THE INITIAL HOMINID COLONIZATION OF ASIA: A SURVEY OF ANTHROPIC EVIDENCE FROM BIOGEOGRAPHIC AND ECOLOGICAL PERSPECTIVES

Nicolas Rolland

Department of Anthropology, University of Victoria, BC, Canada

ABSTRACT

I review the fossil and Palaeolithic evidence, palaeoenvironmental circumstances, and issues concerning the earliest peopling of Asia. Issues include long versus short chronologies for a hominid presence datum and determining migratory paths toward East Asia and the Indo-Pacific region. This review will consider biogeographic concepts such as dispersal probabilities influenced by physiographic, bioclimatic and latitudinal obstacles, as well as ecological concepts such as plant and animal food biomasses and carrying capacities.

CONCEPTUAL FRAMEWORK

Concepts relevant for surveying early *Homo* dispersals and the colonization of Eurasia include: (1) biogeography, with respect to faunal regions and dispersal probabilities; (2) human population movement processes; (3) palaeoecological and adaptive constraints; and (4) ancient hominid behaviour/culture.

Biogeographical concepts

These apply here since the present-day distribution of the human species results from long-term population movement episodes of varying scales and tempos originating from an Old World tropical region, spreading throughout most of the northern and temperate zones and into insular and oceanic areas, illustrating common biogeographic patterns (Darlington 1957). The current Faunal Regions (Ethiopian, Oriental, and Palaeoarctic) represent average distributions over continental landmasses from historical migration cycles whose boundaries shifted or fluctuated in the past. North Africa remained an Ethiopian biogeographic island throughout the Pleistocene. The Indian Subcontinent was predominantly endemic with some Palaeoarctic elements lying entirely outside the Oriental Region during the Pleistocene. Hominids, originating in the Ethiopian region, dispersed into the Palaeoarctic and Oriental regions.

Dispersal Probability (Simpson 1962) refers to the dispersal and migratory movements of animal species in relation to constraints or limitations, such as physical, bioclimatic or latitudinal barriers, and to demographic fluctuations. Major dispersal settings include: (1) corridors, where barriers do not impede movements by most species, such as the Eurasian corridor covering much of the temperate continental Palaeoarctic region from the Taurus to the Tibetan Plateau; (2) filters, where barriers become sufficiently effective to restrict movements by many species, as in Central America or episodically, most of the Sahara; (3) sweepstake routes, these being major water barriers such as those between the Oriental and Australasian regions, with dispersal involving only one or few species.

Hominid Population Movement Patterns

Mobile hominid foraging group dispersals cannot be described as linear directional patterns. They represented instead a series of loosely connected migratory pulses, stretching through centuries, millennia, and countless generations, by multidirectional random movements involving gradual home range displacements into unfamiliar habitats, influenced by stochastic demographic fluctuations, short or long-term climatic oscillations, or ecological factors. They involved recurrent migratory drifts by founder populations, expanding or contracting episodically, sometimes with localized extinctions leaving "empty quarters". Depicting these movements as "random walks" does not obviate broad directional trends caused by physical, climatic and ecological bottlenecks, and by simpler cultural repertoires during the progressive Pleistocene colonization of Asia.

Palaeoecological Aspects

Hominids intruding into new biomes or regions became acquainted with unfamiliar animal/plant food resources, and interacted with new carnivore competitors. Exploiting unknown habitats made ancient humans a new ecological factor, introducing survival stresses for species hitherto without natural predators. Recurrent Quaternary palaeoclimatic cycles became more abrupt and intense after 850 kya (Ruddiman *et al.* 1986), and opened up both new opportunities and constraints for hominid immigrants. Stadial advances triggered sea level low stands, thus widening coastlines and uncovering continental shelves, such as the Mesopotamian delta, and the Persian and Oman Gulfs. They also created land bridges, including Sundaland connecting Sumatra, Java, Bali and Borneo with Mainland Southeast Asia, or Japan with continental East Asia. Stadials created or favoured (1) eutrophic lake expansions, as in Central Asia and northern Iran; (2) open, game-rich grasslands; and (3) more productive landscape mosaics and richer animal and plant food biomasses in regions such as Eastern Java, areas of Mainland Southeast Asia, Northern China and Japan. Interglacials with temperate bioclimatic conditions provided warmer habitats for hominids, a primate species of tropical origin, and endowed the broadleaf coastal regions of Central China, Korea and Japan with a high primary productivity and varied, abundant vegetal food resources for omnivorous hominids.

Behavioural and Cultural Repertoires of Early Homo

This topic remains underexplored, what is known relating mostly to lithic toolmaking. Though simple in range, repertoires already displayed skill and versatility, regional variation, with reduction sequences specific to particular manufacturing techniques and different raw material conditions, and progressive technical improvements. Little information exists about lignic technology for modifying and using hard or soft plant fibres. Some argue that hominids mastered fire, as a harnessed energy source, at an early date in Africa, particularly as a hunting aid and for bush clearing, influencing Quaternary bioclimatic fluctuations (Schule 1990). Evidence for domestic fire, however, clusters at the end of Lower Palaeolithic times (James 1989; Perles 1987; Rolland 2000). Regular fire use would be helpful for dispersing into new environments and habitats or adjusting to temperate latitudes.

More concrete information is available about subsistnce and socioecology. Hominids undoubtedly enhanced their carnivorous propensities by 2.5 mya with active procurement strategies. Combining a phylogenetically inherited primate sociality and omnivorous diet with a carnivorous shift entailed coevolutionary interactions with other African carnivore species. Structural tensions stimulated dispersal tendencies (Shipman and Walker 1989) because, as ground living primates finding safety in group cohesion and large local group sizes, hominids had to ensure low enough predator/prey ratios by expanding their home-ranges.

I have hypothesized (Rolland 2000) that before ancient hominids mastered fire-making by the late Lower Palaeolithic, they relied on a "core-area" land use organization involving strict segregation of activities and settlement locations between daytime and night time. Diurnal hominid primates concentrated subsistence and maintenance activities during daylight hours to minimize interactions with dangerous carnivores. Darkness hours were spent sleeping in safe locations (trees, rocky outcrops, cliffs), when nocturnal carnivores become more active and aggressive. Local hominid groups aggregated in open woodlands where tree cover remained available for safety, rather than risking hazardous occupation of treeless grasslands or steppes.

AFRICAN ANTECEDENTS

Both Sub-Saharan Africa and Tropical Asia were major centres of higher primate evolution, but Tropical Asia was predominantly a recipient region of mammal immigrants. The region witnessed widespread specialized adaptations to forested environments by pongid species and was not the locus of anthropogenesis. Africa was the setting for human origins and major biocultural formative stages, probably preconditioning movements and successful adaptations beyond this continent. It was a mammalian evolution centre and supplier of emigrant species. It contains an almost continuous and unmatched record of anthropic fossil evidence for human emergence since 6.0 mya, with phyletic branching into separate early hominid genera and species, including *H. erectus*, by 1.8 my. Regular toolmaking appeared by 2.5 mya, evidenced by modified hand morphology and artefact clusters, with a progressive linear succession from Oldowan (mode 1) to Acheulian (mode 2).

Africa also witnessed a broadening of the hominid omnivorous diet through regular meat-eating and exploiting medium and large-sized ungulates. Some argue that fully bipedal humans with "liberated hands" for making and carrying stone artefacts could also easily have manufactured simple wooden weapons such as spears or clubs. These would have enabled them to exploit mega-herbivores hitherto without natural predators (Schule 1991).

OUT OF AFRICA

Why early humans dispersed beyond their Sub-Saharan cradle remains elusive. These movements may have been part of a comprehensive biogeographic event involving African carnivores (Turner 1982). Coercive or voluntary factors may have operated independently or jointly. One possible explanation may relate to hominids' dual identity:

"primates by phylogeny, carnivores by vocation" (Schaller 1973:264). Ground-living primates rely on sociality and large local groups for safety and tend not to migrate over large distances, while carnivores must maintain low predator/prey densities to avoid depleting resources. Herbivorous mammals shifting to a carnivorous diet need to expand their home ranges and migrate to make this adaptation sustainable. Their generalized or eurytropic diet favours geographic radiation and the colonization of new regions (Foley 1987:263, 267).

