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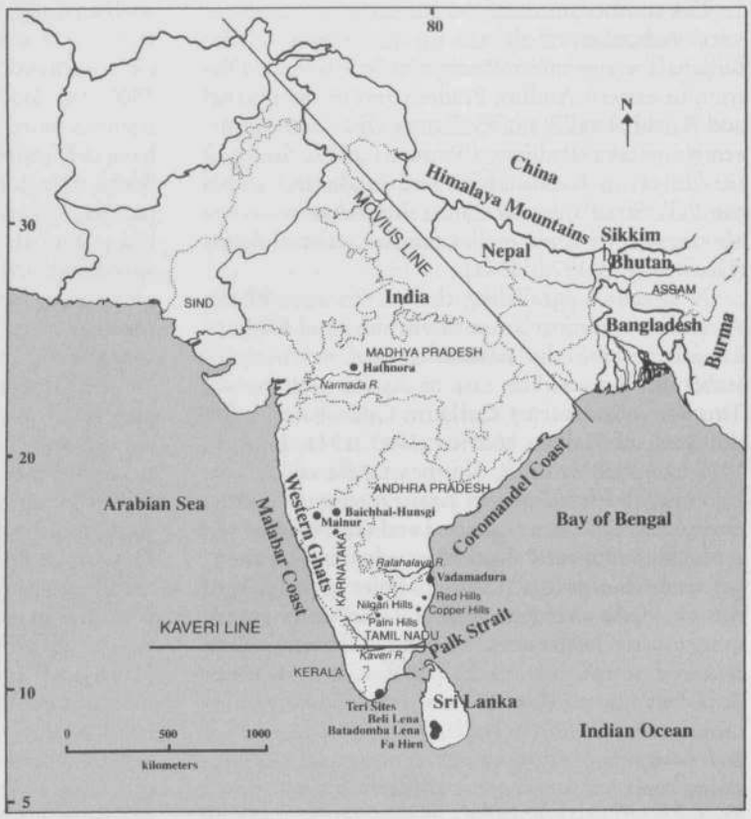

Fig. 1. Map of South Asia with localities mentioned in the text.

Handaxes and cleavers of the Acheulian technological tradition are found in Middle Pleistocene and Middle Palaeolithic sites in the Indian subcontinent. These stone tools decrease in frequency south of the Kaveri (Cauvery) river in Tamil Nadu and are absent in Sri Lanka, the Western Ghats and adjacent coastal region as far south as Kerala, northeastern India, Sind and the Ganges Plains (Misra 2001, 493). Archaeologists have noted this situation: The present study hypothesizes what may have been the causes for the decrease and absence of the Acheulian tradition in southernmost South Asia with respect to environmental settings, geomorphological processes, archaeological industries and biological identities of prehistoric populations of the subcontinent.

Acheulian technology began in East Africa c. 1.4 mya (million years ago), some 0.4 mya after the evolution of *Homo erectus* (or *Homo ergaster*) in Africa. These bifacial stone tools developed from the more ancient Oldowan pebble tool industry (Asfaw et al. 1992). Acheulian handaxes and cleavers were manufactured in South Asia from c. 0.67 to 0.1 mya. Uranium/Thorium dates for the Middle Pleistocene, Lower Palaeolithic sites in the Hunsgi and Baichbal valleys of Karnataka are .35 to .29 mya (Paddayya 2001; Szabo et al. 1990) (fig. 1). These tools were succeeded by Middle Palaeolithic flake-based implements with modified Levalloisian technique and some retouching (Johnson et al. 1982; Misra et al. 1995). A blade and burin industry marked the Upper Palaeolithic, and this continued

in India from 26,000 to 10,000 BP (years Before Present). Microlithic tools associated with a Mesolithic tradition occur in highest frequencies in parts of the Indian subcontinental landmass from the end of the Late Pleistocene and into the Middle Holocene (Clark 1992).

Although a Middle Palaeolithic site is known from Vadamadura in south coastal Tamil Nadu (Sankalia 1974, 140) and from other sites in peninsular India dating from 128,000 to 74,000 BP (Allchin/Allchin 1997, 47), the earliest stone industries of Sri Lanka are flake and pebble (chopper) tools of the Ratnapura tradition which may be as ancient as 125,000 to 80,000 BP (Deraniyagala 1992, 2001).

