India and Java: Contrasting records, intimate connections

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Abstract

The archaeological, paleontological and hominin records of India and Java are compared. It is argued that during the Lower and Middle Pleistocene, the palaeolithic technology in both the regions was Large Flake Acheulian (LFA) which is attested to by numerous sites in Peninsular India, some finds from Pinjor exposures in NW India and the site of Ngembung in the Sangiran dome area of Java. We argue that the non-Acheulian assemblages attributed to this period actually come from later contexts. During the Lower and Middle Pleistocene, fauna in Java associated with Homo erectus was related to the Indian Pinjor fauna. Although hominin fossils have not been found in India for this time period, it is likely that Homo erectus was the maker of the LFA tools in India, given the presence of LFA in Java in strata with a Pinjor related fauna and Homo erectus. Sometime during the Late Pleistocene the fauna in Java underwent a very significant change from the earlier Pinjor related fauna (Stegodon- Homo-erectus fauna) to the Punung fauna (Elephas-Homo sapiens). This change is related to an ecological shift from a more savannah like to a more rainforest like environment. It is during this time, rather than earlier, that the “Movius line” has an archaeological, paleontological and ecological validity.

1. Introduction

Java has one of the richest records of fossil humans, with 123 individual fossils discovered from 1889 to 2003 (Indriati, 2004). India, on the other hand has one of the poorest human fossil records, with only a single Pleistocene fossil discovered to date (Sonakia, 1984). The presence of hominins in India, however, is attested to by a rich archaeological record. Fossil hominins in Java are associated with a fauna related to that of the Pinjor fauna of the Indian sub-continent. Because India is situated along the hominin migration route leading from Africa into Southeast Asia, the early presence of hominins in Java has important implications for the Indian sub-continent, and the Palaeolithic archaeology of the Indian sub-continent has important implications for Java. Fig. 1 illustrates major migration routes which are significant for the dispersal events discussed in this paper.

2. Pleistocene faunas in South and Southeast Asia

The Siwaliks of the Indian sub-continent illustrate a classic Neogene continental faunal record (Flynn et al., 1995). Siwalik geological formations crop out as the Siwalik Hill range, following the Himalayas from Pakistan to Assam. They are formed by the uplift of Middle Miocene to Pleistocene deposits by tectonic movements resulting from the continuing collision of Indian and Eurasian plates. Siwalik formations date from the Middle Miocene (~17 Ma) to the Middle Pleistocene (younger than the Brunhes–Matuyama boundary). The Upper Siwaliks consist of the Tatrot, Pinjor and Boulder Conglomerate formations. The Gauss–Matuyama boundary (approximately 2.5 Ma) separates the Tatrot and Pinjor formations. Above the Pinjor formation, the Boulder Conglomerate consists of boulder beds and is highly time-transgressive. In some areas, it dates to 1.7 Ma, while in others it is younger than the Brunhes–Matuyama boundary (Kumaravel et al., 2005). While the Pinjor formation contains a fairly rich fossil fauna, the Boulder Conglomerate is nearly sterile. The Pinjor fauna from India has recently been reviewed by Nanda (2002), and for Pakistan by Dennell et al. (2006). In addition to the Pakistan and Indian Siwaliks, the Pinjor fauna is also found in the intermontane basins of Kashmir and Katmandu and the Irrawaddy basin of Myanmar (Nanda, 2008). In an attempt to enrich lithostratigraphically defined units by biostratigraphy, Nanda (2002) described the Pinjor fauna as the Equus sivalensis biostratigraphic interval zone. The fauna is distinguished from the older Equus planifrons BIZ by the appearance of Equus sivalensis which is frequently recognized as...
well defined event. The *Equus sivalensis* BIZ is characterized by the occurrence of older genera including *Stegodon* and *Coelodonta*. Turnover rates for the period under study (Fig. 2) therefore indicate a constant composition (no turnover) of the highly diverse faunal units of the Pinjor fauna. At 600 ka, the Pinjor fauna was replaced by a modern fauna, chiefly characterized by the lack of older faunal elements. The interval includes steep declines in both species richness and mean standing diversity. Turnover rates demonstrate that this change is characterized by disappearances and appearances alike.

