MAN AND ENVIRONMENT DURING THE PLEISTOCENE IN SRI LANKA

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INTRODUCTION

Sri Lanka, situated some 50 km off the southern tip of India at 8° north of the equator, has a climate dominated by the tropical Southwest Monsoonal system. Annual precipitation ranges, according to locality, from 600 to over 5000 mm per annum. Average annual temperature varies from 18° in the highlands, which reach a maximum elevation of slightly over 2400 m, to 26° in the lowlands. The rainfall pattern is distinctly seasonal, although the annual fluctuations in temperature are negligible. The natural vegetation comprises tropical rainforest and its variants.

The island's ecozones may be categorised as in Figure 1. There is a broad division into Wet and Dry Zones on the basis of rainfall. The Wet Zone (ecozone D) is characterised by heavy Southwest Monsoonal precipitation in the summer and a drier period in the winter. It is confined to the western and southwestern sectors of the island and comprises ecozone D1 (lowlands below 900 m, with an annual rainfall of 2000-5000 mm); D2 (uplands at 900-1500 m, rainfall 2000-5000 mm); and D3 (highlands at 1500-2400 m, rainfall 2000-4000 mm). The other three-quarters of the country are assignable to the Dry Zone, which is characterised by winter rains and summer droughts. The intermediate climatic regions of the Dry Zone consist of ecozone C (intermediate dry lowlands below 900 m, rainfall 1250-2000 mm) and ecozone E (intermediate dry uplands at 900-1500 m, rainfall 2000-2500 mm). The Dry Zone proper consists, in order of increasing aridity, of ecozone A (semi-arid lowlands below 900 m, rainfall 1150-2000 mm); and ecozone F (arid lowlands below 900 m, rainfall similar to A but with characteristically prolonged droughts). For further details see Deraniyagala 1991, Appendix I.

CHRONOLOGY

Sri Lanka's Pleistocene chronology (Deraniyagala 1991: Chapter 3)[1] has primarily been delineated from three sets of sediments:

(a) the fluviatile Ratnapura Beds of the lowland Wet Zone (D1);

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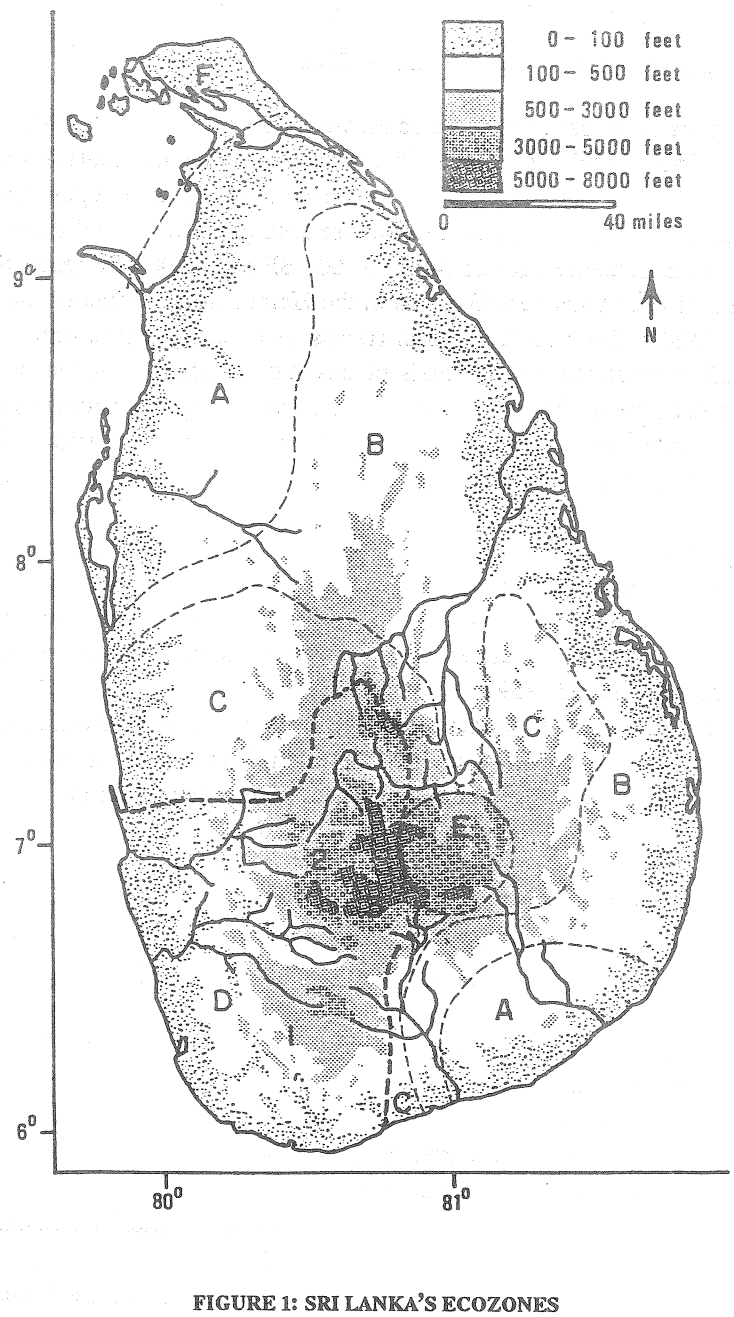