Widespread hominid dispersal into new biomes would not necessarily result in speciation. Carnivorous exogeny, or foraging across a range of habitats, and mating systems requiring mobile, fluid local groups to ensure survival of low density founder populations could contribute to maintaining intraspecific gene flow and species identity. This is despite tendencies to form reproductive isolates and endemic evolutionary groups. These sociodemographic constraints could result in many areas remaining "empty quarters", as immigrant humans selected favourable habitats. Another factor could be the 1.7 mya major arid shift which favoured the spread of open woodlands and savannas, intensifying seasonal contrasts and reliance on animal foods, causing home range displacement and dispersal tendencies.

THE FOSSIL AND EARLY PALAEOLITHIC ANTHROPIC RECORD IN ASIA

Table 1 summarizes the anthropic evidence documenting early hominid settlement throughout Asia, represented by either human fossil or Lower Palaeolithic occurrences, particularly stone artefacts, datable from more than 1.4 to 0.6 mya.

WESTERN ASIA

Available dispersal routes leading into Western Asia could have been across the Sahara into the Maghreb, with hominids moving gradually towards the Levant along the wetter South Mediterranean coastline, or directly across the Horn of Africa through the Bab-al-Mandib Strait (Caton-Thompson 1957) into the southern Arabian Peninsula. Circumstantial evidence suggests that the latter is more likely (Cachel and Harris 1999:134). The Sahara offered episodic filter routes through the narrow Mauritanian passage or oasis areas such as the Hoggar and Tibesti during wetter Quaternary phases, but the earliest dated anthropic evidence is Acheulian occurrences from Atlantic Morocco, not earlier than 0.85 to 1.0 my (Raynal and Texier 1989). The Early Pleistocene Nile flowed into the Red Sea. Nile silt and sandstone are not older than 1.0-0.5 my, while the earliest Lower Palaeolithic finds date to 300-400 kya. Tectonic and glacio-eustatic evidence indicates additionally that the Afar area experienced considerable desiccation and sea level low stands during stadials, considerably narrowing the Strait and creating narrow channels and land bridge strips. The location of the 1.6-1.3 my old Barogali (Djibouti) butchering occurrence (Chavaillon *et al.* 1987) is suggestive in this respect.

Southwest Asia functioned as a crossroad between Africa, Central Asia, the Indian Subcontinent and Europe. It belongs mostly to the Palaeoarctic Region, excepting the South Arabian Peninsula. Its vegetation belts contain overlapping floral communities of Sudanic, Mediterranean, Sindhian and Turanian origins, whose boundaries fluctuated considerably throughout the Quaternary. Geographically, the area includes: (1) the Arabian Peninsula and the Levant, regions of hot deserts and grasslands, along with wetter, lush Mediterranean coastline, reminiscent of Northeast Africa, which presented familiar habitats to hominid immigrants; and (2) a northern hinterland belt of high altitude mountains – the Taurus, Armenian Knot, Caucasus and Zagros ranges – and plateaux, with seasonally cold deserts, connected with Central Asia. This belt formed the westernmost extension of the high elevation arid core of Palaeoarctic Eurasia, and as such, offered effective physical barriers (Howell 1960:224). One dispersal model assumes unbroken, direct northeastward movements of ancient hominid populations despite these barriers (Gladilin and Ranov 1986). I argue (also Howell 1960) that earlier hominid movements more likely funnelled along the more familiar bioclimates of the subtropical bottleneck habitats towards the Indian Subcontinent.

Peopling the Arabian Peninsula would favour a path along the eastern Yemen Hill slopes lying in the rainshadow (known historically for fertile terraced agriculture) over the inhospitable Red Sea coastline area. The Lower Palaeolithic across the entire peninsula remains inadequately documented due to poor preservation conditions, without benefiting from a sediment-trapping tectonic geomorphology. Promising early hominid occurrences include the Acheulian from the Shuwayhitiyah and Dawadmi areas (Wahida 1982), which cannot be dated precisely. Evidence further north into the Levant becomes more informative, represented by early Acheulian occurrences displaying facies with or without handaxes: Bizat Ruhama, Northern Negev, with miniature-sized artefacts and fauna, calibrated to the Late Matuyama (Ronen *et al.* 1998); the 'Ubeidiya multi-layered horizons of Late Matuyama age (Bar-Yosef and Goren-Inbar 1993), the most securely established datum (lithology, biochronology, and palaeomagnetism) for all of Eurasia; and the Evron-Quarry, probably of Late Matuyama age (biochronology). Findspots like Sitt Markho and Khattab, in Syria, represent similar occurrences (Muhesen 1988). The record becomes spotty and poorly dated upon reaching the Anatolian and Iranian Plateaus. Dursunlu (Gulec *et al.* 1999),

Table 1: List of major anthropic occurrences in Asia

Name	Location	Anthropic Remains 1	Palaeolithic Repertoires 2	Geochronology 3, 4	Age 5
Near East					
Bizat Ruhama	S. Israel	P	A2	L; G	LM
'Ubeidiya	N. Israel	P	A1, A2	L, B; G, T, R	1.4 my
Evron-Quarry	N. Israel	P	A1	L, B	LP
Sitt Markho	N. Syria	P	A1	L, B	LP?
Dursunlu	S. Anatolia	P	A2	L, B; G	LM
Indian Subcontinent					
Pabbi Hills	Pakistan	P	A2	L; R	>1.0 my
Bori loc. 4	C. India	P	A1	L; T, R	0.65
Bori loc.1, 4	C. India	P	A2, A2	L; T, R	1.4 my
Southeast Asia					
Anyathian	U. Burma	P	N-A	L?, B?	MP?
Ban Don Mun	N.Thailand	P	N-A	L; G, R, T	EP/MP
Mae Tha South	N.Thailand	P	N-A	L; G, R, T	EP/MP
Phnom Loang	Cambodia	P?	N-A	B	EP
Modjokerto	Java	F	-	L, B; G, T, R	Ep or MP
Sangiran	Java	F	-	L, B; G, T, R	Ep and MP
Sambungmachan	Java	P	N-A	L; G	MP?
Ngebung	Java	P	N-A	L, B	MP?
Mata Menge	Java	P	N-A	L? B; R	MP?
East Asia					
Yuanmou	S. China	P, F	N-A	L; G, R	0.73-0.97
Bose	S. China	P	N-A	L; R	0.73-1.00
Gongwangling	N. China	P, F	N-A	L, B; R	EP/MP
Zhoukoudian loc13	N. China	P	N-A	G	0.73
Xiaochangliang	N. China	P	N-A	L, B	0.73-0.97
Donggutuo	N. China	P	N-A	L, B	0.73-0.97
Kami-Takamori	Japan	P	N-A	L; G, T, R	0.600-800
Inner Asia					
Khonako	Tajikistan	P	N-A	L: G	0.550
Kul'dara	Tajikistan	P	N-A	L, B; G	0.850
Kashafrud	N. Iran	P	N-A	L	EP
Azykh	Azerbaijan	P	N-A	L; G?	EP
Dmanisi	Georgia	P, F	N-A	L, B; G, T, R	EP >1.0 my

1: F = fossil remains; P = Lower Palaeolithic occurrences
2: A1 = typical Acheulian; A2 = atypical Acheulian; N-A = non-Acheulian (Chopper/Flake complex)
3: time-stratigraphic: L = lithostratigraphic; B = biochronological
4: calibrations: G = geomagnetic; T= tephra; R = radiometric dating
5: EP = Early Pleistocene; MP = Middle Pleistocene; LM = late Matuyama

in the southern Taurus foothills, is Late Matuyama (biochronology and palaeomagnetism).

