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# Assemblages with bifacial tools in Eurasia (second part). What is going on in the East? Data from India, Eastern Asia and Southeast Asia

## *Assemblanges à outils bifaciaux en Eurasie (deuxième partie). Que se passe-t-il à l'Est ? Données sur l'Inde, l'Asie de l'Est et l'Asie du Sud-Est*

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ABSTRACT

This second paper is part of a wider review of lithic complexes with bifacial technology, and is devoted to the Asian sector, from India to the south-eastern mainland and the archipelagos and China. For India, sites such as Attirampakham, Isampur, Morgaon and Singi-Talav are described in detail. For China, sites in the Bose Basin, but also Liangshan, Longgangsi and Houfang are included in discussions of technological strategies that are found a long way from East African roots. For the Southeast, discoveries from Thailand and Cambodia are presented, as are some major Indonesian sites (for instance Nebung and the Sangiran dome).



RÉSUMÉ

Cette deuxième partie concerne l'Inde, le Sud-Est asiatique (continent et archipels) et la Chine. Pour l'Inde, les sites d'Attirampakham, Isampur, Morgaon et Singi-Talav sont détaillés. Pour la Chine, les sites du bassin de Bose, mais également Longgangsi et Houfang, permettent de discuter des stratégies technologiques loin des racines africaines. Pour le

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Asie du Sud-Est
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Sud-Est, les découvertes en Thaïlande et au Cambodge sont examinées, de même que celles sur certains sites majeurs indonésiens, comme Ngebung et le dôme de Sangiran.


## 1. Introduction

This second paper is devoted to what is going on in the East. Recent discoveries in Asia indicate that assemblages with bifacial tools cover large areas of Asia from the Middle Pleistocene to the Upper Pleistocene, from 800 ka to 40 ka (Fig. 1). These series are assigned to the Acheulean or local traditions although the question of their origin is subject to widespread debate (Movius, 1944, 1948, 1949). Despite at times the lack of reliable data, key sites have been selected in India, Southeast Asia and China in order to review the different technological strategies in relation to their chronological and stratigraphic frameworks.

## 2. Bifacial tools east of the Levant (second part)

### 2.1. South Asia

Acheulean sites or at least "Acheulean" occurrences are numerous in South Asia (Gaillard, 2006). They are characterised by handaxes and cleavers comparable to those found in Africa. Although they have been known for a long time, the crucial question of their chronology remains unresolved in most cases; due to generally thin stratigraphic sequences and poor faunal preservation. However, improvements in fieldwork and progress in dating methods over the past two decades point towards a Lower Pleistocene timeframe for the onset of the South Asian Acheulean.

Interestingly, one of the main sites described one and a half centuries ago (Foote, 1868) has recently become the reference point for the early out of Africa Acheulean. The Paleolithic localities along the Attirampakkam Stream, a small tributary of the Kortallayar River, have been under reinvestigation since 1999 (Pappu, 2001) and several trenches and horizontal excavations have been opened. The deepest trenches yielded quartzite artefacts and measurements of the $^{26}Al/^{10}Be$ ratio of these tools assess their burial age. The results provide an average age of $1.51 \pm 0.07$ Ma, corroborated by reverse paleomagnetism (Pappu et al., 2011).

At Attirampakkam, the Acheulean industry is made from local fine to coarse quartzite. Apart from the large cores from which large flakes were detached, which are missing from the site, all the stages of lithic production are present. Trench T8, for example, provided 3528 artefacts from Acheulean levels (layers 6 to 8), of which 95% are ordinary debitage products (< 10 cm), alongside a few flakes resulting from handaxe shaping. The remaining 5% are mostly large flakes (> 10 cm), half of which were shaped into handaxes (1.4% of the assemblage), or cleavers (0.6%) with a few trihedrals ($n$ = 6), while the other half was minimally retouched or used (Pappu et al., 2011).

The rich complex of sites in the Hunsgi and Baichbal valleys allows researchers to trace technical evolution from the Early to Late Acheulean in this sector of north-western Karnataka (Paddayya, 2008) and to present hypotheses regarding the seasonal movements of Lower Paleolithic populations (Paddayya, 2014). Quartzite is not available in these valleys, except in the form of pebbles from the overlooking Trappean plateau. Silicified limestone is thus used instead, especially at Isampur in the Hunsgi Valley. A few faunal remains have been preserved and the ESR dating of three enamel samples from bovine teeth resulted in a mean age of 1.2 Ma.

Trench 1 yielded 13,043 artefacts, of which 92% are "incidental" products (flakes and debris including products >5 mm from sieving). The industry results from the exploitation of silicified limestone slabs, up to 1 m long, directly quarried at the site itself. Knappers started the reduction sequence on protruding slab corners and these opening removals on the profile then served as striking platforms for flake production, using unifacial or bifacial methods. The resulting flakes (excluding the "incidental products") are mostly side-struck (technically short). Altogether, they average 18 cm long. The shaped tools in this assemblage comprise 48 handaxes, 15 cleavers, 18 knives, 3 discoids, 14 chopping-tools and 65 scrapers. Half of the handaxes (26/48) are made from slabs or cobbles, while the other half (22/45) are made on flakes. Cleavers and knives are on flakes, except two cleavers on slabs. These larger tools are mostly in silicified limestone while the scrapers, usually on flakes (49/65), are in chert or quartzite (Paddayya et al., 2002, 2006).

Isampur is one of the "core activity spots" in the Hunsgi Valley beside many small sites and "non-sites" (occurrence of one or several artefacts). Acheulean-making human groups settled directly on raw material sources. Cleavers are made on flakes, whereas handaxes are often made on other opportunistic blanks.

Morgaon (Pune district, Maharashtra) is one of the rare Acheulean sites in the Deccan Trap region, as basalt is generally subject to weathering and the slightest reworking completely destroys basalt artefacts (Mishra, 1982). They can thus only be preserved in situ (Deo et al., 2007; Mishra et al., 2009). The stratigraphic sequence is of alluvial origin suggesting that Acheulean-making populations settled near a stream. The main Acheulean level is at the surface of black fissured clay, about 2 m thick. A few more fresh and abraded artefacts occurred in sandy pebbly gravel above the clay, including two well-preserved cleavers. Below the clay lies gravel with cobbles and boulders where some laterite pebbles indicate former lateritic formations, now eroded away from the landscape. Such formations are widespread in the western part of the Deccan Traps and often yield Acheulean artefacts (Rajaguru et al., 2004). They usually lie on weathered basaltic bedrock, as at Morgaon.

