but there were no new theories, so the interest in these special flaking-signals suddenly vanished. The large platforms and bulbs were no longer considered as typical and the name Clacton-flake came into use as a synonym for non-Levallois-flake. But we now understand that the typical flaking-signals are typical for oblique bipolar flaking (chapter 3-4).

In 1932 Denis Peyrony claimed that Clactonian cores we flaked in a special sequence. When the first flake was removed, the core would have been turned to use the first negative as platform for the next strike. So according to Peyrony the Clactonians used alternate flaking, this explains why the large platforms showed only one or two large facets. Today however, we know this alternate flaking was not done from the free hand but with the core lying on the ground. *Figure 7.9* shows an experiment with this method. The flakes show the characteristic flaking-signals; at the left we see a part of a wide and deep platform (the red dots are the points of percussion). You need great strength to make such thick flakes from the free hand, but it is very easy to make them on the

Figure 7.9: Clacton-type alternating-core and Clactonian OBFs (experiment by Ton van Grunsven). The anvil was not used in the experiment, it merely helps to display the objects for this photo.

ground. There are no contrasting bulbs, just like we saw in Dmanisi the ventral surface instead shows a diffuse curvature. Breuil, Bordes, de Heinzelin and Alimen mistook this curvature for a very large primitive bulb. Flaking the core on the ground after it was turned, led to flaking-angles (= the angle between the platform of a flake and its ventral surface) of 120-130 degrees. This wide angle was until 1990 considered typical for Clactonian-flakes (Acheulean flakes on average show 110-120 degree angles). Of course many bipolar cores are reduced in a different sequence, we for instance saw in *figure 6.13* that the parallel-OBF-method produces angles close to 90 degrees.

The Clactonian toolmakers used the same bipolar methods as pebbletool-makers: the primary flaking methods from *figure 7.3* and contre-coupe. They made deep contre-coupe notches in large OBFs, this created the typical flaked-flakes. Another very typical notched tool-type is the Clactonian bill-hook (*figure 7.10*). Bordes defined the bill-hook as a flake (of course an OBF) that shows distal truncation (the blunting used to create a grip) and a lateral deep notch.

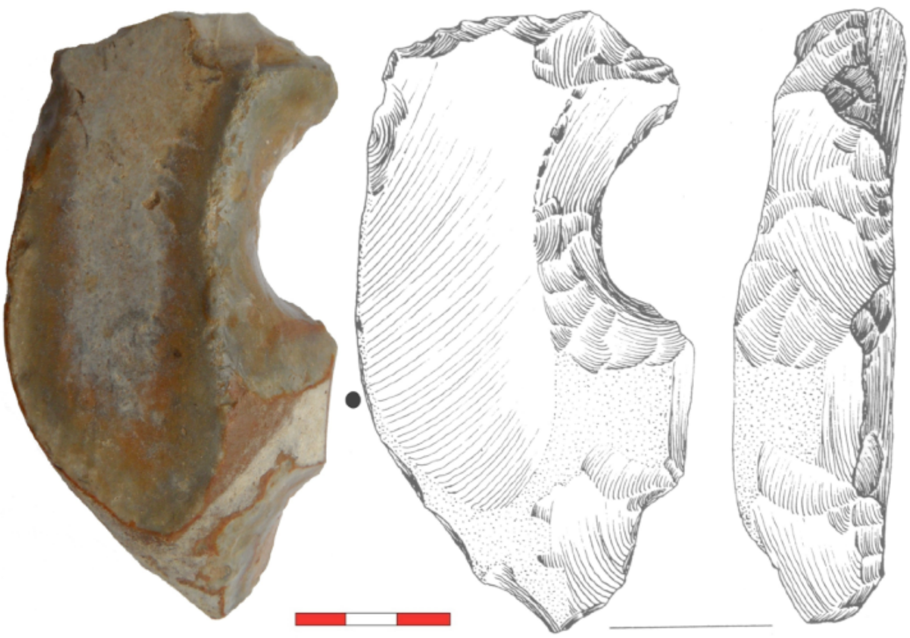


Figure 7.10: Clactonian bill-hook. From Berg (near Maastricht).

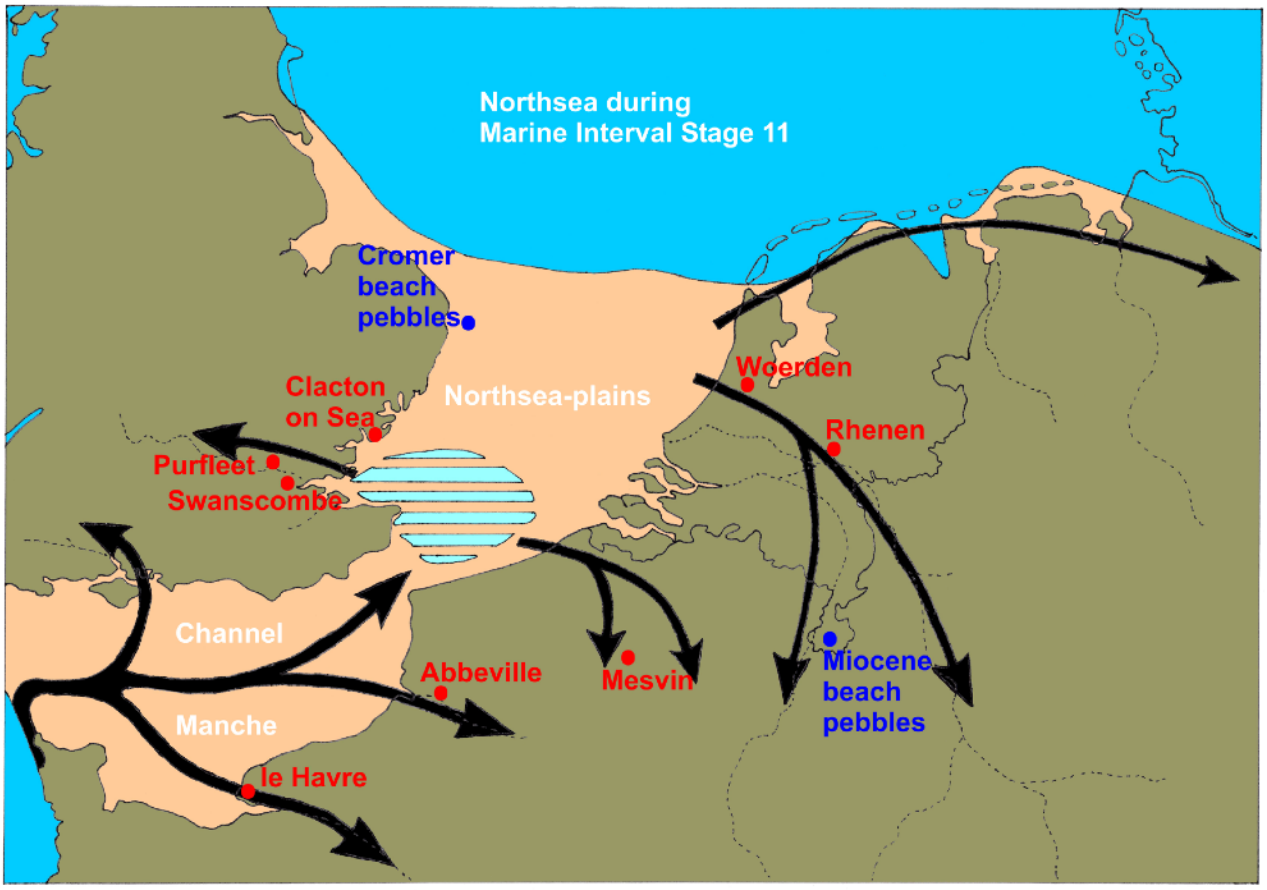


Figure 7.11: During MIS 11 England was connected to the continent by the dry North-Sea-plains. Fossil shells indicate the Thames and Schelde may have fed a large lake, that emptied its waters into the Channel-river. The arrows show how the bipolar toolkit concept must have spread.

Spreading into Northwest-Europe

The story of the unexpected journey solved 'the Clactonian question' by explaining why Heidelberg-man did not use the good flint that he found in Swanscombe and Clacton-on-Sea at the start of MIS 11, to make classic Mode-II-handaxes. His ancestors had over many generations flaked small pebbles with bipolar techniques so he used those same techniques on the large flint-nodules. The same goes for hominids that spread along other river-valleys into Northwest-Europe at the beginning of MIS 11. The black arrows in *figure 7.11* represent the most likely migration routes that they could have followed (hypothetically starting from Saint-Colomban in Brittany). This explains why all hominids (during the first half of MIS 11) in this area used bipolar technique: they had all descended from groups that made the journey through the lowlands and followed the Channel-river upstream. The valleys of the Somme, Schelde, Thames, Rhine, Meuse, Weser and Elbe were all populated by descendants of the pebbletool-makers. At the start of MIS 11 none of the Northwest-Europeans made classic-Acheulean-handaxes, they all used the bipolar toolkit concept. Depending on the raw materials they either made pebbletools, or Clactonian tools, or closely related bipolar toolkits.

Interestingly the same thing also happened during migrations at other times and in different places. We saw in chapter 5 that LFB-Acheulean migrants lost the ability and desire to make handaxes when they crossed the Ponto-Caspian lowlands or Ganges-Brahmaputra lowlands. Chinese handaxe-makers that migrated towards Beijing also had to cross a vast lowland where they lost the ability and desire to make handaxes. This explains why the Zhoukoudian pebbletool industry that did in some phases have the raw materials to make large Clactonian OBFs, never made any attempts to flake these large blanks into handaxes. The groups that reached Hungary in MIS11-9 probably followed the Danube upstream, so these groups also migrated through vast lowlands. The groups at Vértesszöllös (chapter 1 and *figure 7.4+7.5+7.12*) therefor felt perfectly happy making bipolar pebbletools. Vladimir Doronichev called the non-handaxe groups in Central and Eastern-Europe Pre-Mousterian, because their toolkit tradition continued until Mode-III (the

Mousterian traditions) spread through this area. We can now understand that these groups also used bipolar flaking as the result of crossing the Ponto-Caspian lowlands. It is obvious that the name Pre-Mousterian cannot be used in Western-Europe and in China where the Acheulean was the precursor of the Mousterian. In general we should therefor use the generic-technical name 'bipolar toolkit concept'. Loosing the ability and desire to make handaxes was not always due to lowlands; the hills between the Seine river-system and the Rhine river-system also provided too few raw materials that could be used to make handaxes. So when the classic-flint-Acheulean groups in MIS 13 migrated through these hills from France to Germany they also lost the ability and the desire to make handaxes. This explains why the original Heidelberg-jaw (type-fossil) was not accompanied by formal Acheulean tools. The beds in which it was found (the MIS 13 Mauer-sands) have only shown tools made with the bipolar technology.

The return of Mode-II
The excavations at Swanscombe show that the handaxe did however return to England in the second part of MIS 11 immediately after a short cooler climate-phase. That is an interesting finding, because the Clactonian could not have reinvented the handaxe. The handaxe was invented 1.75 Ma on the African savanne because groups along the seasonal watercourses were forced to use the extra-large OBFs that they carried as their exclusive raw material. The Clactonian toolmakers at Swanscombe were in a completely different situation: they had plenty of other raw materials at hand. With the luxury of ample raw materials they had no desire to change their technical tradition; the Clactonian continued to be made from the lower gravels deposited by the Thames at the end of MIS 12, all through the middle gravels and into the middle loam at Swanscombe. The hominids were completely content with their bipolar toolkit so they persisted in making Clactonian from the end of MIS 12 all through the first part of MIS 11.

The presence of beautiful, fully developed (often pointed) classic Acheulean handaxes in the upper gravels (the beds dated to the second part of MIS 11) can therefor only mean that new groups of migrants had arrived who had not lost the ability and desire to make handaxes. This brings us to the question how this second wave of migrants had been able to hold on to its South-European technology. The first and most important reason is that the population had grown in the first part of MIS 11. The population-growth of extinct hominids was much slower than that of Modern-man (see chapter 10) but the population of the middle-Garonne nevertheless grew in MIS 11. The new generations did therefor not only migrate downstream but also spread into other valleys. Groups for instance followed the Tarn upstream and spread into the foothills of the Massif-Central. By spreading through the hills, step by step and valley by valley, these groups reached the Dordogne river-system without loosing the ability to make handaxes. Because the streams that eroded valleys in the hills carried enough raw materials. Step by step the handaxe-technology progressed from the Dordogne to the Vézère, to the middle-Isle (the upper-Isle carries mostly quartzes and other poor raw materials) and so on until this technology finally reached the Somme river-system.

This mechanism was not merely limited to the migration to England in MIS 11: the fast-spreading bipolar groups also arrived first in other areas and at other moments. They were followed later by handaxe-makers; the slower-spreading handaxe-technology sometimes needed an extra push to reach new areas, like the change to a more open landscape at the beginning of the middle-pleistocene. The extra push that got the handaxe across the Channel-valley from France to England was probably provided by the cool phase in the middle of MIS 11. Many trees died during this cool climate-phase so there were more open areas and the increased erosion brought more raw materials into the lower valleys. This increased availability of the raw materials helped the classic-Acheulean technology across the Channel-lowland into England.

No standard forms
We saw in chapter 5 that social motivation gave Acheulean handaxes many different, but highly stylized and standardized forms. The hominids who made bipolar tools were undoubtedly just as susceptible to compliments, there is no reason to assume that they were less socially motivated than the handaxe-makers or than we are; they also wanted likes and followers. So why did the bipolar toolkit concept never develop aesthetic standard forms? The reason becomes ver clear when we take another look at the pebbletools from Vértesszöllös. But now instead of focusing on selected forms (like the nice flake and retouched flake in *figure 7.4-7.5*) we must look at the 'general habitus' (what this means was explained discussing *figure 4.5*) of the toolkit. The

Figure 7.12: In bipolar indrustries a random sample of the total assembly does not shows standardized forms. This box with finds from Vértesszöllös shows no structurally organized forms. HNM, Budapest.

contents of the box in *figure 7.12* represent the 'general habitus' rather well because this is a group of artefacts prior to selection. All lithics in this box were excavated in the same spot at the same time, that is the reason why all pieces in this box share the Pb-65/18.. code. Most of them are simply fragments of pebbles, produced with the primary methods in *figure 7.3*; these primary methods gave the fragments nearly random forms (forms more or less comparable to the Mode-I artefacts from Dmanisi in *figure 4.5*). It is essential that you understand that the content of this box represents the basis for the toolkit. Some pieces (like the flake in *figure 7.4* that you see lying at the center of the box) had a point or cutting-edge that did not deed to be modified. These highly functional forms were often selected and used as tools. Other forms were selected to serve as blanks, these fragments were retouched with contre-coupe (like the flake in *figure 7.5*). It is very obvious that no matter what you select from the box in *figure 7.12*, you will never be able to give your selection a standardized form. The absence of standard forms in the bipolar toolkit concept clearly does not indicate lower intelligence or less skills or even a lack of social motivation.

Still these hominids did manage to create forms that we can recognize as specific Techno-Functional-Units (TFUs). You will not find the name TFU in Bordes' popular book Le paléolithique dans le monde, because the concept that tools have TFUs only became popular after Semenov popularized the microscopic analysis of use-wear traces. Today microscopic use-wear analysis enables specialists to recognize how for instance a handaxe has been used. The wear-traces at the tip can for instance show this part of the handaxe was used to stab or carve (point-TFU). The wear-traces along one long edge of the same handaxe can for instance show this part was used as a cutting-TFU, whilst the other long side was held in the hand (grip-TFU). The use-wear on bipolar tools has not been studied often, the lack of standardization and also lack of aesthetic attraction does not motivate researchers. But a simple macroscopic inspection of the contre-coupe retouche can sometimes already indicate the presence of specific TFUs. It is i.e. very likely that the steep retouch at the top of the bill-hook in *figure 7.10* was meant to serve as a grip-TFU. The ventral spalls at the top-right clearly resharpen the tip, so this tip was probably used as a point-TFU for cutting or carving. The deep notch must be a concave scraper-TFU, this was perhaps used to sharpen a stick, maybe a wooden spear (like the wooden spear-tip that was found in Clacton on Sea). The angles below the notch both show resharpening-spalls and there is also an extra point-TFU at the bottom. So this bill-hook represents far more than just a form that can be defined by Bordes' typology: we can tell that it served as a multi-tool with at least 6 TFUs. Of course most TFUs were made on blanks with no specific form, so most bipolar tools have no specific typological name. Laszo Vértes already recognized this problem in 1965, so instead of working with a failing typological system, Vértes designed a digital code for the classification of pebbletools. *Figure 7.13* shows a small part of his digital code-system: the numbers represent codes for the raw materials, the shape of the blanks and also give some indication of the TFUs.

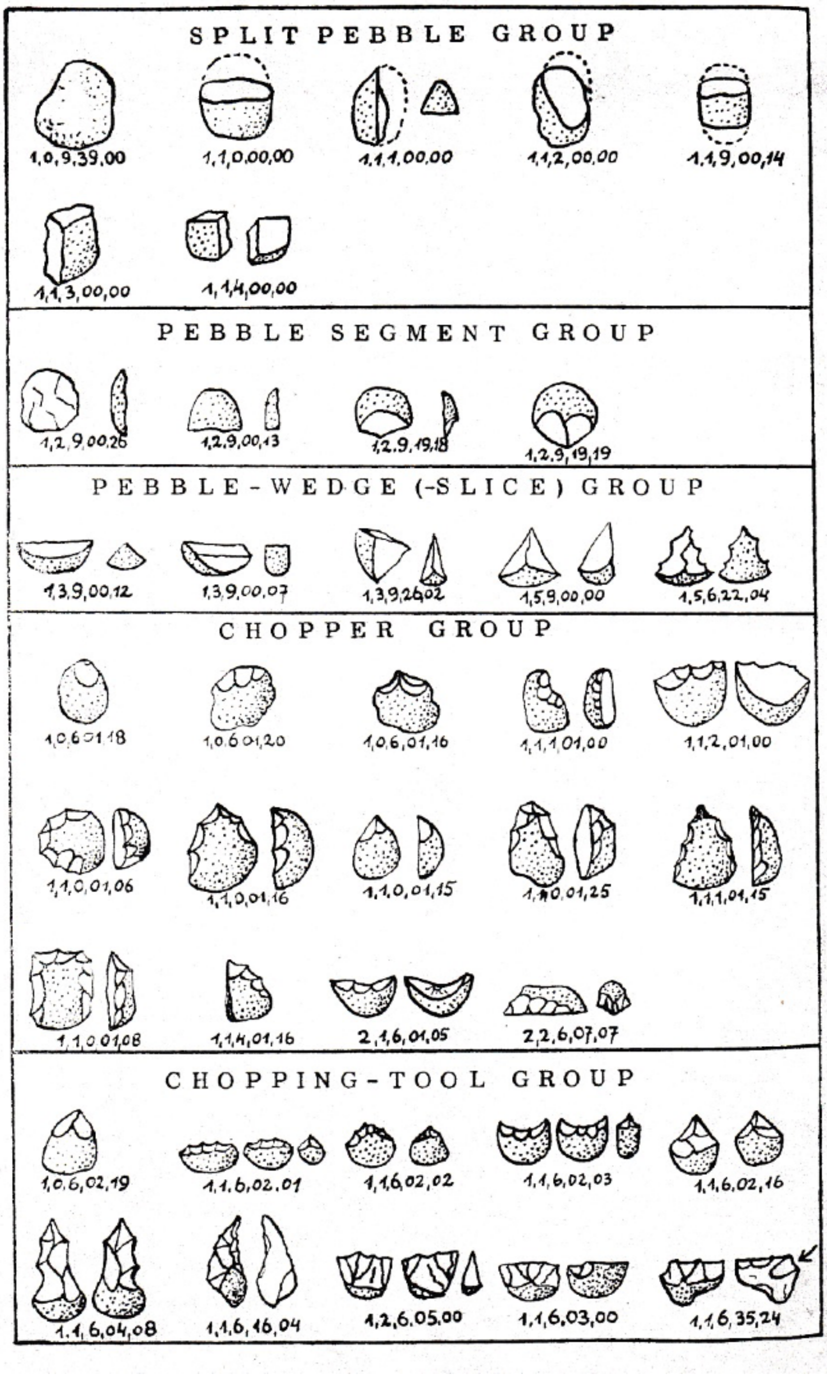


Figure 7.13: Code-system by Vértes. From: L. Vértes: Tyopology of the Buda industry, a pebble-tool industry from the Hungarian lower paleolithic. Quarternaria VII, Roma 1965.

Previous page, frontpage Chapter 8: pebbletools from Valkenburg (in the Geul-valley 10 kilometers from Maastricht, Netherlands). Collection Piet Kelderman, display size 40 by 70 cm.

Chapter 8: In the Netherlands

Movius-line
The handaxe-makers that lived in Swanscombe in the second half of MIS 11, were physically able to walk across the dry North-Sea-plains to the Netherlands. A group of hunter-gatherers could easily walk 15 kilometers in one day, if they did that each day the English handaxe-makers would have been able to reach the Meuse and Rhine in just 3 weeks. Theoretically this was a piece of cake, so why have we never found Mode-II MIS 11 or even MIS 9 handaxes in the Netherlands? We saw in chapter 7 that the hunter-gatherers were not like pilgrims; they did not walk in order to go to a specific goal. When you walk any further than strictly necessary, you waste of energy. That is today a healthy thing to do, for people with a western lifestyle. But when you only have limited access to food it is very bad to waste energy; when pleistocene hunter-gatherers walked any further than strictly necessary they lowered their chances for survival. So the migration of our ancestors was not driven by curiosity or by the intelligent desire to know what lay beyond the horizon. To the contrary: our ancestors were intelligent enough to stay in their own area.

Our ancestors only migrated in search of food, predominantly as the result of climate-change or population-growth. The population growth in MIS 11 may have forced some English handaxe-makers onto the North-Sea-plains. But the groups that hunted and gathered in these lowlands could not find the proper raw materials to continue making handaxes. They had to make bipolar tools and their children grew up making the bipolar toolkit. So after many generations, when the population on the North-Sea-plains grew to a point that groups moved further east, it had lost its ability and desire to make handaxes. The hominids which finally reached the foothills on the other side (where they found large flint-nodules and cobbles on the riverbanks of the Meuse and the Rhine) had no idea what a classic handaxe was. So in the second part of MIS 11 and in MIS 9 the North-Sea-lowlands became the Movius-line: the border between the Acheulean technology in Britain and the bipolar toolkit concept in (what today is) continental-Northwest-Europe.

Technical approach
Our eyes are our most important sensory organs, so we do not judge stone artefacts by their smell or sound but by their form. When we look at the pebbletools on the frontpage of this chapter we are drawn to the fact that nearly all show a rounded part. This unworked natural part is the most striking connective form-element. These naturally rounded forms led to the German name Geröllgeräte (= rolled-stone tools) and the French call pebbletools galets aménagés (= worked rounded-stones). But these German and French names allow us to call the artefacts in *figure 8.1* Geröllgeräte or galets aménagés, but that does not make them pebbletools. People tend to throw such galets aménagés and pebbletools into one basket, even specialists believe that both belong in the same typological unit (in German Formengruppe) but they are completely unrelated. Pebbletools measure between 4 and 64 millimeters (Krumbein) and are technically bipolar tools. The choppers in *figure 8.1* are not made from pebbles but from cobbles, technically they are freehand cobble-Acheulean choppers just like in *figure 6.2*. Many are (like the tool at the left in *figure 6.2*) unifacial because the flat surface on one side formed an easy platform. Amidst many choppers there are also a few flakes and picks on the Portugese beaches.

This shows us how quickly we can make mistakes when we approach the tools by looking at their forms. The same mistake is also made the other way around: many small and large tools without rounded forms are assumed to be Acheulean whilst they are technically bipolar. This makes them technically related to pebbletools. For instance the stone tools found in Schöningen (a 300 ka site in Germany that is famous for its well preserved wooden spears) do not have rounded forms, most therefor researchers believe these must be Acheulean tools. But on careful inspection it is clear that there are no classic handaxes in Schöningen; only flakes, scrapers, points and denticulates. Flakes, scrapers, points and denticulates can all be made with bipolar methods and according to *figure 7.11* it is very likely that Schöningen was settled by bipolar toolkit groups. One way to find out whether or not Schöningen is a true Acheulean industry is by studying the flaking

signals like we did in Dmanisi. But for the MIS 11-9 industries we also have a far easier way to recognize the technical tradition: some of the typological forms are rather specific. The classic handaxes are highly specific for the Acheulean freehand tradition, so the absence of classic handaxes is a first indication for bipolar traditions. In this chapter I show forms which are more or less typical for the bipolar toolkit concept, this may help you become more familiar with the typology of these industries. Most of the examples in this chapter were found in the Netherlands, hence the title of this chapter.

Left, figure 8.1: Choppers and pics found on Portugese beaches are classified as galets aménagés. Do not mistake these objects for pebbletools. This is a freehand cobble-Acheulean tradition, comparable to the groups from the Tarn valley (see chapter 6).

Below, figure 8.2: Pebbletools from the North-Sea plains from the Ad Wouters collection. Enlarged at the top-right: this pebble-segment was retouched with contre-coupe to become a scraper.

