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Cueva Negra del Estrecho del Río Quípar (Murcia, Spain): A late Early Pleistocene hominin site with an "*Acheulo-Levalloiso-Mousteroid*" Palaeolithic assemblage

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ABSTRACT

At Cueva Negra del Estrecho del Río Quípar biostratigraphy and palaeomagnetism indicate a time in the late Early Pleistocene (i.e. somewhat before the Matuyama-Brunhes boundary of 780,000 a, 0.78 Ma), for the entire 5 m thick sedimentary fill excavated in the rock-shelter, from which there are hominin teeth (cf. *Homo heidelbergensis*), a rich palaeontological and palaeopalynological record demonstrating warm moist environmental conditions (possibly MIS 21), a fundamentally homogeneous artifact assemblage throughout the sedimentary deposit, and evidence of fire at over 4 m depth. A brief introduction to the site and the assemblage is offered. Palaeolithic artifacts were produced by *three* different reduction sequences, because: (a) an "*Acheulian*" hand-axe was flaked bifacially on a flat limestone cobble; (b) several excavated chert flakes had been struck off small cores by recurrent flaking, with one flake showing a facetted striking platform, whilst two surface finds of small discoidal cores bear the broad central concave scar that in a "*Levalloisian*" prepared-core reduction sequence would correspond to centripetal removal of the final flake; and (c) abundant small artifacts (25–60 mm), mainly of chert, reflect expedient removal of small flakes or fragments from cores, by both unipolar and bipolar reduction techniques, including many keeled pieces that could be residual cores which have notches, slender spurs or beaks ("*becs*"), or a planoconvex ("slug"-like or "*limace*") shape, all of which may be remnants of cores subjected to bipolar knapping, in addition to very small pointed and "awl"-like pieces, and several fragments and flakes with steep abrupt ("Mousteroid") edge-retouch, and abundant knapping spalls and waste. Although the site had been interpreted conservatively in earlier publications as *early Middle* Pleistocene, recent palaeomagnetic findings show that the entire sedimentary fill corresponds to the *late Early* Pleistocene, somewhat over 780,000 a (0.78 Ma), an age which is acceptable from the standpoint of the biostratigraphical data. Among the aims of this paper are: (1) a consideration of the Palaeolithic assemblage in relation to local availability of raw materials of appropriate shapes and petrology for knapping in a palaeoenvironmental context far different from that of today; (2) consideration of the implications for human cognitive and technological evolution in the European late Early Pleistocene; and

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(3) a proposal that those considerations highlight practical, methodological, and theoretical drawbacks to the classical European interpretation of earlier Palaeolithic chronologies from a perspective of typological sequences.

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1. Location and origin of Cueva Negra

Cueva Negra (Black Cave) is a large, north-facing, rock-shelter at 39° 02′ 5″ N, 1° 48′ 10″ W (Lambert coordinates 36-38385, 24-75820). The surface of its sedimentary fill lies at 740 m above sea level. The cave is in a cliff of Upper Miocene biocalcarenite 40 m above the right bank of the R. Quípar where it flows northwards from a small gorge ("*estrecho*") below the hamlet of La Encarnación, near Caravaca de la Cruz in northwestern Murcia (Fig. 1). The river follows the Quípar Fault within the major Cadiz-Crevillente Fault system that crosses southern Spain from the Atlantic to the Mediterranean. The Murcian region of southeastern Spain today enjoys a sub-humid to semi-arid climate and a thermomediterranean flora with some supramediterranean taxa.

The most recent account of Cueva Negra in English is Walker et al. (2006). It superseded earlier publications that were inaccurate in several respects. It, in turn, has now become out-of-date. This article addresses some of its flaws as well as presenting important new information. A very brief summary of the significance of the site is in order here. Findings from the 5 m depth of sediment in the cave show that its surroundings afforded noteworthy biodiversity, including a flora and fauna typical of a former gallery woodland beside rivers and lakes. As well as abundant pollen of the holm oak and pines that are widespread nowadays, there also were willow, elm, ash, beech, hazel, maple, rushes, and deciduous oak (Carrión et al., 2003, 2005) that offered acorns required by jays (*Garrulus*) whose remains, together with those of waterfowl (*Tadorna*, *Anas*, *Netta*, *Aythya*) and waders (*Calidris*, *Tringa*), mute testimony to erstwhile lakes and swamps, are among over 60 avian species identified (Walker et al., 1998, 1999, 2004). In that vanished landscape, different ecological habitat zones or biotopes intersected: lakes and rivers with temperate woodland; open mixed woodland; open grassland and moorland; and the crags and steep mountainsides that today offer an open, dry landscape of scrub interspersed with holm oak and pines.

Geological and geomorphological vestiges of former Pleistocene lakes in the Quípar valley are widespread upstream and downstream from the cave. Tectonic activity doubtless contributed to their drainage; and activity continues: in 2011 an earthquake severely damaged the large Murcian city of Lorca, lying on the Guadalentín Fault 60 km south of the cave on the Quípar Fault and parallel to it within the Cadiz-Crevillente system. Unsurprisingly, the geology around Cueva Negra is complicated. Today's valley floors and lower hillsides were still under the Tethys Sea in the Upper Miocene. As the Miocene gave way (ca. 5 Ma) to the Pliocene widespread uplift commenced, and in the Upper Pliocene the present continental relief began to be established. It has culminated in the valley floor at Cueva Negra lying at 700 m above sea level today, dominated by mountains mainly of Jurassic limestone rising up to 1500 m, and even to over 2000 m near the headwaters of the

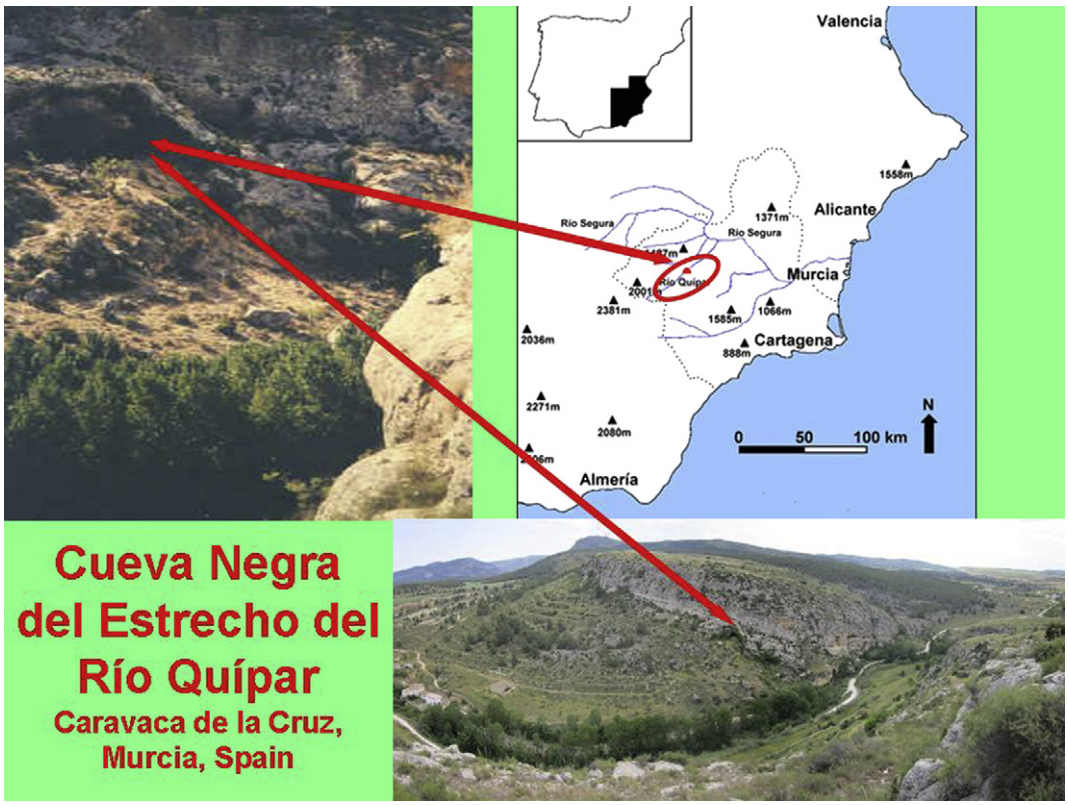

Fig. 1. Cueva Negra del Estrecho del Río Quípar: Location and general views.

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valley. Uplift caused massive continental erosion during the Upper Pliocene and Early Pleistocene, which has relevance for Palaeolithic procurement strategies (see below). Cueva Negra developed as a trapezoidal cavity, formed by endokarst phreatic solution of rectilinear fissures and horizontal fracture planes in an Upper Miocene (Tortonian, 11–7.5 Ma) marine sedimentary biocalcarenite covered by Lower Pliocene lagoons, swamps and lakes, fed by rivers behind an emerging new shoreline. Cave-wall scalloping and other karst features are clearly visible at Cueva Negra and have been acknowledged by several visiting geologists and geomorphologists.

Differential uplift of the left and right flanks of the Quípar Fault with vertical shearing, and consequent erosion, probably exposed the rock-shelter. On the same right flank there are at least two more trapezoidal rock-shelters (including the Cueva del Rey Moro or Moorish King's Cave). These demonstrate the predominance of endokarst structures on this side of the valley. By contrast, on the left flank, fifteen ellipsoidal rock-shelters opposite Cueva Negra resemble *tafoni*, and further behind and above them lie similar ones, far beyond, high on hillsides west of the river. There is no doubt that activity of the Quípar Fault during the Early and Middle Pleistocene has greatly complicated the geomorphology of the area around Cueva Negra, together with a rate of uplift in and around the upper Quípar valley that has protected the area around the cave from encroachment by the Quípar downstream, and thus from further ensuing erosion, attributable to fluviatile rejuvenation of the valley landscape in consequence. Indeed, following Early and early Middle Pleistocene uplift of the left-hand flank of the valley, which probably deflected the course of the river, uplift of the right-hand flank has been responsible for saving the Cueva Negra sedimentary fill from later fluviatile erosion. Whereas today the R. Quípar flows 40 m below Cueva Negra, the cave undoubtedly lay close to the water-table when sediment was accumulating in it. It is likely that there was a lake less than a kilometre downstream from the cave, which perhaps formed in relation to neotectonic changes involving the gradual suppression of continued northward flow of the river to join the R. Argos near Caravaca and causing it to swing eastwards towards Cehegín instead.

2. Age of Cueva Negra sediment

Cursory archaeological exploration was undertaken in 1981 (Martínez Andreu et al., 1989). When systematic excavation commenced in 1990, Cueva Negra was thought likely to be an early Late (i.e. early "Upper") Pleistocene site within 130,000–40,000 a (0.13–0.04 Ma). Subsequently, palaeontological and multi-grain optical sediment luminescence indicated a Middle Pleistocene age ca. 300,000–500,000 a (0.3–0.5 Ma) (Walker et al., 2006); single-grain analysis is in progress to try to improve dating. Nevertheless, biostratigraphical considerations of the abundant extinct arvicolid rodent teeth excavated in all lithostratigraphical units indicate contemporaneity with the Atapuerca Gran Dolina levels TD4-TD8 which span the transition from the late Early (i.e. late "Lower") to early Middle Pleistocene ca, 800,000–750,000 a (0.8–0.75 Ma). Palaeomagnetic findings show reverse polarity of minerals both from the entire 5-m depth of sediment inside Cueva Negra, and also from a further 3 m deeper down that are exposed outside in the eroded escarpment below the cave mouth (Scott and Gibert, 2009): therefore the entire sedimentary fill predates the 780,000 a (0.78 Ma) Matuyama-Brunhes boundary. Because the Cueva Negra faunal range lacks species found at older Early Pleistocene Spanish sites, its sediment almost certainly was laid down *after* the 1,070,000–990,000 a (1.07–0.99 Ma) Jaramillo episode of normal polarity that briefly interrupted the long Matuyama period of reverse polarity (2,588,000–780,000 a; 2.588–0.78 Ma). The palaeomagnetic evidence refutes an earlier speculation (Walker et al., 2006) that the rodents could be anachronistic survivors, or faunal atavisms, in a mid-Middle Pleistocene refugium around Cueva Negra. Excavated mammalian taxa include *Mimomys savini*, *Pliomys episcopalis*, *Microtus [Allophaiomys/Euphaiomys]* sp. cf. *chalinei*, *Microtus [Allophaiomys/Arvicola]* sp. cf. *deucalion*, *Microtus [Terrícola/Pitymys/Iberomys] huescarensis huescarensis*, *Microtus [Iberomys] brecciensis brecciensis*, *Microtus [Stenocranius] gregaloides, Prolagus calpensis*, *Megaloceros/Megaceroides* sp. cf. *Megaloceros savini*?, *Dama* sp. cf. *nestii vallonnetensis*?, *Equus* sp. cf. *altidens*? *sussenbornensis*?, *Stephanorhinus* sp. cf. *etruscus*, *Bison* sp. cf. *priscus*, *Macaca* sp. cf. *sylvanus*, Elephantidae *[Mammuthus meridionalis?], Ursus* sp., Hyaenidae gen. et sp. indet., Cervidae gen. et sp. indet., *Capra* sp. cf. *ibex*?, *Sus scropha*, *Canis* sp. cf. *mosbachensis*, *Felis [Lynx?]* cf. *lynx*. (Mammalian palaeontologists Drs. Antonio Ruiz Bustos of Granada University and Jan van der Made of the CSIC Museo de Ciencias Naturales at Madrid are thanked for their assistance; palaeontological references in earlier publications are superseded). Non-modern human teeth show morphological affinities with Neanderthal teeth and can be regarded chronologically-speaking as pre-Neanderthal (i.e. *Homo heidelbergensis*); in this context, it is worth remarking that *Homo antecessor* from the Atapuerca Gran Dolina ca. 780,000 a (0.78 Ma) is now considered to be a possible early forebear of the *H. heidelbergensis – Homo neanderthalensis* lineage (Dennell et al., 2011). Palaeopalynological findings indicating a warm, moist environment (Carrión et al., 2003, 2005) were published when clear evidence still was lacking that the sedimentary fill predated the early Late Pleistocene, but in view of the subsequent biostratigraphical and palaeomagnetic data they now can be seen as pointing to a late Early Pleistocene interglacial period, within 990,000–780,000 a (0.99–0.78 Ma), perhaps MIS (OIS) 21, of particular warmth – even in today's warm postglacial climate, hard winter frosts are very common at north-facing Cueva Negra at 740 m above sea level.

3. Sedimentary sequence

Six lithostratigraphical units (I–VI) have been designated (Walker et al., 2006). Unit I consists of superficial, loose, disturbed, grey soil containing both Holocene and Pleistocene artifacts, below which heavily-indurated, pale-beige, Pleistocene sediment characterizes the deeper units mainly. This sediment was due to infilling at the cave mouth from outside. Designations II-VI (Fig. 2) reflect prudent excavation precautions, taken when vughs, calcareous marls or crusts, or fine gravel were encountered, though they do not necessarily imply significant lithological separation (especially between III–IV–V).