The southernmost of the Indian peninsular sites with Acheulian tools are on the banks of the Rallahalava river near Renigunta in Chittoor District, in eastern Andhra Pradesh and in the Hunsgi and Baichbal valleys of Gulbarga District in southern Karnataka (Paddayya/Petraglia 1995). South of the Kaveri in Kerala and Tamil Nadu and across the Palk Strait into Sri Lanka Acheulian tools are absent, despite some earlier unsubstantiated claims (Deraniyagala 1972, 1981).

A situation paralleling the evanescence of the Acheulian tradition in southern India and Sri Lanka exists along the border area of northeastern India and Asia to the east of Assam and Burma. This was observed by Carleton Coon based upon the work of Hallam Movius (1943, 1944, 1948) in 1937 and 1938 in India, Southeast Asia and China. Movius considered eastern Asia a region of "cultural retardation" since handaxes and cleavers had not replaced the Lower Palaeolithic technology of chopper tools manufactured from pebbles in this part of the world. As an isolated cultural backwater during most of the Pleistocene, Movius concluded that the hominid populations of the Far East and Southeast Asia had branched away from the mainstream of biological evolution in India, Western Asia, Europe and Africa. Separating the two cultural and biological spheres was an imaginary "Movius Line" drawn across northeastern India, its trajectory marking the division of Acheulian handaxes and cleavers to the west and the chopper tool industry to the east (Shick 1994).

Later interpretations of the Movius Line came from P. I. Boriskovski (1968) who was familiar with the prehistory of Viet Nam, Tom Harrisson (1978) who had examined archaeological sites in Borneo, and the palaeoanthropologists Geoffrey Pope (1988, 1989) and Russell Ciochon (Ciochon et al. 1990), both of whom had conducted research in Southeast Asia. These investigators rejected Movius' thesis of advanced and retarded prehistoric Asian populations with the argument that raw materials other than stone were more efficient in the manufacture of certain implements. Paramont in this argument was the role of bamboo, a grass plant of the taxonomic family *Poaceae (Gramineae).*

Could bamboo have played the same technological role in India south of the Kaveri river? Does the model of the Movius Line serve to clarify a Kaveri bamboo curtain?

There are over 1200 extant species of the gramineous genus *Bambura (Bambos)* of which the commonest species in peninsular India are *Bambura arundinacea* and *Dendrocalamus strictus*, while *Dendrocalamus hamiltoni* and *Melocanna bambusoides* are predominant in Assam. Distributed in Asia between 46 degrees North Latitude and 47 degrees South Latitude and from sea level to 4000 m (metres) (Haubrich 1992), these grasses thrive in openings of the forest canopy. *B. arundinacea* grows in dense strands along watercourses in localities with an annual rainfall of 1000 to 2000 mm (millimetres). *D. strictus* is adapted to a greater range of environments with annual rainfall of 600 to 1500 mm. Both species are shade intolerant and become more widely dispersed wherever humans have deforested single areas (Gadgil/Prasad 1984). South Asia does not have climax grassland (such as pampas, steppes and savannahs), but these bamboos flourish at interim stages in succession of woodlands (Whyte 1968). In southern India open grass areas occur in the Nilgiri hills, along the Malabar coast adjacent to mangrove forests, and sporadically in dwarf forests.

The present-day distribution of bamboo in various landscapes does not represent pre-Holocene conditions. The Miocene epoch marked a transition from wet evergreen forest to dry evergreen forest following an arid deciduous stage. These changes were in response to climatic fluctuations related to Himalayan uplift and monsoonal patterns. During the Pleistocene Himalayan glaciations lowered temperatures in southern India by five to seven degrees C (Celcius; Meher-Homji 1970). Many species of plants and animals migrated from the Himalaya belt into peninsular India, some adapting to highlands when lowland temperatures were elevated. Several faunal species survived in ecological pockets already occupied by the more ancient Indo-Malayan subkingdom species which were established in the peninsula before the onset of Pleistocene glacial conditions. Humidity was lower in the Pleistocene than it is today because moisture was locked up in glaciers. New ecozones were established in southern India with the retreat of the Last Glaciation, and these were modified into suboptimal areas by human practices of deforestation as a consequence of agricultural and pastoral practices.