FIGURE 1: SRI LANKA'S ECOZONES

F, arid lowlands; A, semi-arid lowlands; B, dry lowlands; C, intermediate dry lowlands; E, intermediate dry uplands; D1, wet lowlands; D2, wet uplands; D3, wet highlands. Adapted from Gaussen *et al.* 1968; Mueller Dombois 1968.

(b) the coastal alluvial gravels and overlying dune sands of the Iranamadu Formation[2] (Figure 2) in the semi-arid Dry Zone (A); and

(c) the cave deposits in the lowland Wet Zone (D1).

The Ratnapura Beds have yet to be adequately resolved chronologically. Despite the occurrence of Upper (perhaps Middle) Pleistocene[3] faunistic elements in these gravels, their chronostratigraphy is complicated by evidence of cycles of redeposition. However, the Iranamadu Formation has been dated more securely. The coastal dune sands have yielded thermoluminescence ages of 74,000-64,000 BP and 28,000 BP respectively at two sites separated by over 6 km near Bundala in the Hambantota District of the deep south (Singhvi *et al.* 1986). The associated basal gravels have been assigned dates of *c.*125,000 and 75,000 BP respectively on the basis of eustatic altimetry, with the heights above present sea level of these "thalasso-static" coastal gravels being interpreted as having been determined by contemporaneous sea levels. The former is correlated with a 15 m high sea level (Main Monastirian, Eem Interglacial) and the latter with another at 8 m (Late Monastirian, Final Eem). While it is possible to estimate in this way the ages of a wide array of occurrences of the Iranamadu Formation, it is hypothesised that some of the raised terraces of the coastal gravels are at least as old as the Holstein Interglacial at *c.*300,000 BP (30 m terrace, Tyrrhenian high sea level) and the Cromerian Interglacial at *c.*500,000 BP (50 m terrace, Milazzian high sea level; for nomenclature and chronology of global sea levels see Zeuner 1959).

With regard to the cave sediments, several series have been reliably radiocarbon dated (on charcoal) from *c.*34,000 down to 3000 BP, notably from the Fa Hien, Batadomba, Kitulgala Beli-lena and Attanagoda Alu-lena caves (Deraniyagala 1991).

ENVIRONMENT

As stated above, the Ratnapura Beds are chronologically amorphous and may hence be discounted from further consideration at the present juncture. But the Iranamadu Formation has yielded sedimentological evidence that its basal gravels were deposited during interglacial, or otherwise altithermal, episodes under climates with greater seasonal extremes of drought and high rainfall than are prevalent in the Dry Zone today. This evidence is being interpreted as a function of increased atmospheric circulation during such altithermals (eg. at *c.*125,000 and 75,000 BP) which led to the katabatic Föhn winds of the Southwest Monsoon desiccating the Dry Zone to a much more pronounced degree than they do today. Increased atmospheric circulation could also have meant increased cyclonic and convectional precipitation in the Dry Zone. Thambyahpillay (1958; 1967) has observed a positive correlation between Southwest Monsoonal, cyclonic and convectional intensities over the island. This would have led to massive denudation of the hinterland (parched by the extended summer droughts that have been postulated with a resultant decrease in protective vegetational cover) and the consequent deposition of the denuded sediments as gravels on the coastal plain. The lag deposits which constitute the basal gravels of the terrestrial Reddish Brown Earth Formation of the hinterland (Figure 2) seem to have had a similar origin (Deraniyagala 1976).

This hypothesis concerning the correlation between altithermal and pluvial conditions has recently been corroborated by the radiocarbon dating of a basal gravel at Gedige in Anuradhapura to *c.*5900 BP. This date correlates with the Atlantic altithermal maximum in Scandinavia and the Older Peron high sea level at *c.*5300-6300 BP, which was contemporaneous with a humid southern Sahara and high levels in Lake Victoria and the Middle Nile. More specifically, the date of *c.*5900 BP coincides almost exactly with the rainfall peak at *c.*6200 BP postulated for Rajasthan by Fairbridge (1976) and by Deraniyagala (1991)[4].