Dmanisi in Georgia (Gabunia *et al.* 2001) may represent the most important and earliest hominid discovery in Western Asia. An 1.8 my basalt layer underlies sediment layers containing simple artefacts, an Early Pleistocene fauna, and crania and mandibles showing archaic *Homo* traits. This evidence confirms the site's early age, while raising puzzling issues. Dmanisi is situated in a mild, lush, and ecologically rich habitat, favouring ancient hominid occupation. Its geographic location, however, lies beyond major biogeographic barriers, namely Eastern Anatolia's extreme, harsh climate in a difficult Alpine terrain, next to the arid, enclosed, and biotically impoverished Central Anatolian plateau. The Taurus, northwest Zagros and Armenian Knot form intricate arrays of irregular folds, while the West Taurus wall encloses a region marked by long-lasting endemism (Fisher 1963:280, 321, 327). Eastern Anatolia belongs to the European, rather than Near Eastern, Pleistocene faunal province. These factors suggest that migratory conditions from the Levant to the Transcaucasus, under present-day circumstances, would exceed the adaptive capabilities of early *Homo*. The region's history of marked tectonic instability and multidirectional orogenic uplifts makes it conceivable that these barriers were mitigated, as elsewhere in Asia, during Early Pleistotocene times: milder climates, a more wide-spread Colchian rainforest, availability of rolling plains and low valley migratory paths along an axis from the Levant to the Caucasus Barrier (Horowitz 1979; Liubin 1998). In the Mid-Pleistocene, uplifting in northeast Anatolia and faulting creating the Levant Rift occurred, with concomitant climatic deterioration. This scenario may find support from the fact that Dmanisi is separated from a later local Acheulian horizon (< 600 ky, Kudaro I, Treugol'naia, based on ESR, RTL and biochronology) by a long occupational hiatus (Liubin 1998:32).

The rare (and undated) Lower Palaeolithic finds from the Zagros and Western Iran indicate that ancient hominids rarely penetrated or occupied higher altitudes or inland areas until they developed vertical seasonal transhumance land use during the Middle Palaeolithic (Smith 1986:16). This earlier phase of human occupation of the Near East was apparently concentrated in subtropical habitats, including the South Anatolian and Iranian coastal enclaves, with limited or exceptional penetrations of foothills, leaving virtually empty regions further north, including the forbidding, desolate and hazardous edge of the South Iranian Plateau (Fisher 1963:288; Spooner 1972:248). The Mesopotamian lowlands and coastal areas of Iran south of the Zagros barrier – both enlarged substantially during sea level lowstands – constitute an outstanding gap in anthropic evidence, due to insufficient investigation.

THE INDIAN SUBCONTINENT

Moving eastward, mountain and plateau barriers became increasingly steep and less accessible to ancient hominids, because the Tertiary uplift in the Himalayas and related ranges was already significant by 40 mya (Chung *et al.* 1998; Fort 1996). Natural habitats and vertebrate faunas become progressively more diverse and richer towards the Subcontinent – excluding the desolate Makran area and Thar Desert. The Indian Subcontinent fits the zoogeographic concept of greatest concentration in the largest and most favourable areas (Darlington 1957:415). Throughout the Pleistocene, geoclimatic patterns differed in major ways in this vast subregion, which did not belong to the Oriental region. The mammalian fauna consisted largely of endemic species incremented by Palaeoarctic elements probably coming from the northwest (Azzaroli 1985; Kretzoi 1961-64). This suggests that a filtering factor existed to the East from dense subtropical or tropical forests in southern Nepal, Bengal, and Assam to Burma. India combines environmental characteristics of Africa, Southwest Asia and Southeast Asia. Some of its mammalian biomasses approximate East and Central Africa (Schaller 1967). The Indian Subcontinent was ecologically favourable for an omnivorous hominid subsistance (Paddaya 1994), with varied plant or animal food staples, in addition to a wide range of tropical hardwood and bamboo materials. The Subcontinent played a dual role in hominid dispersals: as an attractive setting and obligatory migratory pathway to the East.

Direct evidence of hominid occupation consists of Acheulian occurrences and facies (excluding the problematic Early Soanian). This abundant documentation contrasts with most of Western Asia, reflecting more investigative activity but probably also more concentrated early human occupation. This advantage is offset by unfavourable geomorphological conditions – mostly a Precambrian substratum and weak sedimentation in the south – and also by taphonomic conditions such as surface runoff, high energy stream transportation, and even chemical decomposition of artefacts (basalt artefacts in the Deccan Trap region; Mishra 1981). The evidence is rarely found in primary context (Korisettar 1994; Paddaya and Petraglia 1993; Pappu 1996). Associated vertebrate fauna survived in some areas such as the Narbada Valley. Most sites are found near rivers or tributaries, reflecting stream transportation, and indicating that ancient hominids settled close to water and raw material sources. It is now evident that early humans ranged into varied habitats, including Nepal (Corvinus 1998).

The earliest remains of human occupation are probably dispersed without trace or buried deeply, or have not been found yet (Misra 1989:17). The Riwat finds in Pakistan (Dennell *et al.* 1988) contain genuine artefacts, but their provenience and dating (1.9 my?) are subject to debate. The earliest secure radiometric dates (Ar^{39}/Ar^{40}) are from the Bori localities, near Pune, with 650 kya for the Acheulian, while isolated stratified finds of flakes may go back (if confirmed) to 1.4 my, hence as early as 'Ubeidiya (Mishra 1994; Mishra *et al.* 1995). Equally ancient may be artefacts collected from the Pabbi Hills, Northern Pakistan (Hurcombe and Dennell 1992). Given anthropic evidence dating to at least 1.0 mya for the Far East (Java, North China), a minimum age of 1.0-1.4 my seems plausible for the Subcontinent (Mishra 1999).

THE FAR EAST

This entity covers major portions of the Indo-Pacific region. Researchers separated it from the rest of the Old World as belonging to the "Movius Line", though a widespread adoption of this concept has not gone unchallenged (Huang and Hou 1998; Yi and Clark 1983). One biogeographic argument proposed that Southeast Asia and South China formed ecological barriers to hominid migrations (Luchterhand 1984). The Far East north of the Qinling range (central China) was settled first from the Iranian Plateau and Central Asia according to Luchterhand (1984).

I maintain that regions south of Western and Central Asia's main ranges and plateaux were more accessible and ecologically familiar to hominids, and that Lower Palaeolithic populations did not venture deeply into areas beyond the Fertile Crescent foothills. Further southeast, paralleling Asia's high altitude divide, the open and ecologically impoverished habitats in Baluchistan up to the Suleiman range were inhospitable. The piedmont belt flanked by the major physical obstacles of the Himalayas and Tibet plateau since the Miocene (Fort 1996), becomes wetter and densely forested, supporting various mammals. Ecological filters of deep forests with major bamboo clusters in Nepal, Bengal, and Assam could have delayed but not impeded hominid penetration into Southeast Asia (Shutler and Braches 1988).

A. SOUTHEAST ASIA

This core area of the Indo-Pacific bioclimatic realm is marked by oceanic influences throughout its continental and insular areas. Its complex vegetation includes various types of tropical forests: evergreen high rainfall tropical rainforests of dipterocarps, epiphytes, climbers, palms and bamboos, concentrated especially in Peninsular Malaysia, Sumatra and Borneo; semi-evergreen and seasonal monsoon forests; dry and moist teak forests; and thorn woodlands. Unlike other tropical forests, grasslands or open savannas are scarce, localized and probably anthropogenic (Richards 1952:327). The Indo-Malaysian evergreen flora is reportedly a surviving representative of a widespread pristine Tertiary vegetational assemblage (Corner 1940), accounting for its optimal biodiversity. River valleys and upland regions of mainland Southeast Asia and South China offered attractive habitats and strategically located dispersal paths (Schepartz *et al.* 2000).