Beginning in the Indian Early Historic Period, bamboo survival was threatened by widespread harvesting of forests for teak and chir pine. These hardwood plants contain minerals in their barks and stems of which only a fraction is returned to the soil in leaf litter. With deforestation these minerals are lost and soil impoverishment affects the growth of bamboo. It returns to the soil less

than eight percent of total calcium, potassium and phosphorous under these conditions (Puri 1983). Sporadic seeding averages the death of 70 out of 72 seeds, and some bamboo species seed once within a timeframe of 12 to 60 years. Seven out of 70 species are capable of seeding synchronically over large areas (Gadgil/Prasad 1984). Once regarded as a weed which needed to be eliminated, the commercial uses of bamboo were recognized by Indian and British botanists after 1925, and its growth was encouraged by government regulations (Deogun 1936).

Today, as in the Pleistocene, regional densities of bamboo species respond to geographical and climatological variables. The present dry zone of northern and eastern Tamil Nadu receives maximum rainfall from October to January, but the wet zones of Kerala and Sri Lanka receive abundant rain, the monsoon arriving in April and continuing until November in the southern portion of the peninsula. The Southwest monsoon has full impact on the western coast, and the eastern coast is drier. The dry areas of east coastal Tamil Nadu and northern Sri Lanka allowed for greater movement of human and animal populations than is the case in wet jungle tracts, save for occupation by some human communities (Farmer 1963).

The wet zone in central and southwestern Sri Lanka has been relatively stable since the Pleistocene, as attested by the occurrence of shells of the tree snail *Acavus roseolabiatus* at the prehistoric site of Bela Lena Kitulgala dated to 12,500 BP. *Acavus* is present also at the site of Batadomba Lena in deposits dated to 16,500 BP. This mollusk survives today in the immediate vicinity of these Late Pleistocene cave sites within a restricted ecological setting and geographical range where it is adapted to local conditions of rainfall and temperature (Deraniyagala 1992).

Peninsular India is a stable landmass of the oldest rocks in the world, the Archaean. They have formed insulberg topography and raised beaches, rejuvenated rivers, uplifted horsts and relict mountains, and are marked by lavas and folded strata (Puri 1968). Archaean rocks are azoic. Other ancient rocks of the subcontinent are gnessic of which the oldest – charnockites and khondalites – date to 3.1 billion years ago and appear in the Nilgiri and Palni Hills and in Sri Lanka. Where they lie under strata, Archaean rocks are called "basement complex", the superimposed sedimentary layers including lavas which formed the basaltic Deccan Trap 60 mya. Peninsular India is devoid of tectonic movements and has limited fluvial activity, sedimentation and orogenic uplift of coastal and interior regions.

Geological surveys of the peninsula conducted in the late nineteenth century led H. B. Medlicott (1881) to conclude that the alluvium denuded from the Red Hills of Pondicherry and the Copper Hills of Cuddalore held deposits of fossilized wood and other traces of vegetation indicative of a transition of the land into wooded swamps which merged with the waters of the Bay of Bengal along the Coramandel coast. Foote (1873) considered the entire region to have been covered with water and dense jungle throughout the Pleistocene, a landscape inhospitable to human settlement.

Trap rock and other basalts, such as dolerite, were among the raw materials used by prehistoric South Asians for manufacture of handaxes and cleavers. Other sources include quartzites and sandstones from the sedimentary Vindhyan and Cuddapan Formations. Jasper, chert, phylite, horneblend, schist, pegmatite, limestone and granite were used less frequently (Ghosh 1985), but at the site of Mulnur III near Hunsgi to the north of the Kaveri river a cache of a dozen massive limestone handaxes and cleavers was discovered (Paddayya/Petraglia 1995).

Since the region south of the Kaveri river is not deficient in these potential raw materials, and given the dependence upon tool technology by Pleistocene hominids, it is probable that other raw materials were preferred over stone. If of vegetable origin, preservation of non-lithic tools is unlikely to be recoverable in the archaeological record. Here the ethnographic record is relevant in demonstrating the versatility of bamboo by present-day users of this and other plant species. Living tribal populations in the Western Ghats use bamboo for bows and arrows, hut construction and baskets, and the seeds and stalks are edible. With reference to prehistoric populations east of the Movius Line, Pope (1988, 1989) observes that even when rocks were available, bamboo could have been more efficient, durable and portable. It was effective in the hunting of small game and a more common staple in the prehistoric diet than large game. While stone choppers may have been needed for working hard woods, bamboo could have been shaped by smaller stone flakes.