Unit II is a 1.5–1.8 m deep bed of heavily-indurated sediment that is incompletely consolidated litharenite. Its particulate content is determined more by calcium carbonate and silica in proportions of between 4:1 and 3:1, thus the sediment is not a cemented quartz sand. It has a laminated and cross-bedded structure of near-horizontally bedded fine bands or lenses of silt- and sand-size particles with few coarser components. Here, as indeed in much of the Pleistocene sequence below unit II, sedimentary interfaces are hard to distinguish, and often ephemeral, owing to uniformity of sedimentological components, weak differences between lithofacies, and lateral discontinuities of intercalated bands and lenses. A noteworthy exception separates units II and III (Walker et al., 2006), where unit III ends above in the eroded surface of a poorly-developed alluvial soil that has a light-grey colour implying reducing conditions, maybe owing to encroachment of a nearby swamp causing ponding, and also perhaps incipient organic development. This surface dips weakly south-eastwards. It is sealed by unit II and was exposed continuously over 12 m^2 with no trace of vertical sedimentary disturbance (*pace* insinuation by

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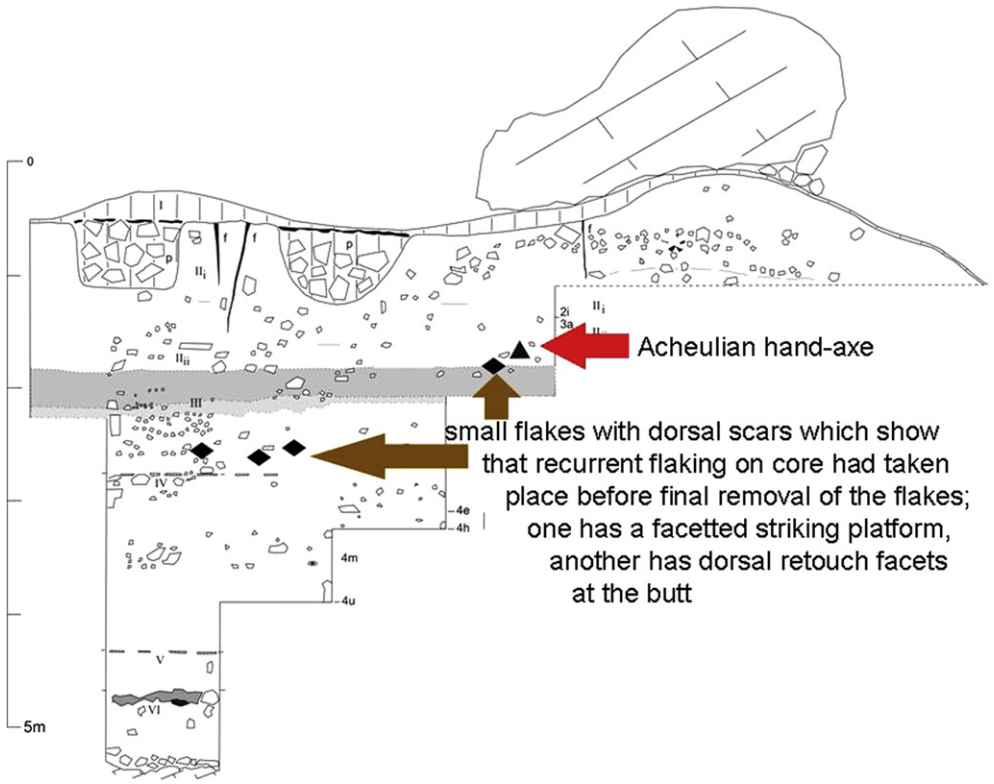

Fig. 2. Vertical section showing the situations of the Acheulian hand-axe and some chert flakes struck by repetitive flaking.

Jiménez-Arenas et al., 2011). This has significance for interpreting the Palaeolithic sequence (see below).

Petrological and mineralogical components of units III–VI are quite similar throughout, apart from some variation in proportions (coarser particles become increasingly scarce in the deepest units). They comprise fragments derived both from the Miocene biocalcarenite cave roof or wall, as well as allochthonous components probably eroded from a sandstone outcrop 2 km upstream that contains the same minerals as the exotic ones identified in the cave sediment which comprise fine silt-sized particles of plagioclase, polycrystalline quartz aggregates, and isolated quartz crystals that under the polarized light of the petrological microscope have different optical characteristics from quartz in the biocalcarenite cave wall (Walker et al., 2006). The sediment also includes numerous clasts eroded from the cave walls and roof, ranging from abundant tiny fragments of Miocene sea-shells and coral, to angular stones, slabs, and very large blocks of calcarenite. Pride of place is given by Scott and Gibert (2009) to erosion of the cave walls and surrounding hillside as having played the major part in determining the composition of the sedimentary fill. Nevertheless, most geologists, geochemists, geomorphologists and geoarchaeologists who have inspected the sediments consider that their near-horizontal stratification, together with the absence of either lenses of sorted rolled gravels (river cobbles) or graded angular clasts (piedmont scree), point to gradual infilling at the cave mouth, probably by intermittent flooding under conditions of very low transport energy. Sedimentation seems to have ocurred under settled conditions away from turbulent currents. The majority opinion is expressed in Walker et al., 2006; it is shared by Dr. D. Angelucci of Trento University, the results of whose sedimentary micromorphological analyses are awaited.

Flooding of the cave might have occurred were the water level to have risen sporadically in a swamp, beside the cave, in a backwater behind a bar or sand-bank of the river when its flood-plain was level with the cave mouth (before tectonic activity led to the 40 m vertical displacement between cave and river today). Some loess-size particles in the cave sediment showing microscopical pitting due to weathering could well have been blown into swampy sediment (so-called "*Diluvialloess*") that later was washed into the rock-shelter. Very small rolled gravel (no bigger than a grape or orange pip) was occasionally washed into the cave and incorporated into the surfaces of underlying sediment (particularly where these had become slightly eroded or softened) and calcretions sometimes formed during or following such episodes. There are almost no rolled pebbles between 5 and 50 mm in size. Rounded cobbles of larger size were brought to the site by Palaeolithic knappers who usually split them open, which is how they appear at excavation. The biocalcarenite walls of the rock-shelter do not contain rounded pebbles of whatever size. The sharp edges of stone artifacts and hundreds of razor-sharp knapping spalls (<2 mm) have neither been rolled nor abraded in a river bed. The cave must surely have been dry for several months of the year when Palaeolithic activity took place.

Excavation in metre-square C2d in 2011 found that unit VI begins as a 50 mm layer of grey sediment with small lenses of darker sediment; it shows signs of thermal alteration and contained heat-shattered chert and white calcined bone (Fig. 3). Underlying layers are seen in the vertical section of C2d exposed in the adjacent metre-square C2a test-pit that had been excavated to bed-rock in 2005, namely a 10 mm layer of very dark sediment lying over 20 mm of reddish sediment, separated by 0.45 m of pale sand-size sediment from underlying bed-rock. However, both the grey sediment and the two underlying thin layers seem to have extended hardly at all into square C2a where only irregular lenses of dark sediment were found in 2005; perhaps the sediments in this most southeastern part of the excavation area were subject to erosion by percolating water dropping down here through a vertical fissure in the cave roof, as it does today sometimes.

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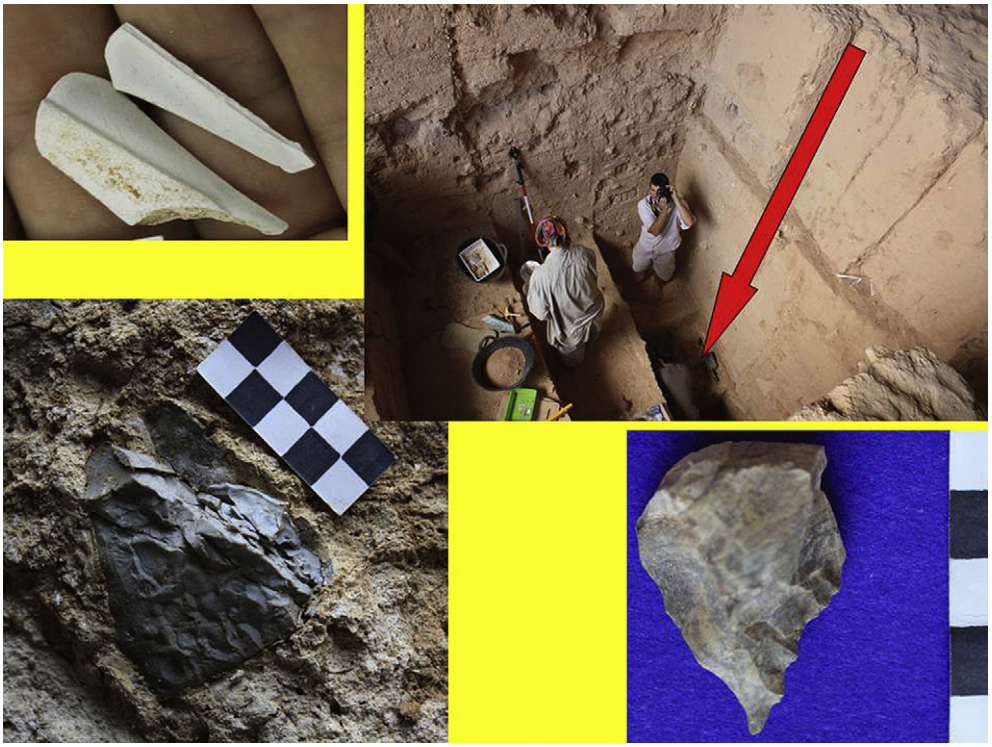

Fig. 3. Excavated Pleistocene sediments, showing location of fossilized ash layer and calcined bone and heat-shattered chert from it, and a pointed chert artifact with steep retouch from its surface.

Exploration of unit VI in adjacent squares is a priority for future campaigns.

4. The Palaeolithic assemblage

During the first decade (1990–2000) of annual systematic excavation campaigns at Cueva Negra, the Palaeolithic elements recovered allowed no assignation beyond a vaguely "*Mousteroid*" catch-all category that sat awkwardly with its presumed late Middle-early Late Pleistocene age. Now that we know the cave to be much older, the assemblage can be seen to show some most unexpected and very intriguing Palaeolithic aspects indeed, which could hardly have been envisaged from a standpoint of time-honoured interpretations of Palaeolithic sequences in western Eurasia.

This account considers only finds excavated between 1990 and 2011 in units II–VI with wet-sieving of excavated sediment down to 2 mm. It excludes several hundred items that were found out of context, whether in the disturbed superficial sediment of unit I or from the cursory 1981 exploration carried out without wet-sieving and with unsatisfactory stratigraphical control. By limiting the account in this way, it is possible to make interesting comparisons between the distributions of lithic finds both as regards rock-type and, most particularly, in terms of the different units. The step-wise form of the excavation means that, because the volumes of sediment removed from the upper units (II, III) exceed those from deeper ones (IV, V, VI) (Fig. 4 top), it is appropriate to represent the numbers of lithic elements excavated in each unit in terms of their density, i.e. number per cubic metre per unit (Fig. 4 bottom), as well as the total numbers of different lithic elements excavated in each of the units II–VI (Fig. 5).

An important consequence is seen at once from this presentation: it is that the highest density corresponds to unit III, in contrast to units II and IV which show low densities (densities are not meaningful for units V and VI that have only been reached in two of the 25 metre-squares under excavation, and numerous minute heat-shattered splinters in unit VI were not reduced by knapping anyway). The relation between the low density in unit II and the high density in unit III is the *opposite* of what would be expected if the bulk of the whole assemblage at the site was largely due to utilization of the cave *after* the top of unit III had undergone erosion (notwithstanding observations from experimental archaeology that downward migration of lithic elements may take place in cave sediments). Moreover, the typological breakdown of lithic elements excavated in units II–VI points far more to similarity among units than to discontinuity between any of them, least of all between II, III and IV (Fig. 5). In short, throughout the sequence there is a *consistent* Palaeolithic assemblage (*pace* Jiménez-Arenas et al., 2011).

In classically formal terms, the assemblage can be called "*Acheulo-Levalloiso-Mousteroid*" without those descriptors signifying any extrinsic "cultural influences" or "quasi-evolutionary trajectories" whatsoever. There is a bifacially-flaked ("*Acheulian*") hand-axe (Fig. 6). There is also a small tool assemblage of many chert and several fine-grained limestone and quartzite pieces (Fig. 7), some of which have steep, abrupt marginal ("*Mousteroid*") edge-retouch (Figs. 8 and 9). A few flakes were removed from cores by repetitive ("*Levalloisian*") centripetal flaking (Figs. 12 and 13). A small ("*Levalloisian*") discoidal core of limestone (Fig. 11) was collected beside the cave mouth and another of chert was collected 800 m to its east at what was very likely a "quarry" site. Both bear the characteristic central concave scar that corresponds to the convex ventral bulb of the last flake to have been struck from it (the so-called "*éclat préférentiel*") by a repetitive centripetal core-reduction sequence. The "quarry" site is an Upper Miocene (Tortonian) in-shore conglomerate outcrop incorporating chert, limestone, quartzite, and quartz nodules that had eroded out of the Jurassic rocks of nearby cliffs; retouched artifacts collected on the surface of the site resemble some excavated at the cave.

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Volumes of Pleistocene sediment excavated, by lithostratigraphical unit	
unit	m^3
II	24.00
III	**8.40**
IV	9.10
V	**1.20**
VI	**0.55**

Approx. average number of lithic elements per m^3 excavated, by lithostratigraphical unit	
II	65
III	**325**
IV	75
V	**135**
VI	**300***
*High value due to heat-shattering of chert into very many minute splinters	

Fig. 4. Top: Volumes of Pleistocene sediment excavated, by lithostratigraphical unit; Bottom: Approximate average number of lithic elements per m^3 excavated, by lithostratigraphical unit.

Most of the artifacts excavated at Cueva Negra are "expedient", frequently of "informal" shape, implying "opportunistic" or "eclectic" technological behaviour. Secondary retouch is seen as often on fragments, as on struck flakes defined by striking platforms and bulbs of percussion. That is hardly surprising, given both that at >780,000 a (>0.78 Ma) secant-plane control was in its infancy worldwide, and also that the raw materials to hand were mainly frangible tabular chert nodules. These were often blocks or

	Excavated lithic finds by lithostratigraphical unit L = large (> 60 mm approx.), S = small (< 60 mm approx.)	II	III	IV	V	VI
L	bifacial hand-axe	1				
L	chopping tool	1	**1**			
L	hammerstone, manuport	15	**18**	1	0	0
L	core, primary base	2	**17**	7	0	0
S	continuous edge retouch ("side-scraper")	10	**47**	23	3	1
S	stubby or keeled, flake-scars at one end ("end-scraper")	3	**9**	2	0	20
S	flake-scars at opposing ends and along edges of planoconvex keeled piece ("limace")	0	**2**	0	0	0
S	denticulate	1	**1**	3	0	0
S	struck flake with notch or discontinuous irregular retouch	19	**54**	26	2	6
S	spurred keeled piece ("bec, microperforator")	0	**3**	2	2	2
S	pointed piece	1	**4**	1	0	0
S	recurrent centripetally-struck flake		**3**	3		
S	unretouched struck flake (striking platform, bulb of percussion)	94	**303**	93	6	17
S	fragments, knapping waste or spalls	1450	**2265**	525	146	117

Fig. 5. Excavated lithic finds by lithostratigraphical unit.

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Fig. 6. Bifacial Acheulian hand-axe fashioned on a flat limestone cobble.

slabs of sub-parallelepiped shape. They might be described as *fissural*[2] because hammering on them often fails either to elicit conchoidal fractures or produce feathered flakes with convex bulbs of percussion. If hammering does not simply shatter blocks into very small chips and fragments, it may split them open along fissural flat planes, or fissures, defined by the internal structure and impurities of the chert, and produce flattish laminar fragments of sub-rectangular shape, suitable for using as tools. The nodules were derived in the first place by erosion from Jurassic rocks exposed as cliffs and crags on mountainsides nearby, after which they repeatedly underwent Miocene, Pliocene and Early Pleistocene rolling and battering, during processes of first marine, and later on, continental erosion and re-deposition in conglomerates or gravels.

Several small retouched artifacts seem nonetheless to fall into overlapping groups, in contrast to some other Spanish Early Pleistocene assemblages that have been called "*Oldowan*" in recognition of perceived similarity to African ones (see below). The term is inappropriate at Cueva Negra because, unlike typically Oldowan artifacts in Africa, nearly all those excavated at Cueva Negra are remarkably small, rarely more than 50 or 60 mm across, and sometimes less than 30 mm (Figs. 9, 10 and 15). One sizeable group comprises flakes and flattish or laminar rectangular fragments, edges of which bear steep abrupt ("*Mousteroid*") edge-retouch, typical of "side-scrapers" (Figs. 8 and 9). Serrated, notched or denticulate edges occur also (Figs. 9, 10 and 16), and pieces bearing one or two large notches are frequent, though semi-invasive retouch is seen much less often (Fig. 13). Steep retouch is seen on many pointed pieces (Figs. 9, 10 and 15).

