Chapter 2
The Unity of Acheulean Culture

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Abstract This chapter examines the issue of whether the Acheulean is a genuine homologous cultural entity, descended via a chain of social reproduction from a common 'ancestor', or whether it was a technological phase that was repeatedly independently invented. An anecdotal experiment is used to determine the relative ease of inventing biface knapping from scratch, versus transmitting it with one bout of social observation. Handaxe and cleaver elongation is compared between East African and Indian Acheulean assemblages to determine if there are systematic differences that might reflect different lineages of social transmission. The age of the first appearance of the Acheulean in various parts of the world is modelled to determine if spread from a single source or independent inventions best fits the timing of its distribution. The issue of whether Pleistocene bifaces from East Asia are homologous with the Acheulean or were independently invented is examined by comparing the extent of bifacial shaping between East Asian and western Acheulean assemblages. The chapter concludes with the following contentions. Acheulean bifaces are hard to invent, or even emulate, but easy to imitate. Pleistocene East Asian bifaces are an example of parallelism; that is, not *de novo* independent invention, but invention from the same Oldowan substrate as the Acheulean. The western Acheulean is however a coherent cultural entity that seems to have spread from a single source region, and with regionally consistent variations suggesting it was maintained through social transmission.

Keywords Cleaver • Handaxe • Invention • Movius Line • Parallelism • Transmission

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Introduction

Acheulean sites have been found at locations separated by over 80° of latitude (Aldhouse-Green et al. 2012; Lotter and Kuman 2017), and in time by over 1.5 million years (Beyene et al. 2013; Benito-Calvo et al. 2014). Such an enormous geographical and temporal range transcends different hominin species and makes the idea that the Acheulean is a single cultural entity, tracing its roots to a common ancestor, seem improbable. For our own species it is not until the modern era of global transport and communication that the same artifact types become so widespread across the globe, and now there is typically rapid turnover of forms rather than the almost interminable persistence of the Acheulean.

One explanation for Acheulean ubiquity, is that it was in part genetically determined (Corbey et al. 2016); a hypothesis which myself and others have critiqued elsewhere (Wynn and Gowlett 2018; Shipton and Nielsen 2018; Hosfield et al. 2018). Here, I wish to address the more plausible alternative explanations that the characteristic bifacial artifact forms of the Acheulean were repeatedly independently invented (Tennie et al. 2016, 2017), or that at least the Asian, European, and African Acheulean traditions arose independently (Barsky et al. 2018; Gallotti 2016).

Acheulean assemblages the world over have a diagnostic feature in common: the presence of bifacially shaped artifact forms. In particular, a tear-drop shaped form with a long cutting edge around much of its perimeter—the handaxe; and, also for most Acheulean assemblages, a form with a broad unretouched bit as its cutting edge—the cleaver. Bifacial flaking is one of the simplest ways to remove multiple flakes from a flattish stone, with bifacial forms present from the Oldowan (de la Torre 2004). It is the easiest way to shape a stone: bifacial flaking being the most common method used to shape stone tools throughout prehistory (Inizian et al. 1983), and with the most elaborate stone artifact shapes in prehistory being bifacial (e.g. Carballo 2007).

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Handaxe-like bifaces crop up repeatedly in later prehistory (e.g. Moore 2003; Brumm and Moore 2012; Brumm and Rainey 2015), so the possibility that Acheulean ones were also independently invented needs serious consideration. Cleavers on the other hand present a very different case, being a very specific tool (Inizian et al. 1983), with few or no parallels at other points in prehistory. Bifacial flaking on cleavers is often limited to a few marginal scars to regularize the outline shape, with the principal cutting edge typically the unretouched straight edge of a flake blank. The only potential example of non-Acheulean cleavers is the localized Middle Paleolithic of the Vasco-Cantabrian region in western Europe (Thiébaut et al. 2012; Utrilla et al. 2015; Deschamps 2017). However, the Vasco-Cantabrian Middle Paleolithic, previously thought to be a late regionalization, is now known to have its origins in Marine Isotope Stage 5 (Deschamps 2017; Álvarez-Alonso 2014), while the Iberian Acheulean persists until Marine Isotope Stage 6 (Rios-Garaizar et al. 2011; Álvarez-Alonso 2014). There may then have been long term continuity of bifacial forms from the Acheulean to the Middle Paleolithic, as unusually for Europe, cleavers were common in the Iberian Acheulean.

This chapter will argue that the Acheulean is a unitary cultural phenomenon, explained by strong social transmission rather than repeated independent invention (convergent evolution). The results of an anecdotal experiment on the social transmission of Acheulean-like biface knapping will be presented; Acheulean biface elongation in Africa and India will be compared to test for cultural divergence versus stochastic variation; the timing of the first appearance of the Acheulean in various parts of the world will be assessed to see if a diffusion or independent invention model is a better fit; finally the phenomenon of shaping of para-Acheulean bifaces in East Asia will be explored as a possible example of convergence.

An Anecdotal Experiment of Biface Transmission

An experiment by Geribàs and colleagues (2010) compared handaxe knapping between experts and complete novices with no prior experience of knapping. Drawing on the Geribàs experiment, this section looks at the difference one bout of social transmission can make to a novice's ability to make handaxes. A naïve subject with no prior experience of knapping was asked to make two handaxes; firstly without any prior knowledge apart from what the final form should look like, and secondly after having seen the process demonstrated once.

The subject, JP, despite being the girlfriend of the author, knew nothing of the process of making stone tools, but was shown a pointy handaxe made by expert knapper Chris Clarkson and asked to replicate it with no other verbal instructions. JP was given a glove, a leather pad, and a copper bopper hammer, and told to select a piece of Norfolk flint from a pile containing a variety of shapes, all suitable for knapping, but not necessarily suitable for making handaxes.