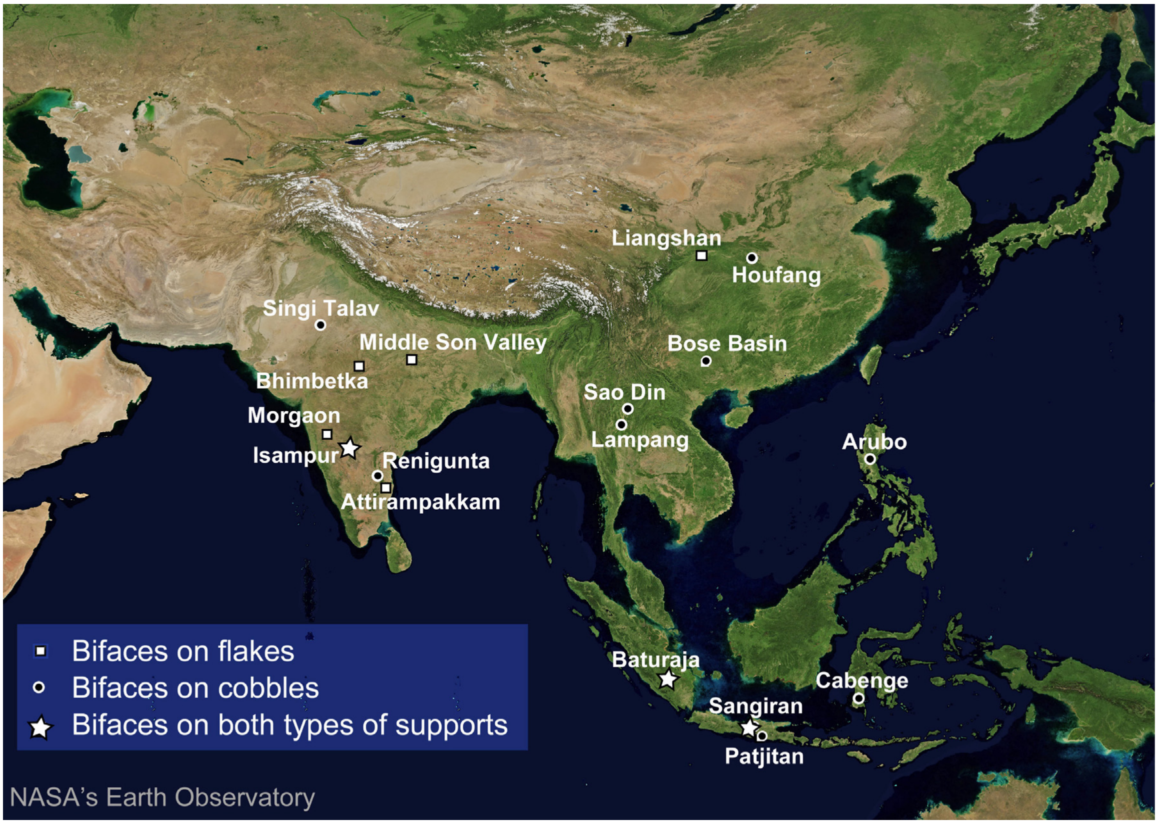


**Fig. 1.** Map of East Eurasia showing the location of the sites mentioned in the text (according to the type of blank for the bifacial tools).
**Fig. 1.** Carte de l'Eurasie orientale avec la localisation des sites mentionnés dans le texte (selon le type de support pour les outils bifaciaux).

Lenses of tephra occur below and within the black-fissured clay. Paleomagnetic studies show that the black clay and the overlying levels have registered at least two magnetic imprints considered to be Matuyama and Bruhnes. The tephra is earlier than the Acheulean occupation, but not much earlier given its position in the stratigraphy. Dating attempts conclude that it is about 800 ka and corresponds to the Old Toba Tephra (Haslam and Petraglia, 2010; Westaway et al., 2011).

Besides the surface collection, 180 artefacts were unearthed from a 4 × 8 m trench at the top of the black clay (Fig. 2). They were made from local basalt available in the form of "core stones" resulting from the weathering of originally prismatic basalt blocks. The assemblage is mainly characterised by large flakes, either directly struck from "core stones" (double patina), or from very large flakes, implying Kombewa reduction. A few of these large flakes were roughly shaped into cleavers. Some rare handaxes were found on the surface only.

Acheulean artefacts were collected from several places around Didwana (Nagaur district, Rajasthan) (Mishra et al., 1982; Mishra and Rajaguru, 1986). The first discoveries occurred in calcrete quarries, especially at Singi-Talav (Didwana) and in the neighbouring village of Amarpura (3 km apart). These calcretes result from pedogenic processes and calcium carbonate precipitation within originally silty clayey sediments with some lenses of sand (Dhir, 1995), suggesting a landscape with abundant bodies of water (inherited from a drainage system disrupted by tectonic tilting in the Late Tertiary). The climate was already semi-arid with alternating dryer and slightly wetter phases. In Amarpura, the calcrete formation reaches a thickness of 12 m. One meter below the top of this formation, a sample was dated to 800 ka (Kailath et al., 2000). The Singi Talav sequence has been correlated with the middle of the Amarpura sequence on the basis of topograpy and lithology.

Acheulean populations settled near a possibly seasonal lake. The two main layers (3 and 4) have yielded Acheulean industry made from metamorphic rocks, mainly quartzite, brought from 3 km away (Fig. 2). However, a few cobbles were also used, which appear to come from 20 km away, based on the closest known source today (Gaillard et al., 1983, 1986, 2010). The assemblages from the two Acheulean layers do not differ much, except for a decrease in the proportion of handaxes in the upper layer (3% in layer 4 as opposed to 1% in layer 3, among 891 and 401 artefacts respectively), and a concomitant increase in cores. Flakes and debris, in equal proportions, are the main component of this industry (80%). The flakes were usually struck from rather homogeneous quartzite while the large cutting tools (mostly handaxes) were struck or split from schistose quartzite, yielding slabs rather than flakes. For the spheroids, polyhedrons and hammerstones, medium to coarse-grained quartzite cobbles were preferentially used. The handaxes and rare cleavers are sometimes very roughly

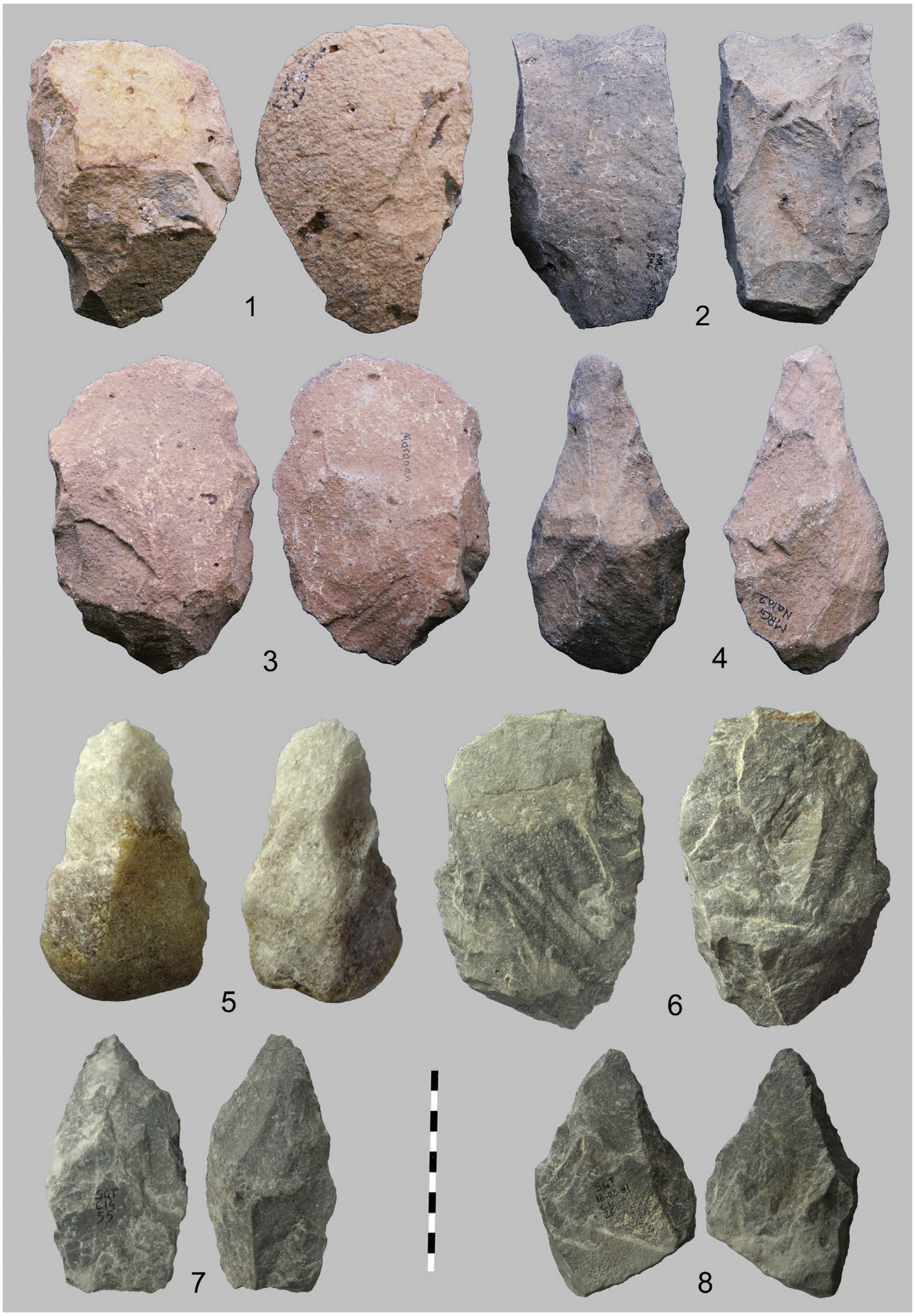


**Fig. 2.** Bifaces from South Asia: 1 to 4, cleavers and a handaxe from Morgaon; 5 to 8, handaxes and a cleaver from Singi Talav (at Didwana).
**Fig. 2.** Bifaces de l'Asie du Sud : 1 à 4, hachereaux et biface de Morgaon (Inde) ; 5 à 8, bifaces et hachereau de Singi Talav (Didwana).

worked, as the original rectangular or rhombic shape of the slabs provides readymade thin, symmetrical and often pointed tools (Gaillard, 1993; Gaillard et al., 1983, 1986).