Classic pebbletools
On the frontpage of this chapter we begin with the most obvious forms: the classic pebbletools. The combination of rounded raw material and small size (4-64 mm) leaves no doubt that the pebbletool-makers used bipolar techniques. The North-Sea-lowlands formed the Movius-line so it makes sense to begin with some classic pebbletools from these lowlands in *figure 8.2*. The site from which these tools originate is shown in *figure 7.11* with a blue dot (and blue text Cromer beach-pebbles). Small rounded flints were brought to this area by the Thames during the Cromer stage (MIS 21-13), during marine transgressions these flints were rounded even more by the surf. In MIS 11-9 Heidelberg-man found these so-called beach-pebbles in many trenches (that were cut by watercourses) on the dry plains and he used them to make tools. Dutch collectors found these pebbletools in a secondary position: they were dredged from the bottom of the North-Sea as aggregate during the eighties and a group of many thousands of these pebbletools was deposited on a company-railroad at Oosterhout (Netherlands). Due to the excellent quality of the British flint there are far more relatively large pebble-OBFs in this group than in the group at the frontpage of this chapter. Some of the larger pebble-OBFs were notched, these notched pebble-OBFs are technically comparable to the Clactonian flaked-flakes.

It seems as if the classic pebbletool-makers left us a trail of pebbletool-sites that we can follow from the North-Sea plains into the Netherlands. The pebbletools in *figure 8.3* were found in the centre of the Netherlands in a sand-pit at Garderen (30 kilometers north of Rhenen). From here we follow the trail south to Neer, here the pebbletools at the frontpage of chapter 7 were found in a quarry. Neer is right in the middle between Garderen and the blue spot in *figure 7.11* where it says miocene beach-pebbles. This blue spot shows an area in the south of the Netherlands, with many beach-pebbles (formed during miocene marine transgressions). During the pleistocene this raw material washed onto the terraces of many streams; this terrace-gravel was used as raw material during MIS 11-9. For instance at Jabeek, Nagelbeek (quarry Brull, see *figure 8.4*) and Valkenburg (10 kilometers from Maastricht, *figure 1.7-1.8* and frontpage of chapter 8).

Figure 8.3: Pebbletools from Garderen. Collection Ab Lagerweij.

Figure 8.4: Pebbletools from Nagelbeek quarry Brull. The refit at the top consists of two scrapers, its drawing at the top right is from: Peeters et al, l'Anthropologie Tome 92. Collection Ad Wouters.

Clactonian

But finding this trail of pebbletool-sites does not mean that an actual pebbletool-culture existed. In the sixties the idea became popular that primitive hominids with a cultural preference for pebbletools lived in Beijing (China), in the Reggan (Sahara, described by Ramendo) and Vértesszöllös (Hungary), who were somehow connected and should therefor all be related to the Chinese Homo erectus. In reality however there was no culture that searched the world for pebbles. Pebbles were simply used out of necessity, so when the bipolar-toolkit-groups found larger raw materials they preferred to use these larger materials. We saw that at Swanscombe and such Clactonian tools were also found at Clacton-on-Sea and in the Netherlands at Woerden and Rhenen (both shown red in *figure 7.11*). The Clactonian and pebbletools were made by exactly the same hominids but the final form of the tools depended on the availability of raw materials.

The MIS 11-9 hominids found completely different raw materials rather close to each-other near Maastricht (in the south of the Netherlands). One group at Berg (a village bordering on Maastricht, close to where the Geul-stream flows into the Meuse) used the gravel it found in a terrace of the Meuse. This gravel holds large flints and cobbles, so the group made large Clactonian tools (*figure 8.5* and the bill-hook in *7.10)*. The flakes in *8.5* show very large platforms and very large diffuse bulbs which are typical for the Clactonian. The grey flake at the left shows a large scar and a dead-end cone. Dead-end cones are often seen in the Clactonian and in bipolar experiments. The tools at the bottom would a century ago have been classified as crude thick Abbevillian-handaxes but are really trihedral blanks (formed with the methods in *figure 7.3*) with contre-coupe retouche.

Figure 8.5: Clactonian from Berg near Maastricht. The Clactonian flake at the top-right is side-struck. The tools at the bottom are retouched trihedral points, the smaller point at the left can typologically be classified as a Tayac-point. All of these tools show multiple TFUs.

Non-classic pebbletools
When we follow the Geul-valley starting from the village Berg for 10 kilometers upstream we arrive in Valkenburg. The MIS 11-9 hominids could at Valkenburg no longer find large stones so they could not make Clactonian like in Berg. The terraces of the Geul-stream were instead littered with small miocene beach-pebbles. So at Valkenburg the MIS 11-9 hominids could only make classic pebbletools (*figures 1.7-1.8* and frontpage chapter 8).

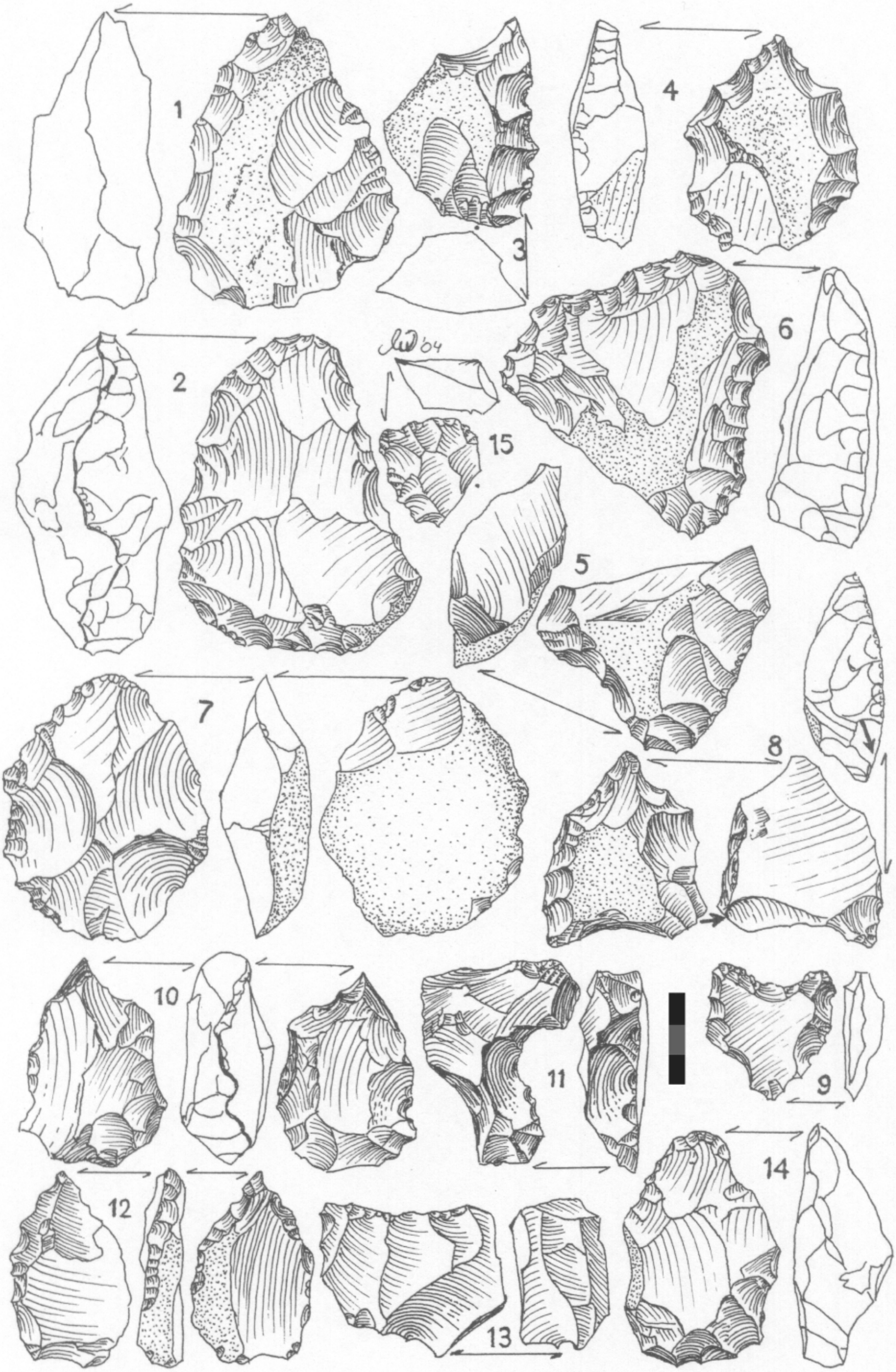
When we follow the Geul-valley for another 10 kilometers upstream, we arrive in Mechelen. Here the geology has changed again: at Mechelen there are hardly any miocene beach-pebbles in the Geul valley. The MIS 11-9 hominids instead found a mixture of gravel that was brought 2 Ma by the Eastmeuse and lots of flints. These flints came from the flint-eluvium; a sticky clay residue that stayed behindafter the karst-erosion (during the tertiary) dissolved the chalk with a high flint-content. When Heidelberg-man used this mixture, he strongly preferred the eluvial-flint over the Eastmeuse-gravel. The flint-nodules had irregular forms and most were small (or naturally broken into fragments smaller than 64 millimeters). So most flints had the size of pebbles, most of the (over 3000) artefacts from Mechelen (*figure 8.6-8.7*) are therefor the same size as pebbletools. But they cannot be classified as classic pebbletools because they miss the naturally rounded forms. So how should we call such tools? In the western part of Europe the name Pre-Mousterian makes no sense because the Mousterian was preceded by the Acheulean. I believe that we should use the name ‘non-classic pebbletools’, because most of the tools at Mechelen are under 64 millimeters but do not show the classic rounded forms.

It is now time for a confession: not all of the artefacts in *figure 8.6* and *8.7* come from Mechelen. I have deliberately mixed twelve artefacts from Mechelen with eleven artefacts from Bilzingsleben (redrawn after D. Mania and T. Weber: Bilzingsleben III, Homo erectus. Berlin 1986) with the objective to show you how much they look alike. Bilzingsleben is a MIS 11-9 site in Germany with exactly the same tool-types as Mechelen, if you do not know which tools were found in Mechelen or Bilzingsleben you cannot tell them apart. So let me inform you that all even numbers plus number 21 were found in Mechelen and the rest was found in Bilzingsleben. The reason for this close resemblance is of course that both groups used the same techniques.

Bilzingsleben
Bilzingsleben became famous in the eighties when all archeologists were struggling to combine the new geological findings with the old typological theories (chapter 1). Geologists dated the site in MIS 11-9, when early-man in France was making Mode-II. Mode-II is characterized by classic handaxes. But like in Vértesszöllös and the Pre-Mousterian industries, there is not one handaxe in Bilzingsleben. According to *figure 1.3*, this made Vértesszöllös and the Pre-Mousterian primitive and professor Dietrich Mania believed that Bilzingsleben was far from primitive. So he decided the site had to be Mode-II and blamed the absence of handaxes on the poor local materials; these were intelligent hominids that would certainly have made classic handaxes if they had good raw materials. They actually used bone fragments to make large bifacial knives and scrapers, Mania compared these to the beautiful classic pointed handaxe made from bone that was found in Castel di Guido (Italy). Everyone accepted this theory and classified Bilzingsleben as Mode-II.

But in chapter 5 we learned that the handaxe was invented because early man carried good raw materials to his camp. So if Bilzingsleben was visited by handaxe-makers over tens of thousands of years at least one person would have carried at least one blank to the site and turned it into a proper classic handaxe. Even the supposed ‘handaxes’ from bone look nothing like the real classic handaxe from Castel di Guido. Typologically they are instead scrapers and knives which do not show Mode-II-retouches, but instead contre-coupe retouches like in number 16 in *figure 8.7*. The only difference is that the hominids in Bilzingsleben used bone whilst number 16 is made on a large side-struck OBF. Tools like number 16 are also seen in the Clactonian industry; in England these OBFs with bifacial flaking are called ‘non-classic bifaces’. Number 21 can lead to a similar ‘mistaken identity’: you can easily mistake this for a freehand Mode-II pic. But this is a bipolar tool, a ‘non-classic pic’. In Bilzingsleben several antler-pics were found that probably served as the replacements for bipolar pics like number 21.

Next page, figure 8.6: Small bipolar tools. Their size classifies them as pebbletools. But they are not made from naturally rounded pebbles, we can therefor call them non-classic pebbletools.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Previous page, figure 8.7: Small and also three large bipolar tools made from irregular flints.

Mania was nevertheless a very good archeologist and he did indeed notice that the blanks in Bilzingsleben were made with hammer and anvil. But the eighties were long before I published my views on the bipolar toolkit concept, so Mania called this bipolar method 'zertrümmern'. This German word is also used when a bomb destroys a house, so using this word shows he had no idea how deliberate and controlled the methods in *figure 7.3* are. Neither did he understand that the retouche was in contre-coupe, it was simply assumed that blanks were retouched from the free hand just like in Mode-II. Mania even thought that the MIS 11-9 date placed Bilzingsleben at the beginning of Mode-III, so he tried to find possible Mode-III tool-forms. He claimed that number 7 in *figure 8.6* represented an early Levallois-core, a first step towards the single-face recurrent Levallois-core (*figure 9.2*). But we can easily spot that this is another 'mistaken identity' because the fine retouche along the edge of a single-face Levallois-cores (*figure 9.2*) is the platform-preparation. The fine retouche is therefor on the side that was hit (the dorsal or cortex-side). But in number 7 the retouche is at the flaked side so this cannot be platform-preparation, it is a Techno-Functional-Unit (TFU-retouche). The TFU was made on a centripetally flaked pebble-segment, Collina-Girard gave such flaked-segments the typological name epannelée (Les industries archaîques sur galets de la Catalogne francaise. Marseille, 1976).

Mania believed that small bifacial tools like number 1 (number 2 and 14 are similar tools from Mechelen) also confirmed that Bilzingsleben was Mode-II, he believed these were miniature handaxes. It is indeed true that similar forms are found in Mode-II-sites (i.e. in Tautavel) but they are also found in bipolar pebbletool-sites (i.e. in Vértesszöllös and *figure 8.17*). Typologically they are classified as Tayac-points, but Tayac-points are not small handaxes. Small handaxes have acute and evenly retouched edges, meant as efficient cutting TFUs. They were most frequently made in the MIS 4-3 Mousterian (for instance in the MTA) and chapter 9 explains why many Mousterian tools were so small. Tayac-points are very different, Bordes defined them as points with a denticulate retouche and added that they are often triangular in cross-section. That sounds like a bipolar blank with contre-coupe retouches (*figure 7.7*). De Heinzelin de Braucourt even wrote that the the edge of a Tayac-point shows macro-encoches (deep notches like in *7.7C*). It is not strange that Tayac-points are found in both Tautavel and Vértesszöllös because anvils were used in both sites.

There are many Tayac-points in Bilzingsleben, so it should not surprise us that Mania was able to present a few selected forms that were rather thin in cross-section and had regular retouche just like in small MIS 4-3 handaxes. One of the best Mode-III-specialists, Jürgen Richter noticed that the retouche on these points was first finished on one side. The blank was only turned over after the first side was finished and it was then retouched on the other side. We saw in *figures 7.6-7.7* that the third special aspect of contre-coupe retouche (the negatives always form on the visible side of the blank) leads to flaking in this order. So we are not surprised to see that Tayac-points do not show alternating Mode-II retouche. Richter however did not specialize in bipolar flaking but in the Micoquian (see chapter 9). Most Micoquian handaxes are also flaked on one side before the other (chapter 9 explains why Mode-III freehand-traditions used this flaking sequence). This led Richter to believe that the Tayac-points from MIS 11-9 Bilzingsleben represented the first step towards the MIS 4-3 Micoquian. Yet another 'mistaken identity'.

Gulpen

The site from Gulpen that I published in 1988 (chapter 1) also shows a non-classic pebbletool tradition, it is technically related to Bilzingsleben and Mechelen. Just like in Mechelen, the group used mostly small eluvial flints. *Figure 8.8* shows a cross-section of the site, situated on the slope of the Geul valley. The Geul valley began to form in the early- or middle-pleistocene as a small cut into the terrace of the Eastmeuse. The valley became deeper over time and near the site it has today a depth of 100 meters and width of 2500 meters. The site lies on a 12.5% slope without recognizable terrace-levels, so the stick clay washed downhill and quickly covered the artefacts. The clay protected the artefacts against corrosion until the stones resurfaced at the result of erosion due to the 20th-century agriculture. We therefor have no datable stratigraphy, we can only note that most large artefacts were found at 140-150 meters above the present sea level. Smaller artefacts were present at the same level but had also washed downhill. The depth of every valley is related to level where the river ends (this is clearly demonstrated by the Nile and Rhône valleys:

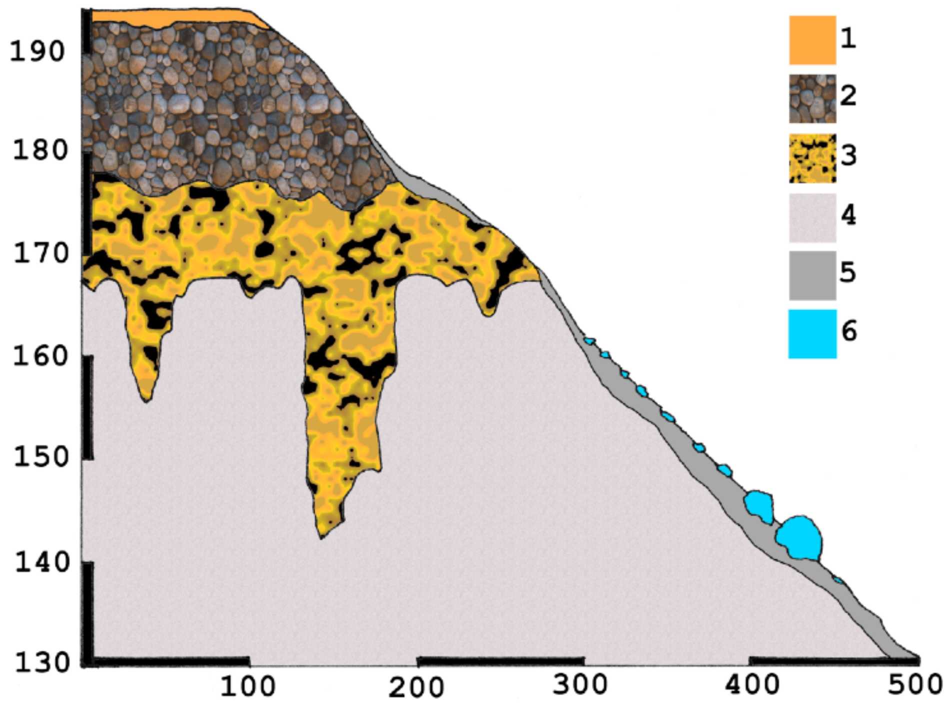


Figure 8.8: Cross-section through the Geul valley at Gulpen. 1: loess, 2: Eastmeuse gravel, 3: eluvial flint bed, 4: cretaceous chalk, 5: slope-deposits 6: artefacts.

these formed kilometers deep gorges around 5.5 Ma when the Mediterranean sea almost dried up during the Messinian salinity crisis but after the sea level was restored by ocean-water that flowed through the Gibraltar Strait, these deep gorges were rapidly filled up with deposits). The Geul is a tributary of the Meuse, so the depth of the Geul-valley is related to the pleistocene terraces of the Meuse. At the site the valley-floor must during MIS 11 have been at 115-120 meters above the present sea level. This is 25-30 meters below the artefact level, so it is geologically possible that the artefacts were made during MIS 11-9. Since 2008 gravel was repeatedly dumped on the site, this has made the site completely inaccessible.

Figure 8.9: Rains uncovered production-waste and also washed small flints downhill.

At Gulpen most of the artefacts measure between 3 and 6 cm and just like in Mechelen they do not show naturally rounded parts. So we must call this a non-classic pebbletool tradition. A part of the production-waste was present at the site (*figure 8.9*) but much must have washed downhill. Like in Mechelen and Bilzingsleben there are some artefacts that measure over 64 mm: some large flint-nodules were used to make large OBFs, others were used as anvils. For instance the converging denticulate in *figure 1.6* was made on a large OBF. The large OBF in *figure 8.10* is not retouched. The often steep retouched scrapers, denticulates, notches and the absence of classic handaxes confirms that the industry is part of the bipolar toolkit concept (see *figures 8.11-8.20*).

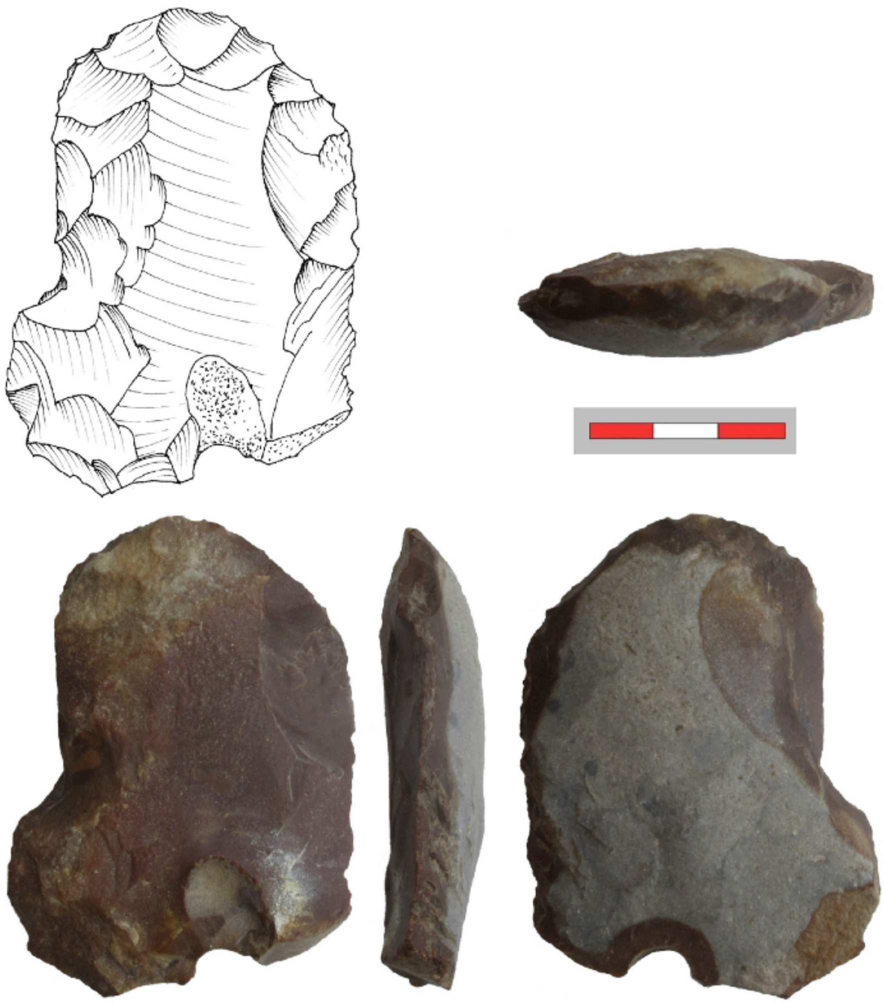
Figure 8.10: This OBF has a 1.5 cm deep and wide (Clactonian type) platform. The scar measures 5x4 cm, this indicates how effective all kinetic energy of the hammer is used in bipolar flaking.

Below, figure 8.11: Combination-tool from Gulpen with point, notch and scraper UTFs.

Figure 8.12: This is not a tool from Gulpen but a 1.8 Ma tool from West-Runton. It also combines point, notch and scraper UTFs. Both traditions are so similar despite their hugely different ages, because the bipolar technique defined the form.
In the Acheulean the freehand technique defined the form so there we see a great similarity between the 1.7 Ma handaxes and 300 ka handaxes.

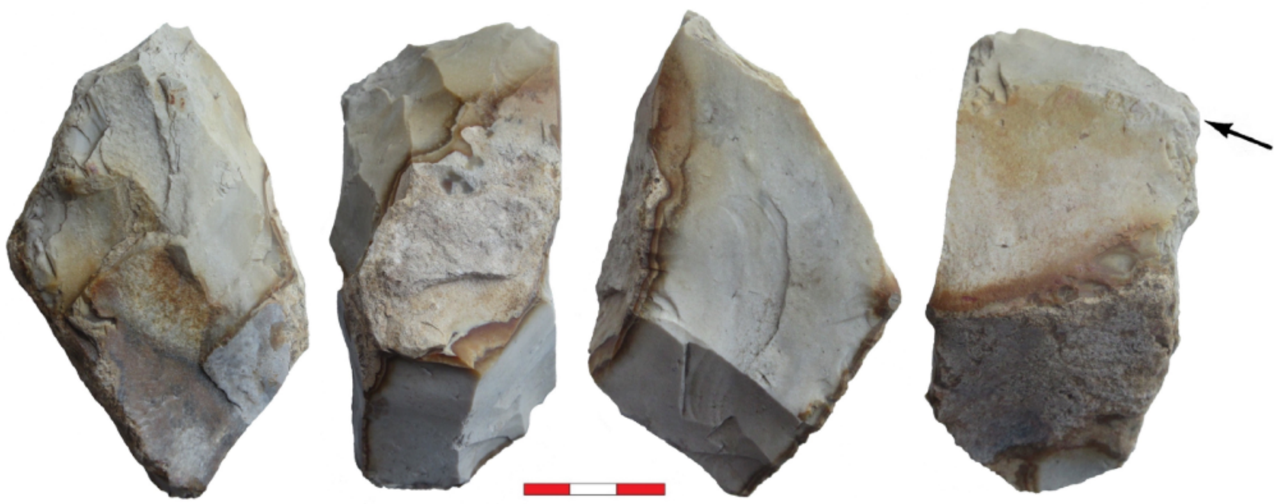
Above, figure 8.13: Pointed and denticulate tools on flakes, Gulpen.