Quaternary fluctuations impacted on Southeast Asia's palaeogeography: Upper Pleistocene stadials induced low sea levels, adding the emerged Sundaland continental shelf to the mainland; localized forest replacements, drier conditions, increased continentality, more pronounced seasonality, and cooler (dropping 5-7°C), more open landscapes in Java, Sumatra and Borneo (Flenley 1985; Majid 1982:31; Maloney and McCormac 1996; Sémah 1984; Kaars and Dam 1995). Episodic sea level changes and repeated insularity created endemic trends in the Oriental fauna east of the Wallace divide (or Wallacea), as well as in Java, Sumatra, Borneo and Palawan (Groves 1985). Oriental mammals comprise mostly forest-adapted, relatively solitary species. That bioclimatic changes had repercussions on vegetation communities and animal biomes, is shown by an increase in the size of fossil orang-utan from Niah Cave (Harrison 1996). It is also shown by localized open landscapes during low sea levels and cooler temperatures, though apparently not long enough to allow long-term evolutionary changes with the appearance of arid or grassland-adapted gregarious species such as equids, camelids, or giraffoids (Pope 1985, 1988).

These regional characteristics and Pleistocene bioclimatic fluctuations influenced hominid colonization and lifeways. Settling Southeast Asia meant adapting to habitats less familiar than Africa, the Near East or India, occupying an oceanic region with humid forest biomes, shallow seas, numerous islands and straits, indented coastlines, and episodic sea level changes. All this made it a staging area for large-scale Upper Pleistocene maritime dispersals. The ice ages created favourable palaeogeographic and palaeoecological circumstances for settling continental and insular Southeast Asia by landbridges and patches of more open, seasonally variable landscapes with a wider spectrum of dietary plant resources for omnivorous human populations.

The evergreen rainforests, however, lacking dry seasons and therefore ground-level growths of tubers and seedy plants adapted to drought, are poor in basic nutrients like carbohydrates and vegetal fats (Hutterer 1983:180), while palm stands require elaborate processing. Although low sea levels allowed for settling the Sundaland islands, this leaves open questions about island occupation during marine transgressions: did local *H. erectus* groups abandon these islands gradually, or did they remain isolated in large islands such as Java, Sumatra, or Borneo, as radiometric dates (Swisher *et al.* 1996) might imply. If *H. erectus* persisted in Java until Late Pleistocene times, would this lead to insular endemism and, perhaps, speciation? Alternatively, these populations developed much earlier navigational means enabling them to migrate back and forth between islands, and colonizing Wallacean islands such as Flores as early as 700 kya (Morwood *et al.* 1999).

Southeast Asia differs from India or East Asia in that it consists of scarce Lower Palaeolithic occurrences for Burma and Thailand, whereas Java has primarily yielded *H. erectus* remains. Taphonomic disturbances due to complex geomorphological and post-depositional processes negatively affected the quality and provenience of this evidence (Hutterer 1985; Pope and Keates 1994), and sites and artefact densities remain significantly lower. A broad time-stratigraphic and biochronological framework is available (Leinders *et al.* 1985), but resolution difficulties persist despite the widespread use of calibration methods in Java. Southeast Asia's environment should offer a good test case for the Movius Line model. The absence of diagnostic Acheulian handaxes, perceived initially as resulting from geographic isolation, would suggest that the entire Far East remained a developmental backwater (Movius 1949). Present viewpoints regard Southeast Asia as having been occupied by sparse, mobile foragers who developed specialized adaptations to dense forests / bamboo-karst landscapes with solitary game by modifying the Acheulian into simpler toolkits (flakes, chopping-tools) for processing bamboo or tropical hardwoods, relying mostly on quartzite (Pope 1988, 1989; Schick and Dong 1993; Watanabe 1985). This techno-ecological shift would explain why the region's Palaeolithic is scarce, compared with India. Evidence from mainland Southeast Asia comes from northern Thailand, with occurrences from the Lampang and Phrae areas such as Ban Don Mun and Mae Tha South, calibrated to the final Early Pleistocene or 800 ky (Keates in press; Pope *et al.* 1986, 1987; Sørensen 2001). The evidence consists of rudimentary quartzite pebble implements. Finds from the Kwai river, South Thailand and Upper Burma may belong to this minimal, specialized complex, as a technological tendency diagnostic of wet tropics (Testart 1977). Evidence of hominid activity, including broken ungulate bones, and coral and quartz pieces brought into the Middle Pleistocene cave of Phnom Loang, Cambodia (Carbonnel and Biberson 1968), is tentative.

Argon/argon dating of Java's earliest hominids to 1.8-1.9 mya (Swisher *et al.* 1994) overlooks uncertain proveniences and complex taphonomic processes (Keates 1998; Keates and Bartstra 2001). The island's zoogeographical history (Bergh *et al.* 1996) makes landbridge connections with the mainland prior to 1.2-0.9 mya unlikely, suggesting this datum line for human fossils there (Pope and Keates 1994). Whether or not Lower Palaeolithic finds are associated or cross-dated with the hominid fossils should not imply lack of toolmaking capabilities. The Pacitanian industry's stratigraphic age is probably late Mid- or Upper Pleistocene (Bartstra 1983; Keates and Bartstra 2001). Scarce finds from Ngebung and Sambungmacan (Sémah *et al.* 1992) could approximate a Mid-Pleistocene age, if their provenience is confirmed.

Peopling Southeast Asia postdated that of the Indian Subcontinent, but to what extent the dense ecological forest filter separating both regions created a time lag, or how soon Southeast Asian mainland hominids crossed the landbridges connecting with the emerging Sunda islands remains unclear. Rainforests without dry seasons throughout much of Peninsular Malaysia, Sumatra and Borneo may not have been attractive for populations whose diet required seasonal plant food staples. The optimal biodiversity and biotic focus on canopy layers in Borneo's evergreen forests, along with an unparalleled range of vertebrates with gliding or flying adaptations, suggest essentially stable characteristics despite Pleistocene climatic fluctuations. Artefacts in Sulawesi (Walanae depression) and Flores (Mata Menge locality), if their early Mid-Pleistocene age (Maringer and Verhoeven 1970; Sondaar *et al.* 1994; Morwood *et al.* 1999) is correct, imply crossing deep straits such as Macassar and an early "sweepstake route" dispersal by hominids relying on technology. Their provenience and stratigraphy make an Upper Pleistocene date more likely (Keates and Bartstra 2001).

B. EAST ASIA

South China prolongs Southeast Asia's wet tropical, subtropical and bamboo-karst biomes, with an *Ailuropoda-Stegodon* fauna, grading latitudinally into the temperate wet, humid broadleaf woodlands of China north of the Qinling, Korea and Japan, whose primary productivity exceeds that of any other temperate biomes. The region north of the Qinling then grades into the steppe and taiga of continental and northeast Asia. The conventional division of China between southern subtropical and northern temperate landscapes is the Qinling divide and the Oriental and Palaeoarctic boundaries, but this overshadows other natural regions of the country. Another axis contrasts the wet, lush broadleaf forest coastline, and the semi-arid loessic plains and higher altitude of the interior, created by the Tertiary Qinghai-Xizang Plateau uplift. The Quaternary fauna shows that the Qinling divide was porous with episodic inter-changes of tropical and temperate mammals from both sides of this mountain chain. The west-east geomorphological structure and latitude gradients were palaeoclimatic factors conditioning biomes (Huang and Hou 1998). Hominids dispersing into East Asia as early as into insular Southeast Asia adapted to new habitats, including temperate zones (Pope and Keates 1994:535; Wang 1998:Figure 2a), up to 40-43° north latitude.

China

Mainland China contains the richest and most informative fossil and Lower Palaeolithic record known so far in Asia. Repertoires, especially in North China, show high site densities and artefact diversity (Wu and Olsen 1985), indicating varied task-specificity, reduction methods, artefact classes, and developed skill and adaptive patterns comparable to the Lower Palaeolithic west of the Movius Line (Pope and Keates 1994; Wang 1998, 2001). Bamboo and lignic resources may also have been exploited. Evidence from South China probably reflects hominid activities analogous to those in Southeast Asia. Many sites here date to the Mid-Pleistocene. The Early Pleistocene dates from Java and North China imply that older evidence should be recovered in South China (the provenience, identification, and 1.8 mya date of Longgupo needs confirming) and is sufficient to refute the notion of a peopling from the north. Fossil and artefact finds from Yuanmou and Bose constitute the earliest evidence.