Another altithermal, represented by a 1 m high sea level at Matota, Mannar, has been radiocarbon dated on charcoal from a prehistoric habitation in its inter-tidal zone to *c.*3800 BP. The sedimentology of the deposit indicates pluvial conditions, with the associated fluviatile regime displaying a transport capability in excess of what is prevalent today. This correlates with the Younger Peron high sea level assigned to 3600-4900 BP, which coincides in turn with increased monsoonal activity in Africa at *c.*3700 BP as represented again by a humid southern Sahara, a high Lake Victoria and a high Middle Nile. These data, once again, are in agreement with the altithermal-pluvial correlation enunciated above for Sri Lanka. As a corollary, it is proposed that since altithermals witnessed increased atmospheric circulation and intensification of weather phenomena over the island, cool hypothermals would have experienced the converse, with depressed Southwest Monsoonal, cyclonic and convectional circulation patterns muting the range of extremes in Sri Lanka's climatic mosaic.

With regard to the evidence from the caves in the wet lowlands (Wet Zone D1), molluscan and botanical data, notably from the gastropod *Acavus* and the trees *Artocarpus nobilis* and *Canarium zeylanicum*, indicate that the annual average temperature has not been lower than 5° relative to the present even at the height of the Würm upper pleniglacial at 15,000 BP. It is likely, however, that the surface run-off, and the fluviatile regimes in the Wet Zone fluctuated with rainfall oscillations to a marked degree due to the permanent state of saturation of the soil substrata. These fluctuations could conceivably be assessed by an analysis of fluviatile molluscan remains, notably those of *Paludomus* species. However, the present indications are that the effective environment of the lowland Wet Zone has not changed significantly over at least the last 34,000 years, according to the evidence from the cave deposits[5].

During the Pleistocene, it is clear that there would have been a gradation of environments in Sri Lanka, ranging from highly differentiated zonal configurations synchronising with altithermals, such as the Holstein, through others with medium differentiation, such as the present Holocene, to pronounced higher latitude glacial episodes which probably witnessed only minimal climatic and biotic differentiation. The structure of the island's pattern of zonal differentiation at any one time would have been reflected in terms of biotic carrying capacity, and thus in human population density.