Left, figure 8.14: Deep notches in thick blanks like in this tool from Gulpen or number 11 in figure 8.6 from Bilzingsleben can only be made with the contre-coupe method (as in figure 7.7C).



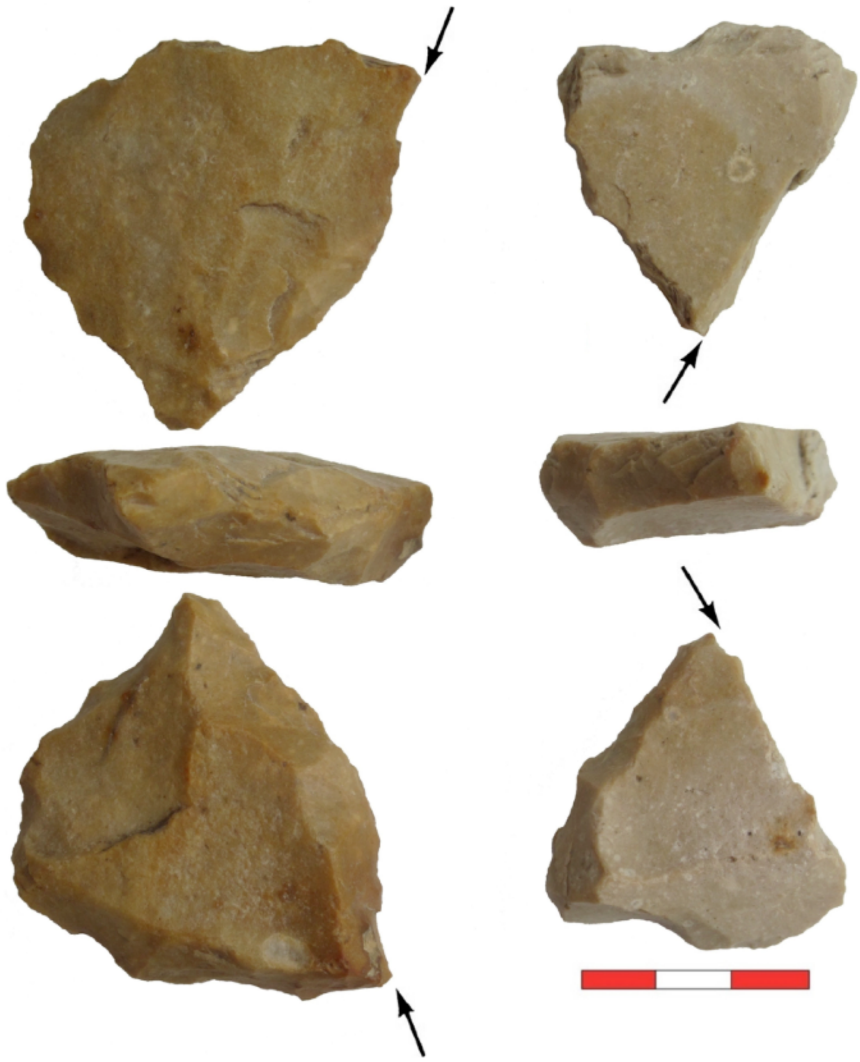
Left, figure 8.15: The edge of this flat blank shows typical flat bifacial contre-coupe flaking. We can call the retouche at the ventral side (drawing and photo at the left) invasive. Gulpen.

Below, figure 8.16: Chisel-edged chopper from Gulpen. The cutting UTF was sharpened by retouche on one side and resharpened by a spall (similar to a burin strike, indicated by the arrow) on the other side.



Next page, figure 8.17: Middle-pleistocene hominids that performed similar tasks needed similar UTFs. This explains why the forms of the five Acheuléen-meridional tools on the left are so similar to the five tools from Gulpen at the right. Top row: Quinson-point and three Tayac-points, in the middle borers-reamers and at the bottom small steep scrapers. Bipolar methods were used in the Acheuléen-meridional (cobble-Acheulean) (OBF and anvils), so some deep notches (macro-encoches) in Acheulean Tayac-points may have been made in contre-coup just as in the non-classic pebbletool Tayac-points.

Below, figure 8.18: The most prominent modified Acheulean tools are cutting-tools (handaxes). But in bipolar traditions most modified tools show points, sometimes resembling the tip of a finger. The points in this photo are called rostrocarinates because they resemblance a beak or keel. In German they are called Nasenschaber because they also resemble a nose. Gulpen.



Left, figure 8.19: Some of the points in Gulpen were sharpened to form a cutting or carving UTF. This was either done with retouches or by striking a spall (burin). Keen observers may have seen that the combination-tool at the left is also in the drawing on the frontpage of chapter 1.

Below, figure 8.20: The tool at the left has a form that can be called a bill-hook (deep notch and distal blunting). The tool at the right resembles a thick crude 'Abbevillian' handaxe. But handaxes are cutting tools and this is not a functional cutting tool. Instead it shows points and notches like the tool at the left so both must have had similar functions despite their completely different forms. We can only understand the function of bipolar tools if we focus on the TFUs instead of the forms. Like we saw in Mode-I, most bipolar toolkit groups mostly used unmodified flakes as cutting tools.

Poor raw materials
The researchers focus on the small flint tools from Bilzingsleben. But just like in Mechelen and Gulpen there are also large stone tools. These are often made from Muschelkalk, a common local material. The large stones were flaked with bipolar methods, they show the typical forms of the bipolar toolkit concept. *Figure 8.21* shows two examples. Mania called the stone at the top an anvil, but its edge definitely shows steep flaking. This suggests it was also used as a very large cleaving tool or chopper. Mania called the stone at the bottom of *figure 8.21* a handaxe-like-shaped hammer. But it isn't flaked like a handaxe, it has no alternately freehand flaked cutting edge. Instead it shows a point that is rather typical for bipolar rostrocarinates. This point was used (or perhaps reused) as a hammer. Pointed hammers are extremely useful for contre-coup flaking. Freehand handaxe-makers have little interest in pointed hammers; Bordes even explained that they preferred the opposite: broad soft (bone or antler) hammers (chapter 1).

Bilzingsleben is (just like Vértesszöllös) preserved in travertine (sweet-water chalk). Nature brings stones into riverbeds, but not into travertine beds. So we know that all stones were carried to the sites (manuports). This means that the hominids considered the large and very heavy stones in Bilzingsleben very important, despite their poor raw material qualities. Many large manuports were not flaked, these stones were perhaps intended as hammers, anvils or cooking stones. Mania classified these unworked stones as elements of the working-areas (Arbeitsplätze). And it seemed logical to place the large flaked stones in the same category.

Figure 8.21: Large bipolar tools made from Muschelkalk (the line at the right measures 10 cm). From: Mania und Weber: Bilzingsleben III, Homo erectus. Berlin, 1986.

So when scholars study the Bilzingsleben toolkit, they get the impression that this is defined by small and highly developed flint tools, whilst the simple large tools from poor raw materials seem to be completely irrelevant. Thirty years earlier when Alfred Rust studied the beds where the MIS 13 jaw of the Heidelberg-man was found (the Mauer-sands, 1907), Rust did the exact opposite. In 1956 Rust still believed that Heidelberg-man was a very primitive species and would therefor have made very primitive tools. Rust wanted to find primitive forms; so he purely focused on the big crudely flaked tools made from poor raw materials and completely overlooked the small stuff. The large steeply flaked scrapers and rostrocarinates (similar to *figure 8.21*) that Rust presented were at first welcomed, but when critics saw that these forms could not have been made by freehand-flaking they concluded that the primitive forms had to be pseudo-artefacts. It is today obvious to every scholar that Heidelberg-man had tools and that no handaxes were ever found in the Mauer-sands. Some of the small tools are therefor now very reluctantly accepted as man-made, but most scholars still reject the large tools from poor raw materials. Perhaps that may change when they understand that the MIS 13 handaxe-makers could only migrate from France to the Rhine-Main valleys by passing through an area with poor raw materials. Where they had to use bipolar flaking and thus lost the ability and desire to make handaxes.

Ede-II

The industry in quarry Goudsberg (in the ice-pushed ridges near Rhenen, also known as Ede-II) also combined small flint tools with large tools from poor raw materials. These tools were found below the Saalian MIS 6 glacial deposits and below another 4-5 meters of earlier fluvial deposits. So the finds were probably older than the earliest handaxes from the Netherlands. In 1982 when Franssen and Wouters presented the artefacts everyone still believed that industries without handaxes were old and primitive. Wouters and Franssen therefor made the same choice as Alfred Rust in 1956: they presented the the industry as primitive by focusing on the large tools from poor raw materials. The small flint tools would merely show that even primitive-man was already able to make precision tools. Today we would (just like Mania did in Bilzingsleben) put the emphasis on the small flint points, scrapers and denticulates. Because Ede-II is (just like Bilzingsleben) not at all primitive; *figure 8.22* shows the hominids even made small flint blades.

The actual age of Ede-II is still debated. The flints, granites and other raw materials come from Scandinavia, they were brought to the Netherlands by glaciers. Many geologists believe that older ice-covers (i.e. the MIS 16 Don-glaciers) did not reach the Netherlands and that the MIS 12 glaciers only covered the northern rim (*figure 7.1*). If that were true, the raw materials would date from MIS 6. The hominids would in that scenario have lived at the site after the glaciers retreated and the site became covered by 4-5 meters of fluvial deposits after the hominids left. All of this happened within MIS 6, because the MIS 6 glaciers returned after this. This is unlikely because the MIS 6 Neanderthals carried raw materials for free hand flaking over very large distances (see chapter 9). So they may have used bipolar techniques but did not loose the ability to make handaxes. It is far more likely that the raw materials were brought by a part of the MIS 12 glacier that stretched a hundred kilometers further to the south. Ede-II could in that case like most sites in this chapter be MIS 11-9.

Figure 8.22: The site of Ede-II also presents a combination of small flint tools (including small bipolar blades) and large tools from poor raw materials. Collection Ad Wouters.

Previous page, frontpage Chapter 9: Mode-III upper-Acheulean. From left to right: Mousterian point, déjeté Levallois-core, handaxe. Middle row: cleaver on side-struck Levallois-flake, trihedral pic, handaxe on Levallois-flake. Bottom: two cleavers and a pic. Acheuléen-meridional.

Chapter 9: Mode-III

Middle-Paleolithic

Handaxes were the leading tool-form in Europe from 700 to 300 ka. After 300 ka the toolmakers made less handaxes, they instead focused on flake-tools (often Levallois). Clark called this phase Mode-III and Bordes called it the middle-paleolithic. Bordes saw the Levallois-technique as proof that middle-paleolithic man had reached a higher evolutionary stage; the handaxe-makers only thought of the present but the 'Levallois-brain' could plan ahead. *Figure 9.1* helps us understand Bordes' theory. The Levallois-maker began by bifacially flaking a flint-nodule or cobble (A) into a form that is called a prepared core (B). The clever part of this is that the toolmaker did not want core B at all: he only made B because that would in a next step give him the Levallois-flake D. So whilst he made B he was thinking ahead planning for D. The residual core C was discarded. Or sometimes reused to make a secondary Levallois-flake F, the residual core E was then discarded. But we saw in chapter 5 that the recurrent Levallois-technique was already used in Peninj 1.3 Ma and Quípar 0.9 Ma and the preferential Levallois-technique was already used in Canteen Kopje 1Ma. So the Levallois-technique simply cannot be indicative for the intelligence-level between 300 and 40 ka. Some scholars still try to measure the intelligence by supposed artefact-levels (or planning-horizons, *figure 10.2*) but in reality tools always tell us more about the raw materials and other environment factors than about man's intelligence.

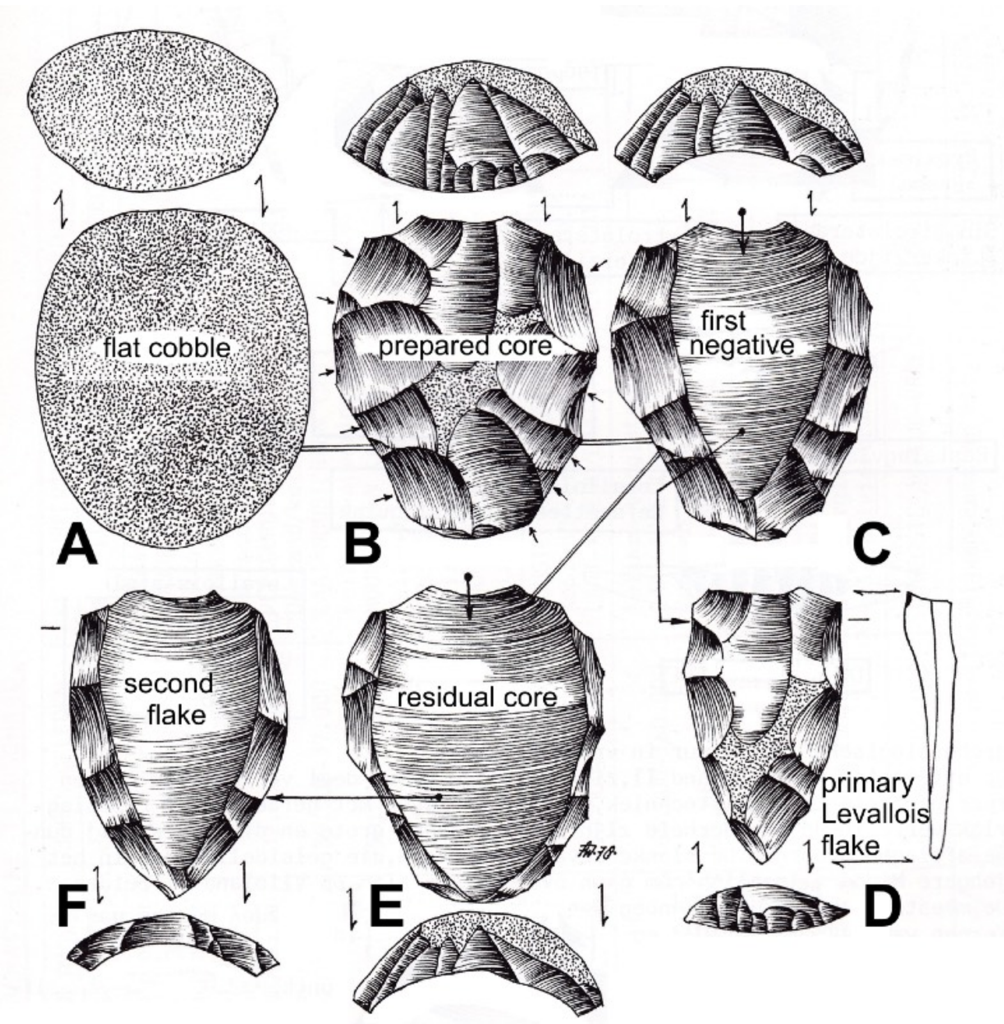


Figure 9.1: Preferential Levallois-technique. Drawing by Ad Wouters.

This is illustrated by the mesolithic and neolithic tools in the Brazilian lowlands: pebbletools made by Modern-man. Professor André Prous experimentally demonstrated that these tools were made with the bipolar methods from chapter 7 (Prous, de Souza and Lima: A importância do lascaento sobre bigorna nas indústrias líticas di Brasil. Arquivos do museu de história naturel e jardim botánico/UFMG 21 pp. 287-326. 2012). But we all know that these indigenous Brazilians were Modern-man and therefor more evolved than the pebbletool-makers in MIS 11-9. Tools can only show a very limited part of the intellectual capabilities. These Brazilian groups simply used bipolar pebbletools because pebbles were the best available raw material in the lowlands and can only be flaked with bipolar techniques. So tools are primarily about living conditions. We must therefor focus on the living conditions, if we want to understand why the Europeans switched from large Mode-II handaxes to Mode-III flaking-techniques. We must study the conditions that determined the hunter-gatherer economy during the Saalian.

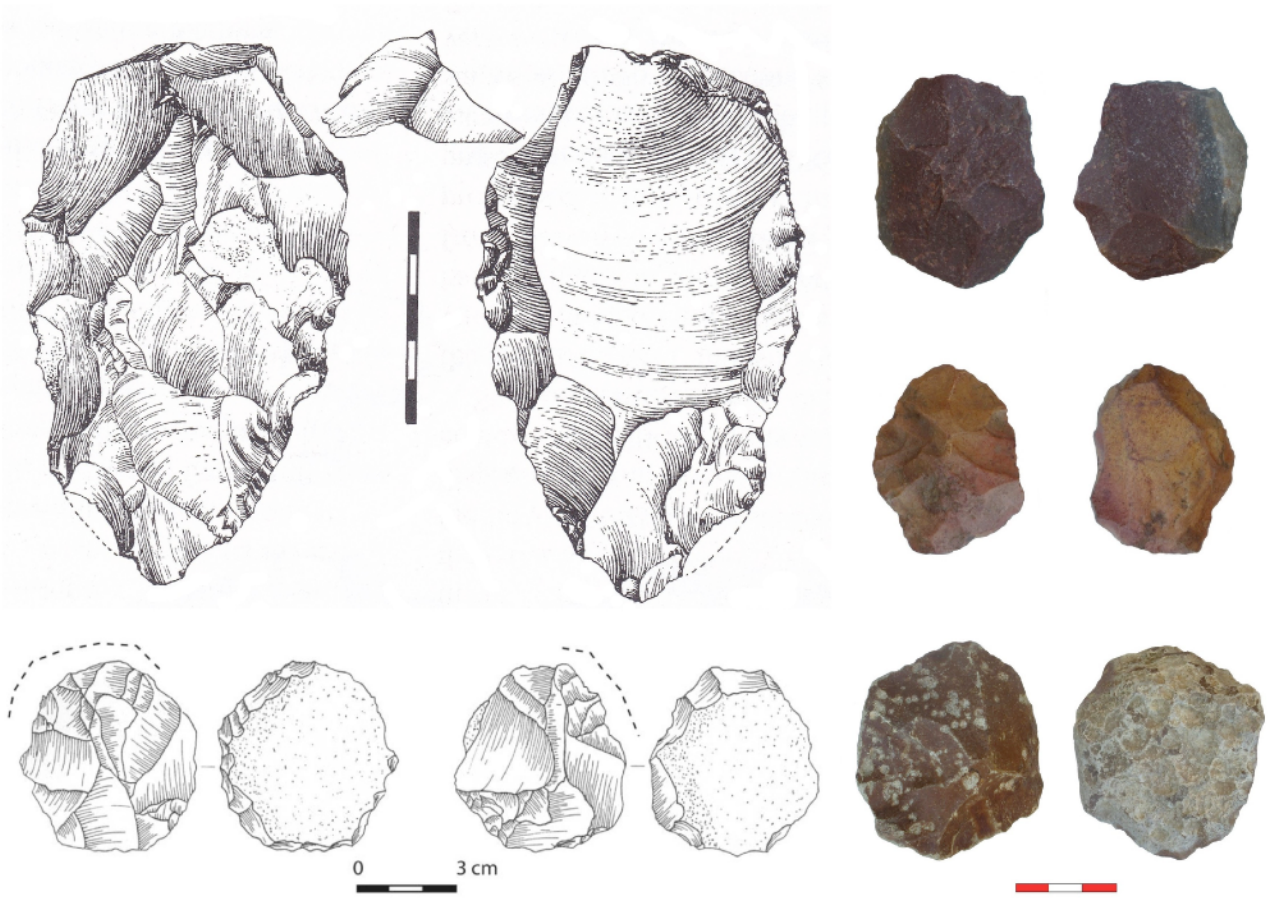


Figure 9.2: The drawings at the left show early Mode-III cores. At the top we see a MIS 12-11 handaxe from Cagny la Garenne with a preferential-Levallois flake-removal. From: A. Tuffreau and P. Antoine: The earliest occupation of Europe: Continental Northwestern Europe. 1995. At the bottom recurrent centripetal cores. From: M.H. Moncel et al: The emergence of Neanderthal technical behavior: new evidence from Orgnac-3 (level 1 MIS 8), Southeastern France. DOI: 10, 1086/658179. 2011. The photos at the right show recurrent cores which are technically the same as the drawings, but much younger: they were made in MIS 4-3.

Preferential Levallois-technique

Large flakes have always been desirable tools. Early-man made large OBFs in Gona, in Dmanisi and in the LFB-Acheulean. The raw materials in the Vaal-valley were unsuitable for large OBFs, so the desire to make large flakes pushed the hominids here to invent Victoria-West prepared-flakes (chapter 5). The cobble-Acheulean industries could fulfill their desire for large flakes by making cobble-OBFs (*figure 6.13*). In the flint-area however, it was uneconomical to make large OBFs. The flint handaxe-makers in Cagny la Garenne (France, in MIS 12-11) found an interesting alternative: they used large handaxes as cores (*figure 9.2* top drawing). This technique is almost the same as the Victoria-West method, but the flakes in Canteen Kopje mostly side-struck and those in Cagny la Garenne were mostly axial. The reason for this difference is that the form of a cobble invites striking from the side; most cobble-OBFs are also side-struck. The goal also differed: Victoria-West flakes were meant to make large flat handaxes (and other LCTs). But the hominids in the European flint-area could easily make large flat handaxes from flint-nodules, so they wanted large flakes for another reason. They used the flakes as scrapers. This different goal explains why the core in *figure 9.2* was still pointed, but the dominant form quickly became oval (tortoise-cores *figure 9.1*). Forms-for-special-purposes also existed, i.e. cores to make one blade or point.

Recurrent Levallois-technique
Preferential Levallois-cores and -flakes are popular with collectors and the public due to their well-recognizable forms. Most lithic-specialists take a greater interest in the recurrent Levallois-techniques; these cores are seen as the typical marker of the Neanderthal economic system. The single-face recurrent cores in *figure 9.2* look rather unimpressive, but these cores produced large series of more or less standardized small flakes. Such small Levallois-flakes became very popular during the Saalian-complex. Not because the brain evolved, but because of how the climate evolved. That may surprise you because in *figure 1.4* it seems as if there is no fundamental difference between the MIS 15-14-13 and the MIS 9-8-7 temperatures, but we clearly see that the ecosystem changed during the Saalian-complex. Again the evolution of the mammoth helps us to understand the changes. The steppe mammoth had 18-19 scales per molar, he flourished in MIS 15-14-13. But the steppe-flora became poorer in the Saalian with less green shrubs and tougher grasses. This first had its effect in Siberia: this is where the woolly mammoth developed around 300 ka. The woolly mammoth had 22-23 scales per molar to grind the tougher grasses, but he was despite this still unable to get the same amount of calories. So whilst the steppe mammoth grew to a height of 4 meters at the withers, the woolly mammoth could only reach 3 meters. After 200 ka this smaller mammoth also replaced the steppe mammoth in Europe. The toughening steppe-flora also changed the migratory behavior of horses and aurochs. The large herbivore herds had to move faster and travel further through the landscape, to find enough food. The survival of the hominid groups mostly depended on these large herbivores, so the groups had to adept to the greater displacements of the herds. This forced many hominids to leave their own river-valley and follow the herbivores onto the steppe. As the Saalian progressed, hominids were forced to hunt ever further from the river-valley where their ancestors had always lived.

The hunters who left their river, also left their familiar source of raw materials behind. This forced the hunters that went into the steppe 300 ka to carry a supply of raw materials. This was not an entirely new behavior, we saw in chapter 5 that the handaxe was invented 1.75 Ma by reusing the giant OBFS hominids carried along the seasonal watercourses. But the situation around 300 ka was totally different: to survive the complete family-group now had to be able to move faster than the migrating herbivores. Speed was essential: carrying even one extra kilogram could slow the group down just enough to let the prey-animals escape. So one kilo could make the difference between killing and eating a horse, or the starvation of the complete group. These hunters could therefor not walk around with giant OBFs or large flint-nodules; they needed a light-weight toolkit. Archeologists studied the change from using well-made but large and heavy handaxes to cutting with small Levallois-flakes at Orgnac-3 (the south of France). Around 320 ka the hunters were still making many large Acheulean handaxes here and they used hardly any Levallois-technique. But around 280 ka (MIS 8, the Saalian Oder-phase) they had stopped carrying large raw materials to the site. Now they only carried flints to Orgnac-3 that were too small to make Mode-II handaxes. These light-weight flints were instead used to make small flakes (2-10 cm) as cutting or scraping tools. About 6% of these flakes were made with the recurrent centripetal Levallois-technique.