Similar to the novices in the Geribàs experiment, JP's principal approach was to strike the clast in the secant plane, i.e. to bash it on the ends rather than work in from the sides (Fig. 2.1). Although JP's clast was ultimately too thick to have ever been made into a handaxe, the Geribàs study indicates that, even with an appropriate clast thickness, one of the reasons naïve people fail to make handaxes is because of their focus on the secant plane and their failure to identify acute angles.

The other striking thing about JP's attempts to knap was the variety of methods attempted. She began by picking up another clast and attempting indirect percussion; she then tried direct percussion; then she rested the core on the hard floor; then she moved a large quartzite cobble to use as an anvil (Fig. 2.2); before finally giving up. The Geribàs et al. experiment also found that novices frequently used the ground and anvils as supports. JP's exploring of different percussive techniques in a single knapping bout was impressive, but not having the knowledge to identify appropriate angles and platforms for flaking, she was not able to strike more than a handful of flakes from the clast.

After this failed attempt, the author then knapped a handaxe with JP watching, but no verbal instructions were provided. During this demonstration there was a key moment of realization: "ah, you hit it from the other side". JP then attempted her second handaxe, choosing a much flatter clast, identifying acute angles, and working in from the edges. Remarkably, with this one bout of imitative social transmission, she was able to produce a handaxe that would be immediately recognizable archaeologically (Fig. 2.3). She flaked it around the entire perimeter leaving no trace of the original clast and created a globular butt and sharp cutting edge.

Of course, with a single subject this is only a pilot study and the conclusions must be regarded as highly tentative, but it is encouraging that some findings of the Geribàs et al. experiment were repeated. The failure of the initial attempt here, despite the variety of percussion methods employed, suggests that even Oldowan style freehand percussion, may not be as easy to invent as Tennie et al. hypothesize. The striking improvement after just one bout of watching another knapper suggests that imitation is also a far more efficient way of learning to knap handaxes than emulation and trial and error. If there was motivation to make them, handaxes could have spread rapidly between hominins in social contact.

Fig. 2.1 The first attempt by novice knapper JP to replicate a handaxe without having seen it done before. Nowhere on the piece has a bifacial edge been established. Note the copper bopper hammer has left marks across all surfaces due to heavy but ineffective strikes, and the base of the clast (bottom right) exhibits extensive battering damage. The scale is in centimeters

Acheulean Biface Elongation

Elongation (length to width ratio) is one of the principal ways in which Acheulean bifaces vary between assemblages (Shipton 2013; Callow 1986; Wynn and Tierson 1990). In this section biface elongation is compared between East African and Indian assemblages to test between the zone of latent solutions and social transmission models of Acheulean ubiquity. If handaxes and cleavers were repeatedly independently invented (Tennie et al. 2017), site-wise variation in elongation should be random at the continental scale, with no systematic difference between East Africa and India. If

Fig. 2.2 JP's varied method of percussion on her first attempt to make a handaxe. Top left—indirect percussion; top right—direct percussion; bottom left—using the floor as a support; bottom right—on-anvil percussion. Note that she is striking the clast in the secant plane

handaxes and cleavers were socially transmitted artifact types, then we should expect local grouping between assemblages as the result of regional traditions.

Measurements on East African and Indian bifaces were obtained from samples collected for previous studies (Shipton 2013, 2016, 2018), with the addition of a small sample of 21 bifaces from Kalambo Falls housed in the British Museum. The East African assemblages in the sample were Olduvai Gorge Bed II and Bed IV; Kariandusi; Isenya; Kalambo Falls; and Olorgesailie CL1-1, Member 6/7, and Upper Member 1. The Indian assemblages in the sample were Isampur Quarry; Teggihalli II; Singi Talav;

Fig. 2.3 JP's second attempt at making a handaxe, after having seen the process demonstrated once. Note the piece is flaked around the entire perimeter and has the characteristic globular butt and elongate cutting edge of a handaxe and would be archaeologically recognizable as such. The scale is in centimeters

Chirki-Nevasa; Morgaon; Bhimbetka; and Patpara. Assemblages with sample sizes of handaxes or cleavers of less than ten were excluded.

Tables 2.1 and 2.2 summarize the data and Figs. 2.4 and 2.5 show the pattern of variation in elongation both within and between sites for East Africa and India. For both biface types, East African assemblages tend to be more elongate than Indian assemblages. One-way ANOVAs confirmed the heterogeneity in assemblage mean elongation for both handaxes (df = 322, F = 10.494, P < 0.001) and cleavers (df = 252, F = 6.405, P < 0.001). The Indian assemblage Chirki-Nevasa has more elongate handaxes than the East African assemblage Olorgesailie Upper Member 1, and more elongate cleavers than the East African assemblage Kalambo Falls. But, the Chirki-Nevasa bifaces are still less elongate on average than all other East African assemblages. Notably, the differences in elongation are apparent between both classic Acheulean sites from either region, such as Kariandusi and Morgaon, as well as sites from the end of the Acheulean, such as Kalambo Falls and Patpara.

Some possible explanations for this geographic pattern are differences in rock type and blank form driving the differences in elongation. However, both the Indian and East African assemblages include examples that were invariably made on lava flakes such as the cleavers from Morgaon and Olorgesailie CL1-1, with an equal variances t-test confirming the significance of the difference between these two (df = 52, t = 3.222, P = 0.02). Likewise, both the Indian and East African assemblages include examples invariably made on quartzite flakes, such as the cleavers from Kalambo Falls and Bhimbetka, with an equal variances t-test confirming the significance of the difference between these two (df = 44, t = 2.901, P = 0.06). Differences in reduction intensity between East Africa and India might be invoked to explain these differences in elongation (cf. McPherron 1999). However, reduction intensity has been shown to have only a subtle influence on handaxe shape (Shipton and Clarkson 2015b); and in the case of cleavers, as their cutting edge is typically formed from the unretouched edge of the flake blank, they were by definition not resharpened (Shipton and Clarkson 2015a). Discounting systematic differences between East Africa and India in reduction intensity, or the influence of blank and rock type on biface elongation, we are left with the explanation that the differences in elongation arose due to divergent cultural traditions between these two Acheulean regions.