The faunal record from Peninsular India and Sri Lanka is considered to postdate the faunas associated with the Pinjor formation. Both faunal records are, however, closely related (Chauhan, 2008; Nanda, 2008). Post-Pinjor faunas of Peninsular India mostly originate from sediments which have Palaeolithic industries younger than the Large Flake Acheulian (LFA). The most important “Early Acheulian” sites such as Chirki, Bori, Morgaon, Singi Talav and Isampur provided only a few fossils. The peninsular alluvium is mostly post-Acheulian in age, while the Pinjor deposits are older. This may lead to some differences in the taxa lists. However, there is no doubt that at any particular time both shared similar faunas. The discussion of potential migrations of the Siwalik fauna into Peninsular India by some palaeontologists (Badam, 1979; Nanda, 2008) is therefore to some extent misleading. Expectation of a young age for the Acheulian from Peninsular India is probably based on the post-Pinjor aspect of its fauna. However, there is no real association between the two. The age of the Indian Acheulian has to be assessed using other criteria than fauna, which has been done elsewhere (Gaillard et al., 2010).

The earliest mammal fauna from Java, the *Mastodon–Geochelone* fauna, is limited to a mastodon (*Sinomastodon bumiajuensis*), a hippo (*Hexaprotodon simplex*), cervids and a giant tortoise (*Son-daar, 1984; Vos et al., 1994*). This fauna is replaced in the Lower Pleistocene by the *Stegodon–Homo erectus* fauna. It has affinities with the Pinjor fauna from the Siwaliks, indicating dispersal via a Siva–Malayan route (see Fig. 1) (Vos and Long, 2001). The Kedung Brubus faunal unit shows maximum species richness, originating from both an influx of new species from the Southeast Asian mainland and local evolution of endemic taxa (Fig. 2). The younger Ngandong faunal unit displays clear continuities with preceding units. However, taxonomic reassessments are impossible, because a major part of the original collections from the 1930s has been lost (Bergh van den et al., 2001). The *Stegodon–Homo erectus* fauna of the Early and Middle Pleistocene reflects a rather open and savannah like ecosystem, and key species of the modern rainforest are absent (Vos et al., 1982, 1994, 2007; Bergh van den et al., 2001; Vos and Long, 2001; Vos, 2004). Unfortunately, the fossil record from mainland Southeast Asia does not allow the assessment of Lower Pleistocene migration events, because deposits of appropriate age are missing.

A major change occurred in insular Southeast Asia towards the Upper Pleistocene *Elephas–Homo sapiens* fauna from Punung (Vos et al., 1994; Bergh van den et al., 2001). The *Stegodon–Homo erectus* fauna, which is characteristic for Lower and Middle Pleistocene deposits in Java, was replaced by a modern rainforest fauna around 128 ka (Westaway et al., 2007). In contrast to the *Stegodon–Homo erectus* fauna being related to the Pinjor fauna, the *Elephas–Homo sapiens* fauna has affinities with faunas from Southern China. This implies a dispersal route leading from South China into Java, the Sino–Malayan route (Vos and Long, 2001; Fig. 1). Although a variety of routes may be considered, this later migration process is best illustrated by Upper Pleistocene localities in mainland Southeast Asia (Tougard and Montuire, 2006).