Apart from the raw material the flakes in Orgnac-3 are the same as in Peninj a million years earlier. But the recurrent-cores in *figure 9.2* look different from the Peninj core in *figure 5.6*, they are much flatter. If we could go back to 1970 and ask Bordes what this meant, he would probably answer that middle-paleolithic man had the skill to flake cores at an acute angle whilst the primitive Homo erectus in Peninj lacked that skill. But the thin 1.75 Ma LFB-handaxes show this answer cannot be right; the reason why early-man used thick cores in Peninj is because he had to work with small thick lumps of raw material. The technology in Orgnac-3 has a completely different reason: the flint-sources were very rich, there was plenty raw material. This abundance allowed the hominids to select (or make) light-weight-cores. So at these sources, they chose flat flints (because you can make more and larger flakes from one kilogram of flat stones, than from one kilogram of thick stones). These flat flints were carried to Orgnac-3. Their edges were prepared as platforms. Now each series of removals made the flat cores even flatter. Until the cores finally became too flat and too small to continue. These small flat residues were discarded; they are the single-faced recurrent centripetal cores that we see in *figure 9.2*.

Prismatic cores
A long cutting edge works better on meat (and other soft materials) than a short cutting edge. Blades offer the longest cutting edge per kilogram (a flake is called a blade when its length is at least twice its width). The MIS 11 hominid fossils from Atapuerca had a cranial capacity between 1125 and 1390 cc, this is very close to our brain-size so we should not underestimate them: they certainly understood the benefit of a long cutting edge. It should therefor not surprise us that in MIS 11-9 bipolar toolkit groups sometimes used their vertical-axial bipolar method (*figure 7.3*) to make series of blades. We can see some of these bipolar recurrent blade-cores and blades that were made in Neer in *figure 9.3*. The assembly in *figure 9.3* almost looks like a mesolithic industry, but this is actually the same industry that we saw at the frontpage of chapter 7 (we can also see choppers in *figure 9.3* and N-0202 is a thin Tayac-point similar to what we saw in Bilzingsleben). Piet Kelderman counted 23 blades per 2223 tools (Kelderman and van der Drift: Het oud-paleolithicum van Neer-Broekheide. APAN/Extern 10, 2003) so the blades-percentage is only 1%.

Figure 9.3: The Neer tradition is a MIS 11-9 bipolar pebbletool industry that shows 1% blades struck from prismatic (recurrent) blade cores like we see top-left, centre-right and bottom-right. Collection Ad Wouters.

The bipolar and Mode-III toolmakers had the same reason to make blades: both wanted to use the full length of the small cores. An early Mode-III tradition that made laminar and also prismatic blade-cores from the free hand, was found near Bologna in Northern Italy in cave Dall'Olio (this is not the English word cave, the Italian word cave means quarry). But the Mode-III groups carried their raw materials over great distances whilst bipolar groups used local materials. This gave the Mode-III-groups an extra motive to make blades: recurrent blade cores produced the most long cutting edges per kilo. So whilst the bipolar traditions kept producing low blade-percentages, we can see that some Mode-III groups towards the end of the Saalian produced far higher blade-percentages.

The recurrent blades also offered a third advantage: standardization. They more or less have the same form so a toolmaker knew exactly what to expect when he made blades (and even long before the production-phase when he was selecting his raw materials). The earliest LFB-handaxe makers already gave their LCTs (handaxes pics and cleavers) predictable standard-forms, but in Mode-III predictability became even more important. Both in the preferential Levallois-technique (where cores were shaped to give one flake a predictable size and form) and in the recurrent Levallois-techniques. The toolmakers at Orgnac-III knew exactly what size their flakes would be and also the average model, because the centripetal technique will (just when you cut slices of pizza) produce mostly converging forms (wide base and narrow top). Recurrent blade-cores of course produced predictable stretched standard-forms.

Upper-Acheulean
Marie-Hélène Moncel called the developments in Orgnac-3 the emergence of Neanderthal technical behavior (see title *figure 9.2*). This phrase seems to suggest that groups who still made large handaxes were technically falling behind (that would be the persistence of Heidelberg-man technical behavior). It could even suggest that the MIS 8 hominids in Orgnac-3 were higher on the evolutionary ladder than MIS 8 handaxe-makers in i.e. Spain. But this is surely not what Moncel meant because both industries were made by the same (or at least closely related) hominids and because the large-handaxe-makers also used the Mode-III technology. If you want to understand why many MIS 8-7 groups still made large-handaxes you should try to imagine that you need to butcher an aurochs or horse. Given the choice between butchering with a large sharp handaxe or with a few small flakes, which tool would you prefer? You would certainly take the large handaxe, this is the intelligent choice because that is the most efficient cutting tool. If the large handaxe is the clever choice today, it also was the clever choice in MIS 8-7. This shows that non-handaxe-groups acted out of necessity. Not making handaxes was a necessity for the MIS 11-9 bipolar toolkit groups because they (or their ancestors) lacked raw materials. And for the MIS 8-3 groups with Neanderthal technical behavior the necessity was that carrying heavy stones hindered their pursuit of the large-herbivore herds.

The MIS 8-7 groups that still made large handaxes actually had the best techniques: they made the best Acheulean Large Cutting Tools and also exploited cores with the most efficient Levallois-techniques. These groups are called the upper-Acheulean. What put the upper-Acheulean into this luxurious situation, why did they still have the luxury of superior cutting tools whilst the hominids in Orgnac-3 had to give their LCTs up? The answer is that the upper-Acheulean groups did not need to carry their raw materials over great distances because they still found enough food in or close to their own river. And that means that herbivores still found enough food near that river, so the puts the upper-Acheulean in places where softer grasses, more shrubs and even some forests could still grow. That means close to the ocean: Northwestern Spain and Western France had the climate conditions for MIS 8-7 large-handaxe-makers. In favorable climate-phases these groups also migrated step by step to the northern river systems and in MIS 7 they even reached the Elbe river-system (Ehringsdorf and Markkleeberg, Germany). The luxury of using large raw materials allowed the upper-Acheulean to make large Levallois-cores. The bottom-right photo in *figure 9.4* shows the top-view of a MIS 7 recurrent centripetal core from the Sint Pietersberg (Maastricht, Netherlands) that is far larger than the recurrent centripetal cores in *figure 9.2*. Because the toolmaker did not need to save weight, he did not make a flat single-face core but a much thicker bifacial multipolar centripetal hierarchized core (like in BK *figure 3.6* and Peninj *figure 5.6*) that weighs 400 grams. This is ten times the weight of a thin single-face core, what a luxury!!! The two Levallois-blades in *figure 9.4* are not esthetically impressive, but beautiful blades (of over 10 cm in length with fine scaled Quina-type retouche) and also large laminar and prismatic cores were found in the MIS 7 upper-Acheulean in Rhenen (Netherlands).

Figure 9.4: MIS 7 upper-Acheulean from Maastricht (Netherlands). Top: two Levallois-blades and two scrapers on Levallois-flakes. The left one has flat retouche and a bifacially flaked back, the right one chapeau-de-gendarme preparation. Then a handaxe on a large déjeté flake, small handaxe on a flake, Levallois-flake and at the bottom a large recurrent centripetal core.

The upper-Acheulean is also called the epi-Acheuléen. Many scholars simply call it Mousterian because it used Mode-III techniques but I find this somewhat misguiding, because the MIS 8-7 upper-Acheulean clearly differs from the classic MIS 6-5-4 Mousterian and Micoquian traditions. Important differences are the smaller size (lighter weight) of the handaxes and the often higher percentage of recurrent flaking in the classic Mousterian/Micoquian.

Blanks set forms
The LFB-handaxes in Africa had flat forms because they were made from flat blanks: the blanks set this form. In Europe the classic Acheulean handaxes (from MIS 16 to MIS 9) were mostly made by alternating bifacial flaking (as in the drawing in *figure 3.9*) of flat cobbles and flat flint slabs. *Figure 9.5A* shows that a combination of flat blanks and alternate flaking leads to dorsoventral symmetry. The handaxe-makers at Wolvercote-channel (MIS 9, in England) had very large flint nodules from which they made very large flakes. But the Wolvercote-flakes were not large flat OBFs like in the LFB-Acheulean. These were instead freehand-blanks with a triangular cross-section like we see in *figure 9.5B*. The ventral face of these blanks offered an ideal platform. The toolmakers used this platform to flake the complete dorsal face as if they were making in scraper (racloir convergent): strike 1 and 2 and all following strikes were made in the same direction. These scraper-like retouches had the same effect as the small retouches along the edge of the single-face recurrent centripetal cores in *figure 9.2*: they provided ideal platforms for the centripetal flaking of the ventral side. *Figure 9.5B* shows the effect on the cross-section of these flakes; the dorsal side was finished before the centripetal flaking of the ventral side even started. The flake that had a triangular cross-section turned into a bifacial tool with a convex dorsal side and a much flatter ventral side. This is called a plano-convex handaxe, the large handaxe in *figure 9.4* is plano-convex (both faces are drawn on the front-page of this paper). At Wolvercote this plano-convex-pointed-form is called a 'slipper-shaped' handaxe. Many plano-convex MIS 8-7 handaxes were made on Levallois-flakes, sometimes we can still recognize the flake-preparation. The centre-right grey quartzite handaxe on the frontpage of this chapter for instance shows very large negatives which were not struck from the edge of the blank, these removals already existed before the blank was struck from the core.

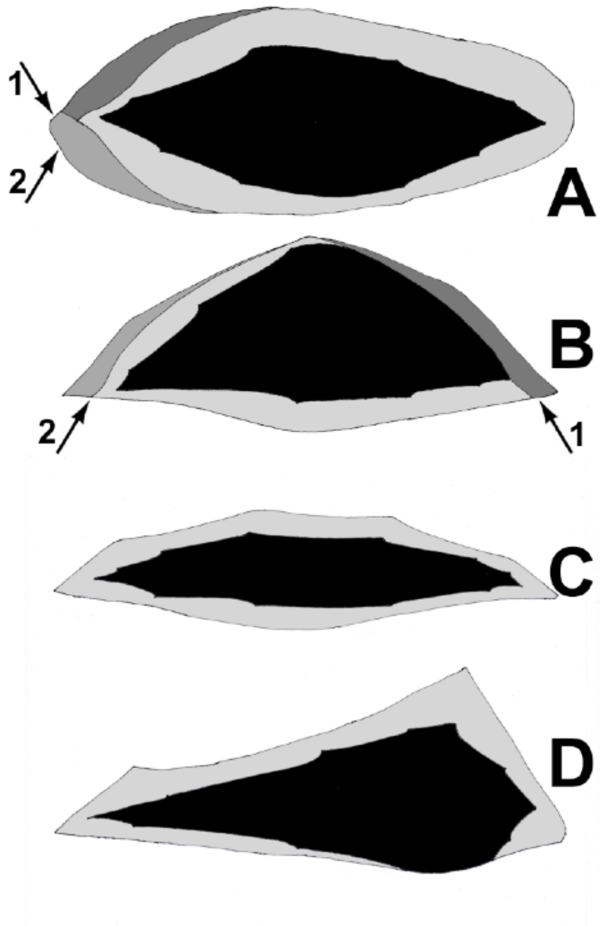


Figure 9.5: The cross-section of the blank (in grey) determines the form of the bifacial tool (in black).
A: Flat cobbles and nodules invite alternate flaking, strike 1 in one direction is followed by strike 2 in the opposite direction. This flaking method leads to dorsoventral symmetry.
B: In flakes with a thicker centre it was better to begin by flaking the complete dorsal side like a scraper. After this was done, the object was turned to the position in the drawing. The dorsal retouches now served as platforms that made flaking the ventral side far easier.
C: In thin flakes or slabs the dorsal retouche is almost parallel to the ventral retouche. Bifaces with parallel sides are called leaf-points.
D: when the blank has one thick edge it is more efficient to sharpen only the thin edge, this is called a bifacial backed knife.

MIS 8-7 groups with excellent raw materials used these to make very large and very thin Levallois-flakes. *Figure 9.5C* shows such a thin flake in cross-section: the dorsal face of this flake is nearly parallel to the ventral face. This makes both faces of the finished handaxe also nearly parallel. This form cannot be called plano-convex, the flat handaxes with nearly parallel faces are instead called leaf-points. The Mode-III group that Jan Meulmeester found on a pile of aggregate dredged-up off-shore near Great-Yarmouth held a series of such very thin and handaxes that were clearly made on extremely large flat Levallois-flakes; on some of these handaxes the chapeau-de-gendarme type platform was (perhaps deliberately?) still visible. These aesthetic tools received so much international attention that archeologists blocked further dredging at the site.

Most blanks are less perfect, many flakes are thick on one side and thin at the other edge as shown in *figure 9.5D*. It is nearly impossible to make a handaxe that has left-right symmetry from such asymmetrical blanks. And even if you succeed, it takes a lot of time and effort to remove the asymmetry. Removing the asymmetry also makes the blank much smaller. The whole procedure is so uneconomical that the toolmakers in the French-English flint-area often simply discarded such awkward flakes. But groups in the valleys of the Rhine, Meuse and Elbe had far less raw materials so they could not afford to waste these awkward flakes. These upper-Acheulean groups had to use these awkward flakes in the most economical way: the thin edge was turned into a sharp cutting edge and the thick side was used as a blunt grip-TFU. The result is a tool with a wedge-shaped cross-section, called a bifacial backed knife (in French called biface a dos, in German Keilmesser). Of course Mode-III toolmakers in the French-English flint-area and even Mode-II toolmakers sometimes also flaked an awkward blank into a bifacial backed knife, but these wedge-shaped tools are far more common outside the French-English flint-area. The MIS 7 upper-Acheulean at Rhenen produced so many wedge-shaped flakes, blades and bifacial backed knives that based on the resemblance of these wedges to citrus-fruit wedges Wouters in 1978 called it the ‘citrus-tradition’. He also called it the Markkleeberg-tradition because just like in Markkleeberg, Rhenen shows large handaxes (larger than 10 cm) of upper-Acheulean types (with all the cross-section types shown in *figure 9.5*) combined with other typical Mode-III tools such as large Mousterian-points (also called Herner-points) and Levallois-blades.

Korolevo
The analysis of raw materials shows these were mostly carried up to just 15 kilometers in Mode-II but around 250 ka Mode-III groups already carried raw materials up to 50 kilometers. The upper-Acheulean groups were less mobile than the single-face-recurrent-core makers, but nevertheless also responded to the increased migration of the herbivore herds. They followed the herds faster and over larger distances than the Mode-II-Acheulean and this clearly increased the spread of the Acheulean. We saw in chapter 7 that the English Mode-II couldn’t cross the Northsea-lowlands so these became the Movius-line in MIS 11-9. But upper-Acheulean MIS 7 groups tried to keep up with the herbivore herds. This made them so fast that they crossed the North-Sea plains within one generation. It would not even surprise me if some groups had walked to the other side within one season. This allowed the upper-Acheulean to colonize the Meuse and Rhine valleys, from here step to the Weser and even to the Elbe valley. Sparse groups even followed the Elbe upstream into the Czech Republic, but that is as far as the large-handaxe-makers got. The North-German lowland stopped them from going further east, because there were not enough raw materials on the banks of the Elbe and Oder (Odra). In MIS 7 the Movius-line ran through Berlin.

But the letter K right in the middle of *figure 6.5* marks a site called Korolevo (Ukraine) that lies much further east than Berlin. Hominids already reached Korolevo before 0,8 Ma and in MIS 13 and MIS 11 but these groups did not make classic handaxes (Doronichev’s Pre-Mousterian). The MIS 7 groups at Korolevo however made real handaxes and stretched leaf-points, so they were upper-Acheulean. How did these handaxe-makers get this far east if they could not cross the North-German lowlands? The Mode-II-Acheulean managed to reach the southern Kaukasus and colonize parts of Turkey but could not spread further to the north through the Ponto-Caspian lowlands (chapter 6). The Mode-III-Acheulean however moved faster over greater distances. This enabled them to reach the Balkan and Karpaten foothills where they found enough raw materials. From here the upper-Acheulean spread to the Western-Ukraine. This explains why there are MIS 7 handaxes in Korolevo and Levallois-flakes at Velyky Glybochok. The groups that made the large MIS 7 handaxes from Lugansk (Eastern-Ukraine) may have followed the more eastern Kaukasus (with sites like Kudaro-I) route. Further east Levallois-flakes have been found i.e. in the Altai in the lower levels of the Denisova cave. Interesting is that no upper-Acheulean has been found near Budapest, despite the mild climate and the fact that this area was already settled in MIS 11-9 (by the bipolar toolkit groups in Vértesszöllös). This shows that the large-handaxe-makers (even in the fast moving upper-Acheulean groups) remained unable to cross the Danube-lowlands.

Porto Maior
The northwestern part of Spain and Portugal are relatively wet so in MIS 8-7 the herbivores could graze in the same place for a relatively long time. The hunter-gatherers therefor still found enough food in their own river-valleys and this allowed them to continue making large handaxes. Most Iberian upper-Acheulean groups used rounded cobbles as raw material so it was often easier for them to make large cobble-OBFs than large Levallois-flakes. The MIS 8-7 handaxe-industries in

this area can therefor look almost as if they were Mode-II traditions. A very peculiar MIS 8-7 (300 to 200 ka) handaxe-industry was found in the lower Miño valley at the Porto Maior site. The most remarkable characteristic of the Porto Maior handaxes is their size: they are extra extra large. On average they weigh 0.9 kilogram and measure 186 millimeters. That may not seem extra extra large when you compare this to the 32 cm Durandal (*figure 6.11*). But the Durandal is one single handaxe that comes accompanied by many much smaller handaxes like in *figure 6.12*. These small handaxes reduce the average size at Tautavel far below the average size at Porto Maior. The handaxes here are so big that they remind us of the large LFB-handaxes (*figure 5.1*). This made some scholars wonder if the groups at Porto Maior could have come from Africa.

But the climate changes during the middle-pleistocene also affected Africa; this continent was also getting dryer. The drought even affected Africa far worse than Europe, the large herbivores in Africa were also traveling over enormous distances. The hunter-gatherers in Africa were suffering from the effects of the drought long before the hunter-gatherers in Europe. We already saw the Africans making Levallois-tools in Peninj 1.3 Ma and Canteen-Kopje 1 Ma so it should not surprise us that the light-weight Levallois tools already began to dominate the African toolkits around 0.5 Ma. These African Mode-III traditions are not called the middle-paleolithic like in Europe, but the Middle Stone Age (MSA). But the use of different names does not change the fact that the MSA tools at the 300 ka site Djebel Irhoud (in Morocco) looked exactly like the MIS 4-3 Mousterian in Europe. So if the group in Porto Maior had African roots, they would be making this MSA instead of extra extra large handaxes. The size of the handaxes is instead due to local factors; Mode-II groups carried the raw materials for their handaxes up to 15 kilometers and Mode-III groups carried their raw materials even further. But the handaxe-makers at Porto Maior carried the raw material for their tools over less than a hundred meters, because the butchering-site was very close to the riverbanks with an abundance of large flat cobbles. In this special extra luxurious situation it was efficient to make the cutting tools extra extra large. Modern butchers use steel knives with 185 mm long cutting edges because that is the most efficient size. Long knives cut fast, that is the reason why the tools from Porto Maior had a similar average size.

The MIS 6 Drenthe glacial

In MIS 6 (the last Saalian cold-phase or Drenthe-glacial) the climate became even more extreme than in MIS 8-7. Mammoths and other large herbivores migrated to the south of Europe and the northern lowlands of the Netherlands, Germany and Poland were covered by glaciers. Even in the south of Europe the herbivores had to travel long distances. So the MIS 6 Neanderthal groups could only survive by pursuing the herbivores over extreme distances. This MIS 6 hyper-mobility had a great impact on the toolkit: it was impossible to carry the raw materials for large handaxes over these distances. So the MIS 6 climate-conditions ended the age of the (upper-)Acheulean: large handaxes, large cleavers and large pics had dominated the world for one and a half million years, but these LCTs simply became too heavy in MIS 6.

Many groups completely stopped making handaxes, instead they used small flake-tools, often made with recurrent (centripetal, blades or other) Levallois-methods. The recurrent Levallois-techniques became so popular in MIS 6-3 that Bordes in 1961 called them the Mousterian techniques. At first glance it seems as if the Quina-Mousterian was an exception, because the parallel Quina-technique produced thicker, heavier flakes. It seems as if this cannot fit into the light-weight-mobility strategy. But the Quina-flakes reduced weight by the special way they were used. These thicker flakes could be repeatedly resharpened, this often gave them scaled Quina-retouches. By repeatedly retouching a Quina-tool that for instance weighed 150 grams, this tool could perhaps even do more work than four Levallois-flakes that weighed 50 grams each. So all of the MIS 6-3 techniques were designed to save weight and whenever MIS 6-3 groups made a handaxe, that was also light-weight and it generally measured under 10 cm.

Sclayn

We can see how the mobility changed by comparing the MIS 7 upper-Acheulean at Maastricht (Sint Pietersberg and Belvédère quarry) to the MIS 5 Mousterian at Scayn (near Namurs, Belgium). All of these sites are in the Meuse-valley and all raw materials used by the MIS 7 upper-Acheulean originate from the Meuse-valley. These early-Neanderthals gathered stones on the dry riverbanks of the Meuse and also found quality flint on steep slopes in the Meuse valley. That all of the raw materials came from within one river-system (the Meuse and its tributaries) and from within 10 kilometers of the sites can be considered typical for the MIS 7 upper-Acheulean lifestyle.

We can tell from *figure 9.6* that the MIS 5 classic-Neanderthals at Sclayn (120 ka) had a very different territory because they also used raw materials from a larger area and from different river-systems. The best raw materials at Sclayn had been carried over large distances; the Campanian-flint was carried over more than 60 kilometers from Spiennes (number 5 in *figure 9.6*) to the site.

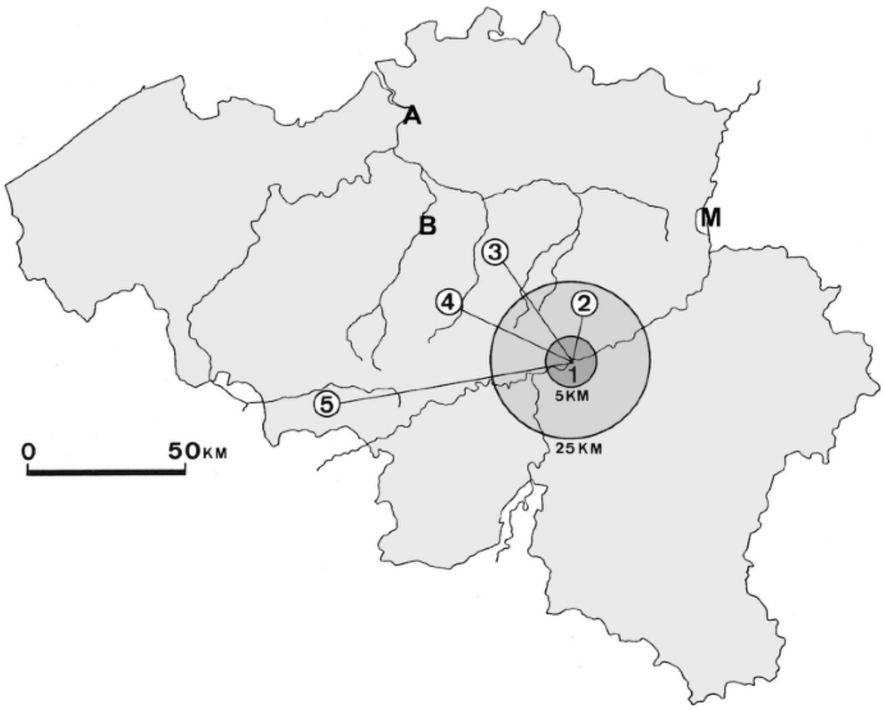


Figure 9.6: The provenance of raw materials in the Sclayn cave (M stands for Maastricht, B for Brussels and A for Antwerp). Chert, limestone, quartz and psammoquartzite (1) were all found within a five kilometer radius. The Maastricht-flint (2) could be from the Belgian-Dutch border area but is also found less than twenty-five kilometers from the cave. Brussels-gres (3) and Cambrian-phtanite (4) were carried over more than thirty kilometers. Campanian-flint (5) was carried over at least sixty kilometers from Spiennes to Sclayn. From: Otte, Patou-Mathis, Bonjean (eds): Recheches aux grottes de Sclayn. Liege, 1998.

It is very easy to get fooled by *figure 9.6*, because we tend to interpret this from our Modern perspective. I do most of my shopping close to my house, but for special supplies I have to go into town. And because I have long-and-narrow feet I must drive in my car to several cities to find shoes that fit me. It seems as if the Neanderthals did a similar thing: they found most of their supplies near Sclayn but had to go to Spiennes to get the very best flint. I know where to buy my shoes because other people with large feet have told me, so it seems that the MIS 5 classic-Neanderthals knew considerably more than the MIS 7 early-Neanderthals that only used materials found nearby in their own river-system. The MIS 5 group seems more evolved, because it seems to have a far better understanding of its surroundings.