The earliest localities from North China include Gongwangling (hominid fossils, artefacts), sites in the Nihewan basin such as Donggutuo and Xiaochangliang, of Early

Pleistocene (*c.* 1.0 mya) age (Schick and Dong 1993; Pope and Keates 1994; Wei 1998). The Nihewan and several other localities refute oversimplified notions about limited behavioural capabilities by displaying a technological mastery and interassemblage variability matching those of the Acheulian. This record indicates that, while solid evidence for a typical Acheulian *sensu stricto* fails to turn up despite intensive research – allowing us to retain this criterion of the Movius Line – bifacial flaking *sensu lato* is amply documented. Reasons for handaxe scarcity in North China, Korea or Japan are probably due to remoteness from the Indian Acheulian tool-making province; the widespread ecological circumstance of varied temperate rainforest biomes containing rich vegetal food resources and raw materials fostering specialized toolkits (thick pointed trihedrals, bifacial cleavers, bifaces and pebble tools). Significantly, the Nihewan sites are located slightly above 40° north latitude, when humans could settle under milder Early Pleistocene conditions, before the onset of intensive glacial cycles by 850 kya. Seasonal variation, though less marked than subsequently, was sufficient to show that ancient populations already coped with winter-time temperate bioclimates requiring increased animal protein intake.

Korea and the Japanese Archipelago

These tectonically active regions of the Yellow Sea rim combine continental influences with underlying oceanic characteristics, more seasonally contrasted in Korea than Japan, with year-round precipitation in the latter. Their dense broadleaf rainforests display a prodigiously rich, varied and luxuriant vegetation and, especially in Japan, an exceptionally high primary productivity with subtropical elements (Gourou 1953:212, 231). These were thus particularly favourable habitats for omnivorous human foragers and for exploiting vegetal fibres for tool manufacture.

Quaternary research in Japan (Masuda and Ito 1999) includes a rich potential for tephrochronological calibration (Machida 1999). Although the existing Palaeolithic record does not contain indisputable evidence for human occupation much before the late Mid- or early Upper Pleistocene, e.g. Kumpari, Jonggokni, Kulpori, in Korea, and Gongenyama, Iwajuku, Hoshino, Souzudai, in Japan, several considerations suggest that earlier anthropic traces may eventually be found: (1) most of the thick bifacial assemblages in Korea are from sites disturbed by intense hydraulic activity (Yi Seonbok, pers. comm. 2000); (2) the Nihewan sites in North China, at a similar latitude, date to 1.0 mya or more; (3) episodic landbridges created by glacio-eustatic lowstands connected Japan with Mainland Asia, through the Korean, or the Tsugaru and La Pérouse Straits. Their role as possible migratory paths, perhaps around 400 kya or 300-200 kya, is suggested by a mammoth fauna in Japan (Kawamura and Taruno 2000).

CENTRAL ASIA

Palaeolithic occurrences datable to the late Early or earlier Middle Pleistocene, and discovered in areas north of the major mountain and plateau range barrier dividing the Asian landmass, lie beyond the range of present-day monsoon rains. Alternative hypotheses regarding dispersal routes into these remote inland regions include (1) directly northeast from the Near East (Luchterhand 1984; Gladilin and Ranov 1986), or (2) indirectly from East Asia (Bordes 1968:89; Chard 1974:10; Smith 1986:14; Rolland 1992:94) through narrow filter passages, bound by deserts and the Siberian taiga in the north, by high mountains and plateaux in the south.

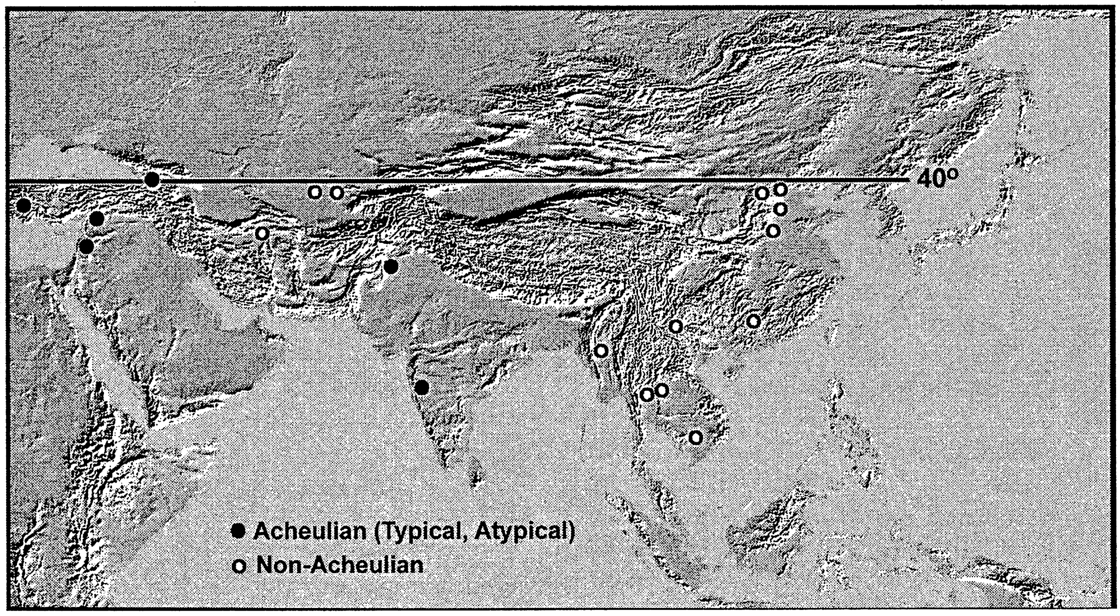
Lower Pleistocene circumstantial evidence from Xinjiang and the Qinghai-Xizang Plateau and, perhaps, non-Acheulian occurrences, make a biogeographic model of roundabout dispersal and eastern origin into Central Asia plausible and less problematic than population movements directly from the Near East that required overcoming major physical, climatic and ecological obstacles. Quaternary evidence in western China (Wang 1984; Xu 1984; Zhao and Xing 1984; Jiang 1988; Zhang 1988; Zheng 1988; Wang 2001) shows that these harsh and desolate arid landscapes resulted from long-term orogenic uplifts and desertification accelerating since the Middle Pleistocene, isolated from monsoon influences (Liu *et al.* 1999) while receiving increased Siberian high pressure (Derbyshire 1996:154). The Early Pleistocene Qaidam, and Qinghai-Xizang Plateau basins retained milder, wet, oasis-like conditions, with palaeo-lakes and ephemeral streams, making these inland areas more suitable than in later times for human settlement, when North China was already occupied. Dispersals toward Central Asia could finger along river valleys (such as the Sulohe or Tarim rivers), and between the Tien Shan and Pamirs.

I do not know of any evidence for an Early Pleistocene presence in western China, but it does exist in Central Asia and the Iranian plateau. Surface finds attributed to the early Mid-Pleistocene, such as Dasht-i-Nawur in Afghanistan or On-Orcha terrace in Kyrgyzstan, need stratigraphic and provenience confirmation. The stratified Khonako II and Lakhuti loess sites in Tajikistan, from pedocomplexes 8, and 11, 12 respectively, datable to 700 and 850 kya by lithostratigraphic correlation, geomagnetism, and biochronological observations (Ranov *et al.* 1987; Schäfer *et al.* 1996), contain non-Acheulian assemblages reminiscent of the Nihewan sites. Further west, the Kashaf Rud artefacts from a reportedly Early Pleistocene fossil lake basin in northern Iran (Ariai and Thibault 1975-77) could represent the westernmost extension of dispersals from the East.