Table 2.1 Elongation values (length/width) for various East African and Indian Acheulean handaxe assemblages

Site	N	Minimum	Lower quartile	Mean	Upper quartile	Maximum
Isenya	18	1.77	1.87	2.05	2.2	2.37
Kalambo Falls	10	1.58	1.77	1.86	1.95	2.13
Olduvai Gorge Bed IV	41	1.52	1.74	1.85	1.95	3.07
Olduvai Gorge Bed II	30	1.41	1.75	1.85	2.01	2.59
Olorgesailie Member 6/7	16	1.69	1.74	1.84	1.93	2.12
Kariandusi	68	1.35	1.65	1.73	1.83	2.04
Chirki-Nevasa	21	1.38	1.59	1.72	1.82	2.32
Olorgesailie Upper Member 1	17	1.29	1.57	1.66	1.82	1.93
Isampur Quarry	47	1.01	1.52	1.66	1.84	2.29
Singi Talav	28	1.25	1.48	1.65	1.81	2.04
Teggihalli II	12	1.14	1.37	1.5	1.67	1.82
Patpara	20	1.22	1.3	1.46	1.59	1.71

Table 2.2 Elongation values (length/width) for various East African and Indian Acheulean cleaver assemblages

Site	N	Minimum	Lower quartile	Mean	Upper quartile	Maximum
Olorgesailie Member 6/7	19	1.41	1.65	1.76	1.91	2.05
Isenya	16	1.43	1.53	1.66	1.8	1.9
Olorgesailie CL1-1	25	1.29	1.56	1.65	1.75	1.99
Kariandusi	12	1.04	1.44	1.64	1.79	2.09
Olduvai Gorge Bed IV	11	1.34	1.45	1.62	1.7	1.88
Chirki-Nevasa	11	1.32	1.35	1.62	1.83	2.19
Kalambo Falls	11	1.34	1.44	1.59	1.73	1.91
Morgaon	31	1.16	1.32	1.47	1.63	1.92
Bhimbetka	36	1.19	1.33	1.44	1.52	1.8
Teggihalli II	19	1.28	1.3	1.43	1.52	1.75
Isampur Quarry	38	0.95	1.27	1.42	1.54	2.02

The First Appearance of the Acheulean

There remains the possibility that, while they represent social traditions, Acheulean bifaces were independently invented in various regions including East Africa and India (Barsky et al. 2018). Immediately prior to the emergence of the Acheulean, the hominin occupied world stretched the length of the African continent (Balter et al. 2008; Sahnouni et al. 2002), into Asia as far as north as the Lesser Caucasus (Ferring et al. 2011), and east into India (Gaillard et al. 2016; Dennell et al. 1988; Malassé et al. 2016) and China (Han et al. 2017; Hou and Zhao 2010; Li et al. 2017; Zhu et al. 2018). If stone tool using populations occupied this vast territory and the Acheulean was easy to invent, we should expect its emergence soon after the first appearance of hominins in a region. Alternatively, if the Acheulean was only invented once and spread from that source as a single tradition, we should expect a pattern of younger ages of first appearance the farther afield one moves from the source.

There have been claims for a very early appearance of the Acheulean in Armenia 1.85 Ma at the site of Karakhach (Trifonov et al. 2016). However, as illustrated, the three possible artifacts are not convincing as Acheulean bifaces (see Fig. 12 in Trifonov et al. 2016); they are extensively rolled and do not appear to have been shaped. Notwithstanding Karakhach, the three oldest Acheulean sites, with ages of 1.7–1.75 Ma, are Konso-Gardula (Beyene et al. 2013), Kokiselei (Lepre et al. 2011), and Olduvai Gorge FLK West (Diez-Martín et al. 2014): all located in East Africa, less than 1000 km apart. The earliest Acheulean sites in southern Africa are dated to 1.6–1.4 Ma (Gibbon et al. 2009; Chazan et al. 2008; Herries and Shaw 2011). The earliest sites in the Levant date to a similar 1.6–1.4 Ma timeframe (Ginat et al. 2003; Martínez-Navarro et al. 2012; Tchernov 1988), and there is one Acheulean site in India with a 1.5 Ma age (Pappu et al. 2011). The earliest date for the Acheulean on the Atlantic Coast of north-western Africa is around 1 Ma (Raynal et al. 2001). Moving further afield into Europe, the Acheulean does not appear until after 1 Ma (Moncel et al. 2013; Vallverdu et al. 2014). Notably, in all these regions there are older non-Acheulean assemblages, so its spread does not reflect the first arrival of stone knapping hominins in an area.