But this must be nonsense, because Neanderthals did not live like Modern nomads. They couldn't stay in one camp for weeks or months because Neanderthals needed 3 times as many calories as Modern humans (see chapter 10). They lived as mobile groups, in pursuit of the herds and rarely stayed in one place for more than a couple of days because their food ran out. So when a site suggests that Neanderthals lived there for 50 days, these were not 50 days in a row but 25 visits of each two days that took place in one century. Archeologists call such revisited sites palimpsets: all large lower and middle paleolithic sites are palimpsets. So the Sclayn cave was not inhabited for months by Neanderthals that went shopping in Spiennes. What really happened was that the group first visited Spiennes, ran out of food and moved on towards the east. They liked the flint at Spiennes so some good flints were taken along, that were later used when they camped near the entrance of the Sclayn-cave for one or two nights. Perhaps they had first made camp in the phtanite region and also brought some of that, but the other raw materials probably came from next visits. Perhaps a few weeks later or perhaps a few years later. Finally mud-streams carried all remains into the interior of the cave into a bed that is dated to 120 ka. Around 40 ka campsite-waste had again accumulated near the entrance, this new material was also washed inside. The result is that it seems as if the cave was visited only once at 120 ka and once at 40 ka. But in reality the artefacts could have been made in more than fifty short term visits, only tools that can be refitted are with great certainty attributable to one and the same visit.

No more Movius-line
More proof that the raw materials were not acquired by 'shopping' but instead carried from the area of an earlier camp, was found at the Schweinskopf volcano (120 ka, Koblenz, Germany). The Neanderthals at the Schweinskopf used Maastricht-flint. If a group that lived near Koblenz did its shopping near Maastricht, a toolmaker would walk 130 kilometers to Maastricht and also 130 kilometers back to his camp just to make a knife. That would be is outrageously inefficient, it is therefor obvious these Neanderthals first hunted and gathered near Maastricht and carried some Maastricht-flints along when they followed the herds to the southeast. This is not a new behavior; the LFB-handaxe-makers already carried their raw materials. But there is a world of difference between carrying one large OBF from Naibor Soit to FLK-west (chapter 5) to carrying supplies over 130 kilometers. It took the group at least days or weeks to make this journey. You cannot hold stones in your hands for weeks whilst you hunt and gather food, so the Neanderthals must have had some kind of bags or baskets or backpacks.

It is reasonable to assume that simple bags already existed in the early Acheulean and that the bags were improved in the extreme MIS 6 climate to support the extremely mobile lifestyle. So we saw that in MIS 7 the upper-Acheulean was unable to carry the heavy materials that it needed to make its large handaxes, from the Elbe river-system to the Oder river-system. But after MIS 6 the handaxes were smaller and the bags were far better, this enabled the classic-Neanderthals to carry enough raw materials to get the freehand-technology across the lowlands. These groups travelled fast and did not solely depend on poor raw materials, so they did not loose the ability and desire to make freehand tools. This wiped-out the Movius-line, it no longer existed after MIS 6. That explains why MIS 4-3 Mousterian-Micoquian tools spread all over the northern steppe: from England in the west, across the North-Sea-plains, the Netherlands, Germany, Poland, the Ukraine and even onto the Russian-plains (i.e. Wolgograd-knives). In MIS 5-3 we even see leaf-point-makers cross the vast Hungarian lowlands (Bávbonyian 80 ka and Szeletian 45 ka).

After MIS 6 even the last bipolar toolkit concept industries (in the east called the Pre-Mousterian) were replaced by the freehand Mousterian. But the basic bipolar-methods were never completely forgotten so a few Neanderthal-groups used a combination of bipolar and freehand-methods. We saw this mixed technology in the denticulate Mousterian on the top-halve of the frontpage of chapter 1. These flakes were struck from the free hand but certainly the deepest notches and steepest denticulate retouches are bipolar. The mixed-technology group at Schuilenburg (north of the Netherlands) made bipolar OBFs as well as freehand bifacial Micoquian tools.

Mousterian variations
There were many climate-changes during MIS 5-3 and Neanderthals inhabited a very large area. So classic-Neanderthals lived in completely different climates, different landscapes, had different food-sources, different raw materials and all sorts of other differences. This resulted in a Mode-III-toolkit that showed more varieties than ever before. Like the denticulate Mousterian that we just mentioned. These tools are not ideal on the mammoth-steppe (I would not like to butcher a mammoth with such small denticulate tools) but they are highly suitable to process plants or small animals. So it does not surprise me that according to pollen-analysis the denticulate Mousterian was not used on the open steppe but in phases-or-areas with shrubs and trees.

Bordes was able to describe the MIS 5-3 variability in the Dordogne by splitting the finds into five groups. There has been much debate over the question what these groups represent: are they different cultures or perhaps merely different toolkits that were used by the same culture under different circumstances? But regardless of what the groups may represent, Bordes made the division in such a good and thorough way that his system became classic and is still used today. These five groups are the denticulate Mousterian, the Charentian (with a Quina-type and Ferrassie-type), the typical Mousterian and the Moustérien du Tradition Acheuléen (MTA). The MTA is known for its aesthetic thin symmetrical handaxes, this tradition is found in most of France and also in the south of England. Most MTA-handaxes to the south of the line Paris-Nancy are heart-shaped, north of this line they are mostly triangular and the MTA-handaxes in the south of England are mostly bout-coupé (a form with a slightly curved base). I do not want to bother readers with photos of these tools because most already know exactly how they look. And if by any chance you do not know these classic-types, they can be seen in almost every popular book and found all over the internet.

Micoquian
The Neanderthals in Germany made a completly different kind of small handaxes. Most were bifacial backed knives, like we saw in the upper-Acheulean (cross-section in *figure 9.5*) but smaller. These traditions are therefor called Keilmesser-Gruppen (KMG); this is German for bifacial-backed-knife groups. But they are also known as Central European Micoquian (CEM), this seems an odd name-choice because la Micoque lies in the Dordogne, very close to le Moustier. La Micoque became famous in the 19th century for its handaxes with stretched points and a thick base. Chauvet in 1896 named this form the biface-Micoquien. Stretched handaxes are frequent in the Acheulean; the Durandal (*figure 6.11*) and the handaxes at Swanscombe also had this form. But those in la Micoque were the youngest and their points were so finely worked that scholars called them the finest handaxes ever made. These fine stretched handaxes had to be made by the last survivors of the Acheulean culture. This old theory is the reason why Bordes did not present la Micoque as the sixth Mousterian group in the Dordogne; Bordes knew the site was contemporary with the Mousterian but he attributed it to the Acheulean culture.

But the biface-Micoquien is not the only handaxe-form at la Micoque, when Hauser began to dig here in 1916 he also found many bifacially backed knives. He took them back home to Germany where everyone of course saw the similarity to the German Keilmesser. This gave scholars the idea that both groups were closely related. That theory was strengthened in 1967 when Bosinski discovered that both (instead of alternate-flaking) used a method in which one side of the biface was fully completed before the other side was flaked. Bosinski called this method wechselseitig gleichgerichtet. With this technical-link the KMG was renamed the Central-European Micoquian. French scholars quickly began to notice that some of their upper-Acheulean handaxes were also flaked with the wechselseitig gleichgerichtet method and some of these handaxes also had a stretched pointed form. They concluded these had to be the earliest Micoquian forms; this would confirm the old theory that la Micoque was made by the last survivors of the Acheulean culture.

Today we know that these conclusions were completely unfounded because the wechselseitig gleichgerichtet method is the one-side-before-the-other technique that we saw in *figure 9.5* and that is just a general Mode-III phenomenon. So the use of this method first of all proves that la Micoque is not a final-Mode-II-Acheulean but a normal-Mode-III-Mousterian tradition. It actually has exactly the same flake tools as the MTA. Secondly this flaking method was so general in Mode-III that it cannot be used to show special links. It was as general as wearing shoes is today, everyone did it. You cannot claim that the people in Europe and Japan must be related because both wear shoes. Neither can you claim that the Romans must have been the earliest Japanese because they wore shoes. A general phenomenon can never prove the existence of a cultural or technological link. That is why many Germans today prefer the original name KMG, but the name Micoquian or CEM has been used so often that it is probably here to stay.

KMG-bifaces
Most KMG-handaxes are asymmetrical and they show many different forms. *Figure 9.7* shows some examples from the Sint Pietersberg and *figure 9.8* from Gulpen (both near Maastricht). I placed red dots in *figure 9.7* at the points of impact to explain the techniques that were used. The red dots show that most blanks were side-struck, close to the base of the final form. In French this is called the déjeté method, that method makes the small tool at the bottom-right a 'pointe moustérienne déjeté'. Déjeté blanks have a tendency to become thinner towards the side that was used as the 'top' of the tool. This blank-type is the essence of the bifaces in la Micoque: this gave them a thick basis and thin top. The thin Techno-Functional-Unit at the top invited the toolmakers to make very fine retouches. At the top of *figure 9.7*, both the ventral view (at the left) and the dorsal view (at the right) show that the thick basis was not carefully shaped, because this was merely used as grip-TFU. We saw in *figure 9.5B* that flaking one-side-before-the-other leads to a plano-convex cross-section, in German this is called a Halbkeil. The biface-Micoquien at the top of *figure 9.7* is therefor also a stretched Halbkeil. The middle biface-Micoquien is not a Halbkeil because it was made on a flatter déjeté blank. Its sides are slightly convex and the top fractured by end-shock before the fine retouches were completed. The handaxe at the bottom has a wedge-shaped cross-section, that makes it a bifacially backed knife or Keilmesser.

Next page, figure 9.7: Micoquian tools from the Sint Pietersberg (Maastricht, Netherlands).

There is no reason to assume a special relationship between the makers of the tools in *figure 9.7* and the hominids in la Micoque but both used Mode-III methods on large déjeté flakes. That is why their tools are exactly the same. That is why the handaxe at the top resembles Tafel 66 in Gaëlle Rosendahl her dissertation (Die Oberen Schichten von La Micoque. Köln, 2004). If the middle handaxe had its top it would be like Tafel 75/1. And the backed knife at the bottom resembles Tafel 71-72. Some of the forms in la Micoque are far more aesthetic than those at the Sint Pietersberg, this is due to the superior quality and quantity of the French flint and also to the groups were larger (which made the toolmakers more socially motivated).

The blanks of tools 8 (on a flat blank) and 9 (with a planoconvex cross-section) from Gulpen in *figure 9.8* are also déjeté like in la Micoque, but their form and size is more like in the German site Bockstein-IIIa. The other tools in this site also have parallels in KMG sites. Wide triangular forms like number 3 are i.e. seen in Bavaria and in the Kulna cave (Czech Republic). These tools are thick but can still be called leaf-points (dreieckiges Faustkeilblatt) because the dorsal and ventral sides are parallel. Number 4 shows a small leaf-point with a very thin cross-section. The retouches of the straight edge are slightly more acute than those at the curved back, this gives the tool the outline and also function of a bifacial backed knife. Number 3 is also a flat bifacial backed knife. We also see a similar straight cutting edge (at the left) and curved back in number 7 but this has a wedge-shaped cross-section (Keilmesser). The impact fracture that broke-off the top of the small triangular leaf-point 1 indicates this tool may have been hafted as spearhead, micro-wear analysis in the Sesselfels Grotte and elsewhere has shown that hafting was a common practice in the KMG. Knife number 10 has a form that is common in Poland, called a pradnik (and in this case Ciemna) knife. The top was resharpened by three burin-like spalls (pradnik-spalls). This was frequently done in the KMG/CEM, the small Halbkeil 5 was also resharpened with a pradnik-spall. Number 6 is a small bifacially flaked core.

Two tribes
The KMG/CEM used the same Mode-III techniques as the MTA but made completely different handaxes: in contrast to the wide variety of asymmetrical forms in *figures 9.7-9.8*, the MTA-forms are standardized and symmetrical. In 1970 scholars believed this made the MTA-tribe superior and placed it at the peak of Neanderthal-evolution. The MTA-handaxes would show the western cultural identity and the Micoquian-forms the eastern cultural identity. The Western-tribe lived in France and England, the Eastern-tribe in Germany and further east. These two tribes met in Belgium; the Spy-cave would therefor show symmetrical forms from the MTA and asymmetrical forms from the Micoquian culture. But if the MTA-tribe really came this far north, why are there no sites in which small flat symmetrical handaxes are the dominant tool-type? We only have a few individual flat symmetrical handaxes, some are isolated finds and others are found in groups dominated by asymmetrical forms. It is therefor far more likely that these individual symmetrical forms are Blattspitzen (leaf-points) made by the KMG/CEM.

It is understandable that scholars wanted to classify every individual find as MTA: after the war they resented all German or Russian influences and they dearly wanted to be part of the superior western alliance. But the MIS 4-3 Neanderthals never formed such alliances because they lived in small mobile family-groups that were always on the move to find food. Large tribal communities under the leadership of Neanderthal-kings could simply not exist! Neanderthal-children of course copied the forms their parents made, this did give the handaxes a clear ‘continuity-in-forms’ but that does not make them national-symbols. Handaxes were not flags but tools and the form of a tool is always influenced by the lifestyle and raw materials. The availability of the raw materials determined the form of the blanks and this determined the difference between the MTA and KMG/CEM. Let me first remind you that the MIS 7 upper-Acheulean could only rarely make large leaf-points (like in Meulmeesters Great-Yarmouth finds) because this required large good flints. It took far less material to make MIS 4-3 bifacial leaf-points, because these were far smaller. Their small size allowed their mass-production in the French-English flint-area: these leaf-points are the MTA-handaxes. There was less flint outside of this flint-area; the Neanderthals in the KMG/CEM area simply did not have enough flint to mass-produce thin symmetrical blanks. If they only had one suitable blank in their camp, they could only make one thin symmetrical Blattspitze. The lack of flint forced them to use blanks with a cross-section like in *figure 9.5D* or *9.5B*, so KMG/CEM mostly made Keilmesser (bifacial backed knives) and Halbkeile (plano-convex bifaces). The MTA-handaxe was not a flag-symbol of the Western-tribe, but a luxury tool-form that could only be mass-produced in the French-English flint-area.

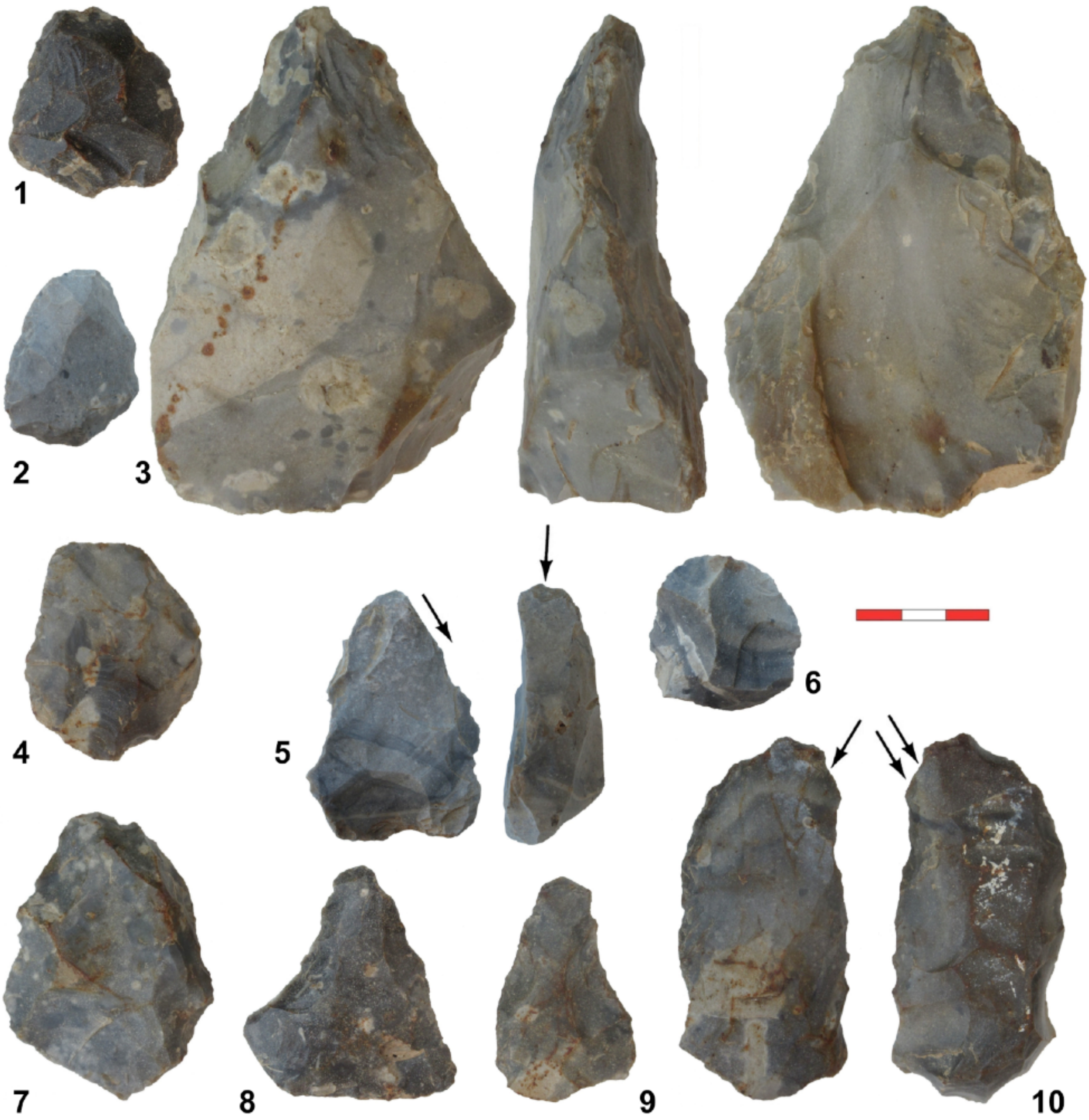


Figure 9.8: Mousterian/Micoquian bifacially flaked artefacts from Gulpen (near Maastricht, Netherlands). These forms are frequently found in the CEM/KMG traditions.

Social motivation
Brittany lies in the heart of the MTA-area. So if MTA-forms were a tribal-choice the Neanderthals in Brittany would surely have made MTA-forms. But due to the geology there is not enough available flint in Brittany to mass-produce thin flat blanks. The Neanderthals in Brittany therefor made an industry with thicker and asymmetrical handaxes, many of their handaxes therefor resemble the KMG/CEM forms. Scholars call this the Moustérien Breton à Bifaces (MBB). The MBB confirms that all tool-forms first of all depend on the raw materials. Within the limits set by the material, the forms were of course perfected and copied as the result of social motivation. In the MTA-area this led to three different handaxe-forms: heart-shaped, triangular and bout-coupé.

The KMG/CEM is found on the northern steppe lowlands from the North-Sea-plains onto the Russian plains. It often used materials from the adjacent foothills and even spread into the Czech Republic, Slovakia and Hungary. This is a huge area, so it is logical that the KMG/CEM developed many different local trends based on the different raw materials and socially motivated choices. For instance the Neanderthals in the Polish hills found excellent quality flint. This allowed them to perfect their bifacial backed knives (pradniks) into renewable forms (Urbanowski: Pradnik knives as an element of techno-stylistic specifics. 2003). Renewable means they could be repeatedly resharpened, without loosing their original form (the best MTA-handaxes were also renewable). The abundance of good raw materials in the hills of northern Hungary, south Slovakia and Moravia also led to a regional trend. The MIS 3 Neanderthals in this area made the same choice as the MTA: they made flat symmetrical handaxes. This Neanderthal-tradition is called the Szeletian. It ended when Modern-man arrived in the area, the first Moderns made Aurignacian. But ten thousand years after the Neanderthals in the area went extinct, Modern-man also began to use thin blanks to make symmetrical leaf-points. The forms of this second Szeletian-stage are exactly like the heart-shaped-MTA-handaxes, but we can clearly see that this is no longer a Mousterian tradition, because the basic toolkit in these sites is an upper-paleolithic blade-tool-tradition.

The last Neanderthals

Mode-III often used the blank-types that we saw in *figure 9.5*. But they also used blades, we saw that the MIS 7 groups at Rhenen already gave their blades beautiful Quina-retouches. The last MIS 3 Neanderthals on the Northern-steppe (38-35 ka) used blades to make retouched points, today we call their toolkit-tradition the Lincombian-Ranisian-Jerzmanovician (LRJ). *Figure 9.9* shows two examples of Jerzmanovice points. The one at the top has been found in the Spy-cave (Belgium). For comparison I also show a neolithic (Michelsberg-tradition) pointed blade at the right of *figure 9.9*. The comparison shows that Jerzmanovice points were retouched in a different way: not along their dorsal edges but over the ventral face. It also shows that the blades used as blanks for Jerzmanovice points tend to have a thicker and often triangular cross-section. The point at the bottom of *figure 9.9* is from Sint Geertruid (Netherlands). It was made on a triangular blade with the Neanderthal retouching-method, to make a Neanderthal-Jerzmanovice point with a fine-retouched top and a narrow pradnik-spall.

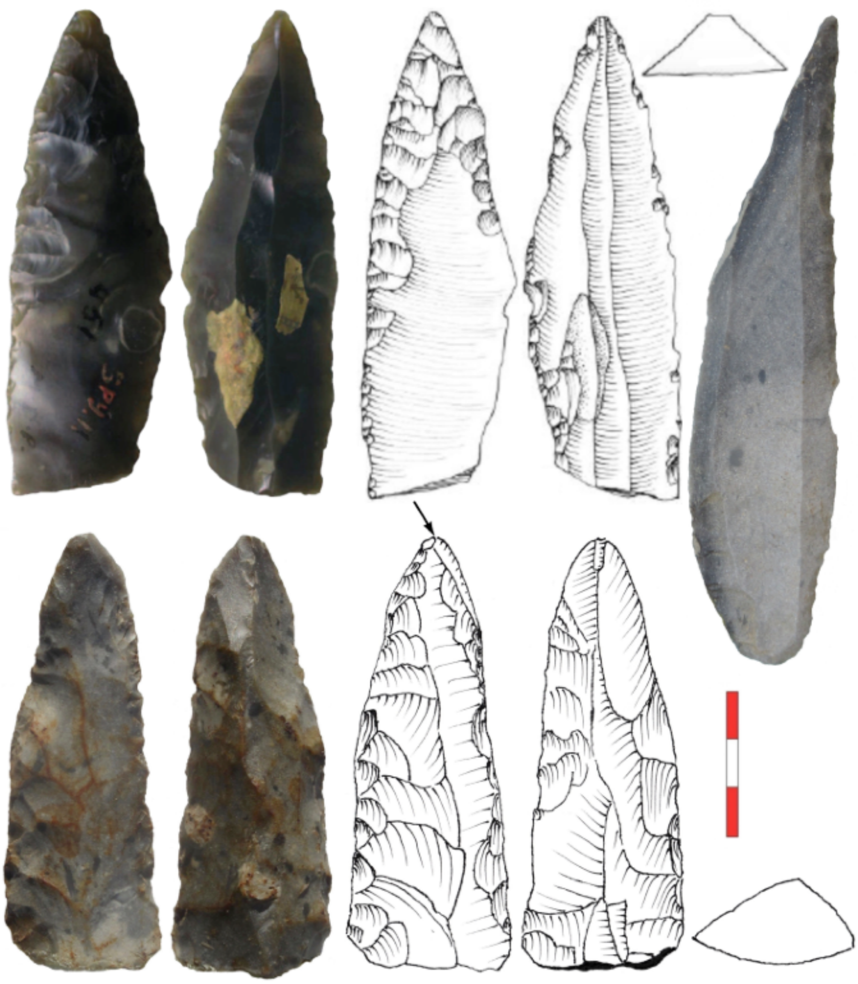


Figure 9.9: Jerzmanovice points at the left compared to a neolithic pointed blade at the right. The one at the top is from Spy (Belgium), pictures from Le Paléolithique Moyen en Belgique, Mélanges Marguerite Ulrix-Closset. ERAUL 128, 2011. The lower is from Sint Geertruid and the neolithic blade is from Gulpen, both Netherlands.