**Fig. 1.** Map of Asia showing the main localities discussed in the text along with the – 100 m depth contour (from Voris, 2000) and the two Siva Malayan and Sino Malayan dispersal routes (after Vos et al., 2007).
Lower and Middle Pleistocene faunas from Southern China and mainland Southeast Asia are characterized by the occurrence of the Panda (*Ailuropoda melanoleuca*). They are therefore called the Stegodon–Ailuropoda fauna, which differs in taxonomic composition from the South Asian Pinjor fauna (Marwick, 2009). The panda, however, never reached insular Southeast Asia, possibly indicating an ecological migration barrier. As an ecological specialist, the panda depends on bamboo, a C3 plant. Recently Wang et al. (2007) have tried to refine the Stegodon–Ailuropoda faunal sequence in South China by studying faunas from caves in the Bubing valley of Southern China. The cave faunas range in chronology from Lower Pleistocene to Holocene. Stable isotope studies of teeth demonstrate that C3 vegetation occurred in South China throughout the period under study. The fauna from Late Middle Pleistocene sites illustrates that this ecosystem extended into mainland Southeast Asia (Tougard, 2001) possibly preventing faunal elements from Northeast India from migrating into insular Southeast Asia. The fossil record from mainland Southeast Asia however indicates a turnover between 600 and 200 ka (Fig. 2) coinciding with a potential migration of modern faunal elements from South China through mainland into insular Southeast Asia.

### 3. Lower Palaeolithic of the Indian sub-continent

In the 1930s, the Soanian was defined on the basis of collections from the Potwar Plateau in Pakistan, where Siwalik sediments are exposed (Terra de and Paterson, 1939). It was on this basis that Movius placed this region to the east of the Movius line (Movius, 1944, 1949). Work in the 1980s in India and Pakistan showed that the Soanian was from an insecure or late context and the Acheulian was associated with areas of Pinjor exposures (Gaillard and Mishra, 2001). The Soanian, the Indian representative of the chopper chopping tool assemblages of East and Southeast Asia, was shown by Dennell and Rendell (1991) and Dennell (2009: 344) to have no validity in the area it was first defined, the Potwar Plateau of Pakistan. In India, however, work by Indian archaeologists in the post-independence period established a context for the Soanian in the Dun valleys and river terraces of the sub-Himalayan region. In the 1980s, they discovered the first Acheulian sites in the Siwalik area. Although Soanian sites occur in all geomorphic contexts, the Acheulian was found only where Pinjor sediments were exposed. As these sediments represented an older context than the other units, Gaillard and Mishra (2001) suggested that the Acheulian and Soanian are not two co-existing Lower Palaeolithic entities, but rather Palaeolithic industries of different periods. The younger age of the Soanian has now been suggested by most of the current workers in the field (Dennell and Rendell, 1991; Soni and Soni, 2006; Lycett, 2007; Soni et al., 2008; Chauhan, 2009; Dennell, 2009).

The archaeology of the Pinjor formation is controversial with contradictory results from India and Pakistan. In Pakistan, Dennell led a team who explored an approximately 25 × 5 km area in the Pabbi Hills where magneto- and biostratigraphy had shown the outcrops to date from 2.1 to 0.9 Ma (Dennell et al., 2004). In this area, foot survey over a total of 10 weeks of fieldwork led to the collection of 607 artefacts from 211 localities of which 45% were isolated pieces and 78% were less than three pieces. This assemblage is “consistent with the very simple, unstandardised type of assemblages that are elsewhere classed as Oldowan” (Dennell, 2009: 140). At the same time 40,000 animal fossils were also collected. In the Indian section of the Siwaliks, in an approximately 150 km length along the Siwalik Frontal Range around Chandigarh, Acheulian artefacts were collected from 21 localities (Mohapatra and Singh, 1979; Mohapatra 1981, 1997). The artefacts from any one locality were usually very few in number, except at Atbarpur where over 50 Acheulian tools were also collected. In the Indian section of the Siwaliks, in an approximately 150 km length along the Siwalik Frontal Range around Chandigarh, Acheulian artefacts were collected from 21 localities (Mohapatra and Singh, 1979; Mohapatra 1981, 1997). The artefacts from any one locality were usually very few in number, except at Atbarpur where over 50 Acheulian tools were also collected. The Atbarpur assemblage has recently been re-analysed and its characteristics described (Gaillard et al., 2008). Although more than half a dozen sections in the Indian Pinjor have been dated by magnetostratigraphy, there has been no correlation made between the Acheulian find locations and the Pinjor magnetostratigraphy. As 0.6 Ma is a terminal date for the Pinjor in this sector of the Siwaliks, the Acheulian artefacts eroding out of the Pinjor should...
predate 0.6 Ma. Mishra (2008) therefore concluded that the Palaeolithic associated with the Pinjor Faunal stage in India should be considered to be LFA (Sharon, 2007) rather than “Soanian” or any other Mode 1 industry. Rendell and Dennell (1985) reported three handaxes from two localities in Pakistan, from sediments above the Brunhes–Matuyama boundary. Corvinus (2006) collected 20 handaxes from the Satpati site in Nepal. Dennell (2007) has suggested that the lack of stone in the landscape when the Pinjor sediments were being deposited may have been a constraint for hominin occupation. Mishra (2007), however, has pointed out that even in Peninsular India, where stone is exposed over most of the landscape, the Acheulian large cutting tools appear to have been routinely carried and are often found discarded as single artefacts. At Yedurwadi, a quartzite hammerstone was part of an Acheulian assemblage in an area ~70 km from the nearest quartzite outcrop. This shows that Acheulian people carried tools at least for days. This behaviour of carrying finished artefacts seems to be a fundamental character of the LFA, and the one that most distinguishes it from contemporary and earlier Mode 1 industries.