However, some differences in ecological and archaeological circumstances set apart the Kaveri bamboo curtain from the model of the Movius Line. Pope (1989) correlates chopper tools in eastern Asia with forest environments and absence of savannah-attracted mammals, such as the horse, camel and giraffe. Naturally occurring bamboo coincides with the distribution of chopper tools in these forested areas. But in India to the west of the Movius Line, Acheulian assemblages appear in more open plains. Pope argues that *Homo erectus,* inventor of the bifacial handaxe-cleaver technology in Africa, was the first member of this genus to enter and adapt to forest environments. This pioneering adventure involved a greater reliance upon non-lithic technology and raw materials. Choppers continued in the forest-adapted tool kit of *H. erectus* as the importance of other implements of the Acheulian declined. The chopper tools persisted in eastern Asia alongside distinctive flake

cultures distinguished from the lithic traditions of the Middle and Upper Palaeolithic and subsequent microlithic technologies subsumed under the label of the Mesolithic.

Peninsular India south of the Kaveri river and Sri Lanka had Pleistocene landscapes which were more diverse than the dense jungles of much of Assam, Burma and lands to the east. Forested areas lay adjacent to dry zones along the Malabar coast of Kerala, the Nilgiri Hills and the more sparsely wooded tracts of the Coromandal coast of Tamil Nadu. Within these diverse ecozones grew bamboo species well adapted for survival, but not always the same species encountered east of the Movius Line.

Furthermore, when the Lower Pleistocene comes to an end in India it is succeeded by Middle and Lower Palaeoliothic stone industries in the extreme south of the peninsula as well as in other parts of the subcontinent. For reasons still unknown, these industries did not diffuse to Sri Lanka. The Mesolithic Teri sites of southernmost Tamil Nadu are of post-Pleistocene antiquity, but geometric microliths are present at the Late Pleistocene sites of Batadomba Lena and Beli Lena Kitulgala in Sri Lanka within the time frame of 31,000 to 10,000 BP. In short, if stone was not a preferred raw material for tool manufacture in the region south of the Kaveri river during the Middle Pleistocene in India, it was reintroduced as a desirable manufacturing medium within the Middle and Upper Palaeolithic traditions of the Late Pleistocene. Among these stone sources for tool-making are quartz, chert, agate, chalcedony and jasper as well as other lithic materials earlier incorporated in the Acheulian implements in areas north of the Kaveri.

Among the explanations for the absence of Acheulian bifaces in eastern Asia is one based upon the notion that a line of biologically distinct human populations (species?, races?) had separated from a common hominid ancestor in the Pleistocene, and this accounts for cultural differences in technological development (Movius 1944; Foley 1987; Clark 1992; Rightmire 1992). This thesis has found support among those palaeoanthropologists who argue that eastern Asian prehistoric populations contributed little to hominid evolution since the Early Pleistocene when one lineage gave rise in Africa to anatomically modern *Homo sapiens* (Andrews 1984; Groves 1989; Wood 1991). Opponents of this "Out-of-Africa" hypothesis propose that modern humans have ancestral lines phylogenetically derived from Early to Late Pleistocene populations represented by the fossil record from geographical locations in which their descendants live today, the "Multiregional Hypothesis" (Thorne/Wolpoff 1981; Wolpoff 1999). Proponents of both camps agree that *Homo erectus* evolved in Africa by 1.8 mya and developed the earliest handaxes and cleavers from chopper tools by 1.4 mya. If the first *H. erectus* emigrants left Africa before the emergence of the Acheulian tradition on that continent, then dispersed to eastern Asia, they could not have brought that tradition with them (Tattersall 1997; Gibbons 1998).

The separate biological lineage hypothesis in the context of the Movius Line does not fit the palaeontological data from central and peninsular India or from Sri Lanka. Fossils of *H. erectus* have not been found in the Indian subcontinent, although the Acheulian tradition is firmly established by the archaeological record. The single instance of the presence of Acheulian handaxes and cleavers in association with a fossil hominid specimen in India is from the Late Middle Pleistocene locality near Hathnora in the central Narmada valley of Madhya Pradesh. Although originally assigned to the taxon *H. erectus* (Sonakia 1984), reassessment of the calvaria six years after it discovery assigned it to anatomically archaic *H. sapiens* (Kennedy et al. 1991).