Several Lower Palaeolithic sites are associated with fossil lake settings or river terraces. Proximity to water met basic survival requirements of drinking water, raw materials, ungulate prey and plant food. Pleistocene playas like the Qum area were common in the northern Iranian plateau and formed under cooler conditions with reduced summer evapotranspiration. None of the Central Asian sites contain handaxes. Their dating, if confirmed, ranges from Late Matuyama to early Mid-Pleistocene. A hominid presence datum in these inland regions may coincide with the Lakhuti 2 faunal locality (Rolland 1992), and with westward dispersals of the so-called Galerian fauna, originating in the Palaeoarctic region of Central Asia and Siberia (Sher 1992). It is worth noting that none of the mid-latitude occurrences from North China to Central Asia, exceed 40-43° latitude north. This may represent the northernmost limit of hominid adaptations to higher latitudes before 500-600 kya, due to shorter winter daylight duration, long before firm evidence for fire-production by 400 kya.

CONCLUDING REMARKS

Figure 1 shows the major Lower Palaeolithic and/or fossil human remains occurrences in Asia. The mapping indicates that all these occurrences are distributed below or around the 40° latitude line. The dispersal paths and adaptive trends resulting in more or less continous occupations of large portions of Asia, as implied by this geographical patterning suggest the following: the earliest traces of hominids beyond Africa go back to the Early Pleistocene, between at least 1.4 and perhaps as early as 1.7 mya, in Western Asia, and possibly in South Asia, as well as more than 1.0 mya in the Far East. This datum and some recent fossil evidence confirms that early representatives of the genus *Homo* (*erectus*, and perhaps, *habilis* at Dmanisi), associated with Mode 2 or Typical and Atypical Early Acheulian ('Oldowan-like) repertoires were involved. These early population movements expanded beyond their Ethiopian cradle into the Palaeoarctic and Oriental Regions, along the Fertile Crescent corridor, probably avoiding the major orogenic barriers of the Eurasian west to east divide, by negotiating forested filter routes in Bengal, Nepal and Assam, into Southeast and East Asia, and eventually, dispersing inland to the west across Inner Asia, but apparently never reaching north of 40-43°. Hominid diets under these tropical or mild bioclimatic conditions and lower latitudes of Monsoon Asia could remain omnivorous and broadly based, though focusing on various plant food staples, while maintaining signficantly active carnivorous propensities and dietary components. This "carnivorous profession" was probably a decisive factor in initiating the first hominid dispersals beyond Subsaharan Africa.



(The modified and selected physiographic map based on an original by GLOBE Task Team *et al*. 1999. The Global Land One Km Base Elevation Model, Version 1.0. National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, Colorado, USA).

Figure 1: Map of major early hominid cccurrences related to the initial peopling of Asia.

REFERENCES

Ariai, A. and C. Thibault 1975-77. Nouvelles precisions a propos de l'outillage paléolithique ancien sur galets du Khorassan (Iran). *Paleorient* 3:101-8.

Azzaroli, A. 1985. Provinciality and turnover events in Late Neogene and Early Quaternary vertebrate faunas of the Indian subcontinent. In V.G. Gupta (ed.), *Contribution to Himalayan Geology* 3, pp. 27-37. Delhi: Hindustan Publishing Corporation.

Bar-Yosef, O. and N. Goren-Inbar. 1993. The Lithic Assemblages of 'Ubeidiya. A Lower Paleolithic Site in the Jordan Valley. *Qedem* 34:1-266.

Bartstra, G.-J. 1983. Some remarks upon: fossil man from Java, his age, and his tools. *Bijdragen tot de Taal-, Land, -en Volkenkunde* 139:421-34.

Bergh, G.D. van den , B. Mubroto, F. Azis *et al.* 1996. Pleistocene zoogeographic evolution of Java (Indonesia) and glacio-eustatic sea level fluctuations. *Bulletin of the Indo-Pacific Prehistory Association* 14:7-21.

Bordes, F. 1968. *The Old Stone Age*. New York: McGraw-Hill.

Cachel, S. and J.W.K. Harris. 1999. The adaptive zone of *Homo erectus* from an African perspective. In H. Ullrich (ed.), *Hominid Evolution. Lifestyles and Survival Strategies*, pp. 128-37. Schwelm: Archaea.

Carbonnel, J.-P. and P. Biberson.1968. Industrie osseuse et presence humaine dans le gisement pleistocene inferieur du Phhom Loang (Cambodge). *Comptes Rendus de l'Academie des Sciences de Paris* 267:2306-8.

Caton-Thompson, G. 1957. The evidence of South Arabian palaeoliths in the question of Pleistocene land connections with Africa. In J.D. Clark and S. Cole (eds), *Third Pan-African Congress on Prehistory (Livingstone 1955)*, pp. 380-84. London: Chatto and Windus.

Chard, C. 1974. *Northeast Asia in Prehistory*. Madison: University of Wisconsin Press.

Chavaillon, J., J.-L. Boisauberter, M. Faure *et al.* 1987. Le site de depecage pleistocene a Elephas recki de Barogali (Republique de Djibouti): nouveaux resultats et datation. *Comptes Rendus de l'Academie des Sciences de Paris* 305, Serie II:1259-66.

Chung, S.-L., C.-H. Lo, T.-Y. Lee *et al.* 1998. Diachronous uplift of the Tibetan plateau starting 40 my ago. *Nature* 394:769-73.

Corner, E.J.H. 1940. *Wayside Trees of Malaya*. Singapore: Government Printer.

Corvinus, G. 1998. Lower Palaeolithic occupation in Nepal in relation to South Asia. In M.Petraglia and R. Korisettar (eds), *Early Human Behaviour in Global Context. The Rise and Diversity of the Lower Palaeolithic Record*, pp. 391-417. London: Routledge.

Darlington, P.J. 1957. *Zoogeography. The Geographical Distribution of Animals*. New York: John Wiley.

Dennell, R.W., H.M. Rendell and E. Hailwood. 1988. Early tool-making in Asia: two million year-old artefacts in Pakistan. *Antiquity* 62:98-106.

Derbyshire, E. 1996. Quaternary glacial sediments, glaciation style, climate and uplift in the Karakora and northwest Himalaya: review and speculations. *Palaeogeography, Palaeoclimatology, Palaeoecology* 120:147-57.

Fisher, W.B. 1963. *The Middle East. A physical, social and regional geography*. London: Methuen.

Flenley, J. 1985. Quaternary vegetational and climatic history of island Southeast Asia. *Modern Quaternary Research in Southeast Asia* 9:55-63.

Foley, R. 1987. *Another Unique Species*. London: Harlow Scientific and Technical.

Fort, M. 1996. Late Cenozoic environmental changes and uplift on the northern side of the central Himalayas: a reapppraisal from field data. *Palaeogeography, Palaeoclimatology, Palaeoecology* 120:123-45.

Gabunia, L., S.C. Anton, D. Lordkipanidze, A. Vekua, A. Justus and C. Swisher III. 2001. Dmanisi and dispersal. *Evolutionary Anthroplogy* 10(5):158-70

Gladilin, V. and V. Ranov. 1986. Ot Pamira do Karpat. *Znanie Sila* 2:29-31.

Gourou, P. 1953. *L'Asie*. Paris: Hachette.

Groves, C.P. 1985. Plio-Pleistocene mammals in island Southeast Asia. *Modern Quaternary Research in Southeast Asia* 9:43-54.

Gulec, E., F.C. Howell and T.D. White. 1999. Dursunly – a new Lower Pleistocene faunal and artifact-bearing locality in southern Anatolia. In H. Ullrich (ed.), *Hominid Evolution. Lifestyles and Survival Strategies*, pp. 349-64. Schwelm: Archaea.

Harrison, T. 1996. The palaeoecological context at Niah Cave: evidence from the primate fauna. *Bulletin of the Indo-Pacific Prehistory Association* 14:90-100.

Horowitz, A. 1979. *The Quaternary of Israel*. New York: Academic Press.

Howell, F.C. 1960. European and Northwest African Middle Pleistocene hominids. *Current Anthropology* 1(3):195-232.

Huang, W. and Y. Hou. 1998. Paleoecology of humans in East Asia: the Movius Line reconsidered. *Bulletin of the Indo-Pacific Prehistory Association* 17:44.