Hominins probably established their camp at Singi Talav in the late Lower Pleistocene due to nearby water availability. Lithic raw materials were totally absent in the immediate surroundings and were collected at least 3 km from the site. There is no production or importation of large flakes, apart from two large flakes or splits, transformed into cleavers. The handaxes are made with

**Table 1**
Fengshudao artifact categories: frequencies and descriptive data.
**Tableau 1**
Catégories d'artefacts à Fengshudao : fréquences et données descriptives.

| Artifact | $n = 155$ | L | s.d. | Wt | s.d. | T | s.d. | Wt | s.d. |
|---|---|---|---|---|---|---|---|---|---|
| Core | 11 | 105.98 | 48.20 | 83.41 | 38.76 | 56.59 | 18.30 | 662.64 | 743.04 |
| Flake | 17 | 71.10 | 34.72 | 53.18 | 21.29 | 19.86 | 8.75 | 93.94 | 97.59 |
| Bipolar core | 4 | 43.22 | 12.17 | 27.46 | 8.72 | 23.10 | 8.69 | 27.25 | 19.96 |
| Bipolar flake | 13 | 29.90 | 11.12 | 22.55 | 11.17 | 10.32 | 10.32 | 7.39 | 11.54 |
| Chopper | 3 | 136.01 | 10.95 | 131.99 | 19.31 | 74.97 | 13.86 | 1372.00 | 154.03 |
| Scraper | 2 | 115.90 | 10.35 | 83.32 | 6.52 | 35.38 | 4.89 | 374.50 | 156.27 |
| Pick | 1 | 149.14 | – | 101.26 | – | 73.86 | – | 896.00 | – |
| Handaxe | 5 | 166.02 | 33.60 | 109.51 | 22.78 | 73.24 | 14.37 | 1116.40 | 445.82 |
| Stone hammer | 6 | 112.14 | 16.75 | 102.79 | 14.89 | 79.39 | 8.01 | 1322.00 | 551.29 |
| Chipped-cobble | 36 | 115.47 | 32.05 | 92.96 | 28.59 | 66.94 | 23.94 | 1109.89 | 1240.16 |
| Debris | 30 | 83.37 | 44.93 | 60.07 | 35.97 | 37.07 | 24.93 | 418.07 | 629.08 |
| Manuports | 27 | 130.21 | 40.42 | 103.85 | 34.49 | 74.92 | 31.22 | 1804.11 | 1954.07 |

After Wang et al., 2014.
L: length; T: thickness; Wt: weight; s.d.: standard deviation.

minimal technical investment from slabs of schistous quartzite, selected for this purpose only, while ordinary debitage is on isotropic quartzite.

The Late Acheulean is known, for instance, in the Hunsgi and Baichbal valleys (Karnataka), the Renigunta region (Andhra Pradesh), Bhimbetka Shelter III-F-23, Middle Son Valley (Madhya Pradesh) and many other sites in peninsular India. In the Middle Son Valley, geological and archaeological studies began in the 1970s (Sharma and Clark, 1982, 1983; Williams and Royce, 1983; Williams et al., 2006) and are still in progress today (Haslam et al., 2012; Pal et al., 2005). Four geological formations have been identified, ranging from the Middle Pleistocene to the Late Holocene. Several localities have been excavated, each yielding several tens of artefacts (Kenoyer and Pal, 1983, Mishra et al., 1983). Recent OSL dating points to ages from the end of MIS 6 and the beginning of MIS 5 (Haslam et al., 2011). Artefacts seem to be confined to the colluvium deposits accumulated at the end of MIS 6, in a dryer climate than during MIS 5. These assemblages are made from local rocks, especially quartzite, collected a few kilometres away from the sites. They are composed of a few cleavers and refined handaxes alongside abundant flakes and cores of various types, including discoid cores. Many of the flakes are retouched, mostly into scrapers. These assemblages are considered as Latest Acheulean or Middle Palaeolithic, depending on the authors.

## 2.2. *East Asia: China*

### 2.2.1. *The sites in the Bose Basin*

The Bose Basin (western Guangxi Zhuang Autonomous Region, Southern China) comprises a complex of 113 Paleolithic sites (Huang et al., 2012; Lin and Xie, 2007). The bifaces were first discovered in 1973 (Li and You, 1975), yet it was a paper by Hou et al. (2000), some time later, that raised controversy over the age of bifaces, c.a. 803 ka, and the stratigraphy of bifaces in this region. Debates focus on whether the age of the tektites corresponds to that of the bifaces (Langbroek, 2015; Wang and Bae, 2014). Among the recently excavated Paleolithic sites in the Bose Basin, two provided further evidence confirming earlier conclusions as regards the age of the bifaces. Among these sites, two yielded relevant series.

*2.2.1.1. Fengshudao site.* Fengshudao, one of the laterite islands, was chosen for excavation due to the presence of abundant bifacially-worked implements found on the surface (Wang, 2014; Wang et al., 2014a, b, c). Nine tektites were excavated *in situ* in the sediments of Terrace 4 (T4). The sedimentary and stratigraphic context, composition, and morphology of the Fengshudao tektites suggest that they did not move very far after landing on the site. Therefore, anything found in T4 can be confidently associated with the tektites, which means that the age of the site should be around 803 ka. The excavated lithic assemblage is comprised of 155 artefacts, and all of the artefacts are restricted to T4 (level 3 of the site). The artefacts include cores, whole flakes, bipolar cores, bipolar flakes, scrapers, choppers, a pick, bifaces ($n = 5$), chipped cobbles, debitage and manuports ($n = 27$). Five bifacially worked implements were excavated *in situ*, and classified as bifaces. The percentage of bifacially worked implements (3.23%, calculated by the author) at Fengshudao is relatively high compared with the other Bose localities (Table 1).

*2.2.1.2. Damei Nanbanshan site.* The Nanbanshan (NBS) locality of the Damei site is located in the upper part of T4. In 2005, a rescue excavation was undertaken (Wang et al., 2008). In the laterite clays of the NBS locality, 155 tektites were discovered and no evidence indicates subsequent tektite transportation or re-deposition. Their primary context confirms the age of the artefacts found in the tektite layers (to be about 803 ka) (Wang et al., 2008).

176 stone pieces were recovered, including bifaces ($n = 2$), picks ($n = 9$), choppers, scrapers, flakes, cores and stone hammers. The raw materials used are quartzite (32%), quartz (14%), sandstone (43%), chert (6%) and pyrolith (5%). Bifaces, picks and choppers are relatively large in size. Scrapers are usually made on small cobbles or flakes. Flake shapes and sizes are varied, but most are small (the largest is 167 mm long) (Table 2).

*2.2.1.3. Lithic technological and techno-functional analysis of the Bose lithic series.* Six hundred and ninety-two

**Table 2**
Classes of stone artifacts from the Nanbanshan locality of the Damei site.
**Tableau 2**
Classes d'objets en pierre de la localité Nanbanshan du site Damei.

| Type | Handaxe | Pick | Chopper | Scraper | Flake | Core | Hammer |
|---|---|---|---|---|---|---|---|
| Amount | 2 | 9 | 13 | 30 | 35 | 17 | 12 |
| Size(mm)(L × W × T) | 155 × 119 × 75 | 160 × 93 × 74 | 136 × 127 × 64 | 74 × 74 × 30 | 62 × 57 × 20 | 138 × 98 × 65 | 109 × 87 × 58 |
| Weight (g) | 1285 | 1221 | 1313 | 202 | 128 | 1233 | 771 |

After Wang et al., 2008.