Some of these are flattish pieces and could be regarded as fine points, "awls", or "perforators", whereas others resemble the thick ("*Tayac*") "points" described often in Middle and early Late Pleistocene European assemblages. Other pointed artifacts are "*becs*", so-called because of fanciful resemblance to a small bird head with a beak (French: "*bec*"); these are usually small chunks of chert from which a delicate elongated tiny spur, or beak, projects incongruously (Figs. 3 and 10). There are also many steeply-keeled fragments. Some of these resemble steep scrapers on short stumpy cores. Others, knapped into an elongated keeled planoconvex shape, can be called "proto-*limaces*" (Fig. 14) by analogy with forms known from Mousterian assemblages that are fancifully likened to "garden slugs" (French: "*limaces*"). They could be interpreted as convergent steep scrapers, or where both ends are pointed they could be envisaged as thick double points. However, researchers at Isernia La Pineta argue cogently that both "*becs*" and "*limaces*" are merely what are left behind after cores had been reduced by bipolar knapping techniques in order to remove extremely small flakes for subsequent use as unretouched tools (Crovetto, 1994; Crovetto et al., 1994; Peretto, 1994; Peretto et al., 2004). Flakes that were the result of bipolar knapping certainly have been identified, though not quantified. This is because quantification of bipolar elements would depend on whether carinated pieces with notches, spurs ("*becs*") or planoconvex double-ended "*limace*" shape, are primarily an outcome of bipolar core-reduction to remove flakes for use, or, instead, were primarily implements fashioned intentionally as such; to complicate matters further, these possibilities need not be mutually exclusive. The Isernia La Pineta researchers made a cogent proposal for the first view to interpret artifacts excavated there, which was corroborated by microscopical use-wear analysis and experimental knapping. Nevertheless, in several continents ostensibly similar lithics, widely separated in time as well as space, are interpreted as implements, and sometimes microscopical use-wear analysis lends support to that view; there is a copious literature with references to "*becs*" (or similar artifacts, e.g. "microperforators") and "*limaces*" from Pleistocene and Holocene lithic assemblages not only in Europe, but also in Africa, North America and South America.

[2] "Fissural" (adj.), entered under "Fissure", in J. Stein (ed.), 1981, *Random House Dicitionary of the English Language The Unabridged Edition*. Random House, New York, p. 537.

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	Excavated lithic finds by rock type L = large (>60 mm approx.), S = small (<60 mm approx.)	chert	quartz	quartzite	limestone	marble
L	bifacial hand-axe				1	
L	chopping tool				2	
L	hammerstone, manuport	1		16	17	
L	worked core/nodule ("primary base")	19			7	
S	continuous edge retouch ("side-scraper")	71	1	6	6	1
S	stubby or keeled, flake-scars at one end ("end-scraper")	15			1	
S	flake-scars at opposing ends and along edges of planoconvex keeled piece ("limace")	2				
S	denticulate	5				
S	struck flake with notch or discontinuous irregular retouch	100		1	6	
S	spurred keeled piece ("bec, microperforator")	9				
S	pointed piece	5		1		
S	recurrent centripetally-struck flake	6				
S	unretouched struck flake (striking platform, bulb of percussion)	408	1	28	71	
S	fragments. knapping waste or spalls	3969	24	35	494	2

Fig. 7. Excavated lithic finds by rock type.

On flattish rectangular laminar fragments of chert, the steep retouch of a perpendicular margin can transform it into an acute angle useful for cutting or scraping (Fig. 17). Steep retouch applied, on the other hand, to thin feathered flakes can spare them from the undesirable risk of accidental breakage by snapping during use; well-formed feathered flakes are uncommon at Cueva Negra however.

Knapping spalls abound at Cueva Negra, as do split cobbles, lumps and fragments, brought to the cave from nearby sources of suitable stone. Apart from chert, knapping was also performed on

Fig. 8. Artifacts with steep abrupt retouch (edge-scrapers).

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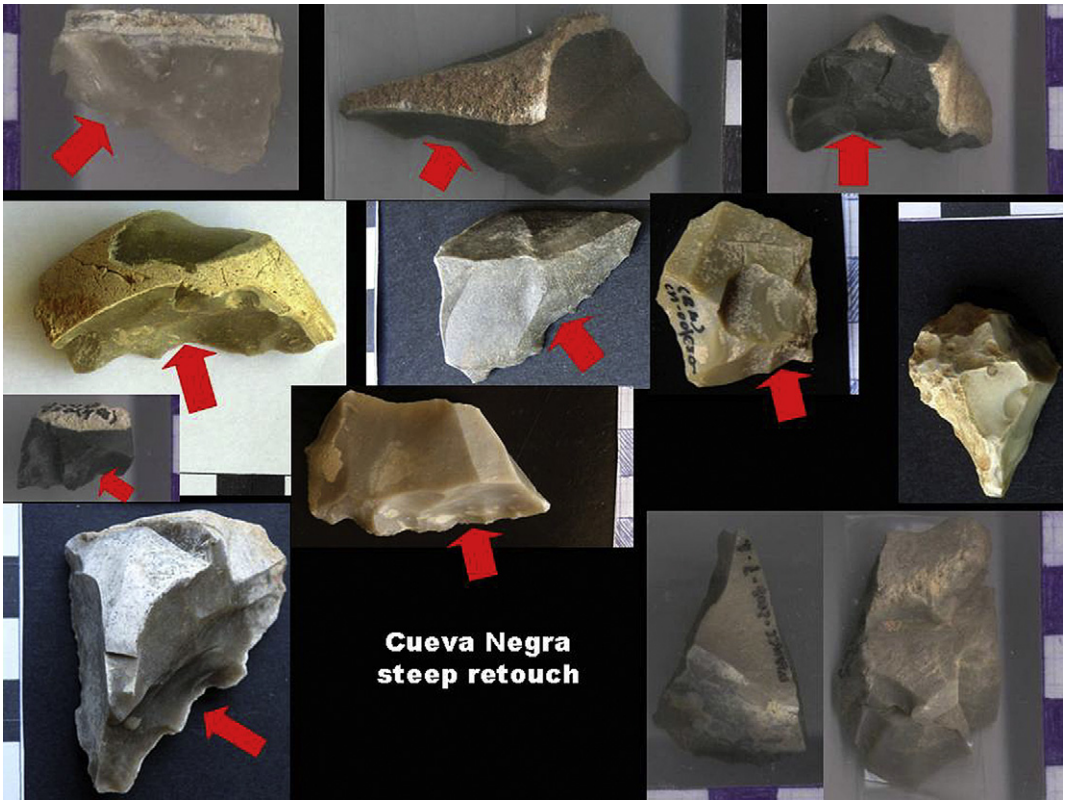

Fig. 9. Artifacts with steep retouch (edge-scrapers).

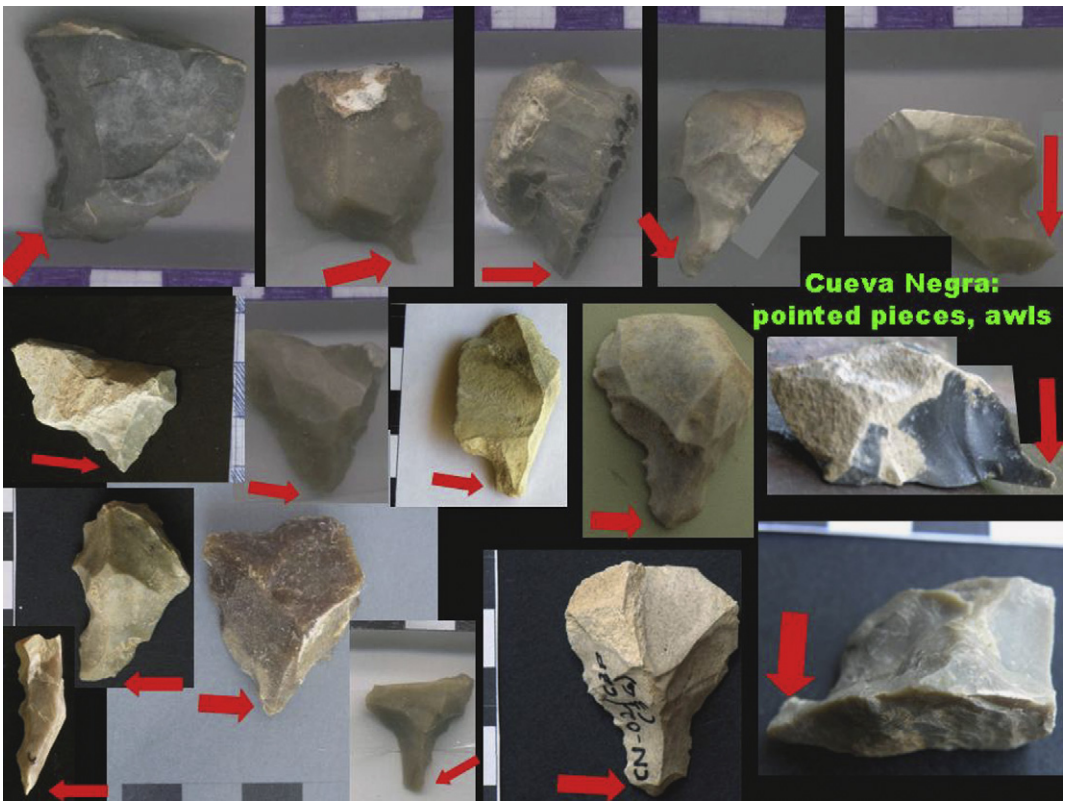

Fig. 10. Retouched artifacts with a pointed end (awls).

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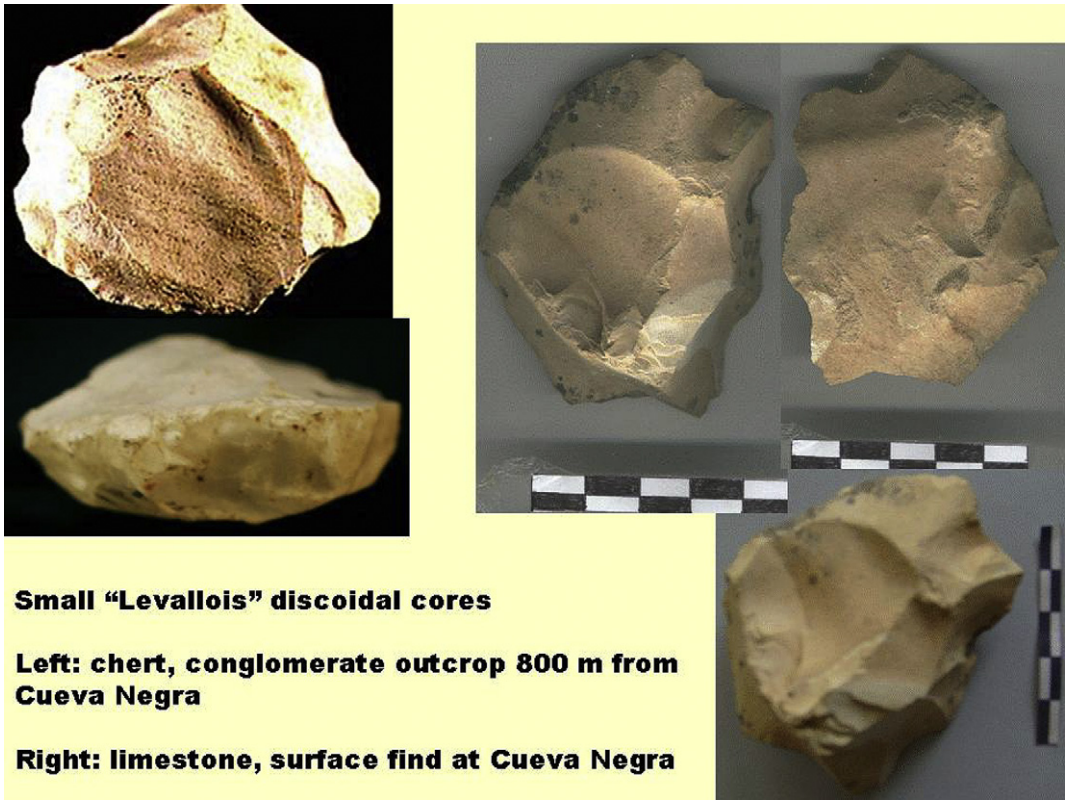

Fig. 11. Small discoidal cores showing concavity corresponding to the last flake to have been removed.

quartzite and fine-grained (including dolomitic) limestone pieces. Some of these bear the conchoidal scars of knapping, and so also, unsurprisingly, do some of the chert artifacts, among which there are flakes with convex bulbs of percussion and striking platforms. Sometimes these flakes bear dorsal scars that testify to repetitive flaking on the core before removal of a flake. Occasionally striking platforms are facetted, indicating particular preparation of that area on the core where the flake was struck from it. Even in the absence of striking platforms and bulbs of percussion, the shape of a fragment of a flake or of dorsal scars it

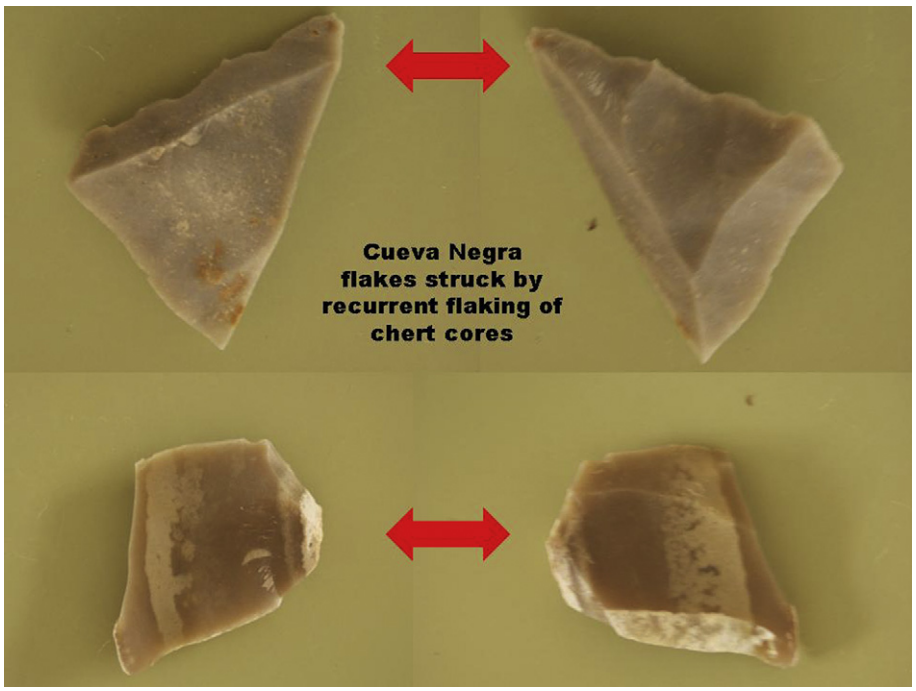

Fig. 12. Chert flakes with dorsal scars indicating previous flaking of the core prior to their removal. A facetted striking platform is present on the lower flake of Fig. 12 which is the middle flake in Fig. 13.