Hurcombe, L. and R.W. Dennell. 1992. A Pre-Acheulean Lower Pleistocene industry in the Pabbi Hills, Northern Pakistan? In C. Jarrige (ed.), *South Asian Archaeology*, pp. 133-6. Paris: Conference of South Asian Archaeologists in Western Europe.

Hutterer, K.L. 1983. The natural and cultural history of Southeast Asian agriculture: ecological and evolutionary considerations. *Anthropos* 78:169-212.

Hutterer, K.L. 1985. The Pleistocene archaeology of Southeast Asia in regional context. *Modern Quaternary Research in Southeast Asia* 9:1-23.

James, S.R. 1989. Hominid use of fire in the Lower and Middle Pleistocene: a review of the evidence. *Current Anthropology* 30(1):1-26.

Jiang, D.-X. 1988. Quaternary palynoflora and palaeoclimate of Qaidam Basin, Qinghai. In P.Whyte (ed.), *The Palaeoenvironment of East Asia from the Mid-Tertiary* I:571-78. Hong Kong: University of Hong Kong, Centre of Asian Studies.

Kaars, W.A. van der and M.A.C. Dam. 1995. A 135,000-year record of vegetational and climatic change from the Bandung area, West-Java, Indonesia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 117:55-72.

Kawamura, Y. and H. Taruno. 2000. Immigration of mammals into Japan during the Quaternary, with comments on land or ice bridge formation enabled human immigration. *Acta Anthropologica Sinica* (Supplement) 19:264-69.

Keates, S.G. 1998. A discussion of the evidence for early hominids on Java and Flores. *Modern Quaternary Research in Southeast Asia* 15:179-91.

Keates, S.G. in press. The Lower Palaeolithic of Thailand: the evidence from Lampang. In C. Falgueres, D. Grimaud-Herve and F.Sémah (eds), *Origine des Peuplements et Chronologie des Cultures Paléolithiques dans le Sud-Est Asiatique*. Paris: Institut de Paléontologie Humaine.

Keates, S.G. and G.-J. Bartstra. 2001. Observations on Cabengian and Pacitanian artefacts from island Southeast Asia. *Quartär* 51/52:9-32.

Korisettar, R. 1994. Quaternary alluvial stratigraphy and sedimentation in the Upland Deccan Region, Western India. *Man and Environment* 19(1-2):29-41.

Kretzoi, M. 1961-64. Mammal faunae and the continental geology of India. *Acta Geologica Academiae Scentiarum Hungaricae* 7-8:301-10.

Leinders, J.J.M., F. Aziz, P.Y. Sondaar and J. de Vos. 1985. The age of the hominid-bearing deposits of Java: state of the art. *Geologie en Mijnbow* 64:167-73.

Liu, T., M. Ding and E. Derbyshire. 1999. Gravel deposits on the margins of the Qinghai-Xizang Plateau and their environmental significance. *Palaeogeography, Palaeoclimatology, Palaeoecology* 120:59-170.

Liubin, V. 1998. Le Paléolithique inferieur du Caucase: ses relations avec le sud, ses traits particuliers et ses principales etapes. In M. Otte (ed.), *Préhistoire d'Anatolie. Genese de deux mondes*, pp. 39-55. Liège: ERAUL 28.

Luchterhand, K. 1984. Mammalian endemism and diversity and Middle Pleistocene hominid distribution and adaptation in Eastern Asia. In R.O. Whyte (ed.), *The Evolution of the East Asian Environment* II:848-63. Hong Kong: Centre of Asian Studies, University of Hong Kong.

Machida, H. 1999. Quaternary widespread tephra catalog in and around Japan: recent progress. *The Quaternary Research* 38(3):194-201.

Majid, Z. 1982. The West Mouth, Niah, in the Prehistory of Southeast Asia. *The Sarawak Museum Journal* 31(52), New Series No. 3:1-200.

Maloney, B.K. and F.G. McCormac. 1996. Palaeoenvironments of North Sumatra: a 30,000 year old pollen record from Pea Bullok. Indo-Pacific Prehistory: the Chiang Mai Papers 1. *Bulletin of the Indo-Pacific Prehistory Association* 14:73-82.

Maringer, J. and T. Verhoeven. 1970. Die Steinfarefakte aus der Stegodon-Fossilschicht von Menge Ruda auf Flores. *Anthropos* 65:530-46.

Masuda, F. and M. Ito. 1999. Contributions to sequence, stratigraphy from the Quaternary studies in Japan. *The Quaternary Research* 38(3):184-93.

Mishra, S. 1981. On the effect of basalt weathering on the distribution of Lower Palaeolithic sites in the Deccan. *Bulletin of the Deccan College Postgraduate and Research Institute* 41:107-15.

Mishra, S. 1994. The South Asian Lower Palaeolithic. *Man and Environment* 29(1-2):57-71.

Mishra, S. 1999. Developing an Indian Stone Age chronology. In T. Murray (ed.), *Time and Archaeology*, pp. 80-8. London: Routledge.

Mishra, S., S. Venkatesa, S.N. Rajaguru and B.L.K. Somayajulu. 1995. Earliest Acheulian industry from Peninsular India. *Current Anthropology* 36(5):847-51.

Misra, V.N. 1989. Stone Age India: an ecological perspective. *Man and Environment* 14(1):17-64.

Morwood, M.J., F. Aziz, P.O. O'Sullivan, Nasruddin, D.R. Hobbs and A. Raza. 1999. Archaeological and palaeontological research in central Flores, east Indonesia: results of fieldwork 1997-98. *Antiquity* 73:273-86.

Movius, H.L. 1949. The Lower Palaeolithic cultures of southern and eastern Asia. *Transactions of the American Philosophical Society* 38:329-420.

Muhesen, S. 1988. Le Paléolithique inferieur de Syrie. *L'Anthropologie* 92(3):863-82.

Paddaya, K. 1994. Investigations of man-environment relationships in Indian Archaeology: some theoretical considerations. *Man and Environment* 29(1-2):1-28.

Paddaya, K. and M.D. Petraglia. 1993. Formation processes of Acheulian localities in the Hunsgi and Baichbal Valleys, Peninsular India. In P. Goldberg, D.T. Nash and M.D. Petraglia (eds), *Formation Processes in Archaeological Context*, pp. 61-82. Madison: Prehistory Press.

Pappu, S. 1996. Reinvestigation of the prehistoric archaeological record in the Kortallayar Basin, Tamil Nadu. *Man and Environment* 21(1):1-23.

Perles, C. 1987. La naissance du feu. *L'Histoire* 105:28-33.

Pope, G.G. 1985. Taxonomy, dating and paleoenvironment: the paleoecology of the early Far Eastern hominids. *Modern Quaternary Research in Southeast Asia* 9:65-80.

Pope, G.G. 1988. Current issues in Far Eastern palaeoanthropology. In P. White (ed.), *The Palaeoenviroment of East Asia from the Mid-Tertiary* II:1097-123. Hong Kong: Centre of Asian Studies, University of Hong Kong.

Pope, G.G. 1989. Bamboo and human evolution. *Natural History* 10:49-57.

Pope, G.G. and S.G. Keates. 1994. The evolution of human cognition and cultural capacity. A view from the Far East. In R.S. Corruccini and R.L. Ciochon (eds), *Integrated Paths to the Past*, pp. 531-67. Englewood Cliffs: Prentice Hall.

Pope, G.G., S. Barr, A. MacDonald and S. Nakabanlang. 1986. Earliest radiometrically dated artifacts from mainland Southeast Asia. *Current Anthropology* 27:275-79.

Pope, G.G., S. Nakabanlang and S. Pitragool. 1987. Le Paléolithique du nord de la Thaïlande. Découvertes et perspectives nouvelles. *L'Anthropologie* 91:749-54.

Ranov, V.A, A.E. Dodonov, S.P. Lomov *et al.* 1987. Kul'dara: novyi-Niizhnepaleoticheski pamiatnik iuzhnovo Tadzhikinstana. *Biuletin komissii po izucheniu Chetvertichnaia perioda* 56:65-75.