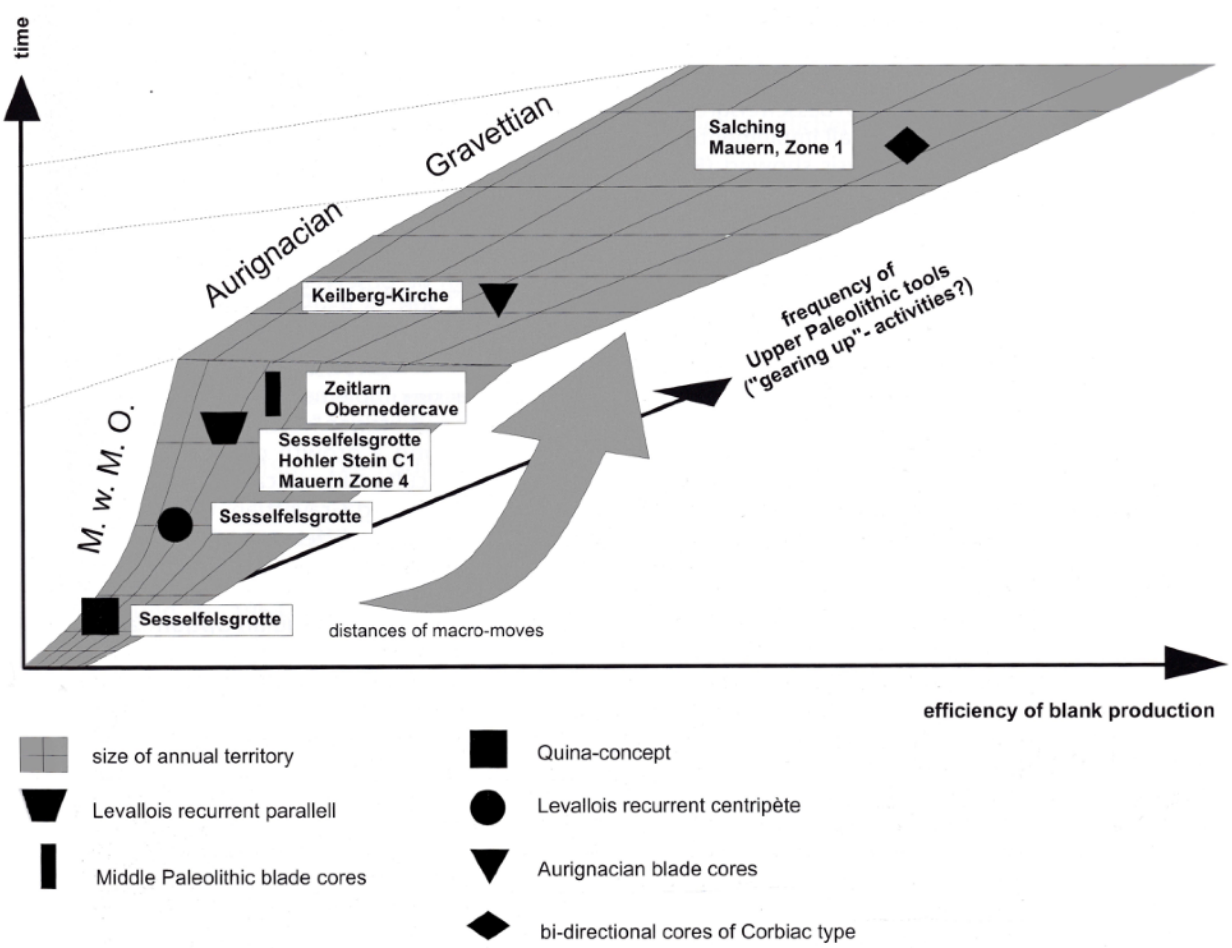
Next page, frontpage Chapter 10: Modern farmers and people in cities survive difficult times by storing their harvest and hiding their money. For them, staying alive is about holding on to what they've got. But hunter-gatherers cannot survive on what they can store, so all hunter-gatherers must base their survival strategy on sharing. The individual Hadza hunter that makes a catch, shares it with the complete group. He even shares with strangers like my Maasai friend Lemra and me.
Paleolithic hunter-gatherers also survived by sharing. In times of food shortages, all shares were small so all group members went hungry. In groups that frequently went hungry, the struggle for survival was therefor not won by the strongest hunters but by the individuals that could survive on small shares.

Chapter 10: Nomads

Transition to Mode IV
The step from the European-Mousterian to the upper-paleolithic (Clark's Mode-IV) brought a new toolkit-approach: this new approach makes it very easy to recognize upper-paleolithic toolkits. Mode-IV is characterized by the use of blades as blanks, for the production of mostly small tools. Thorsten Uthmeier has recorded the transition from Mode-III to Mode-IV in Bavaria (southern Germany) in *figure 10.1*. The developments begin in the lower-left corner with the MwMO. This is short for Mousterian with Micoquian Option; Jürgen Richter gave the KMG/CEM in Bavaria this name because it did not make handaxes in all sites (so the same group that made Micoquian/ KMG-handaxes in one site, also made a classic non-handaxe-Mousterian toolkit in another site). The earliest MwMO preferred Quina-blanks, later groups preferred to use recurrent centripetal flakes, this was followed by parallel flakes and the last MwMO-Neanderthals preferred blades as blanks. This MwMO-development ended at the point in time where the Neanderthals were replaced by Moderns who made upper-paleolithic tools. In the Aurignacian most blades were still struck from unidirectional cores but the Gravettian preferred bidirectional-blade-cores.

The classic interpretation of *figure 10.1*, is that the diagram illustrates our evolutionary progress in three ways. It first of all shows that the efficiency of the blank-production increased from simple thick Quina-blanks to clever blade-sequences. The size of the grey surface and grey arrow show the second development: over time the groups conquered larger territories and they also learned to transport raw materials over greater distances. The third development is indicated by the black arrow: the percentage of small upper-paleolithic tool-types also increased over time. The combination of these three positive trends seems to capture the essence of the evolution.

Figure 10.1: The transition from Mode-III to Mode-IV in Bavaria. From T. Uthmeier: Stone Tools, 'Time of Activity' and the Transition. Neanderthal Museum, 2000.



But we come to an entirely different conclusion if we interpret *figure 10.1* like we learned in chapter 2-9. Let me remind you that the actual step to making stone tools was not the result of the evolution of Homo habilis, this step was taken by Australopithecines that broke bones (chapter 2). The actual step from Mode-I to Mode-II was not the result of the evolution of Homo erectus, but taken by hominids who left the riverbanks and therefor had to reuse their OBFs (chapter 5). The actual step from Mode-II to Mode-III was not the result of the evolution of Neanderthals, but taken by groups that had to save weight in order to follow the herds (chapter 9). Even the big steps forward that we see today (like the industrial revolution or the digital revolution) are not the result of the evolution of a new hominid species. It is certainly true that mankind's technical developments would not have been possible without mankind's growing intelligence, but the actual steps forward are never the result of a new hominid species.

This makes the transition from the Mousterian to the upper-paleolithic a very unusual step, because this is the only step in our evolution that can be linked to a new hominid type! This transition is even more peculiar because it is not about a new invention. Mode-I began with the invention of stone tools, Mode-II began with the invention of the handaxe, the Levallois-technique was invented a million years before Mode-III but this technique still separates Mode-III from Mode-II. But you cannot separate Mode-IV from Mode-III on technological grounds: Neanderthals also produced blade-series, also used blades as blanks and also made small tools. Instead we separate Mode-IV from Mode-III on the basis of its new-look. The technical continuity is very clearly illustrated in *figure 10.1*: we would have seen a discontinuity if the MwMO development had remained on the left side of the diagram and the upper-paleolithic development had started on the right side. But there is no discontinuity, there is no breaking-point: the upper-paleolithic development simply follows the trends which were already set in the MwMO-development. We see that both hominid-types used blades as blanks and both showed the same general trend towards small 'upper-paleolithic' tool-types. Both also exploit ever bigger territories and walk ever larger distances, this simply means both had a hard time finding enough food: both experienced harsh environmental conditions. *Figure 10.1* shows a continuous development because both Neanderthals and Moderns had to respond to the same environmental factors.

We all know the reason why both toolkits are so distinctly different in spite of the technical continuity: the Mode-III toolkit was made by the Neanderthals and Mode-IV by Modern-man. But what was the underlying reason for their choices? This chapter will explain that all differences between Neanderthals and Moderns were caused by lifestyle-differences. This goes for the toolkit and for all other differences, the Neanderthals even went extinct as an immediate result of the lifestyle of Modern-man. This may surprise you because we have all grown up with the belief that Neanderthals died out because Moderns were superior. We fail to see what really happened to the Neanderthals and what is today happening to millions of species, because we are blinded by our superiority-complex. If we really want to understand the effects of Modern-man on all other species we must first of all defeat our sapiens-hypothesis.

Sapiens-hypothesis

The name Homo sapiens is 100 years older than the evolution theory, it was not at all meant to describe our place in the evolution. Linnaeus added the classification 'sapiens' to the name Homo in 1758, to underline that God had created man as superior over all animals and had given man the exclusive right to intelligence, creativity and an understanding of good and evil. The name Homo sapiens is therefor not an archeological but a theological-philosophical concept. This theological-philosophical sapiens-hypothesis was fully accepted as the divine-scientific truth in 1859, when Darwin postulated his theory on 'survival of the fittest'. All scholars of the Victorian era believed they embodied the wise or thinking man: they were the sapiens at the top of evolution. This inevitably made the sapiens-hypothesis an important element of colonialism; the white-man with the gun was superior over the colored-man with simpler weapons. Of course the sapiens-hypothesis was also incorporated into the evolution-theory; Neanderthal-man must have been like the colored-man because he also made simpler weapons. The fact that Neanderthal-man no longer existed clearly showed that he was a primitive evolutionary stage. He was a low and wild race that did not deserve the sapiens-qualification.

Our image of the Neanderthals has never fully recovered from this colonial theory. Today many scholars believe that the hominid-line split-up in two opposite directions between 500 and 300 ka. The European line developed into Homo Neanderthalis, supposedly because this line physically adapted to withstand the cold. Whilst the African line on the other hand evolved into Homo sapiens, supposedly by growing a better brain. The early-sapiens developed a high-domed skull with a raised forehead just like we have. The high skull would prove that their brain was better and brainiacs do not need primitive brutal strength to survive, so the sapiens-skeleton became lighter. The growing intelligence ultimately passed a threshold: 'we' became the superior sapiens-species. 'We' became so clever that we conquered the world and developed new technologies. Thanks to our superior brain the number of humans is now far greater than ever before; there will even be 10 billion humans in 2050.

Measuring intelligence
The hominids in Jebel Irhoud were early-Moderns, they were making MSA-tools (that resemble European MIS 4-3 forms) at 300 ka when the hominids in Porto Maior still made large handaxes. Many scholars think this proves that the early-Moderns were cleverer than early-Neanderthals because they believe they can measure the intelligence by looking at the tools like we see in *figure 10.2*. This theory is extremely tempting for archeologists, because it feels very rewarding when you can tell exactly how clever our ancestors were by looking at the objects that you pull from the ground.

	Planning horizon	Artefact level	Examples
1	Exclusive subject planning	Non-artefact level	use of nails, claws, hooves, fingers
2	Instinctive object planning	Pre-artefact level	use of stones by snails
3	Cognitive/learned object planning	Proto-artefact level	use of stones by otters
4	Planning with figurative approaches	Primary-artefact level	tool production by chimpanzees
5	Planning with indirect solutions	Secondary-artefact level	flake tools
6	Planning for extended present/foreseeable future	Provident-artefact level	transport of raw material over large distances
7	Serial planning	Multistage-artefact level	handaxes, Levallois flakes, blades, knots
8	Planning with intermediate objectives	Tertiary-artefact level	wooden spears, containers
9	Planning for unforeseeable future	Insuring-artefact level	caches, burials
10	Systemic planning	Quaternary-artefact level	composite tools, synthetic materials, representational art
11	Superordinate planning	Administrative-artefact level	measures, currency, formal laws

Figure 10.2: Planning horizon and artefact level. From M.N. Haidle: Neanderthals - ignorant relatives or thinking siblings? Neanderthal Museum, 2000.

But as a veterinarian I cannot believe that snails can climb to level 2 and must therefor be cleverer than horses, that got stuck with their hooves in level 1. And after visiting Bushmen that hunt with composite tools, I cannot believe this only puts them at level 10 whilst I am at level 11 because I buy my meat with money. This way of measuring intelligence clearly belongs in the colonial era when Marcellin Boule compared the Neanderthal skeleton to an Aboriginal, because scholars in

1911 believed that Aboriginals and Bushmen were the lowest living races. Artefacts are very important because they tell us a lot about the lifestyle, but they never show the full intellectual capacity of their makers. So the differences between for instance level 10 and 11 in *figure 10.2* do indicate different lifestyles (during the colonial era this was called the level of civilization) but the levels in this figure are certainly not a way to measure the intelligence.

The fatal flaw

But even if we step away from the colonial theory that hominids with the best weapons represent the top of the evolution it is very hard to step away from the theological-philosophical sapiens-hypothesis. Because it is almost as if the Neanderthals were taken out of production, like we do with malfunctioning machines, as soon as the Moderns arrived in Europe. That does suggest they had some malfunction, some sort of fatal flaw. What was this flaw; did Neanderthals perhaps suffer from physical problems because their body was not yet completely like ours? We for instance know that Neanderthals had a protruding face; this puts the centre of gravity of their head far in front of their spinal column. Archeologist Daniel Lieberman tested what effects this had in his study on ‘Endurance Running and the Evolution of the Genus Homo’. Lieberman fastened weights in front of a test-person’s face, to shift his centre of gravity forward like in Neanderthals. When this test-person was running this weight made it very hard to keep his head straight and he quickly had to stop running. According to Lieberman this proved that Neanderthals were not built for endurance running and incapable of throwing a spear whilst they were running; so they must have been ambush-hunters. But Lieberman’s test-method is misleading; if we let the test-person run with the weight of a horses head in front of his face he will stumble and fall but that does not prove that horses are incapable of running. As a veterinarian I have learned that you can only test the physiology of the horse in a horse. You need a wolf to test the physiology of the wolf. So you need a living Neanderthal to test the physiology of Neanderthals.

But we do know a lot about Neanderthals because veterinarians developed a method called comparative-anatomy. When we compare the anatomy of the best running species, we see that all of them have a protruding face, forward-pointing neck and strong neck-muscles. Moderns do not have that and we cannot run like a horse or a cheetah. But the Neanderthals did have a protruding face, forward-pointing neck and strong neck-muscles, they were built like the best runners so they must have been better runners than us. The comparative-anatomy teaches us that there is nothing wrong about having a forward centre of gravity or any other Neanderthal feature. We know that the Neanderthals had no fatal flaws, their anatomical-design was highly functional and in most respects better than ours. I understand that most readers will find this very hard to accept. If you are a religious person you have learned we were created in God’s image, we look like god or at least like his son Jesus so our anatomy must be superior. If you’re not religious you still want a partner that looks like the classic Greek statues of Apollo or Aphrodite, this is how we imagine the ideal body. This makes it very hard to accept that the extinct Neanderthals were physically better and it makes us wonder why we Moderns evolved in a different way. The answer lies in what happened in Africa during the Saalian-phase.

Economical children

The best hunters had the best chance to survive and pass their DNA on to the next generation, so the natural selection made all hominids before 500 ka stronger and faster and cleverer. But after 500 ka less water evaporated from the cooler oceans, the dry middle-pleistocene climate had dramatic effects on the African landscape. The drought forced the large herbivore herds to feed over greater distances, the hunters had to follow the herds and improved their mobility by making lighter tools. After 500 ka the Africans therefor made fewer LFB-handaxes and instead used more economical Levallois-methods. This resulted in the light-weight MSA toolkit. The drought also led to a shortage of food and this led to starvation. When hyenas are starving the strongest young kills his brothers and sisters to get all food, so the natural selection still makes hyenas stronger. But for our hunter-gatherer ancestors sharing their food was under normal circumstances the best way to ensure the survival of the group (see frontpage of this chapter). So contrary to what hyenas do, our ancestors also shared their food when they were hungry. This had an unexpected effect on the natural selection in dry areas; the sharing-mechanism lowered the chances of survival for the strongest and fastest growing children. Because these children needed more food than the lean slow growers. So each year, during the dry season the fast growing strong children suffered the most from malnutrition. They got sick and died, whilst children with a genetic predisposition for slow growth and a less muscular body survived the dry season and regained their strength after the rains. Chapter 2 already explained that the evolution was not about survival of the champions but about the survival of the fittest.

After 500 ka hominids in Eurasia (and wet parts of Africa) still had enough food, so the natural selection still favored the strongest fastest and cleverest hunters. But in the dry parts of Africa the evolution went in the opposite direction: here the natural selection favored the most economical children. Chapter 2 explained that the brain uses very much energy and our brain shows a fast growth between 4 years of age and puberty. Neanderthal children grew fast at that age, in order to become strong fast hunters. But the Moderns could simply not afford this, British medical studies have shown that Modern children are genetically programmed to decrease the growth of their body during this stage of increased brain-growth. This mechanism ensured that the food an Early-Modern child ate during the wet season would not be spent on extra growth, but instead get stored in the form of fat. Because this fat-reserve was essential to ensure the survival during the next dry season, when there was not enough to eat. Of course today in the Western-world most children never go hungry, so storing fat now makes them obese.

One third

The body was economized so drastically that Moderns today only burn one third of the calories that a Neanderthal burned. That sounds incredible when you know that Neanderthals had the same weight as we have. But their energy consumption was just like the use of fuel in cars more about performance than about weight: Neanderthals had powerful high performance ‘engines’. We can recognize this when we compare the Neanderthal skull to the Modern skull, both are schematically drawn to the same scale in *figure 10.3*. The Neanderthal mouth was three times larger than ours and protruded like the snout of an ape. The survival of the fittest guarantees that every anatomical detail has a function: cows do not feed on tree-tops so they do not have long necks like giraffes. There are no useless body-parts, so the Neanderthal mouth was not a primitive ape-like remnant but a functional necessity. This enabled Neanderthals to eat three times what we eat. Neanderthals used 6000 calories per day, this puts their metabolism in the same class as other great hunters like the wolf. But we Moderns only use 2000 calories per day, our bodies became extremely economical but this had many consequences.

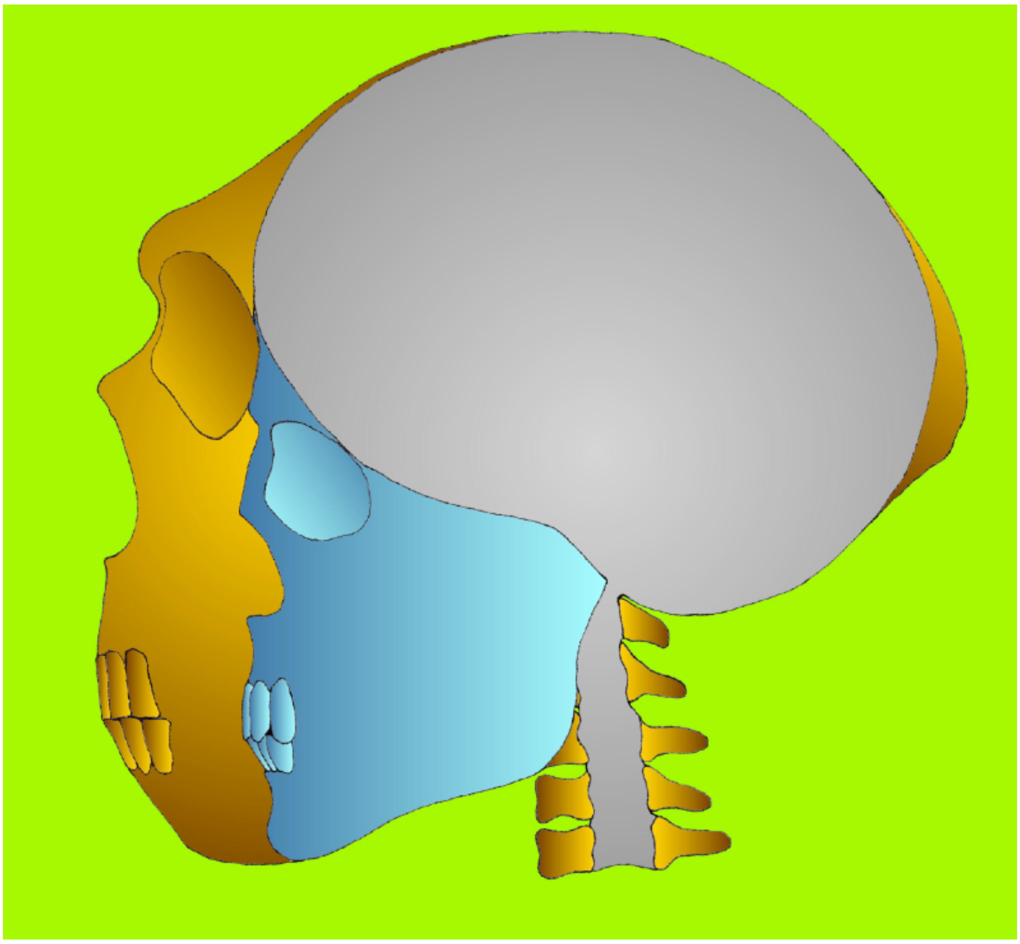


Figure 10.3: When we compare the Modern and Neanderthal skulls to the same scale, the Modern face is much smaller whilst the brain is almost the same. The top of the skull remained at the same height.

In 1950 scientists believed that Neanderthals developed extra large noses because they were an ice-age-species and needed such noses to warm the air they breathed. But arctic animals do not have extra large noses and we know that Neanderthals never lived in arctic conditions because they had to follow the herbivore herds to the south in cold climate-stages. Neanderthals had large noses for a far simpler reason: if you burn more calories you need more oxygen. Moderns use just one third of the food and oxygen Neanderthals used, so our mouths and noses became smaller. Our face shrank and it sank below the brain-case (because this is the most economical position). *Figure 10.3* shows how the shrinking face affected the form of the skull: the eyes also sank below the brain-case. The low position of our eyes creates the illusion that the Modern brain rose, it creates the illusion of a high 'noble' forehead. The brain-case was the only part that did not shrink because Moderns needed to stay just as clever as their strong contemporaries. If you feel any doubts about the scales of *figure 10.3*, please look at the 3-D model in *figure 10.4*. This model places one half of the skull of Cro-Magnon 1 against one half of the skull of la Ferrassie 1. Both halves are joined at the foramen magnum (the opening towards the spinal column). From the artistic point of view this seems terribly wrong, it feels as if we have to 'correct the reality' by making the Neanderthal skull smaller and lowering its eye-socket to the same level as the Modern eye-socket. But this 3-D model shows the truth: Moderns do not have a higher skullcap. The story that our brain rose is a phantasy, the real difference between us and the Neanderthals is not in the brain-size but in the face-size: we have an economized mouth and nose whilst the Neanderthal mouth and nose were designed for high performance.

Figure 10.4: Three views of a 3-D model comparing Cro-Magnon 1 to la Ferrassie 1.

Trouble-shooting

The anatomy of our strong and fast ancestors was the result of millions of years of evolution, the African counterpart of Heidelberg-man (we can call this the developed Homo erectus/ergaster or early Kabwe-man) had an anatomy that was well-tested and perfected over time. But after 500 ka the increasing droughts changed the priorities of the natural selection, the need for a weak lean economized body led to changes in the anatomical design. Changing a good design always leads to problems, our ability to speak is a good example. In 1900 the sapiens-hypothesis led people to believe that the 'missing link' was an inferior apeman that could not speak. But recent research has shown that all social-animals have complex communication systems. This ethological fact makes all debate on the question if erectus-cranium-endocasts really show an enlarged Broca-area and what this means, futile. There is no more doubt, we know that Heidelberg-man sat by his fire discussing his hunting strategies. We know that he told his children where the best food and raw materials could be found. We know that Neanderthals told each-other how to make birch-pitch or use willow-bark as anti-inflammatory drug. Birds sing and dance, so there is no scientific argument to doubt that Neanderthals sang and danced.

But the well-tested anatomical design was changed by making the mouth smaller. Our jaws shifted so far towards our neck, that hardly any room was left for the tongue and no room at all for the larynx. But we cannot speak without our pharynx/larynx and without room to move our tongue, so the Early-Moderns almost lost their ability to speak! The evolution hastily searched for trouble-shooting solutions. We regained a bit of space by removing the interior support-beam of the chin. This weakened the structure so the interior support had to be replaced by an exterior support: our pointed chin. The larynx no longer fitted inside the mouth so this was lowered to a more vulnerable position in the neck. This restored the free movement of the tongue, but also increased our risk of choking (and snoring). Our smaller mouth also led to another problem: we no longer had room for all our teeth. The fossils clearly show that our ancestors had a healthy open space between the last molars and the mandibular arch, archeologists call this the retromolar-space. But Modern jaws are so short that we need to go to the dentist to get our wisdom-teeth pulled. We clearly do not have the anatomy of a 'superior species'.

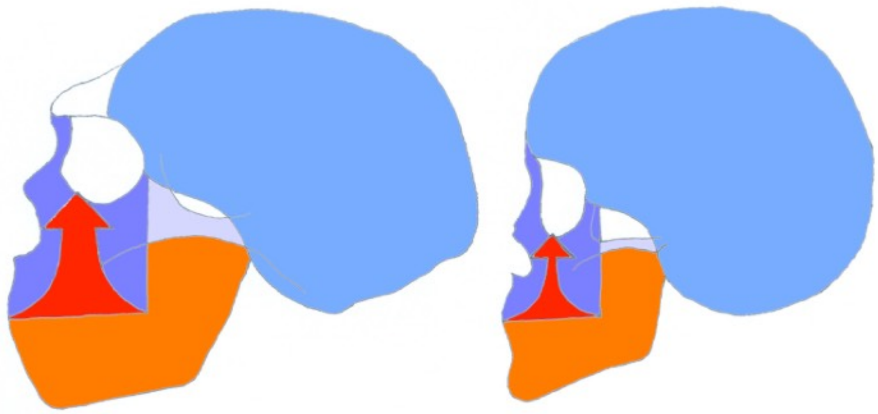


Figure 10.5: In Moderns the biting and chewing force (red arrow) is far smaller and because the jaws are shorter this force is directed towards the cranium.