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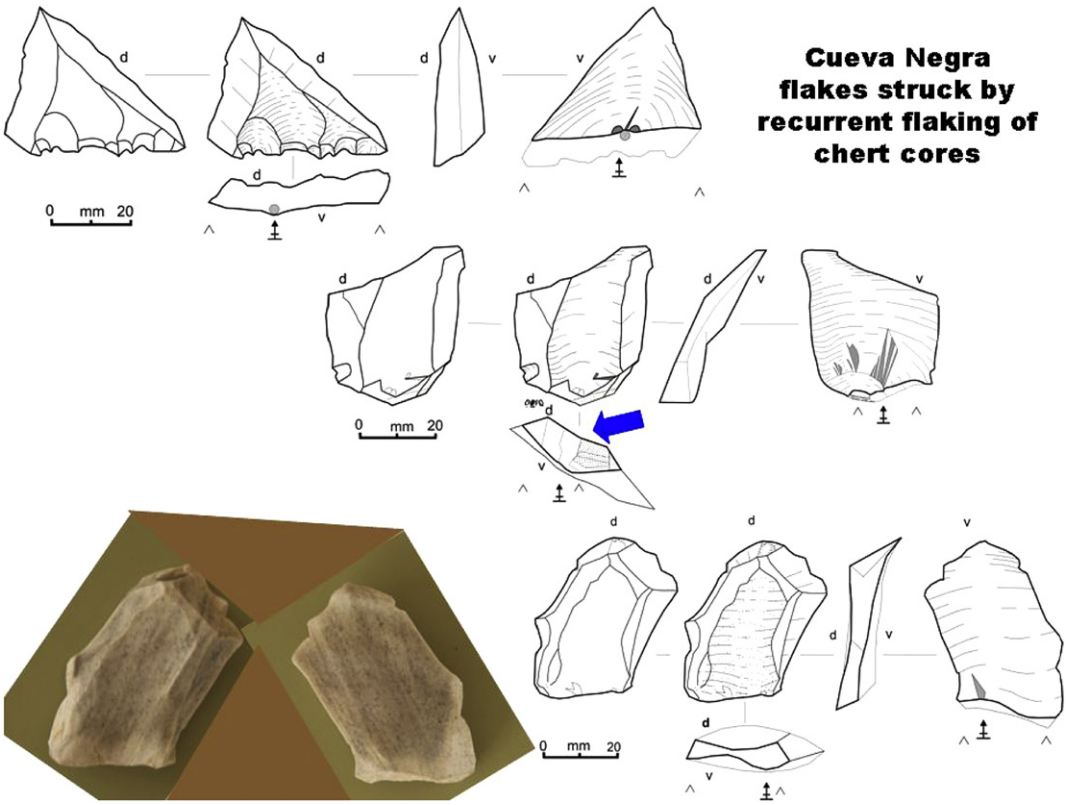

Fig. 13. Chert flakes with dorsal scars indicating previous flaking of the core prior to their removal. A facetted striking platform is present on the lower flake of Fig. 12 which is the middle flake in Fig. 13.

bears may testify to repetitive centripetal flaking before its removal.

The bifacially-flaked "*Acheulian*" hand-axe (Fig. 6) was excavated in 2003 and lay deeply in unit II (Fig. 2), just above the erosion surface of unit III, in an area where there was a noteworthy concentration of Palaeolithic knapping spalls and bone fragments, as well as a human tooth close by (Walker et al., 2006). The hand-axe had lost its tip in antiquity. It presents an S-twist in horizontal

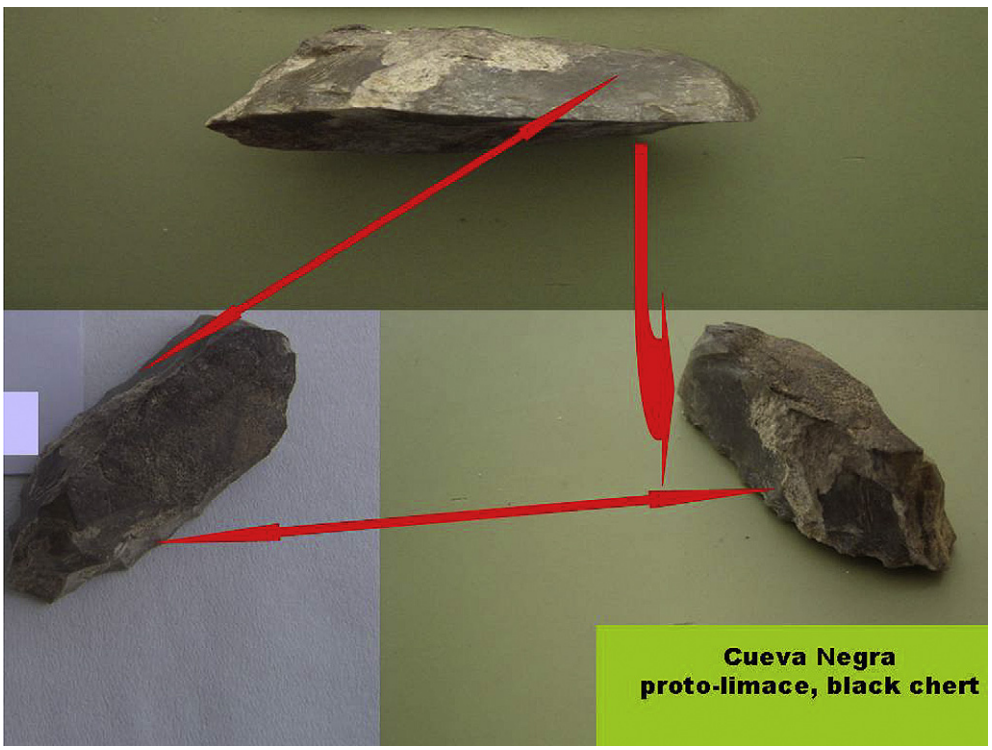

Fig. 14. A planoconvex double-ended chert artifact ("proto-*limace*").

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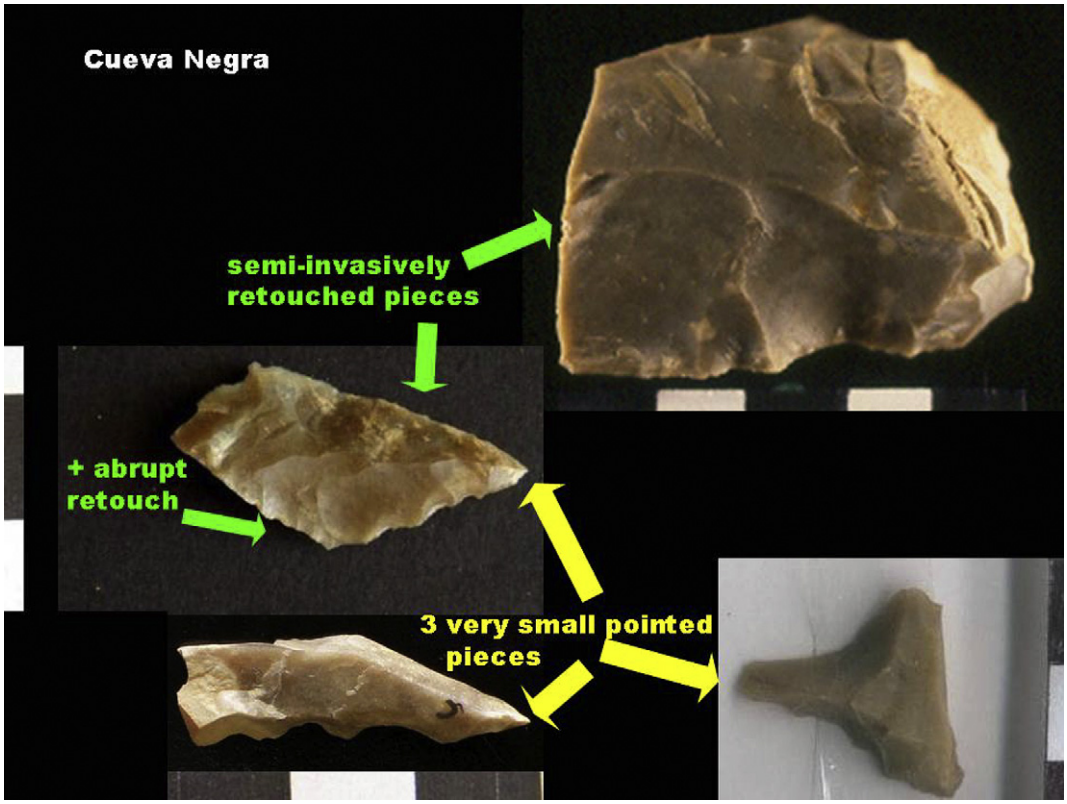

Fig. 15. Chert artifacts of different sizes showing invasive or semi-invasive retouch and in one case steep abrupt retouch.

cross-section. Its edges are sharp and fresh, neither rolled nor water-worn. It was fashioned by removal of no more than thirty flakes from a flat limestone cobble, on which some cortex is still present. The unexpected find brought into perspective the find that had been made in the same level, during an earlier field-season, of a pick-like chopping tool, with sharp, fresh edges made by removal of fifteen flakes, fashioned also on a flat limestone cobble. This had seemed incongruous in an assemblage of small artifacts, which, in 2001, we still regarded as a late Middle or early Late Pleistocene one, for lack of clear-cut evidence to the contrary; however by 2003

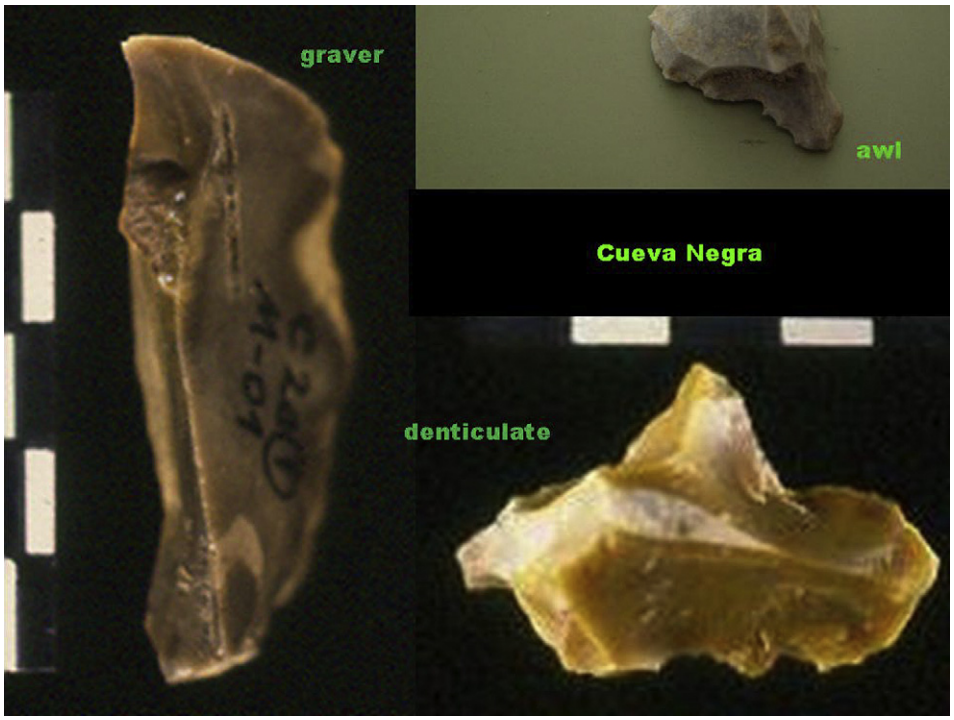

Fig. 16. Chert artifacts: graver, awl, denticulate.

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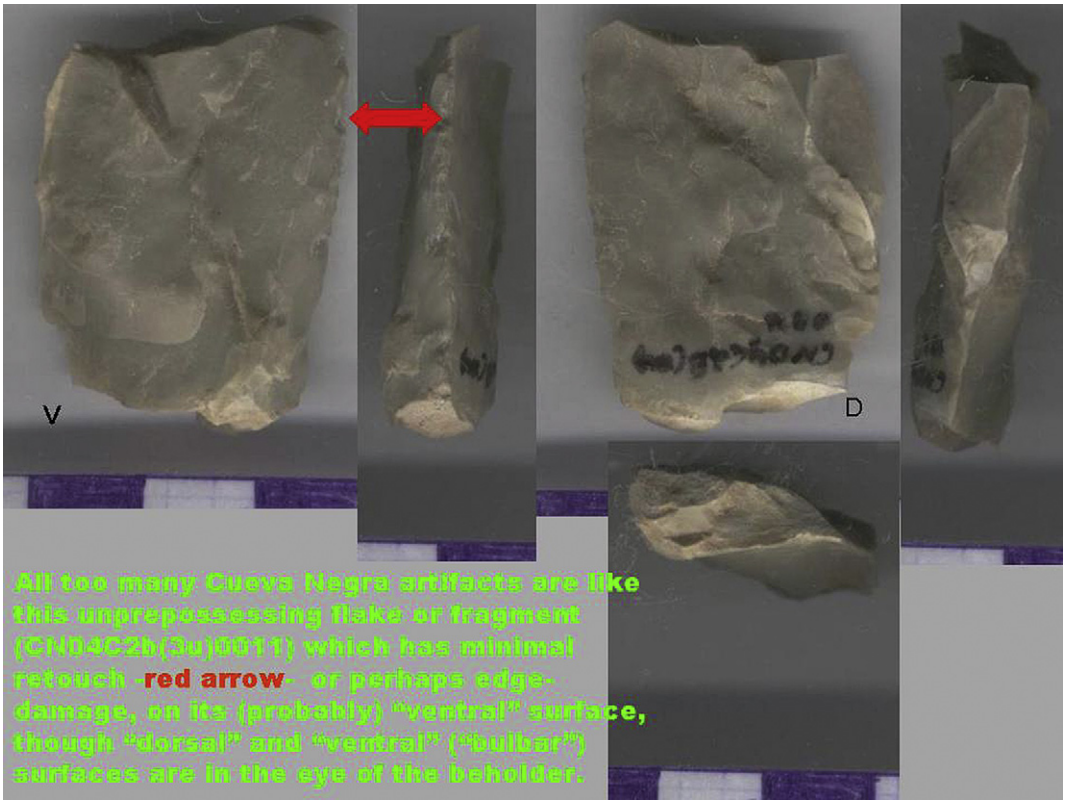

Fig. 17. Alteration on an edge of a fragment of tabular chert, perhaps suggestive of use of steep retouch to render perpendicular edges more acute and thus suitable as cutting tools (edge-scrapers).

the extinct arvicolid rodent species we had begun to recognize, such as *M. savini*, were starting to indicate a much earlier chronology.

Both cobbles are of the grey-blue, micritic limestone (94% calcite, with 6% quartz which contributes to the hardness of the stones: determined by X-ray diffraction of powder and ×80 optical microscopical petrography) that is characteristic of the local Jurassic Lower Middle Lias. Although cobbles of grey-blue limestone were incorporated in the Miocene conglomerate outcrop mentioned earlier, the only two cobbles from it to have been submitted to X-ray diffraction analysis are of pure limestone, lacking quartz: one is composed of cryptocrystalline limestone pellets of organic faecal origin, the other has sparite cement with microscopical fossils (Walker et al., 2006). Two other unworked cobbles excavated at Cueva Negra also were examined by X-ray diffraction analysis and microscopical petrography: one has no quartz and is an oosparite (oolitic limestone with sparite cement), and the other is a dismicrite containing 10% quartz, radiolarian fragments, and filamentous planctonic fragments characteristic of Middle Jurassic Dogger strata that outcrop upstream from Cueva Negra at several localities in hills around the upper Quípar valley.

In 2004 "*Levalloisian*" flakes of good quality chert (Figs. 12 and 13) were excavated in lithostratigraphical unit III (Fig. 2). An asymmetrical, triangular flake of grey chert or flint is a clear example of a centripetal flake-removal, with two dorsal crests converging on a short, single one, leading to the apex of the triangle, in the form of an inverted Y; in other words, it shows prior removal of a small triangular flake. It may be regarded as a "second-order *Levallois* point", or perhaps the so-called "pseudo-*Levallois*", pointed, triangular flake that is nevertheless "*characteristic of particular techniques of preparing the surface of a Levalloisian flake core*" (cf. Boëda et al., 1990; Debénath and Dibble, 1994, p. 52; Mellars, 1996, pp. 65–66). The only retouch it shows is along the long dorsal margin of its plane striking platform, and it varies from semi-invasive to abrupt (perhaps the retouch assisted hafting). A sub-square flake of brown–grey chert or flint, the striking platform of which was prepared with three facets (or perhaps four) of "three-corned-hat" (French: "*chapeau de gendarme*") type, has no retouch and ends in a step fracture which is slightly plunging; two widely separated crests on the dorsal surface delimit a flake scar corresponding to prior removal of a flake that had been struck from the region of the same striking platform. Possible edge-damage at the distal extremity of this piece might perhaps imply its use as a boring tool or awl. An oblong flake of grey–white chert or flint, with a plane striking platform, also has no retouch and again ends in a step fracture which is slightly plunging; it also has two well separated crests on the dorsal surface which delimit a flake scar corresponding to prior removal of a flake that was struck from the region of the same striking platform. Those three flakes are less than 60 mm in length. From the same unit there is an elongated, keeled, planoconvex "proto-*limace*", made of chert, with semi-abrupt or steep squamous retouch. (Other chert proto-limaces have been excavated at the site, some with scalariform semi-abrupt squamous retouch on which marginal abrupt retouch was superimposed).