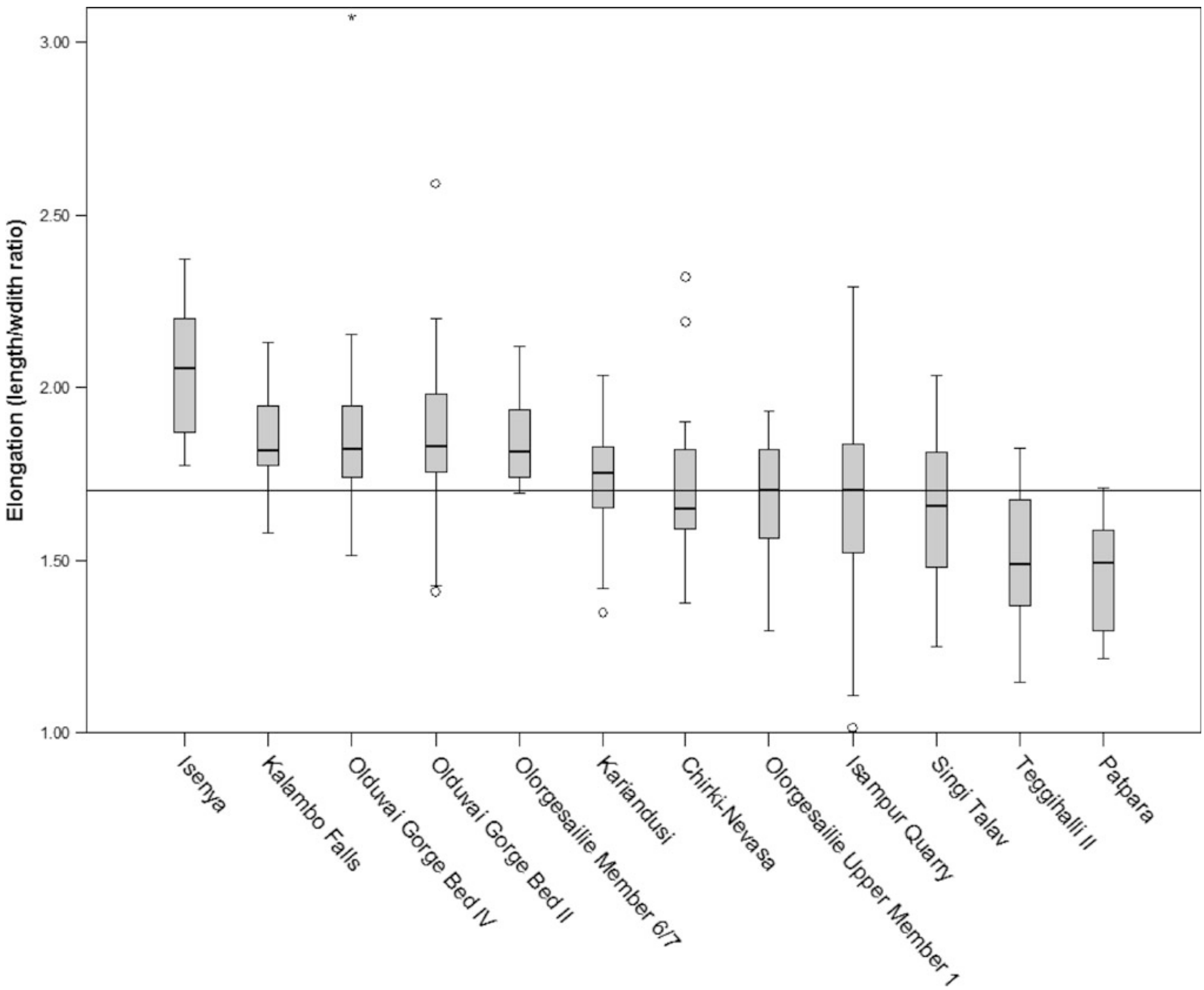

Fig. 2.4 Elongation in Acheulean handaxes for selected East African and Indian assemblages, ordered by mean values. Note that East African assemblages tend to sit above the reference line at 1.7 while Indian assemblages tend to sit below it

Date range estimates are large for sites of this age, particularly outside of East Africa where radiometric dating of volcanic eruptions is usually not possible. However, on current evidence it seems that there is time on the order of 100,000–200,000 years for the Acheulean to have spread from its East African homeland to southern Africa and the Levant, and perhaps as far as India; with several hundred thousand more years for the Acheulean to reach Europe. Table 2.3 shows the above sites alongside an approximate as-the-crow-flies distance from Kokiselei. If the Acheulean were repeatedly independently invented, we would expect there to be no relationship between the age of the first appearance of the Acheulean in a region and its distance from a putative East African source. A linear regression analysis was conducted of the data in Table 2.3 to test this. Attirampakkam was not included in the following analysis as the as-the-crow flies distance goes unrealistically across the Indian Ocean; it is also the only site dated by the relatively experimental technique of cosmogenic nuclides and the only site where the age estimate has not yet been corroborated by another within 200,000 years and 4000 km. The regression analysis (df = 9, F = 40.614, $P < 0.001$) indicates that there is in fact a strong relationship between the distance from Kokiselei and the age of the first appearance of the Acheulean in a region, with an R squared value of 0.835. The most parsimonious interpretation for the appearance of the Acheulean first in East Africa, later in southern Africa and the Levant, and much later still in Europe, is that it was a single tradition which spread through social transmission.