**Table 3**
Composition of lithic artifacts from the Bose Basin.
**Tableau 3**
Composition des artefacts lithiques du bassin de Bose.

| | Gaolingpo | | Nanbanshan | | Yangwu | | Total | |
|---|---|---|---|---|---|---|---|---|
| Debris | 16 | 6.5% | 14 | 7.3% | 0 | 0% | 30 | 4.3% |
| Fractured cobbles | 0 | 0% | 28 | 14.7% | 3 | 1.2% | 31 | 4.5% |
| Cobbles with several removals | 9 | 4% | 14 | 7.3% | 0 | 0% | 23 | 3.3% |
| Fragments of cobbles | 1 | 0% | 10 | 5.3% | 0 | 0% | 11 | 1.6% |
| Identifiable cores | 4 | 1.6% | 3 | 1.6% | 4 | 1.6% | 11 | 1.4% |
| Flakes | 115 | 46.6% | 44 | 23% | 25 | 9.8% | 184 | 26.6% |
| Fragments of flakes | 24 | 9.7% | 6 | 3.1% | 5 | 2% | 35 | 5.1% |
| Tools | 78 | 31.6% | 72 | 37.7% | 217 | 85.4% | 367 | 53% |
| Tools of *façonnage* | 74 | 30% | 67 | 35.1% | 197 | 77.6% | 338 | 48.7% |
| Tools on blank of flakes | 4 | 1.6% | 5 | 2.6% | 20 | 7.9% | 29 | 4.2% |
| Total | 247 | 100% | 191 | 100% | 254 | 100% | 692 | 100% |

After Bodin, 2011.

lithic artefacts were observed, including 254 pieces collected from the surface in 2003 near Yangwu village, 247 pieces from the Gaolingpo site and 191 pieces from the Damei Nanbanshan site, which yielded one bifacial piece in stratigraphical context (Bodin, 2011) (Table 3). The raw materials were almost exclusively cobbles, available in the basal conglomerates of T5 through to T7, which were exposed during the period of artefact manufacture and deposition on the T4 fluvial flood-plain before it was uplifted (Hou et al., 2000). These cobbles consisted of quartzite, sandstone, silicified rock, quartz, chert, conglomerate and basalt (Xie et al., 2003).

The first characteristic is the rarity of *debitage* operative schemes. We identified very few large flakes used as large tool blanks, and no cores producing such flakes were found in these lithic industries. Other core types are very rare and only produce a very small quantity of flakes. Shaping by-products (i.e., flakes) were rarely used as tool blanks. Lithic production in the Bose Basin mainly followed the shaping concept.

The presence of bifacial knapping was extremely sporadic in lithic production, occupying only 4.9% of the tools (Fig. 3). Four pieces evidence bifacial knapping (two with macro-denticulated cutting edges and two chopping-tools). Bifacial tools only make up 6% of the tools. In addition, such tools were intentionally selected during surface investigations. If we take the data from the scientifically excavated sites into consideration (*i.e.* Nanbanshan site), the percentage of bifacial pieces in the assemblage does not exceed 2.7% and tools were characterised by unifacial knapping. However, marked variability is also apparent, with two distinct *shaping* concepts: one for unifacial tools with transverse cutting edges and the other for convergent tools, with unifacial or bifacial knapping, where a distal extremity is associated with one or two longitudinal cutting edges (Fig. 4).

### 2.2.2. *Liangshan Longgangsi Site*

Liangshan (Nanzheng County, Shaanxi Province, south of Hanzhong Basin, on the upper reaches of the Hanshui River Valley) contains dozens of Paleolithic localities (Hanshui, 1985; Tang et al., 1987), including Dabagou locality (Tang et al., 1987) and Longgangsi, which is the best known site (Huang and Qi, 1987; Yan, 1980). Artefacts were mainly found in Layers 2 and 3 on T3 (Huang and Qi, 1987; Tang et al., 1987).

The Longgangsi site is dated by TT-OSL to around 600 ka (Sun et al., 2012). This site yielded more than 120 stone artefacts, which may not be related to the age of 600 ka. Recent work by Wang et al. (2014) in the Hanzhong Basin has provided new data on the series with bifacial technology. The raw materials were dominated by quartz cobbles, followed by quartzite and volcanic rocks, which were all available on the riverbed located at the bottom of T3 (Huang and Qi, 1987; Tang et al., 1987). The lithic assemblage comprised cores (26.45%), flakes (19.83%), tools (53.72%) and stone hammers (1.65%). The tools include choppers and chopping-tools, spheroids, picks, scrapers, notches, borers and bifaces, with a predominance of heavy-duty tools (ca. 44%, calculated after Lu et al., 2006).

Two types of *debitage* systems were applied to obtain flakes. The first type, sometimes called "unipolar flaking" included two operative schemes. Operative Scheme 1 (Type C, Boëda, 2013) consisted of removing flakes from ovoid cobbles (6–10 cm in diameter) along the periphery of a flat natural surface, mostly cortical, but sometimes along fissures, which served as a platform. When this natural platform was absent, the block was usually fractured

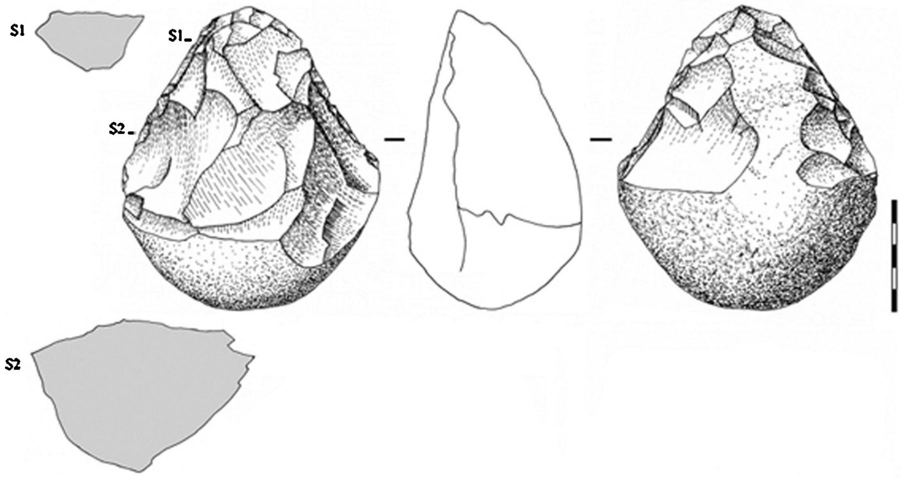


**Fig. 3.** Bifacial piece collected from the Gaolingpo site. S1, Transverse section on mesial part; S2, transverse section on distal part. The tool is thick, not elongated, with a bi-plan/very convex transverse section on the mesial part and a cutting edge on the distal extremity associated with two longitudinal cutting edges.

**Fig. 3.** Pièce bifaciale collectée sur le site de Gaolingpo. S1, Section transverse sur la partie mésiale ; S2, section transverse sur la partie distale. L'outil est épais, court, avec une section transverse biplane/très convexe sur la partie mésiale et un tranchant sur l'extrémité distale, associé à deux tranchants longitudinaux.

into two parts, producing a single large negative removal, which was then used as a platform. The convexity was formed mainly by natural cobble surfaces and by recurrent removals intersecting on the *debitage* surface. Operative Scheme 2 (discoid or Type E1, Boëda, 2013) consisted in producing flakes from a flatter cobble and changing flaking direction more frequently than in operative Scheme 1. Convexity was less pronounced and usually formed by two surfaces or recurrent negatives intersecting on the *debitage* surface. For both operative schemes, the *debitage* series