Of fundamental importance is the incontrovertible fact that "*Levalloisian*" core-reduction and flake-preparation techniques are demonstrated at a depth greater even than that at which the bifacially-flaked "*Acheulian*" hand-axe lay. In other words, at Cueva Negra the contemporaneity (at the very least) of both types of core-reduction is beyond all reasonable doubt. Therefore "*façonnage*" (core-tool fashioning) and "*débitage*" (flake-artifact production) techniques of core-reduction occurred *together* at Cueva Negra before 780,000 a (0.78 Ma). Cueva Negra dispels a time-honoured

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"methodological" consideration, with quasi-evolutionary theoretical overtones (suffused with a touching mystical faith in biological predestination), that a European "Early" Palaeolithic, characterized by bifacial core-tools, must "inevitably" precede and pre-date a European "Middle" Palaeolithic, characterized by "*Levalloisian*" techniques and/or application of steep abrupt "*Mousteroid*" edge-retouch to flake artifacts.

5. Procurement and possible sources of raw material

Chert, and to a lesser extent fine-grained limestone, quartzite and quartz, are the rocks or rock-forming minerals that largely make up the Cueva Negra Palaeolithic assemblage. They all occur in conglomerates and gravels in the flanks of the Quípar valley. Further away from the valley two outcrops of chert, each of a different colour, have been identified. Nodules and cobbles of chert, fine-grained (including dolomitic) limestone and quartzite are found in three kinds of conglomerate or gravels, each formed in a different geological period, albeit with a common origin, namely, in the erosion of the Jurassic rocks that predominate in the nearby high mountains to this day. Unfortunately, from a knapper's standpoint most of the available chert is far from satisfactory, its abundance notwithstanding.

The oldest nearby outcrop of conglomerate lies barely 800 m east of Cueva Negra and about 500 m south of the R. Quípar. It was laid down under the Tethys Sea during the Tortonian phase of the Upper Miocene, between 11.5 and 7 million years ago. It contains fossil sea shells of large extinct scallops and oysters (Walker et al., 1998). Nodules of chert, fine-grained limestone and quartzite were eroded from nearby escarpments of Jurassic rocks. Although much of the chert is tabular, with a tendency to break up into cubical or laminar pieces with perpendicular fracture planes, some nodules are of "better quality" chert which affords conchoidal fracturing and removal of feathered flakes with convex bulbs of percussion. In all likelihood the outcrop was a "quarry" site; a small discoidal "*Levalloisian*" chert core was collected here as well as chert artifacts with steep abrupt edge-retouch resembling several excavated at the cave. The tangled tectonic geology of the area was only fully unravelled here in 2010. Previous publications contain some mistakes that now require correcting. Because the surface of the outcrop at 750 m above sea-level is at the same height as the roof of Cueva Negra, this led to publication of an erroneous re-appraisal (in Walker et al., 2006) that the Upper Miocene conglomerate might represent, instead, an Early Pleistocene lake-side formation that had incorporated components eroded out of a hypothetically long-vanished Miocene formation nearby. A field-survey undertaken in 2010 with accurate GPS control shows that the original interpretation, based on marine palaeontological findings of Upper Miocene Tortonian age, had been correct all along, because the re-appraisal had not taken into account the steep dip of the Tortonian strata (Fig. 18). Because of the steep dip, the same Tortonian marine conglomerate is the source of cobbles that have eroded from it and are exposed in the hillside 15 m directly below the cave mouth, where they, in turn, had been presumed wrongly (Walker et al., 1998) to be vestiges of an accumulation of fluviatile gravel in Late Pleistocene times, merely because they outcrop only 100 m away from the river. In short, uniformitarian conjectures about sedimentary processes have been overturned by considerations of tectonic geology.

Extensive remnants of what once must have been a vast, thick, spread of poorly consolidated gravels (which include chert blocks weighing as much as 3 kg) outcrop 2–3 km upstream from (i.e. south of) the cave, at between 750 and 900 m above sea-level. The nearby high mountains no doubt fringed an inlet of the Tethys Sea during the Lower Pliocene, but neotectonic uplift had greatly reduced its extent here by the Upper Pliocene, when, very likely, the

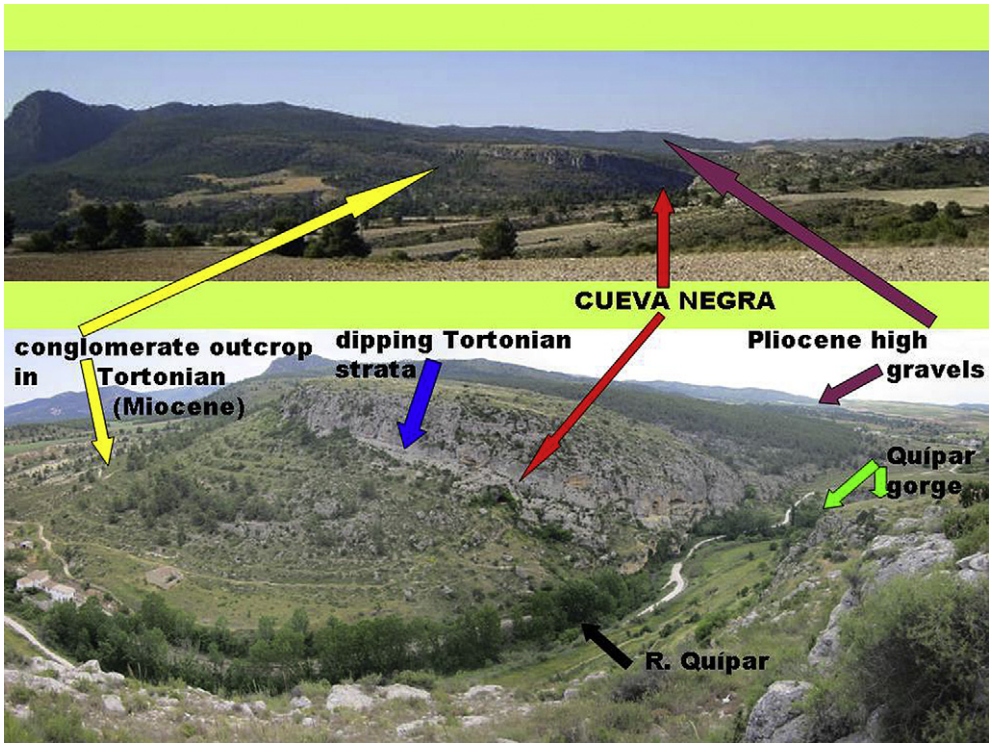

Fig. 18. Panoramic views of Cueva Negra in relation to the nearby Upper Miocene (Tortonian) conglomerate outcrop containing tabular chert that was knapped both there and in the cave, and to Upper Pliocene high gravels of tabular chert. The ultimate source of tabular chert in both cases were Lower Jurassic strata in the mountain on the left-hand side in the background.

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landscape was continental, albeit with marshes and lakes which at first were not far above the pertaining sea-level (which was higher than today). Volcanic eruptions in southern Murcia continued until at least 2.5 Ma according to K-A dating (Montenat 1975, p.162; Bellon et al., 1976, p. 43) and possibly even during the Early Pleistocene (Pavillon, 1972; Dumas, 1977, pp. 174, 272), and barely 15 km upstream from Cueva Negra Plio-Pleistocene conglomerates (see below) underwent diapyric deformation (cf. Ibargüen and Rodríguez-Estrella, 1996). The course of the R. Quípar itself follows an important tectonic fault (the margins of which have undergone differential uplift). In broad terms, the general rate of uplift was considerable overall, and so, in consequence, was the rate of erosion which must have caused the vast, thick, spread of poorly consolidated gravels.

Extensive lakes covered what today are the upper valleys of the R. Quípar and its northern neighbour the R. Argos (which may well have drained both: cf. González et al., 1997). The watershed which separates them today is at 780 m above sea-level 1 km west of Cueva Negra. The separation seems to have taken place after most of the vast, thick, spread of poorly consolidated Upper Pliocene gravels had been washed downstream or, at least, down-slope. Nonetheless, significant vestiges remain on both flanks of the Quípar valley, near La Encarnación and Singla, only a few kilometres upstream from Cueva Negra. Their survival is perhaps not surprising, given that the spread had attained a thickness of well over 100 m, despite the infrequency of outcrops of cemented conglomerate among them (although we have recorded a few). Further upstream, the upper Quípar valley is called, unhelpfully, the Rambla de Tarragoya. The Quípar Fault is crossed by minor faults (lying "normal" to the principal one, i.e. perpendicular to it), activity at which was doubtless responsible for what seem to have been a step-wise series of Plio-Pleistocene lakes lying at different heights relative to one another, and for the presence, today at equivalent relative heights above those, of what seem to be comparable remnants of the vast, thick, spread of poorly consolidated Upper Pliocene gravels, which everywhere contain nodules or cobbles of chert, fine-grained limestone and quartzite. As at the Tortonian outcrop near Cueva Negra, much of the chert is tabular, with a tendency to break up into cubical or laminar pieces with perpendicular fracture planes, though some nodules are of "better quality" chert which affords conchoidal fracturing and removal of feathered flakes with convex bulbs of percussion.

The surface of this large spread of gravels rises in height as the valley is ascended, and at the head of the valley lies at 1100 m above sea-level at Junquera, 20 km from Cueva Negra. There is no higher-level Tertiary conglomerate from which they might have been eroded; only steep Jurassic escarpments of overshadowing mountainsides tower over them. At Junquera we have collected very many chert items, among them a well-knapped proto-*limace* which is clearly a Palaeolithic artifact. However, in Spain surface finds of fractured chert pieces must be treated with the utmost caution, and usually rejected as Palaeolithic, because chert was smashed up with sledge-hammers, even in the twentieth century, for burning in lime-kilns or inserting into wooden threshing sleds drawn by donkeys or mules.

At between 50 and 30 m below the remnants of the aforementioned ancient spread of poorly consolidated high gravels, horizontal conglomerates flank the upper Quípar valley, from Cueva Negra to its headwaters. They lie at equivalent relative heights above the valley floor even though this rises with increasing altitude above sea-level. Their horizontality implies palaeoclimatic synchrony with the step-wise development of the lakes to whose ancient shore-lines they attest. Their components are without doubt derived from the high gravels, but they are often more heavily cemented than are those. They were formed in at least two environmental cycles, each characterized by lacustrine sedimentation followed by a drier phase indicated by deposition of conglomerate and/or orange-coloured lateritic sediment. The conglomerates are the result of the cementation of the shoreline gravels of Early Pleistocene lakes. They contain nodules or cobbles of chert, fine-grained limestone and chert, identical in composition to those of the high gravels. In the Rambla de Tarragoya (i.e. upper Quípar valley) they outcrop on its northern flank. Just above Cueva Negra, they occur on both flanks, though they seem to contain more chert on the right-hand side of the valley (i.e. below the thickest remnants of the earlier gravel cover) than on the left-hand side (where they barely retained a thickness of 50 m following separation of the Quípar and Argos valleys).

Any or all of the aforementioned gravels and conglomerates offered possible sources for the raw materials of the Cueva Negra assemblage. However it also contains chert that may hint at other sources. On the other hand, the more that we sample the conglomerates and gravels, the more we collect less usual kinds of chert or flint. Among other possible sources of raw materials for a few pieces at Cueva Negra mention may be made of two small chert outcrops, both of which lie on the southern side of the watershed which separates the Rambla de Tarragoya (i.e. upper Quípar valley) from the headwaters of the R. Guadalentín to the south (which, like the R. Quípar, drains eventually into the R. Segura). Both lie to the south of the hamlet of Royos de Arriba which is in the Rambla de Tarragoya. One lies about 2 km to the south on the hill of Cuesta del Gitano and is an outcrop of grey-blue chert about 300 m across. It is 15 km from Cueva Negra. The chert forms large, frondiose, "cactus"-like masses, covered by a thick calcrete crust, reduction of which seems to have been the object of an abandoned lime-kiln there. When hit, the chert offers conchoidal fracturing readily, though the resulting flakes are generally irregular and can be large (looking rather like typical "*Clactonian*" flakes from England): one flake excavated at Cueva Negra shows possible resemblance to them. The outcrop was formed in continental Upper Pliocene beds, probably by biogenic processes in lacustrine conditions. The exotic form of the masses may perhaps be compared to that of the well-known Lake Magadi chert in the African Rift Valley. Further south yet, over 20 km from Cueva Negra as the crow flies, in the upper reaches of the small valley of the R. Caramel which feeds the R. Guadalentín, there is a Miocene outcrop barely 500 m across which contains much honey-coloured chert that has a mainly tabular or laminar structure. Honey-coloured chert items have been excavated at Cueva Negra. Nevertheless, we have collected, albeit very occasionally, chert fragments of that colour on the surface of the conglomerate outcrop 800 m from the cave. Among pieces of honey-coloured chert excavated at the cave are a few well-formed flakes, which hardly correspond to forms likely to have been struck from tabular or laminar nodules.

It seems that the chert used at Cueva Negra was mainly of local origin. Trace-element analysis has been undertaken (publication in preparation by Zack et al., in preparation) of chert samples excavated at Cueva Negra and samples collected at the nearby "quarry" site outcrop of Tortonian conglomerate, gravel outcrops on the flanks of the upper Quípar valley, and outlying chert outcrops beyond the it, which points to a general similarity between excavated samples and the conglomerate and gravel outcrops. The analysis is gratefully acknowledged that has been carried out at the Lunar and Planetary Laboratory of the University of Arizona by Dr. A. Andronikov using laser-ablation inductively-coupled plasma mass-spectrometry for 19 trace elements (Sc, V, Cr, Co, Zn, Ga, Ge, Rb, Sr, Y, Zr, Nb, Cs, Ba, La, Ce, Pr, Nd, Sm) and the good offices of Dr. V. Holliday of the Departments of Geosciences and Anthropology for facilitating the collaboration.

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6. Discussion

When considering Acheulian hand-axes, Clark and Riel-Salvatore (2006, p. 39) reasoned that "*their morphological similarities over vast reaches of time and space likely resulted from the mechanical constraints imposed by centripetally flaking relatively large ovoid cobbles and flakes*", rather than demonstrating "*the material remains of a "culture" or "tradition" in stone tool manufacture*"; they declare, "*What we think of as Paleolithic technology almost certainly constituted a range of options very broadly distributed in time and space, held in common by all contemporaneous hominins, and invoked differentially according to context*". However, it was unduly restrictive of them to say Eurasian Middle Palaeolithic industries represent "*a complex mosaic of adaptations that, in aggregate, persists for* ca. *200,000 years (*ca. *230,000 to <30,000 years BP), overlapping extensively with both the Lower and Upper Palaeolithic*" (Clark and Riel-Salvatore (2006, p. 40); one well-known student of the Palaeolithic, Gamble (2007, p. 183) had no problem in accepting an antiquity for Levalloisian flakes of "*at least 300,000 years and probably much older still*". The separate themes of the two preceding sentences set out an introductory contextual Palaeolithic framework for discussion of Cueva Negra.

It must be stressed from the outset that the Cueva Negra Palaeolithic assemblage is for the most part an expedient or opportunistic one of very small flakes or fragments removed from small cores, and both unipolar and bipolar reduction techniques were employed (Fig. 19). The assemblage perhaps could be called "*Isernian*" because of a strong resemblance to many items from Isernia La Pineta (cf. Crovetto, 1994; Crovetto et al., 1994; Peretto, 1994; Minelli et al., 2004; Peretto et al., 2004). The Isernia La Pineta industry commences slightly before 730,000 ± 40,000 a (0.73 ± 0.04 Ma) though most of it is somewhat later. Notwithstanding absence of "*Acheulian*" bifacial reduction and "*Levalloisian*" repetitive centripetal core-reduction, it has been suggested that the Isernia La Pineta industry might be "*an 'opportunistic facies' of a cultural model which was not manifested and which could be… even that of the Acheulean*" (Crovetto et al., 1994). Researchers there found that by conducting knapping experiments on local chert "*it was possible to produce 'protolevallois' type blade forms, Acheulean type bifaces and Levallois type artifacts*" (Crovetto et al., 1994).