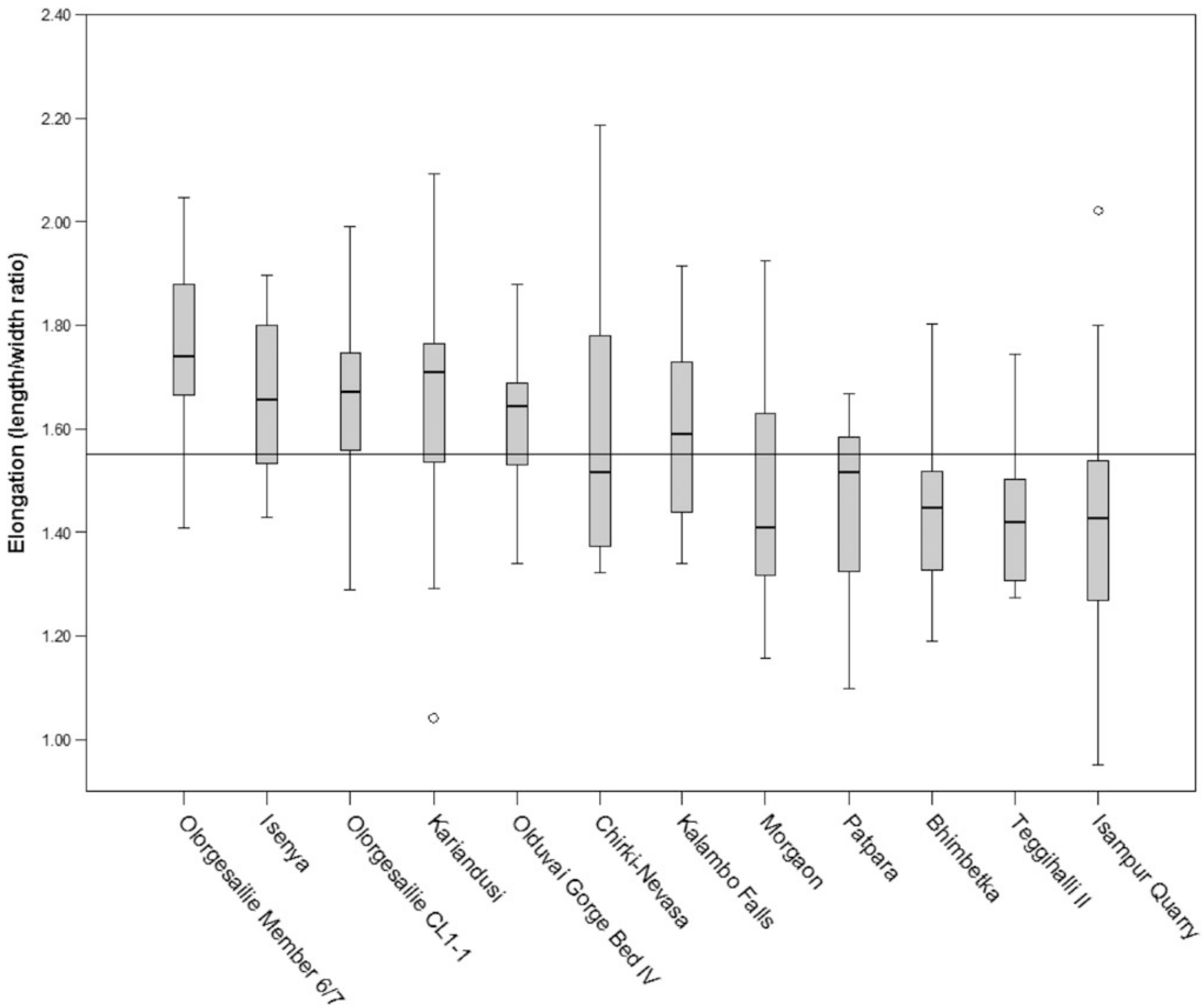

Fig. 2.5 Elongation in Acheulean cleavers for selected East African and Indian assemblages, ordered by mean values. Note that East African assemblages tend to sit above the reference line at 1.55, while Indian assemblages tend to sit below it

Table 2.3 The age estimates of the earliest Acheulean sites in East Africa, southern Africa, north-western Africa, the Middle East, India, and Europe and their as-the-crow-flies distance from Kokiselei. Age estimates are in million years and distance is approximated to the nearest 5 km

Site	Distance from Kokiselei	Age	References
Kokiselei	0	1.75	Lepre et al. (2011)
Konso-Gardula	235	1.75	Beyene et al. 2013)
Olduvai	775	1.7	Diez-Martín et al. (2014)
Sterkfontein	3460	1.4	Herries and Shaw (2011)
Rietputs Formation	3795	1.57	Gibbon et al. 2009)
‘Ubeidiya	3180	1.4	Tchernov (1988)
Nahal Zihor	2860	1.5	Ginat et al. 2003)
Thomas Quarry	5550	1	Raynal et al. (2001)
Attirampakkam	4940	1.5	Pappu et al. (2011)
Quipar	5360	0.9	Scott and Gibert (2009)
La Noira	5760	0.7	Moncel et al. (2013)

The Movius Line

Perhaps the most pertinent issue when it comes to the Acheulean and convergence is the Movius Line. In an early review of the Lower Paleolithic cultures of Asia, Hallam Movius (1948) noted that whereas bifaces are prevalent in India and areas to the west, they are rare or absent in East Asia. In the intervening years, several discoveries of Pleistocene biface assemblages in East Asia have purported to dissolve the Movius Line. The principal areas where such bifaces have been reported are the Bose (Baise) Basin in southern China (Hou et al. 2000), the Luonan Basin and Danjiankou region in central China (Wang 2005; Li et al. 2014), Dingcun on the Loess Plateau in northern China (Yang et al. 2014), and the Imjin-Hantan River Basin on the Korean Peninsula (Norton et al. 2006). Much has been written on whether these bifaces belong to the Acheulean tradition or are an example of convergence in Pleistocene hominin behaviour (e.g. Petraglia and Shipton 2008; Wang et al. 2012; Li et al. 2014; Lycett and Bae 2010).

Several distinctions between East Asian and western Acheulean bifaces are apparent. First, even in the above-mentioned areas of East Asia, bifaces occur at extremely low densities. In the Danjiankou region for example the maximum number of bifaces excavated per square meter at a site is 0.027 (Li et al. 2014), whereas in the western Acheulean densities of over 1 are common and over 10 is not unheard of (Méndez-Quintas et al. 2018). Second, both univariate and geometric morphometric studies have shown that East Asian bifaces tend to be both absolutely and relatively (to width) thicker than those of the Acheulean, and as a consequence heavier (Shipton and Petraglia 2010; Wang et al. 2012; Kuman et al. 2016). There are exceptions to this pattern, with the Danjiankou and Luonan bifaces falling in the range of Acheulean variation. A third distinguishing feature of East Asian bifaces is the dearth of cleavers (Corvinus 2004), which are a common biface type in India, Africa, Iberia, and some Middle Eastern sites. While there have been claims for cleavers in East Asia, for the most part these do not conform to the classic Acheulean cleaver where the bit is formed by the intersection of a dorsal flake scar and the termination of the large flake blank. An exception to this is again the Luonan Basin bifaces (Petraglia and Shipton 2008). The fourth distinction between East Asian and western Acheulean bifaces is the degree to which they have been bifacially shaped. Many of the purported handaxes from East Asia are in fact unifacial (Li et al. 2014; Hou et al. 2000). Absolute numbers of flake scars are low for East Asian bifaces in comparison to those of the Acheulean (Li et al. 2014), with marginal trimming to regularize the edge not apparent (Kuman et al. 2014).