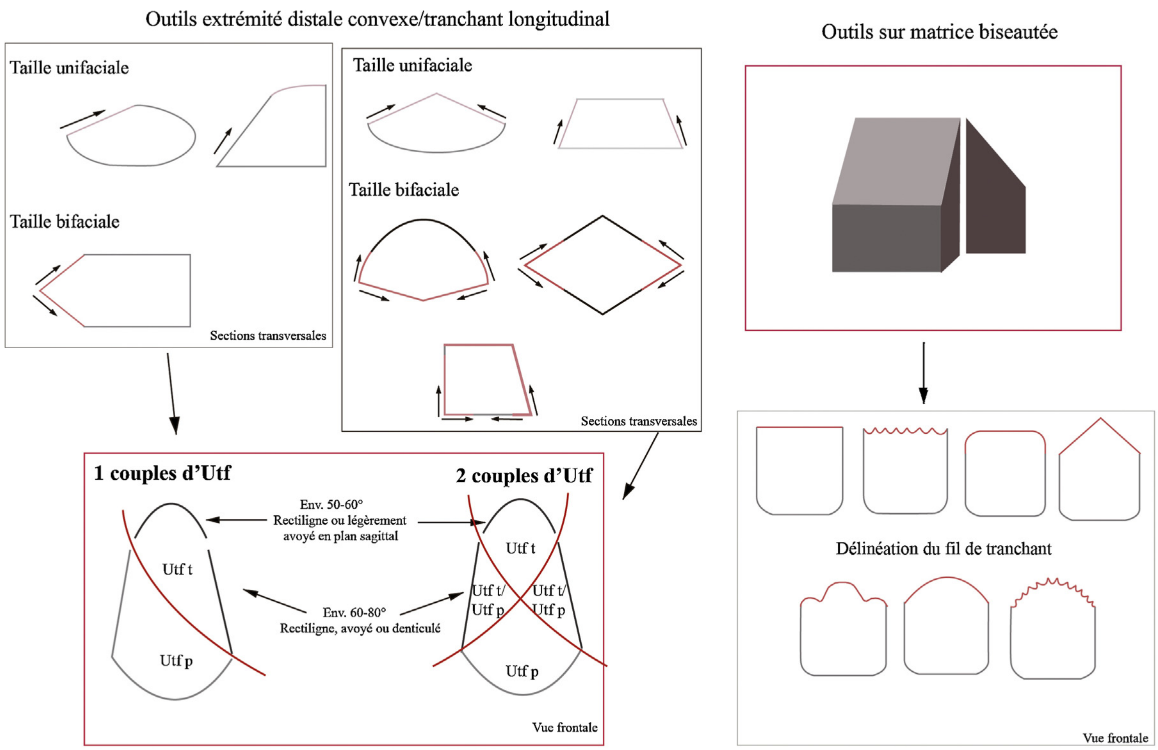


**Fig. 4.** Variability of manufacture in the lithic production of the Bose Basin: convergent tools with unifacial or bifacial knapping and unifacial tools with transverse cutting edges.

**Fig. 4.** Variabilité de l'aménagement des produits lithiques de sites du bassin de Bose : outils convergents avec un façonnage unifacial ou bifacial et des outils unifaciaux avec des tranchants transverses.

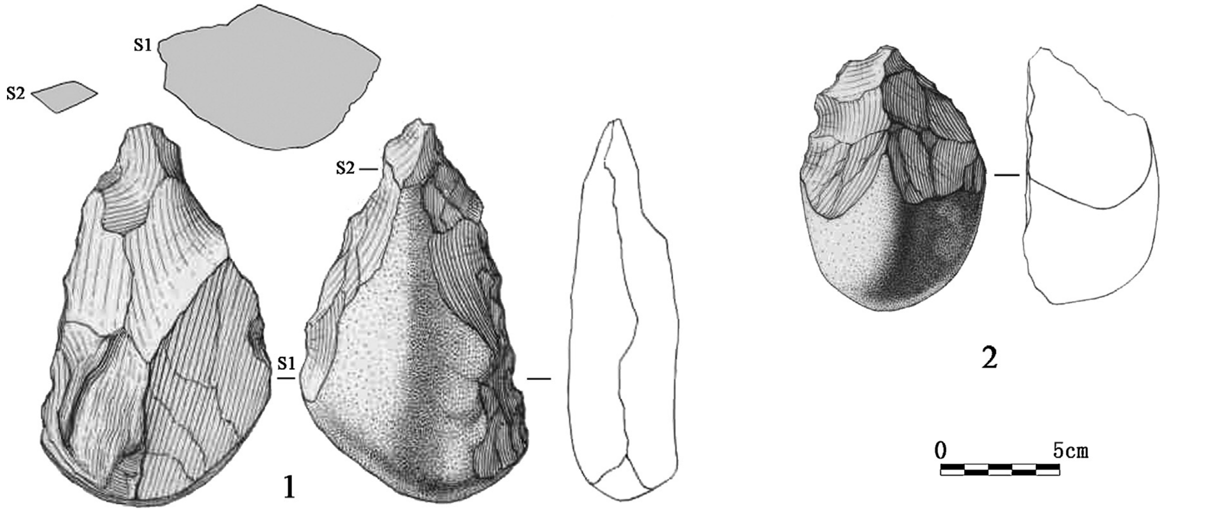


**Fig. 5.** Bifacial and unifacial pieces from the Liangshan Longgangsi site. S1, Transverse section on mesial part; S2, transverse section on distal part. 1, Bifacial piece with convergent cutting edge (P6211). 2, Unifacial piece with convergent cutting edge (denticulate pick) (P6294).
**Fig. 5.** Pièces bifaciales et unifaciales du site de Liangshan Longgangsi. S1, Section transverse sur la partie mésiale; S2, section transverse sur la partie distale. 1, Pièce bifacial avec des tranchants convergents (P6211). 2, Pièce unifaciale avec des tranchants convergents (pic denticulé) (P6294).
*Re-edited after Lu et al., 2006.*

on a single core comprise no more than seven (usually three) removals and less than three flakes were generally obtained in a single flaking series (Fig. 5).

As for shaping, several operative schemes were used to manufacture heavy-duty tools, including operative Scheme 1 (on a simple level matrix), operative Scheme 2 (on a double-levelled matrix), operative Scheme 3 (unifacially-knapped and with a convergent cutting edge on the distal part), operative Scheme 4 (bifacially-knapped and with a convergent cutting edge on the distal part) (Fig. 4), operative Scheme 5 (tools with a longitudinal cutting edge), and operative Scheme 6 (spheroids). For operative Scheme 4 (evidenced by only one typical biface), the blank was a flake with a naturally convex dorsal face. From the ventral face of the flake a series of unipolar flakes were removed in a direction perpendicular to the morphological axis of the flake and then three smaller removals were produced to create a convergent shape on the distal part. As a result, the transverse sections on the mesial and distal parts were respectively biplan/convex (S1) and biplan/biplan (S2) (Fig. 5). Retouch was absent because the cutting edge was suitable for use as soon as the shaping process was finished.

### 2.2.3. *The Houfang site*

In the Hanshui Vally, ten sites have been excavated and a considerable number of bifaces were collected from the surfaces. We will focus on the example of the Houfang site (Wangjiashan Village, Qingqu Town, 20 km west of Yunxian County in Hubei Province), discovered in 1994 during the surveys undertaken by IVPP (Li, 1998). The Houfang site is situated on the left bank of the upper reaches of the Hanshui River. The geological formation of this region is mainly made up of Paleozoic metamorphic rock series, overlain by Tertiary red rock series near Yunxian County (Shen, 1956). Four Pleistocene terraces developed along the valley near the site, closely related to the Qinghai-Tibet Plateau uplift and the development of the Hanshui River. These four terraces are respectively situated 50 m, 40 m, 25 m and 10 m above the old river level. Except for the first terrace, the fluvial gravel bed and coarse fluvial sands underlie Aeolian soils varying in thickness: 2–10 m on the second terrace, 1–5 m on the third and 20 m on the fourth terrace. The loess-paleosol sequences are particularly clear on the fourth terrace, in which 5–6 paleosol layers were identified. The stone artifacts of Houfang site are buried in the Aeolian soils of the second terrace. The fourth terrace can thus be attributed to late Early Pleistocene and early Middle Pleistocene. The Houfang site was buried in the second terrace, the surface of which is 185 m above sea level, with the gravel bed 170–175 m above sea level. The altitude of all stone artefacts is limited between 180 m and 185 m Thus it can be inferred that the Houfang site would have formed from the late Middle Pleistocene to the early Late Pleistocene, which corresponds well to the dating results.

Artefacts were unearthed respectively in Layers 2 and 3. We used the thermally transferred optically stimulated luminescence (TT-OSL) technique for dating quartz. This technique was first used by Wang et al. (2006a, 2006b, 2007), then subsequently modified to resolve some technical problems (Adamiec et al., 2010; Porat et al., 2009; Stevens et al., 2009; Sun et al., 2010, 2012, 2013; Tsukamoto et al., 2008). For the Houfanh site, Layer 2 containing bifaces was dated to 110-90 ka and Layer 3 appears to be younger than 180 ka.

A total of 162 stone artefacts with relatively sharp and fresh edges were unearthed from these two layers. Two pieces were refitted, indicating *in situ* deposition. The raw materials were exclusively local water rounded cobbles. The majority of raw materials were quartz, representing more than 70% of the whole assemblage, following by quartz sandstone, siltstone, quartz siltstone, arkose and sandstone. The lithic assemblage is mainly comprised of cores, flakes, retouched tools, bifaces, picks, choppers, hammers, hammer-anvils, chunks, fragments and unworked cobbles. The heavy-duty shaping tools include bifaces, picks and choppers, most of which were unearthed in Layer 2 ($n = 7$). The knapping technique was solely direct hard hammer percussion.