This highlights an aspect of the Cueva Negra assemblage that has been misunderstood by some readers of a previous article (Walker et al., 2006): namely that by applying the descriptors "*Acheulian*", "*Levallois*", and "*Mousteroid*", these merely were referring in short-hand manner to visible outcomes on lithic artifacts of different knapping *techniques*, and were most definitely *not* signifying some kind of "cultural assignation" (whatever that might mean). Weight must be given to the conclusions of the Isernia researchers that "*At least for the Lower Palaeolithic, the application of conventional type lists (as well as certain kinds of typological study, statistics etc.) should be the object of profound reconsideration*" and that "*the typometrical and typological studies and those of the economy of the raw material appear to be much more significant and indicative with respect to typological studies*" (Crovetto et al., 1994).

Presence together of both "*Acheulian*" and "*Levalloisian*" knapping techniques by 1,400,000 a (1.4 Ma) at Peninj in East Africa implies a differential feedback relationship, between manual skill and cognitive versatility, which permitted Early Pleistocene *Homo* to knap those artifact forms we can dissect in conceptual terms of a secant plane that can be symmetrical ("*Acheulian*") or asymmetrical ("*Levalloisian*") with respect to a core undergoing reduction (de la Torre et al., 2003; de la Torre and Mora, 2004; de la Torre, 2009). The Peninj industry is of singular importance because it shows beyond all doubt that "*Acheulian*" and "*Levalloisian*" reduction techniques there were not time-successive, but, instead, *fully contemporaneous*. Such a possibility in East Africa had been mooted by others (cf. Gowlett, 1986; Davidson and Noble, 1993; Texier, 1995) who nevertheless tended to feel uncomfortable because the "*Levalloisian*" core-reduction technique was otherwise unknown before mid-Middle Pleistocene times of 400,000–300,000 a (0.4–0.3 Ma). Put bluntly, there has been widespread reluctance to abandon a quasi-evolutionary, time-successive notion that "*Acheulian*" implies "Early Palaeolithic" and "*Levalloisian*" implies "Middle Palaeolithic" in western Eurasia. The

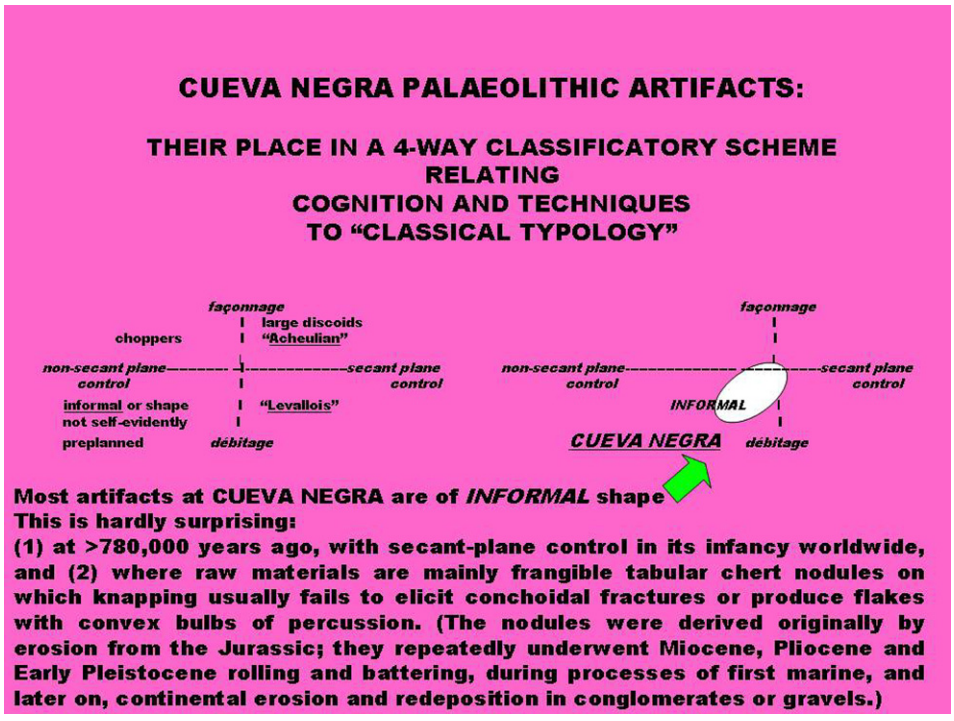

Fig. 19. Schematic representation of the Cueva Negra artifact assemblage in terms of dichotomies of façonnage/débitage and non-secant plane/secant plane features.

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time has come to abandon the notion. It is refuted at Cueva Negra where both "*Acheulian*" and "*Levalloisian*" techniques were in use together before the end (780,000 years ago; 0.78 Ma) of the Early Pleistocene.

In any case, the demonstration of an age of at least 500,000 a (0.5 Ma) (Rose, 1992, p. 23) for the assemblage of small flake-tools at High Lodge in England (see below) definitely undermined any notion that the European Middle Palaeolithic began barely 250,000 a (0.25 Ma) – which is the well-established age of the assemblage from the Dutch site of Maastricht-Belvédère characterized by "*Levalloisian*" core-reduction techniques of recurrent centripetal removal of flakes which often have "*Mousterian*" abrupt edge-retouch (van Kolfschoten and Roebroeks, 1985; Roebroeks, 1988; Roebroeks et al., 1992; Roebroeks and van Kolfschoten, 1995) The notion may have implied that "*Levalloisian*" core-reduction techniques for making the small tools of northwestern Europe had to be dependent, somehow or other, on their prior appearance >284,000 ± 12,000 a (>0.284 ± 0.012 Ma) in the Kenyan Kapthurin Formation of eastern equatorial Africa (cf. Tallon, 1978; cf. Cornelissen, 1992; cf. McBrearty et al., 1996; McBrearty and Tryon, 2006). Nevertheless, those techniques were already present 325,000 a (0.325 Ma) at Orgnac in southern France, in a sequence spanning 350,000–280,000 a (0.35–0.28 Ma) (Combier, 2005) where they were found together with *Acheulian* artifacts (Combier, 1976). They were already present also in Spain at the Atapuerca Gran Dolina in levels TD10 and TD11, where dates range between 418,000 ± 63,000 a (0.418 ± 0.063 Ma) and 308,000 ± 46,000 a (0.308 ± 0.046 Ma) (Falguères et al., 1999; Vaquero and Carbonell, 2003). An age of >350,000 a (>0.35 Ma) for their presence at Cueva Negra del Estrecho del Río Quípar was published on the basis of optically stimulated luminescence determinations on four sediment samples (Walker et al., 2006). However, palaeomagnetic research at Cueva Negra later showed that the entire 5-m depth of its Pleistocene sedimentary fill we have excavated down to bed-rock belongs to the Matuyama Cron: thus it has to be older than the Matuyama-Brunhes boundary of 780,000 a (0.78 Ma) (Scott and Gibert, 2009). A late Early Pleistocene age of somewhat before 780,000 a (0.78 Ma) is compatible with the Cueva Negra arvicolid rodent species, which are the same as those from Atapuerca Gran Dolina levels TD4-TD8 that straddle the 780,000 a (0.78 Ma) boundary. Both sites lack species found at older sites, which had become extinct, and species found at later sites, which had not yet evolved. Interestingly, 0.5 m above bed-rock a retouched chert artifact (Fig. 3) lay on a 50 mm-thick layer of fossilized ash containing several fragments of both calcined bone and heat-shattered chert.

A quarter of century ago, Gamble (1986, p. 117) declared, "…*the application of the terms lower and middle palaeolithic to European data is no longer instructive about the relative levels of technological attainment*". Only five years before, Roe (1981, p. 238) had compared flake-tools from the English site of High Lodge "*to some of the best Charentian Mousterian scrapers*", and illustrated "*steeply retouched limaces or limace-like tools…; (an) end-scraper and double side-scraper…; (and) double convergent sidescrapers*" (Roe, 1981, pp. 238–239). The site also contained hand-axes, which could be *earlier*, paradoxically, than the more deeply-lying flake-tool assemblage (Ashton and McNabb, 1992, p. 164). The High Lodge flake-tools were not made by the "*Levalloisian*" method of reducing prepared cores in order to remove flakes. However, the great antiquity of 500,000 a (0.5 Ma) for High Lodge undermined "…*the notion that not only should there be a European framework for understanding the Lower and Middle Palaeolithic, but that this framework should be structured within an evolutionary model*" (Ashton and McNabb, 1992, p. 165). Ashton and McNabb went on to say "…*the way sites have been compared often over long distances has created a false sense that patterns can be recognised, initially by using type fossils, and more recently by the creation of a type list … little heed has been taken of the effects of site use or of the supply and quality of raw material on assemblage formation*" and they make an interesting remark, which may well be relevant to Cueva Negra, that "…*in the absence of large flakes for chopping … other forms such as chopping tools or bifaces might be made*".

A similar reassessment has resulted from the northern French site of Cagny-La Garenne (probably contemporaneous with marine oxygen isotope stages MIS 11 and 12, ca. 500,000–400,000 a (0.5–0.4 Ma), where "…*the appearance of the Levallois débitage is situated in a context of handaxe production, indicating a conceptual link between the flaking of handaxes and the emergence of the Levallois flaking methods … that stresses the artificial character of the classical break between the Lower and the Middle Palaeolithic*" (Tuffreau and Antoine, 1995). The same authors highlight "…*linkages between methods of handaxe production and methods of Levallois débitage. Some handaxes broken during flaking have yielded a large* éclat préférentiel", and they illustrate a hand-axe one surface of which has a long, wide flake-scar extending from the butt towards the point (Tuffreau and Antoine, 1995, p. 153, Figs. 2 and 6), described as "*a negative of a removal similar to a Levallois flake*" (similar observations were made by Agache, 1976, p. 129, Fig. 50, "*l'empreinte d'un éclat pseudo-Levallois*"; see also Breuil and Kelley, 1956, Fig. 6).

Some bifaces may indeed be merely secondary outcomes, or by-products, of knapping large stones in order mainly to extract flakes for immediate use (cf. Noble and Davidson, 1996, pp. 195–200; Clark and Riel-Salvatore, 2006). This need not always have been the case, however, as is suggested by assemblages (such as Cueva Negra) containing infrequent examples *both* of bifacially-knapped, flattish, ovoid or almond-shape stones, *and* of "*Levalloisian*" recurrent centripetal reduction of muffin-shape stones. This duality may imply that the psychological and manual capabilities of the knappers went somewhat beyond those of "either/or" – either fashioning (shaping) or flaking (*façonnage* versus *débitage*: cf. Boëda, 1988, 1993, 1994; Boëda et al., 1990). It may have included dim awareness of the *limitations and different relationships* that are involved in translating purpose into rapid, complex manual activity, with accuracy and precision. This is especially the case where the secant planes (usually slightly undulating planes) of the stones chosen (cf. White and Pettit, 1995) are as different as those we can readily envisage for the roughly *equal* volumes of a flat almond-shape or ovoid, on (in?) the one hand, and for the *un*equal volumes of a muffin, on (in?) the other. (A concept of symmetry is *not* the cognitive issue here; anyhow, in stone artifacts, more often than not, symmetry is conspicuous by its absence.) As argued elsewhere (Walker et al., 2006; Walker, 2009), the degree of awareness, albeit dim or fuzzy, implies sufficient cognitive flexibility to make choices between *different chains of complex behavioural activities*, that was undoubtedly common to all hominins by a million years ago, who therefore surely qualify to be called *humans*. Writing about "*Acheulian*" bifaces, Noble and Davidson (1996, p. 193) remarked that it is "*highly unlikely that a single stone industry, if patterned by 'culture' could have been produced by two different species*". Quite so. It is therefore more economical to infer that neuronal patterning common to the brains of most palaeospecies of *Homo* has underpinned much Palaeolithic behaviour since late Early Pleistocene times.

"*Levalloisian*" core-reduction by recurrent centripetal flaking involved knappers leaving clues on the core as they were reducing it, which acted as guides to further removals from the core. Thus, the resulting regular shapes that are so often found (e.g. oval, triangular, oblong) of some of the flakes removed as the reduction sequence proceeded were probably not "intentionally preconceived forms". More likely, they reflect the limited mechanical range of possible outcomes from sequential or recurrent psychomotor and neuromuscular interactions between visuo-tactile and

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manual responses to the clues while the core was being rotated during knapping (cf. van Peer, 1992, pp. 35–54).

The fashioning of an oval or almond-shape biface out of a flat ovoid or almond-shape stone may allow the knapper to keep in sight an ostensive relationship between the shape of the stone and that of the flaked biface. The same goes, in part, when blades are struck from a prepared prismatic core (like staves being removed from the surface of a barrel, so to speak). Very different indeed is the situation the "*Levalloisian*" knapper confronts. Here the flakes are, as it were, "hidden" from view (like the yolk inside a hen's egg, so to speak), and "unimaginable" simply from looking at the external shape of the stone before the reduction sequence begins. "*Early stone-knapping techniques like Levallois … and early stone tool types such as twisted profile handaxes appeared at least 300,000 years ago and would appear to require a complexity of images held in the visuospatial sketchpad of working memory… No more complex form of stone knapping* ever *appears*" (Coolidge and Wynn, 2005; their emphasis). With regard to a particular "*Levalloisian*" knapping sequence, analyzed at the Dutch Middle Pleistocene site of Maastricht-Belvédère, Schlanger (1996) has argued convincingly for presence of an underlying "*plan-like principle*" that set out a practical objective whilst letting the knapper monitor the work in hand so as to allow transformation in a fluid yet structured "*configuration of possibilities*".

Moreover, where hand-axes are symmetrical, then "*spatiotemporal substitution and symmetry operations*" were required that are more complex, cognitively-speaking, than are "*the spatial concepts necessary to manufacture blades*" (Wynn, 1979), because they involve envisaging shapes and volumes from alternative perspectives, rotated in the mind, whilst paying attention to congruence (Wynn, 1989, 2000), and this is even more true of "*Levalloisian*" core-reduction. Wynn (1993, 1995) interprets hand-axes as exemplifying evolution of "*constellations*" of behavioural plans of action that involve feature-correspondence as well as the complex cognitive skill of reversibility, which, nevertheless, could well have been learned and communicated by simply observing and copying. As Wynn (1995) put it: "*it would be difficult to overemphasize just how strange the handaxe is … it does not fit easily into our understanding of what tools are, and its makers do not fit easily into our understanding of what humans are.*" It is worth bearing this matter in mind also when considering "*Levalloisian*" cores. Although the "*standard interpretation is that a core was prepared in such a way that a flake of predetermined shape could be removed … it does not seem likely that such cores represented a novelty in planning beginning at the time the Levalloisian technique is said to appear. Rather, such cores had been used for producing flakes almost from the very beginning, and continued to be so used even after knappers began to strike large flakes from them*" (Noble and Davidson, 1996, p. 200).

De la Torre et al. (2003) declared, "*For the Peninj Oldowan industries, the idea of the Levallois core obtained by multiple flaking, or Levallois core of recurrent centripetal flaking* (Boëda, 1993, 1994) *is applicable… If Boëda's definition is applied. The technology of the Peninj assemblage would be similar to the Levallois technology; a strategy seemingly typical of later periods. This similarity is observed not only when applying Boëda's criteria, but also when applying the Levallois phases as defined by* van Peer (1992). *According to him, in the Levallois cores, the original volume of the striking platform is larger than that used for the flaking surface. Therefore, through the whole reduction sequence, the core assumes an asymmetrical profile. From the beginning of flaking, each surface adopts a specific role (striking/flaking) not being exchangeable during the reduction process. This is seen at Peninj.*"

Analytical criteria for distinguishing centripetal discoidal knapping in general from "*Levalloisian*" recurrent centripetal knapping (Mourre, 2003) can be useful in the formal study of flakes removed from small cores in Eurasia. There is well-published disagreement as to whether or not these small cores may be regarded as comparable with African Early Pleistocene large discoids, spheroids, and very large flakes with facetted striking platforms from which some bifaces were fashioned; rehearsal of the technical arguments would be out of place here.

At Cueva Negra techniques of both recurrent centripetal knapping and bipolar knapping were used, not to strike large flakes off cores, but, instead, to produce very small flakes. After flake-removal by recurrent centripetal knapping, the resulting discoidal "*Levalloisian*" cores bear a central concave scar, corresponding to the last flake to have been struck off; these cores are as small as a biscuit that fits into the palm of the hand, like those which occur frequently elsewhere in assemblages of the Middle and early Late Pleistocene. In that respect, therefore, they are unlike large flaked "discoids", lacking any such scar, from other Early Pleistocene assemblages, as well as some later ones, including some that have been described in the Iberian Peninsula (Vaquero and Carbonell, 2003).