Here the fourth of these distinctions between East Asian and western Acheulean bifaces is explored in more detail. Shaping is assessed through two measures, the bifaciality index (the ratio of the number of scars on the more flaked surface to the less flaked surface), and the scar density index (the number of scars per unit of surface area).

In the original publication on Bose, comparison with the bifaciality index from Olorgesailie was used to show that they fall within the range of Acheulean variation for this variable (Hou et al. 2000). However, the sample from Olorgesailie contained a large proportion of cleavers where much of the shaping, including the crucial large scar that will form the bit, is done prior to the striking of the flake blank and therefore would not be measured by the bifaciality index. To reassess shaping in the Bose large cutting tools, their bifaciality index (Hou et al. 2000) was compared with six handaxe assemblages, two from Africa (including Olorgesailie) (Shipton 2018), two from Europe (Shipton and Clarkson 2015b), and two from India (Shipton 2016). Aside from Olorgesailie, the other five assemblages were chosen for their comparability to Bose, where the large cutting tools are primarily made on cobbles of coarse-grained rocks such as sandstone, quartzite, and quartz, although flake-made large tools and finer grained chert also feature in the Bose assemblage. The six assemblages included a sample of the quartz handaxes from Olduvai Gorge (multiple Beds), a sample of phonolite handaxes from Olorgesailie (multiple Members), quartzite handaxes from Singi Talav, basalt cobble and flake handaxes from Chirki, flint cobble handaxes from Swanscombe, and chert cobble and flake handaxes from Broom.

Table 2.4 shows that most of the large cutting tools from Bose are in fact unifacial, with a negligible bifaciality index. Discounting these, even the bifacial large cutting tools from Bose are at the lowermost end of the range of Acheulean handaxe variation for the bifaciality index, although the differences between the Bose bifaces and some of these Acheulean assemblages are not statistically significant. Further details on the Bose bifaces are necessary to evaluate the degree to which they were shaped, but, given that a majority of the large tools are unifacial, it seems they are not comparable to the Acheulean where bifacially shaped artifacts typically form the dominant class of large tool (Gowlett 2015).

In the Danjiankou region the majority of large tools have at least some bifacial working (Li et al. 2014), so they are a potential candidate for Acheulean-like shaping. Published data on the Scar Density Index (Clarkson 2013), the number of flake scars per unit area of a piece of knapped stone, is available for the Danjiankou bifaces (Li et al. 2015). The Scar Density Index is a measure of reduction intensity, and

Table 2.4 The Bifaciality Index of six handaxe assemblages and the large cutting tools from Bose

Site	N	Mean	SD
Olduvai quartz	32	0.73335	0.16138
Olorgesailie	43	0.74789	0.17214
Singi Talav	28	0.80218	0.12777
Chirki	21	0.74117	0.15291
Swanscombe	34	0.76019	0.13712
Broom	29	0.81187	0.12893
Bose bifacial	35	0.68	0.22
Bose unifacial	64	0.03	0.11

for shaped tools such as bifaces indicates the amount of knapping that went in to creating the form that entered the archaeological record (Shipton and Clarkson 2015b). If the Danjiankou bifaces were shaped to the same extent as Acheulean ones, we should expect comparable levels of reduction intensity. Scar Density values were compared between the Danjiankou bifacial large cutting tools (unifacial ones were excluded from the analysis) and handaxes from Acheulean assemblages that have elements of blank and rock type in common with Danjiankou, such as the use of trachyte and other igneous rocks, quartz rich metamorphic rocks, and cobble and flake blanks. These assemblages were Singi Talav and Chirki from India, and Isenya, Kariandusi, Olduvai Gorge Beds II and IV, and Olorgesailie Members 1 and 6/7 from East Africa.

Figure 2.6 shows the variation in Scar Density Index (SDI) values for the Acheulean assemblages and both terraces from which the Danjiankou artifacts were recovered. Both Danjiankou assemblages have markedly lower SDI values than the Acheulean assemblages, with a one-way ANOVA test showing there was significant heterogeneity in this sample (df = 294, $F = 22.352$, $P < 0.001$). The Danjiankou bifaces even have lower SDI values than Olduvai Gorge Bed II, one of the oldest Acheulean assemblages where there was relatively little shaping, with an equal variances t-test showing that this pattern was significant at the $P = 0.005$ level (df = 124, $t = 2.875$). Figure 2.7 shows a selection of Danjiankou bifaces with relatively high SDI values alongside a range of Acheulean ones, to illustrate the limited amount of flaking that went into creating the former.

While a number of researchers have sought to abandon the Movius Line (e.g. Dennell 2016), it remains an important distinction between the western Acheulean tradition with high densities of intensively flaked and relatively thin bifaces, often including cleavers; and the sporadic East Asian examples of thick and cortical Pleistocene bifaces. The Luonan bifaces are more similar to the western Acheulean than any other assemblage currently known from East Asia and require further investigation. In relation to convergence, two explanations are possible for the general pattern of the Movius Line. The East Asian bifaces may be an example of parallelism; an independent invention of large bifacial tools, but from the same Oldowan substrate as the Acheulean was invented from in East Africa. In the latter, flake production from bifacial (discoidal) cores was an established feature of the hominin knapping repertoire prior to the invention of the Acheulean (e.g. de la Torre et al. 2008; Stout et al. 2010). Alternatively, East Asian bifaces may represent the dispersal of the Acheulean into East Asia but with the loss of some aspects of biface knapping due to the founder effect (Stout 2011). This might explain the loss of cleavers and the lack of biface thinning, but it does not explain the sporadic distribution of East Asian bifaces, or the low levels of reduction intensity, lower even than the very early Acheulean from Olduvai Gorge Bed II. Notwithstanding Luonan, the most parsimonious explanation for the East Asian Pleistocene bifaces is that they were independently invented, and given their, patchy distribution, possibly more than once.