Still, some anatomical changes also gave us a lucky break. *Figure 10.5* shows that shortening our jaws changed the impact of the the chewing-forces (red arrows). Neanderthals had very large protruding jaws, so (when they were biting and chewing) the lower jaw (orange) exerted a large upward force in front of the brain-case (blue). In order to withstand this large upward force, the upper jaw had to develop what scholars call an 'inflated' model. We see this in *figure 10.6*, this inflated form can withstand a far greater compressive strain than our Modern hollow-cheeks. The red arrows in *figure 10.6* show how the inflated upper jaw transmitted the bite-force onto the brow-ridge. I gave the brow-ridge in *figure 10.5* a white color to make very clear what would happen without this anatomical structure. If the upper jaw (dark-blue) had only been connected to the brain-case by the nose (like in Moderns) the large bite-forces would break the connection between the face and the brain-case. So the brow-ridge was not a primitive ape-like remnant, it was instead a highly evolved functional necessity. When you understand this function you also understand why Neanderthal babies and young children did not have developed brow-ridges. The babies drank milk so they only needed small jaws. In *figure 10.7* the skull of the Teshik-Tash boy is projected on a Modern adult, to show that pre-adolescent Neanderthal-children had jaws that were nearly similar in size to ours. So children did not yet need a brow-ridge, the full length of the jaws and therefor the full size of the brow-ridge developed during adolescence.

Figure 10.6: Inflated forms (the light colored face of the Amud-1 Neanderthal) can withstand great compression (between the lower jaw and brow ridge).

Figure 10.7: The skull of the Teshik-Tash boy in profile, projected onto a Modern skull.

Post-cranial anatomy
It is even easier to recognize the effects of drastic economizing on the post-cranial anatomy (the part of the body below the head). It is very clear that the arm and leg bones became thinner to save weight. We also saved a lot of energy by bringing all parts of our body closer to the centre of gravity. You can feel how much energy this saves when you lift two buckets of water; the further you hold the buckets away from your centre of gravity, the harder it gets to carry them. This is the reason why we developed a flat chest. In comparison to the far deeper chest of the Neanderthals, we save energy with every breath we take because it takes less energy to lift our ribs. Our breathing is so economical that you may wonder why the Neanderthals had a deep chest. They needed their deep chests for the same reason that a high performance car needs a big engine-compartment; Neanderthals needed more space for their big heart and lungs. We know that dogs with flat chests (i.e. bulldogs and cavaliers) cannot run as good as dogs with deep chests (i.e. greyhounds), veterinarian studies also show that heart-failures increase when the chest-depth decreases. So when we unravel the DNA of the Neanderthal-heart, we are likely to find that the Moderns who inherited this DNA have more heart-failures. Not because the Neanderthal heart had a flaw, but because the engine of a racing-car will fail when you squeeze it into the boot of a beetle.

Figure 10.8: Maasai Koongo Ole Sakai (with stick) shows the 120 ka footprints of Modern man that he discovered at Engareso (Lake Natron, Tanzania).

The horse has curved hind-legs to give it its speed, this shows that Neanderthals had curved femurs because these enabled them to run faster. But our legs are as straight as the front-legs of a horse because this saves energy when we stand still. So the Moderns needed to develop a new system to make speed: we run by leaning forward and shifting our weight to the front of our feet. This led to the development of the arched Modern foot (see the footprints in *figure 10.8*). When Neanderthals were running, all of the shocks were absorbed by their curved legs and forward-leaning neck. This system perfectly protected the head with the eyes, balancing-organs and the brain. But Moderns placed their head straight above the spinal column to save energy and the spine was straight above the straight legs, so when we walk our straight knees transmit every shock to our pelvis and these shocks travel all the way up to our head. So we had to invent a new shock-absorbing system: our spinal column developed an S-curvature in the lower back. This trouble-shooting system does its job. But it is clearly far from ideal because when we age, most of us suffer from lower-back pains.

Economical success
Africa is a large continent with a great variety of environments; these differences led to different hominid-types. For instance the strong Kabwe-man (African-Heidelberg) lived in areas with plenty food whilst Early-Modern-man developed his leaner body in areas where the dry season caused annually returning food shortages. But the Early-Moderns did not avoid the areas with a lot of food that were visited by the strong Kabwe-people. Kabwe-man did also eat small animals but he depended on large herbivores for his survival. The lean-hominids on the other hand were able to survive on merely smaller animals, as we already saw at the frontpage of this chapter. The Hadza in this photo on most days live on a few tubers and berries, so when the men caught a dikdik (an antelope of less than 20 kilo) they really had a good day. They took half of the meat home to feed the women and children and even gave us a small share. Early-Moderns could also survive on tubers and berries and the occasional antelope, so they exploited the small-game whilst Kabwe-man merely passed through the same area in pursuit of the herds. Early-Moderns had their own 'small-game-niche' and this niche was not restricted to the dry landscape so their economical-success-formula spread all over Africa. Early-Modern fossils were found in Jebel Irhoud 300 ka, Florisbad 260 ka, Omo Kibish 195 ka. It is interesting to see that these fossils show different anatomical characteristics but all show mixtures of economized-man and strong-man features. In the 20th century this was interpreted as fossils that still showed some old characteristics because the Modern anatomy had not yet fully evolved; i.e. the Skhul and Quafzeh skulls in *figure 10.9* supposedly showed early stages of Modern-man. But these skulls date to around 100 ka, so we know today that they are far younger than the Early-Moderns from Jebel Irhoud.

So the mixed characteristics must in reality be the result of interbreeding with neighboring hominids. It makes sense that the skulls from Skhul and Quafzeh show Early-Moderns crossbred with Neanderthals, because the fossil-record shows that these hominids lived right next to Neanderthals and they also made the same tools. In *figure 10.9* the parts with Modern features are placed against a blue background and the parts with Neanderthal features against a red background. We know from Lieberman's running-experiment that Moderns have such weak neck-muscles that they need to have their face close to the centre of gravity, we saw in *figure 10.3* that this resulted in a position of the face below the brain-case. The eyes are squeezed-in between the mouth and the brain. That gave the Modern eye-sockets a low-rectangular form; *figure 10.9* shows that the Skhul-skull had this Modern form, whilst the Quafzeh-skull had oval eye-sockets like most Neanderthals. Both have raised foreheads but Skhul has a brow-ridge and his occipital bone suggests strong neck-muscles like in Neanderthals (occipital ridge). Both Skhul and Quafzeh have a large mouth with a clear retromolar-space. But this does not mean that the small mouth had not yet evolved around 100 ka: the 260 ka Florisbad skull already shows a small mouth! We can tell that Quafzeh IX had ancestors with a small mouth because it has a pointed chin and only hominids with a small mouth need to develop this form. Before 2010 most scholars dismissed these signals because they thought Moderns and Neanderthals could not crossbreed. But today we have clear DNA-evidence that proves Early-Moderns and Neanderthals crossbred in the Middle-East. Neanderthal fossils with Early-Modern-DNA were found in the Altai (Prüfer et al, Nature 505 pp. 43-47, 2014) and this DNA can only be part of their genome as the result of earlier crossbreeding in the Middle-East. The fact that DNA from the Middle-East is found in the Altai furthermore proves that hominids were able to walk from the Middle-East to the Altai in MIS 5; you could say that 'the roads were open'.

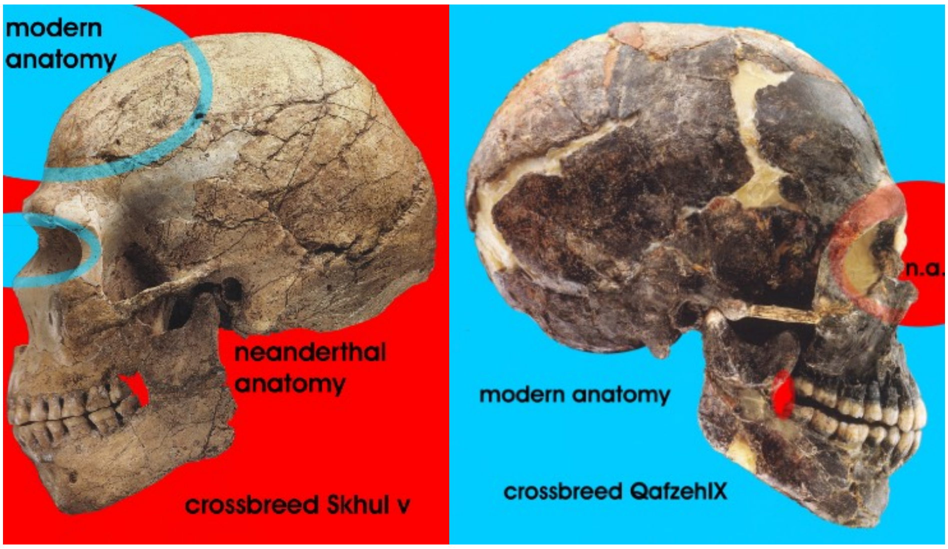


Figure 10.9: The mixed anatomical characteristics in the skulls from Skhul and Quafzeh show they were crossbreds.

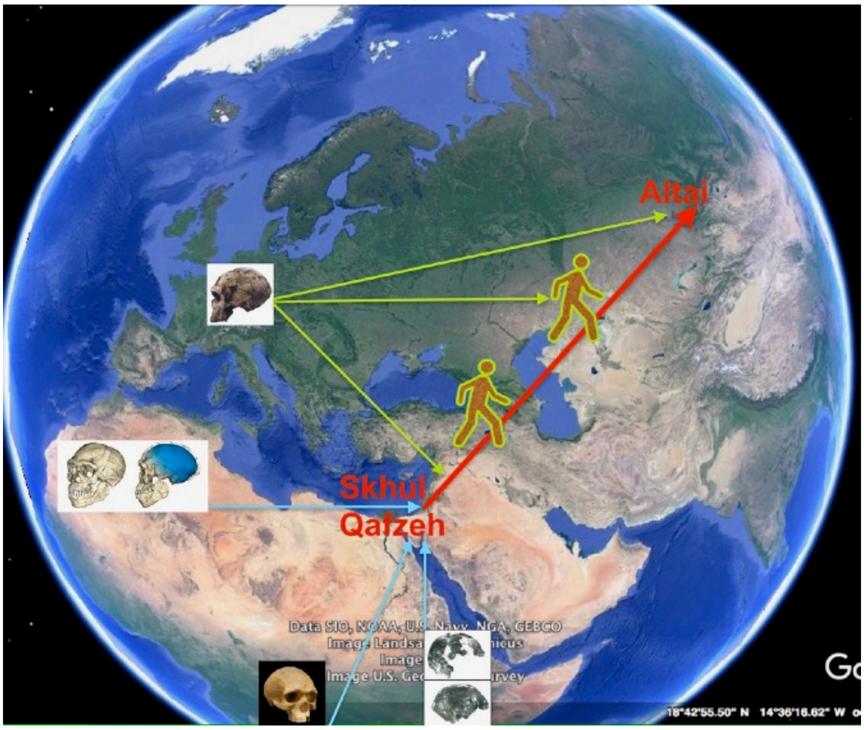


Figure 10.10: The presence of Early-Modern genes in the DNA of the Neanderthals in the Altai proves that crossbreds migrated from the Middle-East to the Altai.

No early out-of-Africa
Figure 10.10 shows that Neanderthals were able to reach the Middle-East in MIS 5 where they crossbred with Early-Moderns and their children took the mixed-DNA to the Altai. So we know that the roads were open, but there are nevertheless no MIS 5 Modern fossils in Europe. It does not take a genius to figure out why the Early-Moderns were unable to migrate out-of-Africa. All strong hominids (Homo erectus, Homo antecesor, Heidelberg-man, Neanderthals, Denisovans) were able to survive moderately cool winters because they burnt many calories. Their bodies kept warm because their metabolism produced enough heat. But the Early-Moderns only burned one third of the calories of a Neanderthal so they could not survive the winters, they would die from exposure to the cold. Babies and children were of course the first victims, because their small size gives babies and children a lower weight-to-surface ratio. So there was no early out-of-Africa from Modern-man at 100 ka.

But something changed in the course of MIS 5 because the Moderns reached Australia at 60 ka and we can see in *figure 10.11* that around the same time the world population suddenly began to grow. The sapiens-theory claims both the out-of-Africa and the population growth were the result of our growing intelligence. Our intelligence supposedly passed a threshold, this made us real Homo sapiens with superior brains, superior weapons and the desire to see beyond the horizon. Passing this threshold also led to the birth of art and culture. This makes perfect sense if you have been raised with the idea that man was created in god's image and is therefor the only intelligent species. It is extremely difficult to step away from the feeling that you are superior. But if you can set this emotion aside for one moment, I will explain the simple mechanism that led to all of these sudden changes.

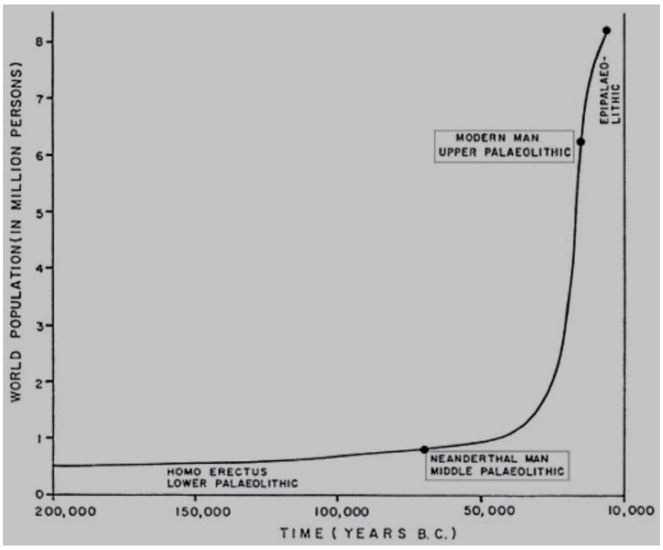


Figure 10.11: Before MIS 5 the estimated world population of hominids always stayed below one million. But the world population suddenly began to rise dramatically when man became fully Modern. From: F. Hassan: Demographic Archaeology. New York, Academic Press 1981.

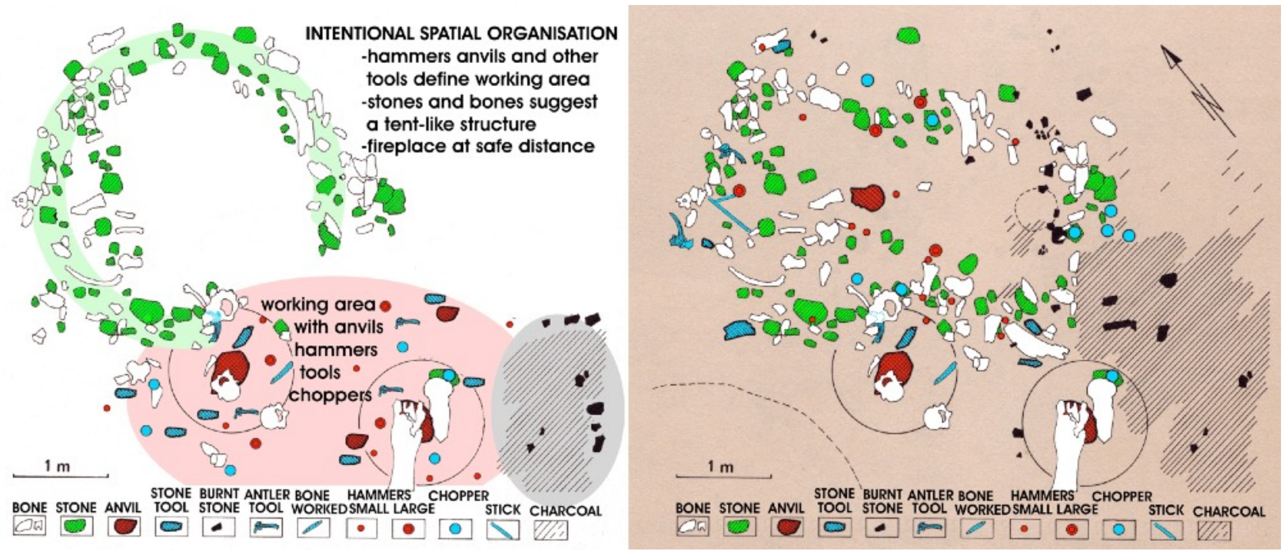


Figure 10.12: Floor-plan at Bilzingsleben. The right drawing shows the actual situation shown by Mania: Auf den Spuren des Urmenschen. Die Funde aus der Steinrinne von Blizingsleben. Berlin 1990. The left drawing shows a popular interpretation of the floor-plan.

Shelters

Understanding the mechanism behind the sudden changes begins with understanding the difference between a home (i.e. a house, caravan, hut or yurt) and a shelter. A shelter is a safe-place for the night, chimpanzees make nest-like shelters and the Australopithecines may have done the same when they still had grasping feet. Later hominids often used a fire as shelter, because fire offers protection against carnivores and mosquitos. A windscreen and a dry-place (under a tree or an abri) are also shelters. Shelters were found in Bilzingsleben (we discussed the bipolar toolkit of this MIS 11-9 site in chapter 8) and in Terra Amata (a 400-380 ka Acheulean site in Nice, South-France). The floor-plan from Bilzingsleben at the right of *figure 10.12* shows stone tools next to a sheltering fire. Mania believed the manuport stones (green) had been deliberately placed in a circular pattern around grass huts. So the 'idealized' floor-plan would look like we see at the left of *figure 10.12*. Experimental archeologists even built these supposed huts at the site, but then Mania saw that the huts stood immediately next to the fires. Mania concluded the huts had a fireproof roof but our ancestors did not use asbestos. Another sign that the huts did not exist is the lack of intentional spatial organization; the tools and rubbish are everywhere.

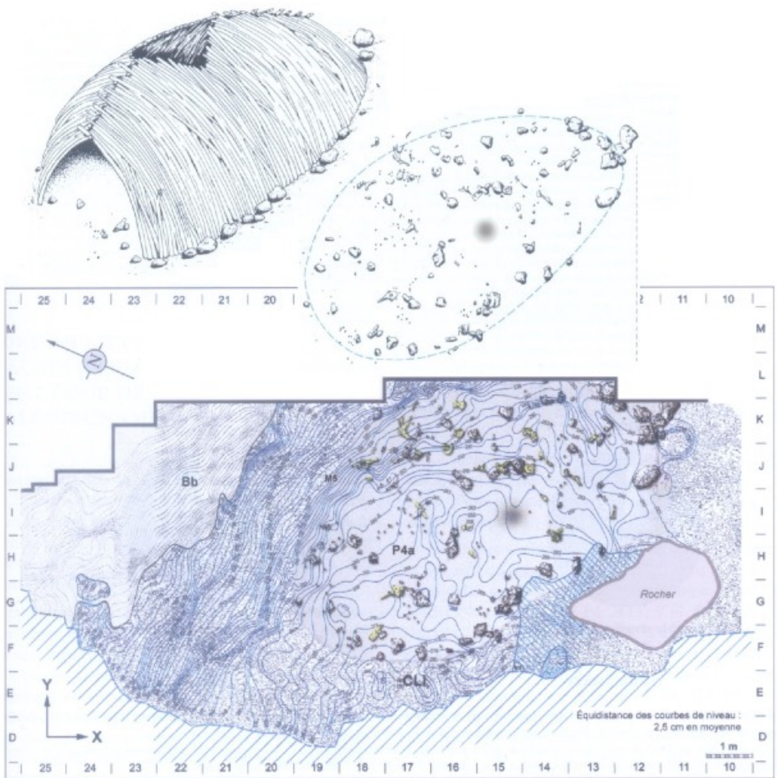


Figure 10.13: Floor-plan and at the top the suggested hut. From Terra Amata / Tome II. Editions CNRS, edited by Henry de Lumley.

The floor-plan from Terra Amata in *figure 10.13* shows the same lack of spatial organization. This floor-plan also shows the same open spots between stones as in Bilzingsleben. Jan Koolen explained that these open spots are simply places where hominids pushed all rubbish to the sides, to create a clean open space where they could sit or sleep. Koolen called these open spaces Centrifugal Living Structures (CLS, in: Hominids without homes: on the nature of Middle Palaeolithic settlement in Europe. 1999). Interestingly Henry de Lumley did not assume that the open spaces in Terra Amata were huts. He found holes in the sand made by branches as thick as your wrist and believed these were from branches that formed a huge 9 by 5 meters wide and 4 meters high hut, like in the drawing in *figure 10.13*. But such a hut would be useless unless it was waterproof and that would take a completely different construction and many weeks to build. When I camped in this area the wind made it hard to heat water on a gas-fire for a simple cup of tea, so it must have been very difficult for the MIS 11 hominids to maintain their wood-fires on the open beach. They had to plant branches in the sand, to form windscreens that protected their fires. These windscreen-branches made the holes de Lumley found.

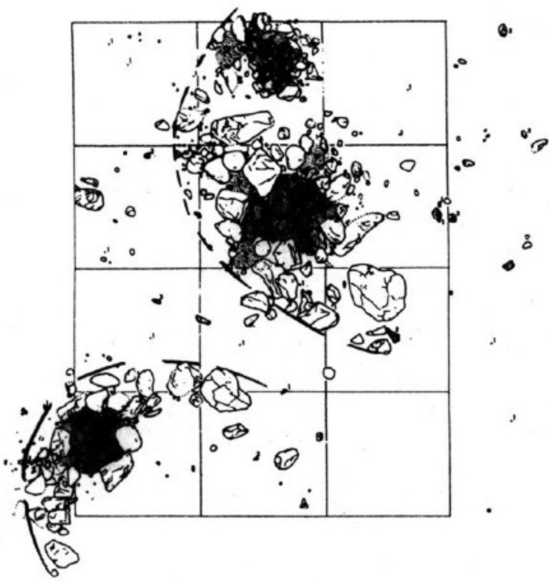


Figure 10.14: Centrifugal Living Structures (CLSs) with structurally organized fireplaces at Vilas Ruivas, Spain.

The Neanderthal floor-plan in *figure 10.14* from Vilas Ruivas in Spain shows many blocks adjacent to the fireplaces. The broken-lines suggest hut-structures but the assumed walls would (just like we saw in Bilzingsleben) be in immediate contact with the flames. Chapter 9 explained that the Neanderthals made light-weight tools to keep up with the fast moving herds and could not stay in one place for more than a few days. So they did not waste any time on building huts, these fireplaces were simply parts of open shelters. The floor-plan in *figure 10.15* from Molodova-I (Dniester valley, Ukraine) reminds us of the large imaginary hut at Terra Amata, but this open space is far too large to be covered with the materials that were available on the steppe. To avoid any confusion I want to stress that Molodova-I is an open Neanderthal site, but the other floor-plans at Molodova are younger and these represent real huts that were built by Modern man.

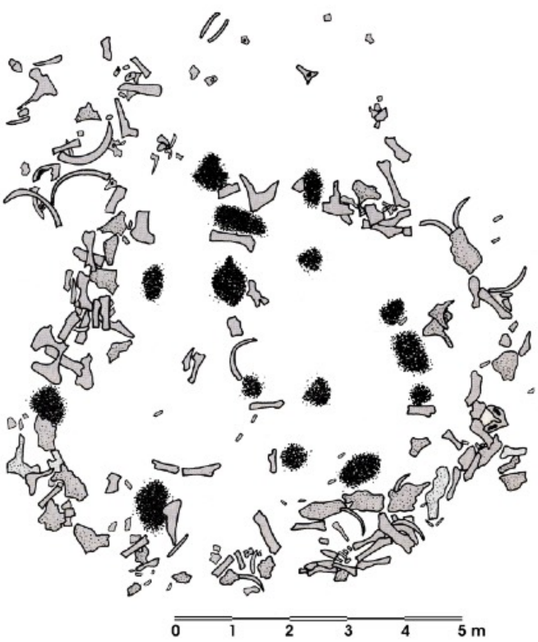


Figure 10.15: Centrifugal Living Structures and fireplaces suggesting repeated visits at Molodova-I, Ukraine.

The first huts

When you understand that the strong hominids in Europe did not make huts, we can return to the situation in Africa. After 500 ka Africans made MSA: they made light-weight-tools for a mobile lifestyle. So we can assume the Africans slept in shelters just like the Neanderthals in Europe. From 500 ka to 100 ka the strong Africans (Kabwe man) and Early-Moderns made the same tools and they must have had similar lifestyles. This similarity enabled them to live together and crossbreed.

But the environment changed in MIS 5. The climate became wetter and the rains made the landscapes more fertile. Some parts of Africa were like a garden of Eden with rivers full of fish, trees full of fruits and grasslands full of game. So now the Early-Moderns with bodies specially designed to survive on very little food lived in the land of plenty. This completely changed their behavior because after they had eaten all the food they needed, there was still enough food for tomorrow and the day after tomorrow and even for the whole next week. In MIS 5 the Early-Moderns could sometimes stay in one place for a complete month. Contrary to Kabwe-man they no longer needed to pursue the herds, this was of course a great luxury. But at night (and especially when it rained) their situation was far from luxurious, their economized bodies burned very few calories so they were very cold. The smallest children shivered from the cold, many became ill and died. They certainly understood that the coming nights would bring the same problems and did not want their children to get wet again. So they invested many hours of their time in making a waterproof roof. And knowing that they would return to the same shelter every night for the coming weeks they also made good windscreens. Over the course of many generations such actions gradually transformed the shelters of the Early-Moderns into huts.