Compared with some other Early Pleistocene Spanish assemblages, Cueva Negra presents both similarities and differences. Perhaps the most similar Palaeolithic assemblage is that from Vallparadís near Terrassa in Catalonia, where numerous small artifacts were excavated, many of which were prepared by bipolar core-reduction, including "*becs*", denticulate and notched pieces, and "*a few examples of centripetal cores and débordant flakes*", as well as artifacts on cobbles which include a chopper, and broad comparison is made with "*Mode 1 (Oldowan-like)*" sites (Martínez et al., 2011). Electron spin resonance-uranium series and palaeomagnetic analysis indicate an age of 830,000 ± 7000 a (0.83 ± 0.07 Ma), between Jaramillo and the Matuyama-Brunhes boundary at 780,000 a (0.78 Ma). Also from before that boundary, late Early Pleistocene Palaeolithic artifacts come from the Atapuerca Gran Dolina and Sima del Elefante sites (Terradillos, 2010; Martínez et al., 2011), though they show neither clear-cut "*Acheulian*" nor "*Levalloisian*" reduction techniques of knapping. At the Gran Dolina the Matuyama-Brunhes boundary lies between TD7 and TD8. Whereas TD8, TD9 and TD10 span the period 600,000–400,000 a (0.6–0.4 Ma), TD6 and TD7 are earlier than 780,000 a (0.78 Ma) and therefore only TD6 and TD7 artifacts could be contemporaneous with Cueva Negra. TD6 has provided 570 chert, quartzite, quartz, limestone and sandstone artifacts (Terradillos, 2010, pp. 65–76) and of the 13 illustrated by Terradillos (2010, p. 76, Fig. 8.12) only two bring Cueva Negra to mind (namely, no. 10, a chert denticulate, and no. 13, a dihedral). Terradillos (2010, pp. 73–74).

Using a formal technological scheme, Terradillos characterizes the assemblage as the product of knapping that predominately involved unipolar hard percussion on one or two sides of a core, or primary base, but sometimes centripetal knapping took place, presumably to take advantage of thicker cores. Some quartzite pieces show evidence of bipolar knapping. Both centripetal and opposite parallel ("*orthogonal*") abrupt knapping were practised on one or two sides of several chert cores, as well as unipolar, centripetal or opposite parallel, abrupt percussion on three sides of some others. The initial *débitage* products of core-reduction show little standardization, though several show the straight ventral surfaces typical of parallel striking and may have facetted butts. Further modification often involved no more than scant retouch that reduced the initial curvature of a sharp semi-abrupt edge of a convex dihedral flake or fragment; dihedral pieces with straighter sides sometimes underwent further modification to give a distal trihedral shape – present on 17% of cores, or primary bases, despite being otherwise infrequent. This last comment is interesting because it may reflect a matter relevant to both the Cueva Negra and Isernia La Pileta assemblages concerning both the keeled, slug-shaped "proto-*limaces*" and "awl"-like keeled pieces with a spur or beak ("*becs*"), both of which have been reproduced by experimental

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bipolar knapping on anvils by researchers at Isernia; in both cases they may be not so much "tools" in their own right, as by-products of a core-reduction sequence directed at the removal of minute flakes; indeed, Palaeolithic examples of minute flakes at Isernia show microscopical traces of use-wear more often than do the so-called "tools".

It must be reiterated that, in contrast to Cueva Negra, the pre-Brunhes assemblages from Atapuerca lack both "*Acheulian*" artifacts and "*Levalloisian*" discoidal cores, and the unstandardized forms of the Palaeolithic artifacts are perhaps compatible with a general "*Oldowan*" designation. A similar designation, given the absence once again of "*Acheulian*" artifacts and "*Levalloisian*" discoidal cores, may be appropriate for the Early Pleistocene assemblages, from roughly 1,200,000 a (1.2 Ma), excavated at Barranco León and Fuente Nueva 3 in Granada, barely 100 km from Cueva Negra as the crow flies (Cauche, 2009; Fajardo, 2009; Toro-Moyano et al., 2010). The Cueva Negra assemblage is hardly reflected, if at all, at these two sites, where retouched artifacts are most infrequent; the number of their small artifacts can be counted on the fingers of one hand which bear comparison to any Cueva Negra items; most are of unstandardized shape. One core from Fuente Nueva 3 shows evidence of both unipolar and repeated bipolar knapping; however, whereas most artifacts were the result of the unipolar technique alone, sometimes centripetal or intersecting knapping scars are present on one or both sides of a core, and, exceptionally, one core bears opposing parallel ("*orthogonal*") scars on several sides (e.g. Cauche, 2009, Fig. 4), no doubt indicating that advantage was taken of its thickness in order to maximize flake removals. Keeled pieces resulted from bipolar knapping (Cauche, 2009).

Were it not for clear evidence of "*Levalloisian*" flake-removal, the Cueva Negra assemblage might be regarded as comparable to such well-known European Middle Pleistocene assemblages as those from High Lodge, Caune de l'Arago, Baume Bonne, Vértesszõlõs and Bilzingsleben. Although these assemblages come from a period when "*Acheulian*" bifacial core-reduction was widespread in Europe, and may even contain occasional bifaces, they have been termed variously as "*proto-Charentian*", "*pre-Mousterian*", "*proto-Mousterian*", "*Archaic Mousterian*", or "*Mousteroid*", flake assemblages. These often include some small artifacts commonly present in later "*Mousterian*" assemblages, whilst containing very many that are relegated to "atypical" forms in Bordes' classification of "*Mousterian* tool-types" (Bordes, 1961; cf. Debénath and Dibble, 1994). Moreover, although "*Mousterian*"-like abrupt retouch of flake edges is seen in several early assemblages, the greater irregularity of flake shapes separates those assemblages from later "*Mousterian*" ones in which more or less regular and repeatable flake shapes were reproduced by means of "*Levalloisian*" recurrent centripetal reduction of prepared cores (Bordes, 1951; van Peer, 1992; Boëda, 1993, 1994; Mellars, 1996, pp. 61–72; Inizan et al., 1999, pp. 63–68). Although various types of these prepared cores are acknowledged (Bordes, 1980), they all permit economical use to be made of the volume of a small core, with regard to removal from it of useful small artifacts (McBurney, 1975). This property must have been particularly useful in regions, such as that around Cueva Negra, where chert, albeit abundant, is of poor quality for knapping.

It is common knowledge that the "*Levalloisian*" core-reduction technique was by no means a universal practice, even at later "*Mousterian*" sites (Bordes, 1951, 1953, 1961, 1961a; Bordes and Bourgon, 1951). Indeed, the calculation of the so-called "*Levallois Index*" was designed to reflect the varying extent of its presence at different French "*Mousterian*" assemblages (thus it is almost absent at "*Mousterian 'Quina'*" assemblages). Consequently, there are no substantive empirical grounds for believing that "*Mousterian*" artifacts cannot – or somehow "should" not – be recognized unless, or until, the Levalloisian core-reduction techniques had appeared or arisen. French Palaeolithic archaeologists have long considered that different kinds of later "*Mousterian*" assemblages might reflect continuity with particular Middle Pleistocene precursors, in terms of variable presence or absence of bifacial artifacts, variable presence or absence of Levalloisian core-reduction, and variable presence or absence of different kinds of formal small tools or retouch (Bordes and Bourgon, 1951; Bordes, 1953a, 1961a, 1973; Bourgon, 1957; de Lumley, 1969, 1971, 1975, 1976). Thus, the "*Tayacian*" assemblage at Caune de l'Arago is said to have "*proto-Charentian*" convex scrapers (de Lumley, 1971, 1975, 1976) and in a striking coincidence with Cueva Negra a biface there was made on a flat cobble or pebble (de Lumley, 1971, p. 307, Fig. 275). Nevertheless, European Middle Pleistocene assemblages of small artifacts show great diversity. Some well-known ones do not look at all like harbingers of the "*Mousterian*", though they share aspects with "*Tayacian*" or "*Clactonian*" assemblages elsewhere in Europe (e.g. Vértesszőlős: Kreztoi and Dobosi, 1990; Bilzingsleben: Weber, 1986; Mania, 1995).

As Clark and Riel-Salvatore remind us, identifying formal stone-tool "types" is a task fraught with uncertainty. In her study of the Terra Amata assemblage, on the French Mediterranean coast, of perhaps 250,000 a (0.25 Ma) (dates range from 380,000 to 230,000 a; 0.38–0.23 Ma), Villa (1983, pp. 86–162) drew attention to a very wide spread of overlapping "types", not only among core tools (from simple unidirectionally-flaked pebble tools to bifacial hand-axes and cleavers: Villa, 1983, Fig. 24 opp. p. 112), but also among flake and other small tools (Villa, 1983, pp. 134–9), which present a picture of overlapping gradation between side-scrapers, denticulates, "*Tayac*" points, awls and "*becs*", and include many "*amorphous*" or "*casual*" items, showing "*a minimum of shaping*", of which several belong to a "*core-fragment class*" (Villa, 1983, p. 134). Such "amorphous", "casual", "informal", or "expedient" stone blanks, whether retouched or not, predominate at Cueva Negra, and at many other sites like it where raw materials do not lend themselves readily to flaking or "standardized" preparation, nor, for that matter, to uniform patterns of re-working, re-fashioning or "freshening" of retouched edges.

It goes without saying that the uses, for which stone tools were needed, were both many and various, and often overlapped, and that stone-knapping skills were developed over a life-time by individuals gifted with greater or lesser manual dexterity or capacity to learn. Although it is likely that members of *Homo* – early humans – could speak a million years ago, perhaps speech played a minor part in learning how to knap stone. After all, even today much learning is by astutely copying, and modifying, the physical actions of experienced trainers, whether in playing musical instruments, performing dances and sports, craft skills such as pottery-making, and, most important of all, in hunting where silence and stealth are of the essence. We learn many activities which we must perform far too quickly to let us to attend to a running commentary of detailed verbal instruction. Speech is more useful for comparing and contrasting information, but there was a demographical impediment to this, because, especially in Eurasia, early *Homo* groups were restricted to environments of great biodiversity in order to be able to survive throughout the year. Palaeoenvironmental and palaeogeographical considerations of Cueva Negra lay behind a proposal that early humans in Europe were "environmentally challenged", so to speak, and, in order to survive at all, let alone reproduce, were constrained to exploit and inhabit small areas of rich biodiversity, often far from other ones (Walker et al., 2004). In consequence, groups were isolated and had very infrequent contact with one another, so exchange of news and ideas must have been infrequent occasions. Although most of their behaviour may have been silent and imitative, speech may well have been required for making and taking choices, which chain to

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take part in, what is wanted, why it should to be done, and where and when to do it, or even if it should be done at all.

Plausibly, those well-known artifact "types" that have aroused special interest among Palaeolithic archaeologists were outcomes of *chains of behavioural activities* (Walker, 2009), involving often more than one actor, from searching for and retrieving raw materials (whether close to hand or further afield), to knapping processes that went beyond a single knapper's "*chaîne opératoire*" and extended to use (indicated by micro-scars of edge-damage), and re-fashioning at a later time (patinated flakes were reworked sometimes at Cueva Negra, as at many Pleistocene sites). We must eschew the notion that Palaeolithic knappers had self-aware, conceptual "intentions". Instead, we should refer the outcomes of their behaviour to evolutionary biology, most especially the non-linear evolution of psychomotor circuits in the brain and rapid neuromuscular coordination. The artifact outcomes can be interpreted as being the results and by-products of deterministically self-organizing chains of complex purposeful activities.

These, by natural selection, afforded tried-and-tested adaptive value to evolving *Homo* populations with an emergent cognitive capability that, by and large, was unspoken. It was no doubt largely unconscious, to the degree that, once learnt, knapping skills were retained in the brain for life, in long-term ("procedural") memory, like other expert aptitudes (cf. Wynn and Coolidge, 2004). Initially, the learning process involves visuo-tactile short-term (active or "working") memory, relying on cerebral neuronal circuits which not only include sensorimotor integration, but also mirror- and canonical neurone systems for imitating behaviour, control systems for error-detection and correction, and even self-generated anticipation of difficulties requiring innovative responses, as well as adjustments attuned to circuits for logico-mathematical combinativity and, most important, second-order cognition (Walker, 2009). This last is particularly relevant where alternative exclusive behaviours are possible, and when, therefore, *choices* have to be made between them: because, once a particular chain of behaviour has been selected, there is no easy way to go back and turn it into the alternative chain. The choice between fashioning a flat ovoid or almond-shape stone into an "*Acheulian*" hand-axe and reducing a stone of muffin-shape in order to extract "*Levalloisian*" flakes at Cueva Negra shows us that these two mutually exclusive alternative chains of behaviour are likely to have been present in long-term procedural memory in the brains of whoever was there 800,000 a (0.8 Ma), as was the capacity to *choose* between them.

7. Conclusion A, re-thinking Palaeolithic thinking

The Cueva Negra artifact assemblage draws attention to both the technological and cognitive versatility of *Homo* in southwestern Europe almost a million years ago. It is unnecessary to labour unduly points already outlined. Formal distinctions are useful, indeed, between archaeological notions of "*façonnage*" and "*débitage*" (Boëda et al., 1990), and between archaeological notions of stable secant planes and more random, non-secant migrating planes (White and Pettit, 1995). However, they are not aetherial ends in themselves, but, rather, the starting point for reflexion about the evolutionary significance of all-too-real Palaeolithic assemblages, among which is Cueva Negra. High-level theory, or middle-level modelling, sooner or later has to come face to face with the incontrovertible findings of low-level reality. They bring us back down to ground. It is always archaeological ground. It must be approached with common sense, and without an intellectual baggage hampered by many irrefutable preconditions and inherited preconceptions. For example, if somewhere between 990,000–780,000 a (0.99–078 Ma) hand-axes and small tools coexist at Cueva Negra, and at 40,000 a (0.04 Ma) they still do so elsewhere in the "*Mousterian of Acheulian Tradition*", then any distinction between European "Early" and "Middle" Palaeolithic assemblages ceases to offer quasi-evolutionary meaningfulness or classificatory helpfulness.

More worrying than that, however, is the following insidious matter. It can be caricatured as postage-stamp sized maps of the Africa and Eurasia covered by very large arrows of, allegedly, successive unidirectional hominin dispersals from Africa. Behind them lies a belief that they are analogous to other faunal dispersals, in so far as their biological composition and ranges are seen, sometimes, to be mutually dependent outcomes of specific natural selection, even to the extent that it has been proposed that different palaeospecies of *Homo* might be characterized differentially in behavioural terms according to the nature of their Palaeolithic toolkit. This simple-minded, and self-justifying, notion underpins another, namely that, before a major human dispersal from Africa which probably took place only during the early Late Pleistocene (100,000–50,000 a; 0.1–0.05 Ma)), all previous dispersals of *Homo* had been, so to speak, "*non-human*" or not "*human*", in the sense that their purposeful behaviour was more like the unreflective and instinctive behaviour of hominoid apes (albeit inquisitive, productive, and reproductive in alien temperate latitudes), rather than humanly self-organizing, with intentionally self-generated choices made between different activities, and communicated, stored, and accumulated differentially (and inter-generationally) within different social systems. The simple-minded notion is directly challenged by the findings at Cueva Negra which show that its denizens could and did choose between alternative chains of Palaeolithic behaviour: namely, sometimes to flake a flattish limestone cobble into a bifacial hand-axe roughly similar to it in shape and size, or sometimes to reduce a muffin-shaped nodule, whether of chert or limestone, by repetitive flaking in order to remove flakes of shapes and sizes that could not be envisaged by simply looking at the nodule beforehand (Walker, 2009).