Two types of flaking methods were used to produce formal tool blanks; unipolar and bipolar. They are exclusively made from quartz, generally on medium-sized blanks. Retouched tools were made from bipolar products, unipolar flakes and cores, chunks, fragments and flakes removed during the production of shaped heavy-duty tools. Unworked cobbles were transported by hominins to the site.

Heavy-duty tools consisted of unifacial and bifacial pieces, classified into choppers, picks, backed bifaces and typical bifaces. The raw materials are exclusively non-quartz rocks, namely siltstone and quartz sandstone. All these tools are large in size, with a mean length of 147 mm.

The choppers were manufactured on quadrangular flat cobbles. Most of the surface is cortical and one face serves as a striking platform. For the pick, bifacial knapping was applied to non-symmetrical surfaces. On one face, a series of removals intentionally produced a flat surface, which served as a basic platform to create the cutting edge. The mesial part of the pick presents an approximately triangular (convex/plan) transverse section and a regular triangular section on the point. The bifacial tool with a back shows an irregularly trapezoidal transverse section on the mesial part and a triangular transverse section on the point and bears an irregularly long triangular profile. The two typical bifaces were products of symmetrically bifacial shaping (Figs. 6 and 7). Both of the specimens are thick, with a width/thickness ratio of approximately 1.4. Nearly 1/3 of the surface is cortical. After a series of bifacial knapping, the final tools present a double-wedged transverse section on the mesial part and the sagittal face, an irregular double-wedged transverse section on part of the cutting edge and a double-wedged profile. Both of the specimens present a convergent outline on the (subsequently broken) point and two independent cutting edges on the mesial part.

In general, unipolar and bipolar knapping were both applied, while the heavy-duty shaped tools were largely present in Layer 2 and nearly absent in Layer 3. It is clear that the knapper did not spend much energy initializing raw materials but invested considerable time and effort into cobble selection before the operation. The selected cobbles presented some suitable natural characteristics that were taken advantage of after knapping began.

#### *2.2.4. The Yunxian Man site*

In addition to chronometric analysis, geomorphologic investigation was also conducted around the site. In the upper reaches of the Hanshui River (from Shiquan to Danjiangkou city), about four fluvial terraces were well developed and comparable in different regions (Shen, 1956). The four terraces at Quyuanhekou (near the Yunxian Man site), very close to the Houfang site, can serve as a reference. Geomorphological and sediment analysis revealed that the craniums and lithic artifacts of Yunxian Man were buried in the fourth terrace, the surface of which is 200 m above sea level and 50 m above the old river level.

The Yunxian Man site is located 1.5 km south of the Houfang site. Two hominin skulls were discovered in 1989 and 1995. Fieldwork in the 1980s provided data on the paleoenvironmental context of the craniums (de Lumley and Li, 2008). According to paleomagnetic and ESR dating, the sediments at the Yunxian Man site were deposited during the 830–870 ka (Yan, 1993), 984–780 ka (de Lumley and Li, 2008) or 581 ± 93 ka time period (Chen et al., 1997). Recent work by Guo et al. (2013) shows that the levels of the Yunxian hominin fossils and other mammalian remains were formed around 800–785 ka. Hominins lived during a glacial to interglacial climatic transition.

### *2.3. Continental Southeast Asia: Thailand and Cambodia*

During the late 1960s, P. Sorensen claimed that early humans were present in northern Thailand. In the Lanna area, he highlighted an "archaic" assemblage with pebbles and scrapers made of silicified wood (Sorensen, 1981, 2001). This Thai Paleolithic culture was called the "Lannatian" and was controversially attributed to between 900–600 ka.

Fewer than ten pebble tools, choppers and quartzite flakes were discovered by G. Pope at the Lampang open-air site (Ban Don Mun and Ban Mae Thae, Pope et al., 1981, 1986, 1987), above a basaltic level estimated at 700 ka by paleomagnetism (Keates, 2002). The Ban Don Mun site (Lampang) was recently re-analysed and surveyed, and assigned a minimum age of 550 ka by K/Ar dating of the basaltic level (Forestier et al., 2008; Zeitoun et al., 2013). Pebble tools were located above this level. Recent discoveries of 25 new artefacts were added to the first series. They include numerous choppers with convex, convergent or transverse cutting edges, few chopping-tools, rare small flakes (<10 cm length), broken pebbles and only one trihedral pick.

Sao Din is another open-air site in Northeast Thailand (Na Noi Basin, see also Fig. 8.2). It presents an upper and lower alluvial terrace system comprising numerous stone artefacts. Zeitoun et al. (2008, 2012a, b) refer to more than 300 pieces in the lower part of the eroded section, 20 of which are stratigraphically located below a layer dated at 300 ka (minimum age estimated from paleomagnetism, ESR and OSL, Chenglong, pers. comm). This pebble tool assemblage shows the same technical pattern as the one observed on the Ban Don Mun artefacts, with the production of large choppers (20 cm long) with transverse, convergent or lateral cutting edges on sandstone and quartzite pebbles, rarely on quartz. These stone tools are more massive than the Lampang tools and are associated with chopping-tools, large flake-tools (scrapers, denticulates and notches), massive and heavy prismatic cores and some atypical tools with a bilateral pointed shape. The majority of the Sao Din artefacts are unifacial, although several are bifacial.

These massive unifacial pebble tools in the North of Thailand have no equivalent in other mainland Southeast Asian countries, despite the recent discoveries of stone tools on the Quaternary terraces of the Mekong River (Forestier et al., 2014).

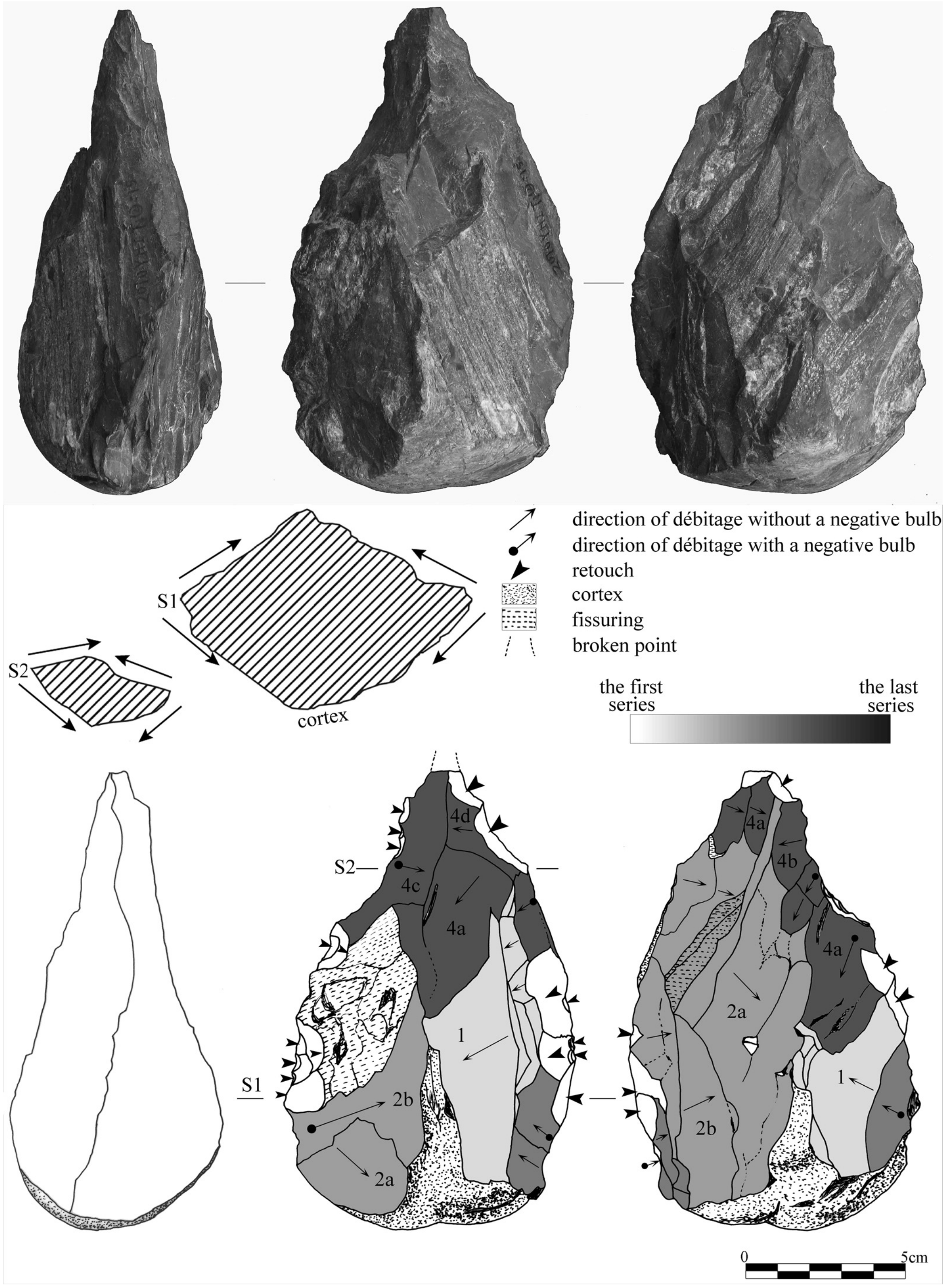


**Fig. 6.** Photograph and diacritical diagram of typical biface from Layer 2 of the Houfang site (2010YHIT1② 15). S1, Transverse section on mesial part; S2, transverse section on distal part.