India has not yielded Pleistocene hominid remains south of the Kaveri river, but these have been recovered from three cave sites in Sri Lanka: The most ancient skeletal specimens are from the cave of Fa Hien in depositional levels radiocarbon dated from 37,000 to 5,400 BP (Kennedy/Zahorsky 1997). Non-geometric microliths come from this site, geometric microliths emerging from the other cave sites of Batadomba Lena and Beli Lena Kitulgala after 28,500 BP[1]. Given these archaeological and skeletal records, it appears that India was inhabited by anatomically archaic *H. sapiens* who made Acheulian tools, but this industry is not associated with anatomically modern *H. sapiens* in Sri Lanka. Nor do handaxes and cleavers occur with the chopper tools on the island. An argument for separate biological lineages paralleling the Movius Line model would be a weak one if applied to the present archaeological and palaeontological record from southern India and Sri Lanka.

Sri Lanka appears to have been a region of relative cultural and genetic isolation with respect to adjacent landmass and islands in the Indian Ocean from the time of its initial hominid settlement in the late Middle Pleistocene to the middle Holocene. However, Deraniyagala (2001) notes that over the past 0.7 mya there have been 17 occasions when sea levels dropped and formed island chains and land bridges linking southern India to the island. Thus geographical factors may not have been related to the apparent cultural isolation of Sri Lanka. Archaeologists have argued that Neolithic, Chalcolithic and Bronze Age cultural traditions had not diffused to the island from India, but contact was established by the eighth century BC with the onset of an Iron Age and colonization by invaders from the mainland a few centuries later.

[1] Deraniyagala 2001; Kennedy 1999, 2000; Kennedy/Deraniyagala 1989; Kennedy et al. 1986, 1987, 1991.

Recent revival of interest in the Movius Line promises to shed light on the circumstances of the diminution of the Acheulian tradition south of the Kaveri river in southernmost peninsular India and Sri Lanka (Schick 1994; Gibbons 1998; Keates 2002). The following considerations are relevant:

1. During the Pleistocene and well into the Holocene epochs prior to the initiation of deforestation practices by farmers and pastoralists, large sectors of the terrain south of the Kaveri river were covered with dense jungle. Although dry zones existed in southern Tamil Nadu and northern Sri Lanka, geological, ecological and palaeobotanical data indicate regions where human population movement was restricted. Emigration from the Indian mainland to Sri Lanka was possible, as noted above, but changing Pleistocene and Holocene landscapes may have established limited and constricted migration routes. Genetic and cultural contacts severed in the Middle Pleistocene may have been reestablished in some areas with the termination of glacial conditions in the Himalaya. Yet, any migrations to the island may have been sporadic.
2. Associated with geological, climatological and biotic changes are different timings for diffusion of technologies and other cultural elements. The Acheulian tradition persisted intermittently in some localities in South Asia and never penetrated into other regions, particularly when older and well-established tool-making practices suited the survival strategies of earlier hominid populations living under different ecological settings.
3. Although raw materials for the manufacture of handaxes and cleavers were always available in peninsular India and Sri Lanka, within tropical forest habitats a lighter tool kit would have been easier to use and transport than a lithic kit dependent upon heavy blocks of raw materials.
4. Bamboo is a superior raw material over stone in certain respects, and its abundance in southern India and Sri Lanka during the Pleistocene is apparent from ancient and modern botanical evidence. This versitile and geographically widespread grass may have been valued as an important raw material in areas under discussion, accounting for its dominance over tools of the Acheulian tradition here as well as in eastern Asia.
5. Biological evidence of an association of distinctive hominid species or races with the presence or absence the Acheulian tradition is not established by any fossil record for prehistoric populations inhabiting regions to the south of the Kaveri river. Nor is a biological-technological relationship established for the model of the Movius Line. Rejections of Movius' archaeological and phylogenetic theses are now based upon the anthropological observation that practices of specific lithic technologies are driven by habitual patterns of behaviour as well as by adaptations of innovative strategies which promise survival in a variety of ecological settings. The reality of a Kaveri Line is evident, but any parallels to the Movius Line model with respect to the Acheulian tradition are based upon the behavioural capacities of earlier hominids to adapt to a wide range of technological practices and to exploit environmental and trade sources for raw materials.

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