In addition to the Pabbi Hills localities, Dennell and Rendell found artefacts at Riwat in sediments dated to 2 Ma by paleomagnetism (Rendell et al., 1987; Dennell et al., 1988). The most convincing artefact is R001. This core has a maximum dimension of 16 cm, and a large proportion of the other possible artefacts from the same horizon are also >10 cm in maximum dimension, so the Riwat assemblage does not resemble any “Mode 1” assemblage, either in Africa, Europe or China, where the maximum dimensions of the artefacts are less than 10 cm, often considerably less.

Mishra reviewed the Indian (2007) and the global Lower Palaeolithic (2008) and concluded that the Indian Lower Palaeolithic is exclusively Acheulian in character. Entities which have been considered non-Acheulian Lower Palaeolithic are either younger (Durkhabi assemblage in the Narmada valley (Armand 1983), Soanian of the Siwaliks), or poorly provenanced sparse material for which the technological attributes are difficult to determine (Pabbi Hills). In the global context, the Indian Lower Palaeolithic is remarkably homogeneous and continuous compared to any other region of the world, for which the unique ecology of the Indian sub-continent is probably responsible. The Indian sub-continent is one of the largest areas of tropical grassland in the world. The ecological shift to a grassland ecosystem occurred by 7 Ma in both the Siwaliks (Quade and Cerling, 1995) and southernmost peninsular India (Armstrong-Altrin et al., 2009). Variations in rainfall, rather than temperature, determine the different ecological zones in India, so that climate zones follow the east to west rainfall gradient rather than north to south latitudinal gradient seen elsewhere. Frequent and large climate fluctuations during the Quaternary, which led to the alternation of favourable and unfavourable conditions for hominins elsewhere, only shifted the location and extent of the tropical grassland biome in India, but never eliminated it, leading to continuity of hominin populations.

4. Archaeology associated with Stegodon–Homo erectus fauna in Java

The archaeology associated with the Stegodon–Homo erectus phase in Java is also scanty and difficult to interpret although one can argue now that it is better known than that of the Pinjor in the Indian sub-continent due to the efforts of Indonesian and French archaeologists in the last few decades. In Java, the earliest artefacts known so far are not much older than 1 Ma, despite the early arrival of hominins in this southern part of the Sundan Shelf (Swisher et al., 1994; Sémah et al., 2000). These artefacts occur in the region of Sangiran. They are represented by a few flakes from a river deposit at Miri (Lumley de et al., 1993), and at Dayu by small flakes found in the upper part of the Pucangan formation (Widianto et al., 2001; Simanjuntak et al., 2010). At that time the vegetation was evolving from a seasonal forest towards an open grassland (Sémah et al., 2010).