**Fig. 6.** Photographie et diagramme diacritique d'un biface typique du niveau 2 du site de Houfang (2010YHIT1② 15). S1, Section transverse sur la partie mésiale ; S2, section transverse sur la partie distale.

Generally, Paleolithic stone tools from mainland Southeast Asia are dominated by choppers, *i.e.* unifaces, and include few handaxes (Gorman, 1972; Heekeren et al., 1967; Heider, 1958; Higham, 2014; Marwick, 2007; Matthews, 1964; Moser, 2001; Mus, 1977; Schoocongdej, 2006).

### 2.4. *The islands of Southeast Asia: the Indonesian archipelago and beyond*

The lithic assemblages from the Indonesian archipelago point to comparable techno-typological behaviour to the continental series, including the presence of pebble tools

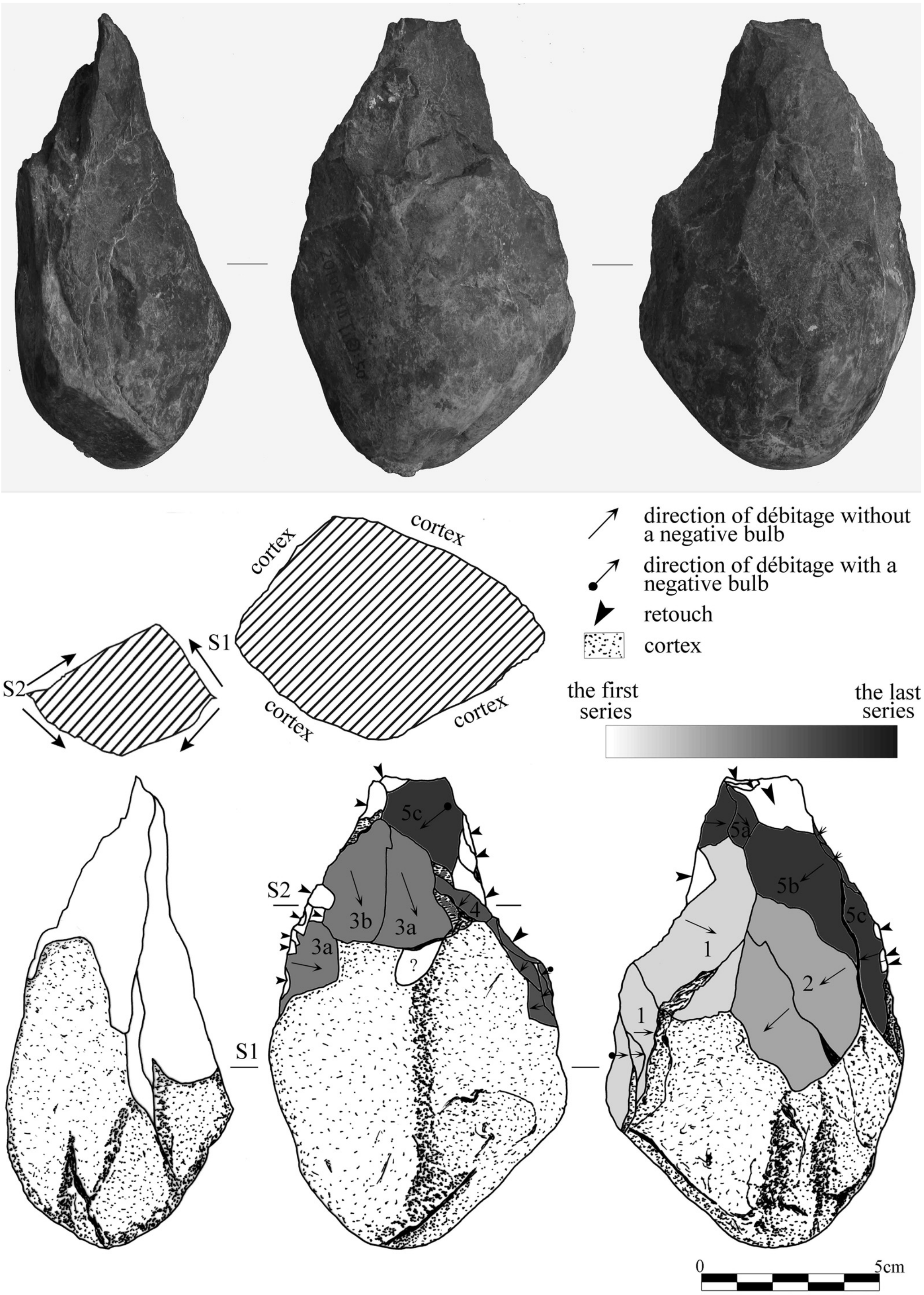


**Fig. 7.** Photograph and diacritical diagram of typical biface from Layer 2 of the Houfang site (2010YHIT1② 50). S1, Transverse section on mesial part; S2, transverse section on distal part.

**Fig. 7.** Photographie et diagramme diacritique d'un biface typique du niveau 2 du site de Houfang (2010YHIT1② 50). S1, Section transverse sur la partie mésiale ; S2, section transverse sur la partie distale.

(Fig. 8). They also include a classic but 'exotic and tropical' Acheulean toolkit.

Java Island, famous for its paleoanthropological record since the discovery of 'Pithecanthropus' remains at the end of the 19th century (Dubois, 1994; Koenigswald, 1936, 1940), lacked stratigraphically controlled archaeological data for *Homo erectus*, until recent decades, apart from isolated discoveries (see for instance