Put another way, it is likely that *Homo* individuals who dispersed into Eurasia over a million years ago already had brains that allowed choices to be made between undertaking very time-consuming alternative chains of complex behaviour leading to greatly deferred rewards that were by no means predictable, let alone guaranteed. Especially interesting are behavioural chains with self-determining or self-constraining properties in so far as choices taken in order to embark on the activity of the next link set both the scope of, and limits to, what may be undertaken thereafter. Our awareness of the limits can stimulate recursive attention being paid to previously unnoticed opportunities for exploration in earlier parts of a chain once it ceases to be seen as defining a single, exclusive pattern of behaviour and begins to be seen as allowing alternative behaviour at will (what some psychologists call "second-order cognitions"). Regarding cognitive evolution in Early Pleistocene *Homo*, where sequential chains of behaviour can be inferred from the Palaeolithic record, as at Cueva Negra, it is more prudent to consider it in hypothetical contexts of *evolving populations*, than to attribute an entire chain one or more contemporaneous individuals.

The cognitive and manual technical skills must have involved recruitment of neuronal circuits in the brain, most particularly ones concerned with storage in active or working memory of "haptic" (tactile) stimuli and the nigh-instantaneous appropriate manual responses to them, as well as others concerned with imitation of actions, and the control and integration of all of those, not to mention the detection, and even anticipation, of errors or appropriate deviation from anticipated practice. Areas of prefrontal cerebral cortex, parietal cortex and adjacent temporal cortex, were surely involved, including the so-called "mirror" neurones and "canonical" neurones. Even at neuronal levels of basic tactile representation in the parietal cortex of monkeys, electrophysiological recordings from single cells,

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during psychophysical experiments into the interaction of touch with inputs from sight and sound, show that those neurones respond as "*components of a larger network of polymodal perceptual memory… at the service of the temporal integration of behavior*" (Fuster, 1999 [1995], p. 208). When a monkey performs discrimination tasks involving touch and sight, its attentiveness leads to enhancement of the active or working tactile memory, for which those neurones are fundamental building-blocks, whereas if it is distracted from the task in hand its working memory is impeded; moreover, electrophysiological findings show that its attention to *tactile* stimuli has an even more noticeable effect than does its attention to *visual* ones in consolidating the corresponding cortical sensory neuronal responses, an effect, furthermore, which *increases with increasingly difficult tasks* (Romo and Salinas, 2001). This is *before* higher-level circuitry in the parietal, temporal and frontal lobes comes into play and brings to bear error-detection, adjustments to responses, anticipatory perceptual and attentional filtering, and without doubt prefrontal selective control and ordering of appropriate responses. Acquisition of manual skills implies their storage in so-called procedural or long-term memory (involving deeper-lying parts of the cerebral cortex, such as the hippocampus, parahippocampal cortex, and cingulate gyrus). Without going further into those matters here, endocasts of the brains of palaeospecies of *Homo* from the later Early Pleistocene demonstrate expansion of frontal and prefrontal cortex, parietal cortex and temporal cortex, vis-à-vis their size in australopithecines or chimpanzees.

The Palaeolithic record of stone artifacts suggests that attention should be turned to considering the primacy of tactile perception, "haptic" memory and versatile manual dexterity. Speech and language may have been unimportant in transmission of manual skills. Nevertheless, they may have been necessary in choosing what to do, why it should be done, where to go to do it, who should do it, what outcomes and consequences might be anticipated, and so on. The ability to make choices between alternative complex chains of behaviour that we know how to perform may be a more significant criterion by which to recognize Palaeolithic humankind than was its capacity for symbolic thinking expressed in artificial marks or through language. Even in the cognitive sciences there is a tendency, in regard to human evolution, to pay far more attention to visual and linguistic aspects of brain function, memory, and corresponding behavioural responses, than to "haptic", tactile or palpatory aspects.

The facilitative part language could have played raises a question of whether fluency might have increased as human populations increased. Selection pressure for fluency could have been an outcome of exponentially-increasing interactions between growing numbers of people. Perhaps, in those later Middle Pleistocene communities which underwent greatest demographic growth, the acceleration in both rate and frequency of interpersonal discourse gave rise to positive feedback, in non-linear fashion, with cascade effects, thereby further channelling those lines of future self-organization that would be followed, with abandonment of others. Perhaps one that would be followed was a growing tendency towards *débitage* assemblages and production of these especially by secant-plane techniques, perception of which could have gone hand in hand with neuroanatomical exaptations in brain-circuitry favouring non-linear evolution, in self-organizing manner, in large-brained, later Middle and early Late Pleistocene *Homo*. If natural selection came into play at both biological and behavioural levels, advantages accruing from increasingly *débitage* assemblages may have permitted growing demographic abundance, density, and proximity of communities in Africa, south-western Asia and Europe, favouring an increase in interpersonal contact and discourse.

On the long time-scale of the Early and Middle Pleistocene, sequential chains of behaviour could well have involved multiple actors, whether together, or separated discretely in time or space. Just as with palaeobiological evolutionary interpretations of skeletal fossils, so too can behavioural chains be interpreted in terms of the palaeoethological evolution in *Homo* of evolving *populations*. It is a different approach from that which assumes tacitly that separate *individual* stone-knappers were responsible, *personally*, for the different reduction sequences ("*chaînes opératoires*") inferred from archaeological analysis of stone tools and knapping waste at a site. How does the populational palaeoethological approach differ?

This is how. Imagine that, while ploughing a field, a mediaeval Italian peasant found a Roman coin or a small Greek vase. Despite obvious differences from anything being made in mediaeval Italy, he surely was aware of aspects of the functions plausibly fulfilled by his finds, notwithstanding his ignorance – this is important – of their *historical–social–economical–political–cultural–literary* context, which was utterly beyond his imagination, though he *could* imagine what *might still* be done with the objects (obtain recompense for a coin found as "treasure trove" surrendered to the authorities; place the strange vase on his child's grave). This awareness is both a consequence of our long-term or procedural memory, sometimes also called "episodic" memory" because we can recall episodes from our past, and also of our ability, by reference or contrast to it, for self-generated thought, self-awareness, conjecture, imagination, and dreams.

That was an example of a *chain of behavioural activity that comprised sequential links, involving different actors separated in time by many generations*. What we identify as "Palaeolithic artifacts" are outcomes of modification of one object by undeniable manipulation of another (rather than due to natural agency), though they hardly imply one palaeospecies of *Homo* rather than another, nor yet "intention" as regards ostensive tool-form or use (or as regards absence of form in the case of knapping waste). Where signs of undeniable manipulation elude us, we have no way of telling, of course, whether a fractured stone was an "artifact" in that sense, or was not.

8. Conclusion B, re-thinking Palaeolithic chronology

In the light of what has just been proposed, we can appreciate the vacuity of notions that attempt to reduce the Palaeolithic past to a penecontemporaneous human scale, whether quasi-historicist or quasi-ethnological (cf. Murray and Walker, 1988), by pretending to regard as "traditions" or "cultures" such technical descriptors, or classifiers, as "*Acheulian*", "*Levalloisian*", and "*Mousterian*".[3] These

[3] These are no more than referential names, or indexial classifiers, conferred by archaeologists in order to facilitate discourse about things that share definable characteristics, in the same way that we distinguish between "horse" and "mouse", or "spoon" and "kettle". It is imprudent to confer on them preconceived notions, whether about the spatio-temporal relationships (if any) between the material objects of a class, their relationships with particular palaeospecies of *Homo*, or the intentions of their makers (e.g. whether the artifact was intended to represent a finished tool, whether it was a by-product of flake production, or both). In this context "*intentionality should be interpreted less in terms of a single individual's fully self-aware intentions, and more, by reference to evolutionary biology, as results and by-products of deterministical chains of complex activities that afforded tried-and-tested adaptive value to evolving hominin populations (societies or communities? – perhaps these words imply more than we have a right to infer) which as yet possessed only an emergent cognitive capability that was unspoken and unconscious, not yet self-aware or spoken aloud, though perhaps this itself might have been an exaptation that reflected the coopting of brain circuitry, which similarly may well have enabled dispersal of social groups of Plio-Pleistocene hominins* (cf. Gamble, 1993: 99, 111)" (Walker, 2009). Palaeolithic archaeology is plagued by the epistemological problems that arise from conflating the normative methodology of taxonomy with ontological conjectures about the taxonomical elements defined, and the matter is discussed further elsewhere with regard to "*Acheulian*", "*Levalloisian*" and "*Mousterian*" (Walker, 2009).

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"***Mysterians***" are a figment of feeble-mindedness, or at least simple-mindedness. Without begging more questions than they answer, notions of Pleistocene "traditions", let alone Palaeolithic "cultures" fail to be archaeologically helpful, let alone useful, in interpreting either bifacially-flaked hand-axes (McCarthy, 1976, p. 21, 24 Fig. 8) or "*Levalloisian*" flakes from Australia (Dortch and Bordes, 1977), none of which can be older than 50,000 a (0.05 Ma) at most, or the elongated points on facetted-platform flakes, with an uncanny resemblance to *Levalloiso-Mousterian* forms, from the Indonesian island of Sulawesi at about the time of the last glacial maximum 20,000 a (0.02 Ma) (Glover, 1981). These cases are not offered in a spirit of facetious comment. Rather, they highlight a fundamental epistemological issue: namely, if such outlandish instances are dismissed out of hand as being merely "exceptions to the rules", then how many other exceptions might there have been during the Pleistocene? Anyway, what rules are supposed to have existed? Why? Where? When? How? As other Palaeolithic specialists who have taken a world view have pointed out, there are not too many ways to flake stones which leave irrefutable traces on them of artificial knapping (cf. Noble and Davidson, 1996; Clark and Riel-Salvatore, 2006).

Bifacially-flaked "*Acheulian*" hand-axes appear between 1,500,000 and 1,200,000 a (1.5 and 1.2 Ma) in East Africa at Konso-Gardula (Asfaw et al., 1992) and Peninj (Isaac and Curtis, 1974), and only slightly later 1,400,000–1,200,000 a (1.4–1.2 Ma) in Israel at 'Ubeidiya in layers stratified above others containing chopping tools (Bar-Yosef and Goren-Inbar, 1993). By 780,000 a (0.78 Ma) hand-axes and cleavers were fashioned on large flakes at Gesher Benot Ya'aqov in Israel (Goren-Inbar and Saragusti, 1996; Goren-Inbar et al., 2000). Hand-axes and cleavers have been excavated in India at Attirampakan from a deposit estimated by ^{26}Al–^{10}Be cosmogenic nuclide analysis to have a pooled average age of 1,510,000 ± 70,000 a (1.51 ± 0.07 Ma) and certainly older than 1,070,000 a (1.07 Ma) (Pappu et al., 2011), and at Isampur, where electron spin resonance suggests an age of 1,270,000 ± 17,000 a (1.27 ± 0.17 Ma) and unlikely to be younger than 730,000 a (0.73 Ma) (Paddaya et al., 2002), hand-axes and cleavers were fashioned both from limestone flakes and "*slab-like nodules*" (Paddaya et al., 2006, 65, Figs. 23 and 24), which perhaps is interesting in the light of the limestone hand-axe at Cueva Negra. Other early "*Acheulean*" finds in the subcontinent seem to be later than the Matuyama-Brunhes boundary (Dennell, 2009, pp. 339, 375). The cognitive processes involved in bifacial techniques were doubtless common to early forms of *Homo* across Eurasia. Although bifaces from the Bose Basin in China were fashioned on both cobbles and flakes, "*it seems unwise to press too closely any cultural connections with the Acheulean: after all, there is no reason that indigenous populations of* Homo erectus *would have been incapable of producing large flakes or flaking bifacially*" (Dennell, 2009, p. 421). Quite so. Whilst the contemporaneity of the Bose artifacts with the tektites dated there by ^{40}Ar–^{39}Ar to 800,000–780,000 a (0.8–0.78 Ma) (Hou et al., 2000) has been questioned, a balanced opinion is that their contemporaneity is probably acceptable (Dennell, 2009, p. 422).

Large flakes were commonly used for fashioning African hand-axes and cleavers; pre-planned removal of the large flakes was widespread, maybe implying cognitive processes in early *Homo* related to those involved in bifacial fashioning. In the Middle Pleistocene, large flakes were used to fashion cleavers found at some Spanish and southern French sites, and further north in Europe hand-axes were not infrequently made on large flakes, despite a predominance of hand-axes fashioned from nodules (especially of good flint), as also occasionally were cleavers (Villa, 1983: pp. 204–205 and refs).

Returning to Western Europe, from an anecdotal standpoint of formal comparisons with Cueva Negra, it was mentioned earlier that at the French Middle Pleistocene rock-shelter in the Pyrenean foothills of Caune de l'Arago, where a deep sedimentary fill commenced at 694,000 a (0.694 Ma), the earliest biface was excavated in a layer corresponding to marine oxygen isotope stage 14 (Barsky and de Lumley, 2010). Forty years ago a biface and a chopping tool, fashioned on flat cobbles of chert, were excavated at the site in an assemblage mainly consisting of small artifacts (the biface is shown in de Lumley, 1971, p. 307, Fig. 275). From La Tourasse, an open site near Montpellier, a biface on a flat cobble bears a extraordinarily striking resemblance to that from Cueva Negra (de Lumley, 1971, Fig. 174). Clearly, fashioning pebbles does not imply generic relationships between sites, regions, or continents, let alone those which may be separated by hundreds of thousands of years.

The notion of an "*Acheulian*" tradition or culture is too fantastical a conjecture to be worth entertaining seriously, at least in Eurasia, where its use as a short-hand way of referring to a European "Lower" Palaeolithic is quite simply inappropriate. What is true of the descriptor "*Acheulian*" applies no less to "*Levalloisian*" and "*Mousterian*" descriptors, which are inappropriate referents for invoking alleged traditions or cultures, as was pointed out in the Introduction. Cueva Negra underlines the inappropriateness of using those terms as short-hand ways of referring to a European "Middle" Palaeolithic. Indeed, at Cueva Negra the terms "Lower" and "Middle" Palaeolithic lose the sequential or chronological meaningfulness which is usually attributed to them. It should be pointed, perhaps, out that bifaces in Western Europe do not seem to be much in evidence before 500,000 a (0.5 Ma), though at Solana de Zamborino, which is less than 150 km south of Cueva Negra, they may not be very much later than the Matuyama-Brunhes boundary (Scott and Gibert, 2009). The Atapuerca Sima de los Huesos hand-axe and *H. heidelbergensis* seem to come from between 500,000 and 350,000 a (0.5–0.35 Ma) (cf. Bischoff et al., 2002), as do the Swanscombe and Boxgrove bifacial assemblages in England. As already mentioned, at Orgnac in France "*Acheulian*" bifaces and "*Levalloisian*" flaking were present 350,000–280,000 a (0.35–0.28 Ma), comparable in age to their earliest dated appearance in the Kenyan Kapthurin Formation.

Although the most egregious abuse of a Palaeolithic descriptor to imply an all-pervasive intercontinental tradition or culture is exemplified by the catch-all epithet of "*Acheulian*", the terms "*Levalloisian*" and "*Mousterian*" have hardly fared any better; indeed, they have suffered from a tendency to conflation, in so far as some writers seem to be of the opinion that "*Mousterian*" abrupt edge-retouch of flakes did not occur before "*Levalloisian*" flaking had already become well-established, whereas the High Lodge flake-tool assemblage of 500,000 a (0.5 Ma) contradicts that. There is an unwillingness to put to sleep the notion of a "Middle" Palaeolithic "*Mousterian culture*", stretching from the Atlantic Ocean to Central Asia, and taking in North Africa, a large part of East Africa, and at least the western part of the Indian subcontinent.

If, however, as seems likely, there is a cognitive relationship between secant-plane control of stone-knapping in both "*Acheulian*" bifacial flaking and "*Levalloisian*" core-reduction and flake-removal, and if "*Mousteroid*" abrupt retouch were both to serve the purposes of strengthening the working edges of feathered flakes and forming acutely-angled working edges on the perpendicular margins of small pieces, then the three technological descriptors become convenient short-hand ways of characterizing different aspects of a single assemblage such as that from Cueva Negra, instead of vying for pride of place as alternative Procrustean beds onto which Palaeolithic findings have to be racked into shape by archaeologists. If, moreover, bipolar core-reduction also was

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practised widely at Cueva Negra, as the "*becs*" and "proto-*limaces*" suggest, then the versatility of both cognitive and technical manual skills shed new light on early human adaptations for survival in late early Pleistocene Europe.

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