Conclusion

The vast temporal and geographical extent of the Acheulean raises the possibility that it was not a single cultural entity, but a technological phase that was repeatedly independently invented. The experiment conducted by Geribàs and colleagues (2010) and the anecdotal experiment reported here, suggest that it is not easy to invent *de novo* or even emulate biface knapping. Furthermore, with the capacity for imitation and overimitation in our own species, the anecdotal experiment reported here indicates that biface knapping is easily transmitted via social transmission.

Mark Nielsen and I have argued on the basis of generalized means-end correspondence in multiple-step manufacturing sequences, and, the repeated localized occurrence of arbitrary variations in the most complex manufacturing sequences; that a propensity for imitation and even overimitation were features of Acheulean hominin behavior (Shipton 2010; Nielsen 2012; Shipton and Nielsen 2015; Shipton in press). If these mechanisms for robust social transmission were operating during the Acheulean, its

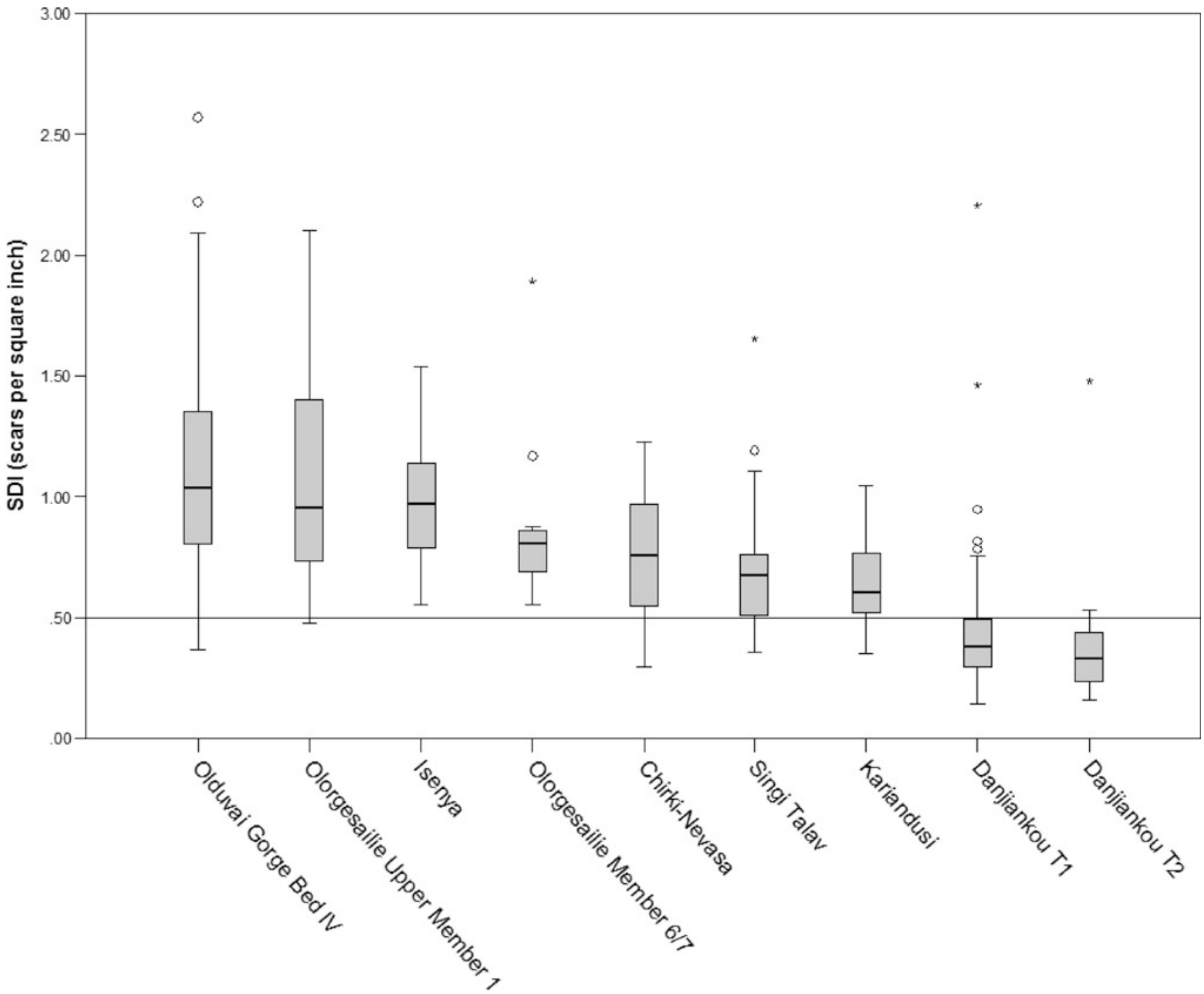

Fig. 2.6 Variation in Scar Density Index for seven Acheulean assemblages and two from the Danjiankou region. Assemblages are ordered by mean Scar Density Index (SDI) value. The reference line is at 0.485

artifact forms could have been maintained indefinitely and spread from a single source over a large area. The possibility that handaxes and cleavers were repeatedly invented from scratch without a prior knapping tradition seems remote for an animal even with the baseline levels of social transmission seen throughout the great apes, let alone if they had propensities to imitate and overimitate like our own species. A strong convergence argument to explain the ubiquity of the Acheulean can therefore be rejected.