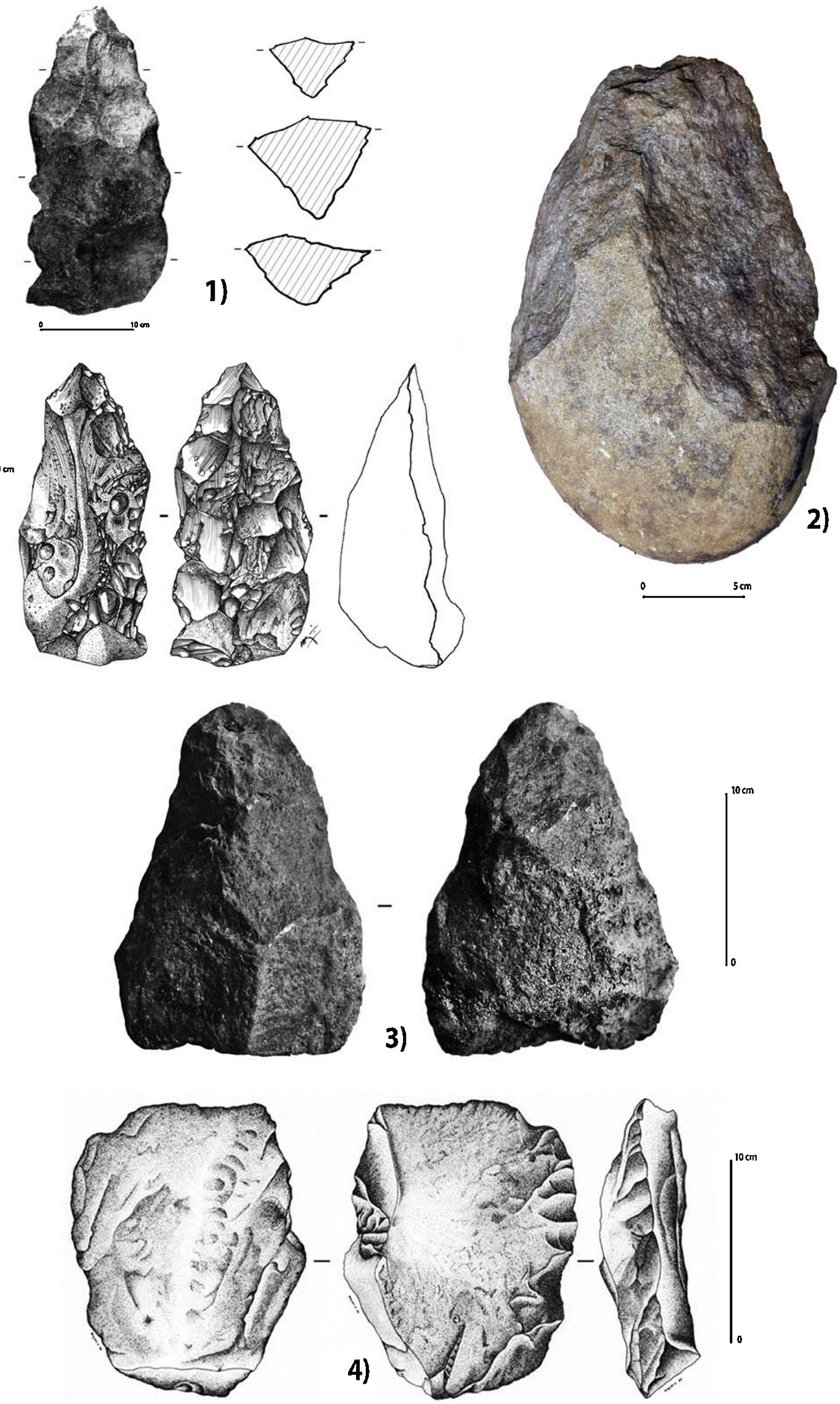


**Fig. 8.** Lithic artefacts from Indonesia and Thailand. 1. South Sumatra biface (Ogan River). 2. Unifacial pebble tool from Sao Din (North Thailand). 3. Patjitanian biface (Baksoko River, East Java). 4. Cleaver on a large andesitic Kombewa flake, Ngebung (Sangiran Dome, central Java). 1,3,4: Pictures Muséum national d'histoire naturelle/Indonesian National Centre of Archaeology (drawings: 1 by Hubert Forestier; 4 by Dayat Hidayat). 2: Courtesy of CNRS/Silpakorn University (Bangkok) prehistoric mission.

**Fig. 8.** Artefacts lithiques d'Indonésie et de Thailande. 1. Biface du Sud Sumatra (Ogan River). 2. Outil sur galet unifacial de Sao Din (Nord Thailande). 3. Biface du Patjitanian (Baksoko River, Est Java). 4. Hachereau sur un grand éclat Kombewa en andésite, Ngebung (Sangiran Dome, Centre Java). 1,3,4 : Photos du Muséum national d'histoire naturelle/Indonesian National Centre of Archaeology (dessins : 1 par Hubert Forestier; 4 par Dayat Hidayat). 2 : Permission du CNRS/Silpakorn University (Bangkok) Mission préhistorique.

Koenigswald et al., 1973; Sémah et al., 2014a, b; Widianto, 2006).

The "Patjitanian" industry was discovered in the southern mountains of Java by Koenigswald (1936), and defined by the presence of numerous choppers, chopping-tools, small and large flakes, and cores (including some giant cores, with volumes of more than 100 $dm^3$). It has since become clear that handaxes existed on pebbles or flakes associated with a broad spectrum of artefacts in chert and silicified wood (from eroded Miocene series), volcanic stone (andesite) and silicified breccia.

Although the age of the Patjitanian industry is still unknown, several markers tend to attribute it to the Middle Pleistocene, in relation with the oldest flake-and-core assemblages discovered in the surrounding caves of the Gunung Sewu karstic hills (*e.g.* Song Terus cave, Sémah et al., 2004, dated to the second half of the Middle Pleistocene).

For a long time, the famous Sangiran dome hominid-bearing site yielded small flakes (called "Sangiran Flakes", see von Koenisgwald and Gosh, op. cit.) made from small siliceous pebbles collected from alluvial formations. The first discoveries of "heavy-duty tools" are related to the discovery of bolas and a chopper in metamorphic rock at Ngebung (Soejono, 1982). In the north-western part of the dome, excavations conducted at the Ngebung open-air site (Sémah et al., 1992), dated at around 800 ka (Sémah and Sémah, 2012; Sémah et al., 2011), yielded many andesitic pebbles or manuports, but also polyhedrons, spheroids and bolas with pecked tracks (shaping traces and usewear). Some artefacts were made with raw materials collected tens of km away: large fine-grained suitable andesite pebbles (usually lacking in the local lahars) or milky quartz. The toolkit includes cleavers, massive scrapers ("horsehoof" type), choppers and a few flakes. Surveys and excavations at the Sangiran dome confirmed the behavioural diversity of *Homo erectus* groups at the dawn of the Middle Pleistocene, most probably reflecting repetitive exchanges with the mainland owing to the drastic sea level drops that occurred during this period (Sémah and Sémah, 2012; Sémah et al., 2014a,b).

Other discoveries in the Sunda Islands are less detailed. It is important to mention the artefacts found in South Sumatra in the Air Tawar and Semuhon Rivers, not far from the Ogan River in the karstic region of Baturaja (Forestier, 2007; Forestier et al., 2005). All the material from this series is massive, made in local chert and composed of handaxes with triangular and trapezoid sections (>30 cm long), and cleavers. It also includes choppers on limestone or andesitic pebbles, prismatic cores and large flake-tools (scrapers and denticulates). The quality and morphology of the raw material varies, with blocks of chert, glossy sandstone, breccia or silicified wood (Forestier, 2000, 2007; Simanjuntak and Forestier, 2009). Therefore, in addition to Java, Sumatra provides evidence of Lower Paleolithic occupations showing the toolkit diversity of these earliest islanders.

The evidence beyond the Wallace line is restricted to a couple of sites, the oldest one probably being the c. 1 Ma-old artefacts discovered in the Soa Basin on Flores Island (Brumm et al., 2010). We may also mention the tools collected on the terraces of the Walanae River, at Cabenge (South Sulawesi), including partial or complete triangular handaxes, unifacial tools with abrupt retouch, pebble tools (choppers and chopping-tools), and flakes and cores (Bartstra, 1976, 1977; Keates, 2004; Keates and Bartstra, 2001). So far, the bifacial artefacts discovered at the site of Arubo on the island of Luzon raise the question of early human settlement in the Philippines (Dizon and Pawlik, 2010).

## 3. Conclusion

The Southeast Asian Paleolithic lithic series seem to disprove the model of linearity in the Acheulean tradition. There is widespread disparity between these series and what we call the Acheulean outside Europe.

The bifacial phenomenon in Asia covers an extensive period of time and the recently discovered Korean LCT assemblages demonstrate the duration of this technology and the difficulties involved in tracing a technological history, origin and filiation over time (Bae and Bae, 2012; de Lumley et al., 2011; Norton and Bae, 2008; Norton and Braun, 2010; Norton et al., 2006). It is the same case in the Chinese Luonan Basin where handaxes and abundant typical cleavers similar to East Asian samples, are dated from 800 to 100 ka, and mainly from 250 to 50 ka (Wang, 2005).

While lithic series with bifacial technology are well represented in India by handaxes and cleavers, and often assimilated to the Acheulean, they are more controversial in China as they are rare and were discovered recently (Movius, 1948, 1949). The Indian findings are characterised by tools made by few removals and mainly on flakes. They are frequently assimilated to the LFA (Large Flake Assemblages) described in Africa and the Levant, and thus to the Acheulean world which would have developed from African roots (Gaillard et al., 2010; Kleindienst, 1961; Sharon, 2007). For China, bifacial tools are also rare in the three major regions in open-air sites with a low density of artefacts. Unifacial heavy-duty tools are predominant, regardless of raw material quality and climatic contexts throughout time. They are often made on thick cobbles by few removals, and minimally shaped, leading to conflicting discussions: Acheulean or not Acheulean (Bar Yosef, 2015; Hou et al., 2000; Kuman et al., 2014; Wang et al., 2014a, b, c)?

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