From mobile to nomadic
Our ancestors lived as hunter-gatherers before the invention of huts and still lived as hunter-gatherers after this invention. But their lifestyle nevertheless changed completely! Because mobile hunter-gatherers often couldn't say in the morning where they would make their next night-shelter because that depended on the herds. And in another week the large herbivores could almost be anywhere. This means that the group always had to stay together: when mobile hominids were hunting the complete group was hunting and when they were picking berries the complete group was picking berries. Mobile hunter-gatherers always worked together as one entity. But hominids with huts know exactly where their group will be the next night or even the next week. So it does not matter if one person looses contact during the day-time, because he can simply rejoin the group in the evening. This means that the hunters could now go in one direction whilst the gatherers went in another direction. This changed the foraging strategy: we saw in chapter 9 that Neanderthal-groups always exploited the area where they were on that day. But the nomads sent sub-groups to 'shop' elsewhere. Nomads brought supplies from elsewhere to their home just like we do today. The best hunters formed a small hunting-party that brought their catch back home to the camp. The gatherers brought tubers and fruits or firewood to the camp. Other sub-groups went shopping for raw materials to make stone tools. Individuals could now have special tasks because every individual and every sub-group knew its way back home. The women could now have tasks that differed from what men did. Old people now had tasks that differed from what young people did. This new lifestyle is such a decisive step in the development of mankind, that I look at it as the borderline that separates the Early-Modern-behavior (still living in mobile groups) from the real Modern-behavior (living in nomadic groups).

Staying in one place for a long time also led to dramatic changes of the material culture. Socially living individuals want to show-off, we saw in chapter 5 that this motivated many Mode-II-makers to create perfect handaxe-forms. These forms were only used a few times and discarded when the group left the site, so the real value was in showing-their-skill. But when the Moderns began to live in huts they could use the same tools for weeks or months. This was a game-changer: making the best tools was no longer just about showing your skills but also about owning the best tools. We can see the first steps towards permanent ownership in several South-African sites, for instance Blombos and Klaasies River Mouth. Many artefacts in these sites (such as carefully flaked spear-points) look as if they were made for keeps. The ability to posses objects forever (Moderns even took their possessions into their grave) meant that a person's social status now became determined by what he owned. Today the person that can buy a luxury car has a higher social status than the people who have the skills to build this car.

Potential population growth
This change in the material culture was very important, but the most important effect of the transition from mobile to nomadic life is the change of the growth-potential of the population. We all understand that the reproduction of each species is primarily regulated by physiological factors. For instance the uterus of a dog often holds ten puppies in one litter, whilst the human uterus mostly only holds one baby. But this number is no coincident: all physiological factors that regulate the reproduction evolved through the survival of the fittest. Let me illustrate this by asking what would happen if mammoths had ten calves, just like dogs have ten puppies. Ten mammoth-calves need a lot of calories and proteins for their growth. But steppe-grass is low in calories and proteins, so the mammoth-mother can only produce milk for one calf. It is far more economical to have just one calf, instead of ten from which nine starve. The mammoth-calves depend on milk for years and they also need to learn what to eat and where to find water. So mammoths cannot have

a calf every year like a cow; the growth-lines in the tusks show us that mammoths only had one calf in four years. Chimpanzees also need to give their young milk and teach them a lot, even more important is that a chimp-baby needs to be carried until it can follow the group on its own. This takes so long that chimpanzees only have one baby in five years.

The hominid physiology determines that a woman mostly has just one child at a time. But the lifestyle determines how often women have children. The hominids with a mobile lifestyle (so all extinct hominids) carried their child until it was able to follow the group, so the women had just one baby in five years. Five years was the average, some children needed six years whilst others grew so fast that they could follow the group after four years. These extra fast growing children were favored by the natural selection in hominids with a mobile lifestyle. Except in the mobile-Early-Moderns, because in this case the natural selection restricted the growth to prevent children from starving in the dry season. These opposed directions of the natural selection explain why Neanderthal children grew much faster than Modern children. So the Early-Moderns had a slightly lower birth-rate when they still had a mobile lifestyle, but that changed completely when they became nomads. Because nomadic women do not have to carry their children for years. The Modern mothers only carried their babies for a few months, because older babies and toddlers were simply left at home in the care of grandmothers or older sisters. So the natural factor that controlled the birth-rate disappeared, Modern mothers were suddenly able to have a child every year. This explains why nomadic-populations can grow much faster than the Neanderthal-population ever could. *Figure 10.11* shows that the natural birth-rate before MIS 5 always kept the world population under one million. *Figure 10.15* shows us how dramatically the growth-potential changed when the hominids began to live in homes.

Figure 10.15: The potential population growth in mobile hominids (at the left) is far lower than the potential population growth in hominids with a home (at the right). The mobile lifestyle has always kept the number of Neanderthals low and when a climate event reduced the population the recovery took a very long time. Having a home has turned Moderns into rapid-breeders, today the global population almost doubles with every generation.

In *figure 10.15* time runs from top to bottom and one red line stands for the 30 years lifespan of one woman. The red line at the left represents a Neanderthal that gave birth to a daughter when she was 13 years old, followed by a son when she was 18 and another daughter at 23 years of age. Men are not shown in this diagram, but the two daughters are represented by the two orange lines. All hominids in this diagram die at the age of 30 years, so the Neanderthal-boy that was born when the woman was 28 lost his mother too early and died. To keep the calculation correct we must reverse the order in the orange generation: the firstborn is now a boy. The first daughter survives but the second daughter is born when her mother is 28 and dies. This means that even if everything went right the orange generation could never produce more than one daughter, so the yellow generation still shows two lines. The green and blue generations both show four lines. So over 75 years, the number of Neanderthal women could maximally grow from 1 to 6. At the right of the diagram we see that women with homes could have a child every year, so (despite the later birth of the first child) they had a maximum of 9 children from which 4 or 5 were girls. In 75 years the number of Modern women could therefor potentially grow from 1 to 215.

Out of Africa
Figure 10.15 is about 'potential', but what were the real numbers like? *Figure 10.11* correctly shows that the global population of extinct hominids hardly grew. In MIS 4-3 the Neanderthal-population was instead repeatedly decimated by the climate-fluctuations. And we know from *figure 10.15* that the numbers could only recover very slowly, so it is possible that the European population was extra low when the Moderns arrived. We have a good idea of how fast the Modern population grow because we see this today; today our global population nearly doubles per generation. Locally the growth is even greater and historically the growth has always continued until our food-systems failed. So we can be sure that the prehistoric Modern population also grew rapidly until the food-systems failed. This brought the population in Africa in MIS 5 to a point where the size of the herbivore herds and also the numbers of antelopes were still far greater than today, but where it nevertheless became difficult to catch enough preys to keep the children in the nomadic camps alive. Survival of the fittest is not about strength or speed or intelligence (chapter 2) but about adaptation. The Modern children were adapted to grow up on very little food but the Kabwe-children needed far more. So the growth of the Modern population inevitably led to the starvation and extinction of Kabwe-man.

When the nomadic population had reached the maximum the landscape could locally support, the next generation of course had to find food elsewhere. But after the nomads had settled a new area their numbers kept on growing and the next generation again had to go to another area. So the nomadic lifestyle spread like a wildfire. It only took millennia from the development of the hut to the extinction of Kabwe-man. The population kept growing and food became so scarce that even children with mixed-DNA died, because they needed more food. So between 100 ka (Shul and Quafzeh) and 60 ka the anatomy of our ancestors clearly changed: the people no longer had a retromolar-space. All Africans were economized, they all had a uniform fully Modern anatomy. No borders could stop the 'spreading wildfire' so the next generations of Moderns pushed out of Africa. At 100 ka the cold winters still stopped the Early-Moderns from leaving Africa (*figure 10.10*) but lean slow growing children no longer froze to death around 70-65 ka because they now grew up in the warm micro-climate of their huts. The huts opened the way to the Tigris and Eufrates rivers and to India, where the population of Moderns kept growing. Spreading like a wildfire the Modern nomads reached China and even Australia within just a few thousand years. Not because they suddenly developed a brain that wanted to see what lies beyond the horizon, but simply because huts increased the population and protected children in the winters.

Into Europe
The simple hut brought the Moderns to Australia. But the hut was not enough to conquer Europe because all hominid life in Europe depended on eating large herbivores. The large-herbivores that lived north of 40 degrees latitude between 60 and 50 ka had to walk many kilometers from their summer feeding-grounds to find enough food for the winter. The Neanderthals were mobile enough to follow the herds because they slept in shelters and made light-weight tools (chapter 9), so when the climate forced herbivores to travel over greater distances the Neanderthals simply increased their territory (*figure 10.1*). Because the Modern nomads also depended on the herds, they had to move their camp at least four times per year. But they could not move their camp when it was cold because it took weeks to build good warm and dry huts at the new spot. Healthy adults could survive the cold for one or two weeks in simple shelters, but the children got ill and died before the new huts were ready. This explains why the Modern nomads had already travelled halfway across the earth and across the seas to Australia before they spread into Europe.

The nomads first had to develop a new mobile-home concept. They needed tents that were light enough to be transported over large distances, but also warm and dry enough for their children and clever enough to be rebuilt in a very short time. Around 50 ka the nomads learned to make such tents from poles and hides, so by 40 ka the Moderns had spread all over Europe and also into the northern parts of Asia. Modern women could give birth every year so it is obvious what happened next; the nomad-population grew as fast as it spread. This put the Neanderthals and Denisovans in the same situation as Kabwe-man had been around 70 ka: in only a few thousand years they were all starving. Neither their strength, nor their speed, skills or intelligence could save the Neanderthals escape their fate. They were simply economically outcompeted because they gave birth to far less children and because they needed far more food.

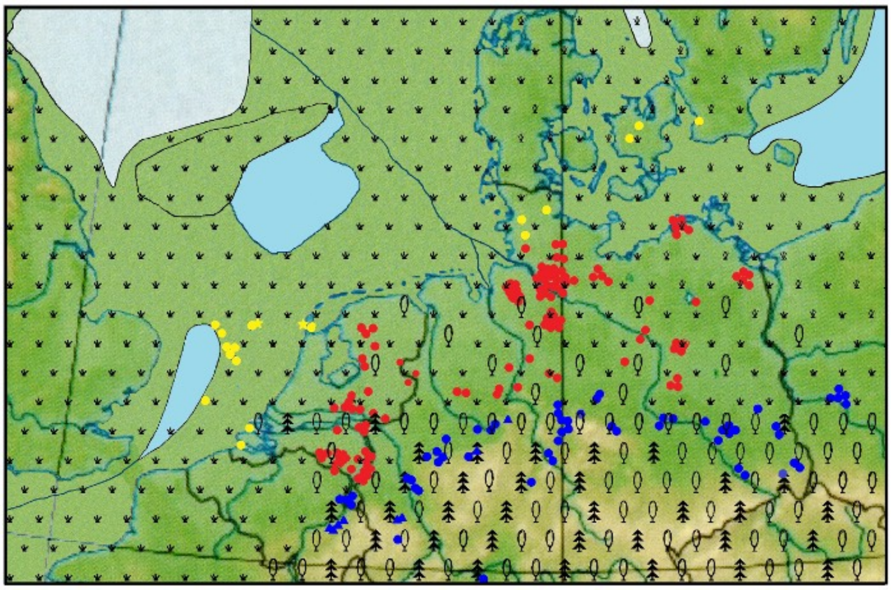


Figure 10.17: Nomads (in this example Ahrensburg groups) came together in macrobands that made large camps (red dots) in the spring and fall. In the summer the herds and the Moderns spread out further north in small groups (yellow) and in the winter the nomads spread out further south in small family groups (blue). Figure by Govert van Noort.

Physically impossible
The sapiens-hypothesis planted the idea in our mind that the Neanderthals were too stupid to adapt to the Modern lifestyle. But in reality Neanderthals could not live like Moderns because of their high metabolism. It was physically impossible for them to live like nomads, *figure 10.17* helps us understand this. It shows the situation of the reindeer-hunters in Northwest-Europe at the end of the MIS 2 glacial. The nomads lived in macrobands (large groups) at moments when they could exploit large reindeer-herds. This happened in the spring because the reindeer form large groups when they give birth, with many calves and only a few wolves in one area most calves survive. Macrobands could also form in the fall when the reindeer mated. But during the summer and winter the reindeer spread-out in smaller groups over their feeding-grounds, so during the summer and winter the hunter-gatherers had to split up into microbands (small family groups). The MIS 3 Aurignacian hunted other herbivores, but they also survived the winters in microbands of about a dozen individuals. These microbands were so small because there was only enough food within walking distance from the campsite, for about a dozen people to survive the season. But 12 Neanderthals ate the same amount of food as 48 Moderns. So if a Neanderthal microband spent the season in one camp, the group quickly exhausted all food sources close to the camp and starved before the end of the season. Neanderthal groups had to stay mobile (chapter 9), it was physically impossible for them to live as nomads.

Neanderthals were not too stupid to adapt, we know this for certain because we know that a few Neanderthals lived as isolated individuals together with the Moderns. One single Neanderthal used the same calories as three Moderns so one Neanderthal plus nine Moderns could survive the season in one microband. It was very profitable for the Moderns to have such a powerful hunter in their group, who also knew all the qualities of every plant and understood the behavior of every animal. But not many Neanderthals wanted to live amongst the Moderns, they were probably disgusted by the idea of living in a stuffy tent and sleeping in a bed full of parasites in a campsite surrounded by stinking human excrements. The few Neanderthals that did choose to live amongst the nomads also crossbred and this explains why we still have Neanderthal-DNA. The crossbred-children grew up getting the same small shares as the other children in the camp. So crossbreds with a genetic disposition for fast growth, strong muscles and a Neanderthal-type skeleton became malnourished, got sick and died. This explains why the Moderns in the Peștera cu Oase (a cave in Romania, 40 ka) who had 6-9% Neanderthal-DNA, did not have 6-9% Neanderthal features in their skeleton. Their fossils look completely Modern because only the economized crossbreds survived.

Deep graves
The sapiens-hypothesis claims that growing brainpower led to the birth of art, culture, religion and civilization and suggests our brain will continue to evolve. This strengthened our self-respect and gave us an optimistic future-perspective. I do not want to take this away, but I do want to stand up for our Neanderthal ancestors. It is certainly true that archeologists do not find many material

objects that we can call Neanderthal-art or cultural symbols. But that is inherent to their mobile lifestyle. You cannot expect to find Neanderthal-city-plazas or Neanderthal-temples for the simple reason that hominids without homes do not build cities. Even our Modern burial-practices are clearly linked to the fact that we live in homes. When somebody dies in a nomadic camp, his friends and relatives are obviously stuck with the corpse. They cannot just leave it lying around until the group leaves the camp and builds their huts elsewhere. First of all because it is not an attractive sight to see your best friend rotting away, but also because it smells and the bacteria and scavengers pose a risk to everyone in the camp. The MIS 5 nomads were hunter-gatherers and all hunters know what dogs do if they cannot eat a prey at once. Dogs bury the rest to reduce the smell and keep scavengers away. So the nomads did the same with their dead: they buried them to reduce the smell and keep scavengers away. The deeper the grave the better it worked, a two meter deep grave can keep the stench and also the scavengers away forever.

When a Neanderthal died the group could simply walk away. But they didn't: the archeological record proves they cared for the dead. The corpses were often laid to rest on a side with bent knees and some even got simple grave-gifts. So Neanderthals had the same emotions we have: they also hoped or believed that the spirit of the dead person would rise in the after-life. But they did not dig a deep grave. Researchers who didn't understand the Neanderthal lifestyle believed they could not protect their dead against scavengers because they were too primitive to dig deep holes. But the life of every Neanderthal depended on his freedom of movement, the hunters had to follow the herds so from the Neanderthal point of view it was incredibly cruel to rob a dead friend of his freedom of movement. If you buried a man two meters under the ground, then how could his spirit rise and walk free again under the open skies? I have no doubt that Neanderthals knew that the exposed bodies were eaten but they did not see this as disrespectful: eating and being eaten was just the circle of life. When Neanderthals killed and ate herbivores they did this with respect, so there was no reason why being eaten by scavengers (or even being cannibalized) should be disrespectful to the dead. The shallow graves are not primitive or inferior in any other way, these graves instead beautifully reflect the mobile lifestyle and the love for the freedom of movement.

We are far less threatened by the thought of loosing our freedom of movement, because we are used to locking ourselves up in our homes. We locked our children up to protect them against the cold and against the dangers of the night. We feel safe in our homes and believe that we must keep the dead just as safe by locking them inside a deep grave. So deep graves do not signal better skills or better brains, this only shows that the living had homes.

Complex art

I explained that homes made it possible to keep objects forever and that the social status of a person with a home therefor became determined by what he owned. The nomadic Moderns did not need to carry all their stuff every day from shelter to shelter so they began to accumulate property. Of course nomads still had to carry everything several times per year when they moved camp. But when they moved to a new camp they were not on a hunting trip, so in contrast to mobile hunter-gatherers they did not have to travel fast and light. This means that it did not really matter if they were slowed down by all the stuff they carried. If you can carry everything with you, it makes sense to invest in objects. So you begin to trade in precious objects and you begin to invest time in creating material culture. When you have a home it makes sense to make complex art. The Aurignacian statuette from Hohlenstein-Stadel known as the lion-man is a clear example of a time-consuming work of art: it took the artist Wolf Hein 400 hours to make a copy of the lion-man. For Neanderthals it made no sense at all to spend so much time on making a statuette. Even if a Neanderthal spent just one hour on a statuette, what would be the use? He knew that his group had to stay mobile and had to travel light, to be faster than the herds. He knew that carrying just one extra kilogram could be the difference between catching a prey or being too slow and starving (chapter 9). So if a Neanderthal made a statuette, he knew that he would leave it lying amidst the rubbish on the next morning when they left the shelter. So the hour he had spent was a complete waste of time. For Neanderthals it was far more useful to spend their time and energy on talking about the hunt or on singing, dancing and other social activities.

This explains why complex material culture, including complex art developed within the short timespan of tens of thousands of years. At the moment when the nomadic lifestyle is introduced in Europe, we see a 'creative explosion': sculptures and paintings suddenly appear. Scholars who did not understand the link between homes and complex art were struck by the extreme contrast between the millions of years it took to develop the hominid brain and the short time it took to develop complex art. Stringer and Gamble (In search of the Neanderthals,1993) called this the onset of symbolic behavior and believed this marked the actual moment when the evolution of the brain passed a threshold, the moment when we became the Homo sapiens. But there are two kinds of symbolic behavior: materialistic symbolism leads to material objects (like temples and paintings) and transient symbolic behavior (like singing and dancing) does not necessarily leave any material traces. Archeologists work with material objects so of course they tend to focus on materialistic symbolism and especially complex forms which the general public appreciates. But the Neanderthals did have transient symbolism, we already saw they had very specific ways of caring for the dead. We even have indications that transient symbolism is far older.

Transient art

In the colonial era scholars believed that art began in Egypt Greece and Rome, was improved by Christianity and culminated into our superior Western culture. In this theory there is no place for prehistoric paintings so the discovery of Altamira in 1879 met with anger and denial. Today many supporters of the sapiens-hypothesis still react with anger and denial to any claims that extinct hominids used symbols. Stringer and Gamble argued that symbolic behavior required memory and periodic renewal through repeated ritual. Symbolism had to show continuity, repetition and standardization and once this was established, it could not simply be dropped and forgotten. But the supposed female statuette from Berekhat-Ram (Israel, Goren-Inbar 1981) is a one-off, we do not know any comparable statuettes of the same age. So if Stringer and Gamble are right this object cannot be a symbol; it has to be just a lava-cobble that incidentally developed this form when Acheulean hominids used as a hammer. The engravings on shells made by the Homo erectus between 430 and 540 ka (Joordens et al: Homo erectus at Trinil on Java used shells for tool production and engraving. doi:10.1038/nature13962) present the same problem, we have not found engraved shells all over Indonesia so the scratches have to be incidental. The engravings made on bones in Bilzingsleben (400 ka, i.e. *figure 10.18*) can for the same reason not be true symbols. The pattern of lines that Neanderthals painted in the La Pasiega cave in Spain (*figure 10.19*) is somewhat similar, but these lines are separated from the engravings by a quarter of a million years without such forms. So if Stringer and Gamble are right even these lines must be incidental patterns.

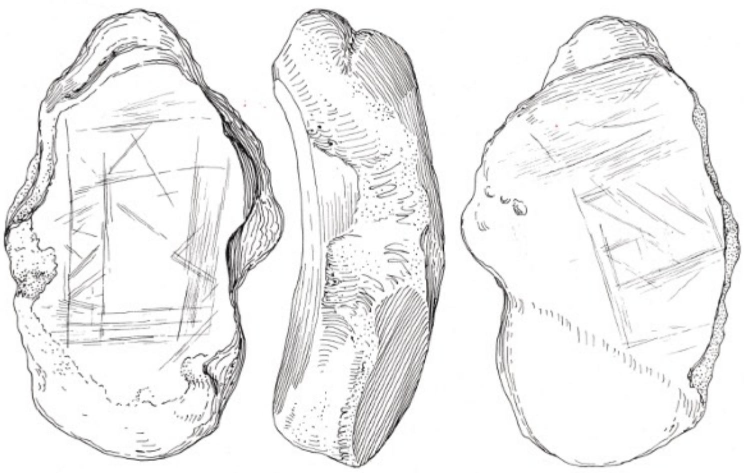


Figure 10.18: Engravings on a Elephas antiquus bone from Bilzingsleben. From D. Mania: Auf den spuren des Urmenschen. 1990.

Figure 10.19: Similar rectangular symbols painted on a cave-wall at La Pasiega. Photo by Pedro Saura.

But if we accept that hominids without homes told stories, sang and danced we come to a different conclusion. The line-patterns may well have been a part of some transient behavior; extinct hominids may have formed similar patterns when they danced or formed patterns by placing sticks on the floor. I do not want to speculate why they did this, but believe that these exact and deliberate transient acts existed and provided the continuity and repetition needed to sustain the memory of the symbolic meaning of the line-patterns. The transient acts left no traces other than the sporadic examples where the lines were preserved; scratched in bone or painted on a cave wall. Researchers that do accept the line-patterns as symbols, often tend to see them as the first steps towards ornamental art. The lines Neanderthals painted in la Pasiega would then be simple primitive fore-runners of the cave-art in Altamira or Cosquer. This would prove that Neanderthals were incapable of making complex art and only reached the intellectual level of a Modern-toddler. The reaction ‘wow, we did not know that Neanderthals were able to make this’ reveals that we still want to classify Neanderthals as primitive simple-minded creatures. But we are not dealing with a primitive attempt to make ornamental art, the line-patterns are merely the by-products (or waste-products) of transient symbolism.

The same goes for the disputed figurine from Berekhat-Ram: this is no ornamental art so it is absolutely wrong to interpret this as a primitive fore-runner of i.e. the Willendorf-Venus. The artist that made the Willendorf-Venus spent weeks sculpting his figurine because he made it for keeps. But the Berekhat-Ram figurine was never meant to be a mantle-piece, it was never meant to be worshipped on a house-shrine. It only took minutes to make and the person who made it did not even care to carry it to his next shelter: he simply discarded it. In contrast to the line patterns, old figurines do not necessarily need to be part of a repetitive tradition, because figurative forms can be inspired by what the artist saw. In this case the maker of the figurine may have been inspired by the model of the lava-cobble. We can see ‘the man in the moon’ or ‘sheep’ in the clouds because our brains recognize form-patterns, but Homo sapiens is not the only creature that can recognize forms. Dogs for instance show a different reaction to a sculpture of a dog than to a garden-gnome, so dogs also recognize patterns. Acheulean-man at Berekhat-Ram undoubtedly had the same ability: he recognized the female form in a lava-cobble and decided to accentuate this form with a few hammer-strikes. We do not know if the maker of the figurine looked at the form with awe or accentuated the form as a joke. But he certainly talked about it with his friends: the value of this female symbol was in the act of making it, showing it and talking about it. This makes the object a discarded by-product of transient symbolism.

Epilogue

Whilst our ancestors made classic Acheulean handaxes in France, groups at Gulpen were making bipolar tools. I had to show what role bipolar flaking played in Mode-I to explain this and also how and why handaxes were developed and disappeared. I ended my paper showing that we are not so different from our ancestors; they also had clever brains. Our assumed superiority is merely economic: we eat less and we lost our natural birth-control mechanism when we began to live in homes. So if Linnaeus lived today he would probably set our species apart from the Neanderthals and Denisovans by calling us Homo domesticus. We breed so fast that it hardly matters what new food or energy technologies we develop, because the population of the world after each new step quickly grows to a new point-of-exhaustion. You may perhaps believe there is a message in this finding, the message that mankind has to find a fair and socially acceptable way of birth-control. But please do not try to read any messages into my paper for I am not a preacher. To the contrary: I am convinced of every word I wrote but I am also well-aware that Bordes was just as convinced about *figure 1.3*. The great professor was proven wrong, so why should I fare any better? In just a few years, everything I believe may also turn out be wrong.

My hope and aspiration is that you read my paper carefully and with an open mind. But instead of accepting my ideas, please discuss them with your friends and form your own conclusions. Don’t be a follower, become a thinker.