This does not preclude the possibility of independent invention of Acheulean bifaces from a baseline Oldowan knapping tradition. Such parallelism indeed appears to have been operating with the emergence of bifacial large cutting tools in the Lower Paleolithic of East Asia. These bifaces, although similar in some respects to those of the Acheulean, are distinguished from them by their low density and patchy occurrence, their relative thickness, the dearth of cleavers, and, as demonstrated above, the low levels of shaping. East Asian bifaces thus provide us with models of what non-Acheulean large cutting tool assemblages look like.

When it comes to the western Acheulean several factors point to it being a single cultural phenomenon, rather than being invented in multiple places penecontemporaneously. Firstly, there is the specificity of cleavers as a tool type, which, unlike handaxe-like forms, do not recur at other points in prehistory. Secondly, regionally consistent differences are maintained over the course of the Acheulean (Wynn and Tierson 1990; Vaughan 2001; Lycett and Gowlett 2008) that are not easily explained by reduction intensity, rock type variation, or blank type variation. These differences suggest these biface forms were socially transmitted over extremely long periods. Thirdly, improvements

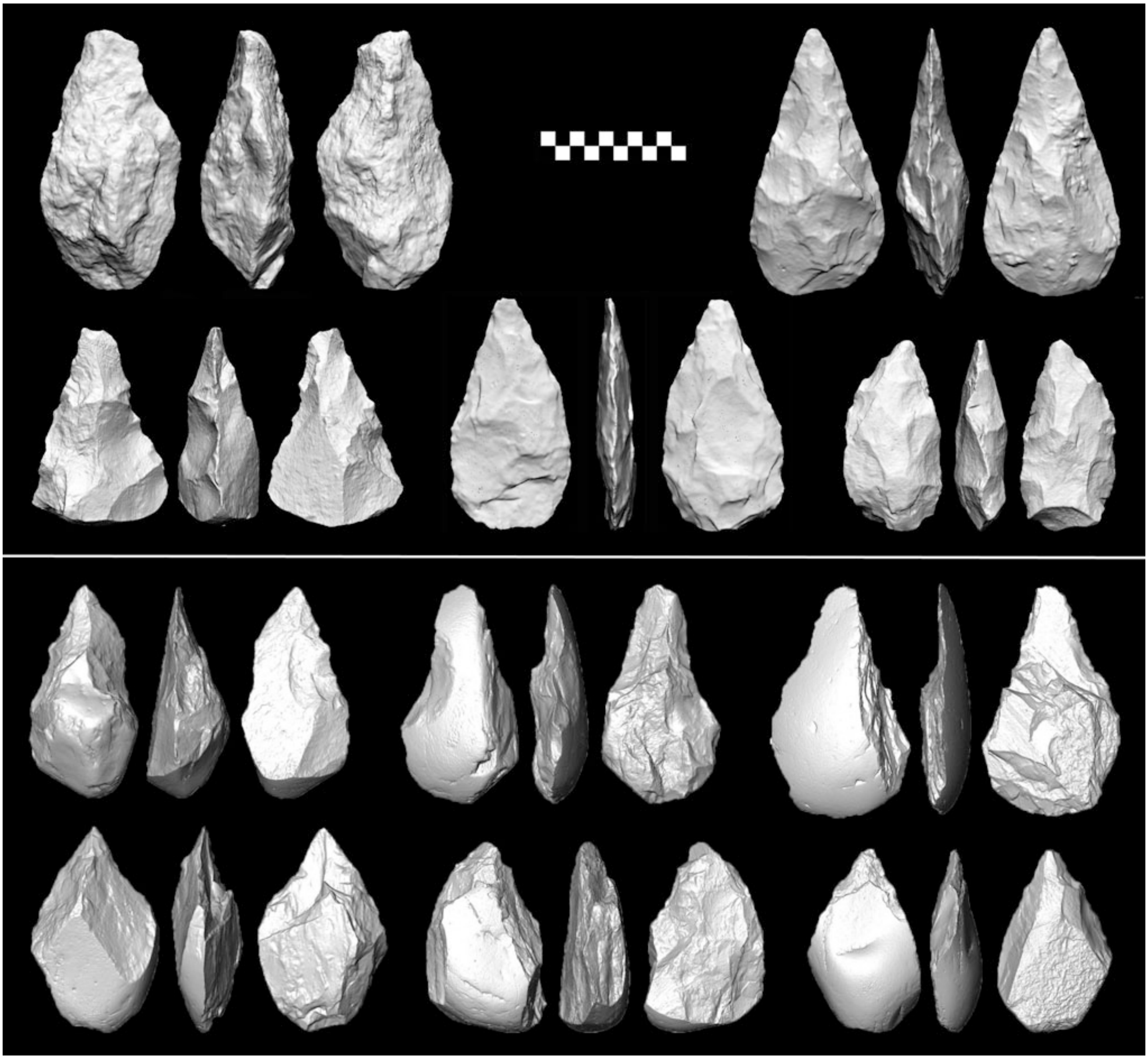

Fig. 2.7 Acheulean handaxes with a range of Scar Density Index (SDI) values (top) shown alongside a selection of Danjiankou bifaces with relatively high SDI values (bottom). Acheulean bifaces are from Olduvai Gorge Bed II (top left) (SDI = 0.55), Isenya (top right) (SDI = 1.13), Chirki (left) (SDI = 0.68), Olduvai Gorge Bed IV (middle) (SDI = 1.36), and Olorgesailie Member 6/7 (right) (SDI = 1.16). Note that a large proportion of the surface area of all the Danjiankou bifaces is still cortical. Lower part of the figure adapted from Li et al. (2015). The scale is in centimeters

over time in Acheulean knapping skill (Shipton 2013, 2018; Schick and Toth 2017; Chazan 2015), suggests it was a tradition that was maintained and improved upon. Fourthly, the three oldest Acheulean sites are all to be found in East Africa, and the date of the first appearance of the Acheulean in other parts of the world is consistent with a model of dispersal or diffusion from this source. Therefore, the contention of this chapter is that the Acheulean was indeed a unitary cultural phenomenon.

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