Acheulian, based on the production of large flakes, is attested in Java at Ngémbang near Sangiran in a well stratified alluvial context.

**Fig. 3.** Correlation chart for faunal changes, hominin fossil record and changes in the archaeological record between Indian sub-continent, mainland and insular Southeast Asia.
dated to 0.8 ka. This site has preserved stone and bone artefacts along with faunal remains (Sémah et al., 1992; Lumley de et al., 1993). Although not numerous, this assemblage is very characteristic with close resemblance to the LFA of India. Handaxes have been found in significant numbers in Java, especially in the Baksoka river bed near Pacitan, but without any chronological context (Bartrsta, 1976). In the same region, Acheulian tools also occur in a residual terrace of the Korboran River whose deposits are correlated with the lower unit of the Song Terus Cave sequence, dated to between 392 and 216 ka (Hameau et al., 2007).

Simanjuntak (2001) suggested that the Sangiran flakes and the Acheulian both occurring in the Kabuh layers at Nggebung should belong to the same industry. Here, the parallel with the Indian Neva-

sian occurred in the same gravel unit and therefore were the same age. Sablok (1985) did an exhaustive study of the Nevasian and Acheulian contexts in the Godavari basin and concluded that there was no difference between them. The conclusion that the Indian Middle and Lower Palaeolithic were the same age was therefore entertained and led to the idea that both were quite late. Mishra (1986) argued instead that they actually are both Acheulian, with the Nevasian transformed into a “flake” industry by the removal of the basalt tools from the original Acheulian assemblage. As siliceous raw material on which the Nevasian flakes were made does not occur in large nodules, the assemblage from which basalt had been removed was then deprived of the component diagnostic of the Acheulian. The basalt is missing from the Nevasian assemblage because it is more susceptible to weathering and destruction by fluvial transport than is the siliceous material on which the Neva-

sian flakes are made. The Sangiran flake industry appears to be quite similar to the Nevasian in character, and similarly to the Nevasian comes from strata equivalent to that from which at least one definite Acheulian assemblage (Nggebung) has been recovered.

To date, no stone tools have been recovered from contexts contemporaneous to the earliest Homo erectus fossils in Java. It is most probable that this is related to rarity of the stone tools and not the absence of stone tools. Based on the discussion of the Indian Archaeological record given above, it is expected that these tools, when found, will also belong to the LFA.

5. Conclusions

The archaeology of the Pinjor Formation in the Indian sub-continent and that of the sediments in which the Javan Homo erectus fossils occur is scanty. Until the 1980s, it was considered that during the Lower and Middle Pleistocene the hominins in both these areas had a non-Acheulian (and more primitive) “chopper chopping” stone tool technology, while those in Peninsular India had an Acheulian technology. However, the discovery of Acheulian tools in areas where Pinjor sediments are exposed in India, Pakistan and Nepal led us (Gaillard and Mishra, 2001) to suggest that the Pinjor formation archaeology is probably Acheulian. In Java, the discovery of Acheulian tools in the excavation at Nggebung showed that Homo erectus in Java also had an Acheulian technology. This paper suggests that during the Lower and Middle Pleistocene Large Flake Acheulian, Homo erectus and a rather open and dry ecosystem are found in the Indian sub-continent. In Java the fauna associated with Homo erectus is related to the Indian fauna and migrated from the Indian sub-continent along a “filtered” dispersal route. Homo erectus in Java is not only associated with a fauna related to that of India, but also shares a LFA stone tool technology. Then, in the beginning of the Upper Pleistocene, a clear change in faunal composition occurs: the Punung fauna is related, not to the Indian sub-continent, but to that of Southern China and SE Asia. It repre-

sents a tropical rainforest rather than a savanna-like environment. At this time the archaeology in the two regions is also different. A close relationship between ecological and cultural boundaries is suggested (Fig. 3). The Movius line is in accord with Late Pleistocene and not Lower and Middle Pleistocene ecological and cultural boundaries.

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