Raynal, J.-P. and J.-P. Texier. 1989. Découverte d'Acheuleen ancien dans la carriere Thomas I a Casablanca et probleme de l'ancien-nete de la presence humaine au Maroc. *Comptes Rendus de l'Academie des Sciences de Paris* 308, S. II:1743-49.

Richards, P.W. 1952. *The Tropical Rain Forest.* Cambridge: Cambridge University Press.

Rolland, N. 1992. The Palaeolithic colonization of Europe: an archaeological and biogeographic perspective. *Trabajos de Prehistoria* 49:9-111.

Rolland, N. 2000. Cave occupation, fire-making, hominid/carnivore coevolution, and Middle Pleistocene emergence of home-base settlement systems. *Acta Anthropologica Sinica* (Supplement)19:209-17.

Ronen, A., J.-M. Burdukiewicz, S.A. Laukhin, Y. Winter, A. Tsatskin, T. Dayan, O.A. Kulikov, K. Vlasov and V.V. Semenov. 1998. The Lower Palaeolithic site, Bizat Ruhama in the Northern Negev, Israel. Preliminary report, 1996 excavations. *Archäologisches Korrespondenzblatt* 28:163-73.

Ruddiman, W.F., M. Raymo and A. McIntyre. 1986. Matuyama 41,000-year cycles: North Atlantic Ocean and northern hemisphere ice sheets. *Earth and Planetary Science Letters* 80:117-29.

Schaller, G.B. 1967. *The Deer and the Tiger.* Chicago: University Press.

Schaller, G.B. 1973. *Golden Shadows, Flying Hooves.* New York: Alfred Knopf.

Schäfer, J., P. Sosin and V.A. Ranov. 1996. Neue Untersuchungen zum Loesspalaolithikum am Obi-Mazar, Tadzhikistan. *Archäologisches Korrespondenzblatt* 26:97-109.

Schepartz, L.A., S. Miller-Antonio and D.A. Bakken. 2000. Upland resources and the early Palaeolithic occupation of Southern China, Vietnam, Laos, Thailand and Burma. *World Archaeology* 32:1-13.

Schick, K.D. and Z. Dong,. 1993. Early Palaeolithic of China and eastern Asia. *Evolutionary Anthropology* 21(1):22-35.

Schule, W. 1990. Landscape and climate in prehistory: interactions of wildlife, man and fire. In J.G. Goldhammer (ed.), *Fire in the Tropical Biota. Ecosystems Processes an Global Challenges*, pp. 273-318. Berlin: Springer Verlag.

Schule, W. 1991. Human evolution, animal behaviour, and Quaternary extinctions: a palaeoecology of hunting. *Homo* 41(3):228-50.

Sémah, A.-M. 1984. Palynology and Javanese Pithecanthropus Paleoenvironment. *Courier Forschungs-Institut Senckenberg* 69:237-43.

Sémah, F., A.-M. Sémah, T. Djubiantono and T. Simanjuntak,. 1992. Did they also make stone tools? *Journal of Human Evolution* 23:439-45.

Sher, A. 1992. Beringian fauna and early Quaternary mammalian dispersal in Eurasia: ecological aspects. *Courier Forschungs-Institut Senckenberg* 153:125-33.

Shipman, P. and A. Walker. 1989. The cost of becoming a predator. *Journal of Human Evolution* 18:373-92.

Simpson, G.G. 1962. *Evolution and Geography. An Essay on Historical Biogeography with Special Reference to Mammals.* Eugene: Oregon State System of Higher Education.

Shutler, R. and F. Braches. 1988. The origin, dating and migration routes of hominids in Pleistocene East and Southeast Asia. In P. Whyte (ed.), *The Palaeoenvironment of East Asia from the Mid-Tertiary* II:1084-89. Hong Kong: Centre of Asian Studies, University of Hong Kong.

Smith, P.E.L. 1986. *Palaeolithic Archaeology in Iran.* Philadelphia: The University Museum.

Sondaar, P.Y., G.D. van den Bergh, B. Mubroto, F. Aziz, J. de Vos and U.L. Batu. 1994. Middle Pleistocene faunal turnover and colonization of Flores (Indonesia) by *Homo erectus. Comptes Rendus de l'Academie des Sciences de Paris* 319, S. II:1255-62.

Sørensen, P. 2001. A reconsideration of the chronology of the Early Palaeolithic Lannathaian culture of North Thailand. Indo-Pacific Prehistory: the Melaka Papers 5. *Bulletin of the Indo-Pacific Prehistory Association* 21:138-41.

Spooner, B. 1972. The Iranian deserts. In B. Spooner (ed.), *Population Growth: Anthropological Implications*, pp. 245-268. London: MIT Press.

Swisher, C.C., G.H. Curtis, T. Jacob *et al.* 1994. Age of the earliest known hominids in Java, Indonesia. *Science* 263:1118-21.

Swisher, C.C., W.J. Rink, S.C. Antón, H.P. Schwarcz, G.H. Curtis, A. Suprijo and Widiasmoro. 1996. Latest *Homo erectus* of Java: potential contemporaneity with *Homo sapiens* in Southeast Asia. *Science* 274:1870-74.

Testart, A. 1977. Ethnologie de l'Australie et prehistoire de l'Asie du sud-est. *Journal de la Societe des Oceanistes* 33:77-85.

Turner, A. 1982. Hominids and fellow travellers. *South African Journal of Science* 78:231-37.

Wahida, G. 1982. The Acheulian of Saudi Arabia: current excavations at two sites in the Central Province. XI INQUA Congress, Moscow. Abstracts 1:336.

Wang, X. 1984. The palaeoenvironment of China from the Tertiary. In R.O.Whyte (ed.), *The Evolution of the East Asian Environment* II, pp. 472-82. Hong Kong: Centre of Asian Studies, University of Hong Kong.

Wang, Y. 1998. Human adaptations and Pleistocene environments in South China. In H. Ullrich (guest ed.), 'Lifestyles and survival strategies in Pliocene and Pleistocene hominids', *Anthropologie*, special issue 36(1-2):165-75.

Wang, Y. 2001. A comparison of the Lower and Middle Palaeolithic in East and West Asia. *Bulletin of the Indo-Pacific Prehistory Association* 21:142-7.

Watanabe, H. 1985. The chopper-chopping tool complex of Eastern Asia: An ethnoarchaeological-ecological re-examination. *Journal of Anthropological Archaeology* 4(1):1-18.

Wei, Q. 1998. Some archaeological sites from the Lower Pleistocene in China. *Bulletin of the Indo-Pacific Prehistory Association* 17:79.

Wu, R. and J.W. Olsen (eds). 1985. *Palaeoanthropology and Palaeolithic Archaeology in the People's Republic of China*. Orlando: Academic Press.

Xu, R. 1984. Changes of the vegetation in China since the late Tertiary. In R.O. Whyte (ed.), *The Evolution of the East Asian Environment* II, pp. 426-32. Hong Kong: Centre of Asian Studies, University of Hong Kong.

Yi, S. and G.A. Clark. 1983. Observations on the Lower Palaeolithic of Northeast Asia. *Current Anthropology* 24(2):181-202.

Zhang, L. 1988. The trend towards dryness in north and western China since the Mid-Pleistocene. In P. Whyte (ed.), *The Palaeoenvironment of East Asia from the Mid-Tertiary* I, pp. 445-52. Hong Kong: Centre of Asian Studies, University of Hong Kong.

Zheng, N. 1988. Studies of the glacial characteristics and environment of the last glaciation in west China. In P. Whyte (ed.), *The Palaeoenvironment of East Asia from the Mid-Tertiary* I, pp. 453-63. Hong Kong: Centre of Asian Studies, University of Hong Kong.

Zhao, S. and J. Xing, 1984. Origin and development of the Shamo (sandy deserts) and the Gobi (stony deserts) of China. In R.O. Whyte (ed.), *The Evolution of the East Asian Environment* I:230-51. Hong Kong: Centre of Asian Studies, University of Hong Kong.