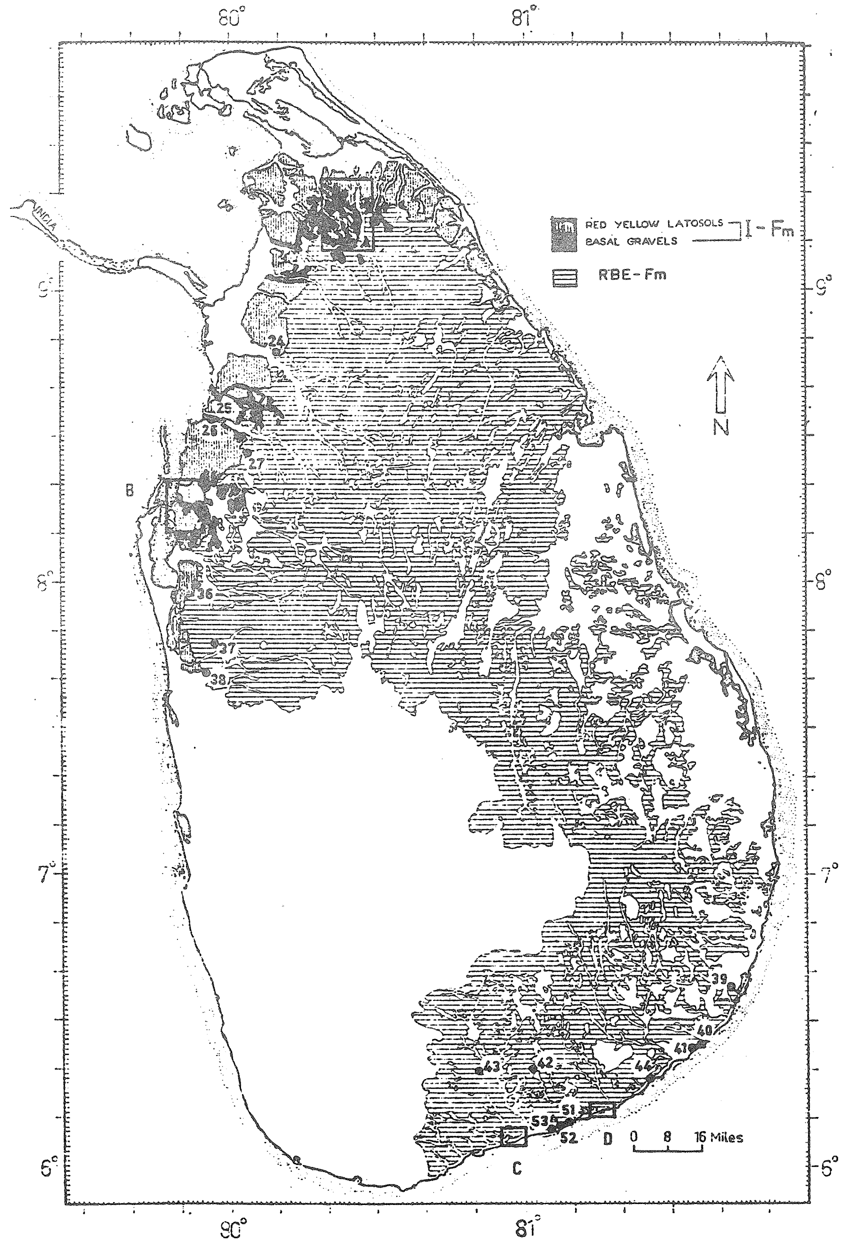

FIGURE 2: DISTRIBUTION OF IRANAMADU (I-Fm) AND REDDISH BROWN EARTH (RBE-Fm) FORMATIONS

Courtesy, Soil Survey of Sri Lanka

The altitudinal boundary of the wet highlands (Wet Zone D3), which is at 1500+ m above sea level today, would, however, have shifted with temperature fluctuations. Such shifts could (at least in part) be computed by taking into consideration the present altitudinal lapse-rate (Domrös 1974) of *c.*100 m per 0.65°C change. For instance, a hypothesised 5°C drop in temperature during the Wurm pleniglacial could have lowered the boundary of ecozone D3 by *c.*770 m. This would have resulted in an approximate trebling of the present area encompassed by the wet highlands to include all of the present ecozone D2, and more. On the other hand, the discontinuous distribution of uropeltid burrowing snakes in Sri Lanka and southern India (Gans 1990) indicates convincingly that rainfall conditions resembling those of the Wet Zone have not prevailed in the Dry Zone for several million years. Since the relative dryness of the Dry Zone is a direct function of the interaction between the Southwest Monsoonal weather system and the exertion by Sri Lanka's topography of a luff and lee effect on the rain-bearing Southwest Monsoonal air-stream, this serves to establish beyond doubt that the dominant weather system in South Asia over the last several million years has, without a significant break, been the Southwest Monsoon. This represent an important advance in our knowledge of palaeoclimate in this region (Deraniyagala 1991: Chapter 4).

The information from the dated cave deposits suggests that it is unlikely that the Wet Zone witnessed significant shifts in human carrying capacity throughout the Upper Pleistocene, and perhaps this was so in the Middle Pleistocene as well, between *c.*700,000 and 150,000 BP.

CULTURE VERSUS ENVIRONMENT

The settlement of Sri Lanka in the Pleistocene would have its obvious source in the sub-continent of India, since the landmasses of Southeast and West Asia were presumably too far away for prehistoric seafaring at that time. A eustatic drop in sea level of a mere 10 m would have sufficed to create a landbridge across the Palk Strait. Holocene sea level curves (eg. Fairbridge 1976) suggest that the last severance of such a land link occurred at *c.*7000 BP (Deraniyagala 1991: Chapter 4). Hence, the prehistoric human ecology of Sri Lanka has perforce to be viewed as a part of the overall sub-continental scene and it would be futile to consider it otherwise. Transhumant prehistoric bands would have been interacting not only with the mosaic of Sri Lanka's ecozones but also with its counterparts, at times very different, in southern India and probably further afield as well. While bearing this caveat in mind, it is here proposed to focus on Sri Lanka since a consideration of the wider Indian scene would be beyond the scope of this paper.

It is very probable that *Homo erectus*, known to have been on the sub-continent in the Middle Pleistocene, was also inhabiting Sri Lanka during this period. It is further predicted here that the high level coastal gravels of the Iranamadu Formation, representing 50 m and 30 m high sea levels at *c.*500,000 and 300,000 BP, will yield the requisite artefactual evidence. By 28,000 BP, anatomically modern *Homo sapiens sapiens* is recorded from Batadomba cave (Kennedy and Deraniyagala 1989) and perhaps also from Fa Hien's Cave at *c.*31,000 BP, making these some of the oldest known specimens of anatomically modern humans from anywhere in the world and the oldest in South Asia. How did these populations interact with their environments in Sri Lanka?

On the basis of ethnographic analogy (Deraniyagala 1991: Chapter 6) deriving from the Kadar of Kerala and Semang of Malaysia, it is hypothesised that the population density in the Wet Zone through much of the late Quaternary, from at least *c.*34,000 BP, was around 0.1 individuals per km^2 (Deraniyagala 1991: Chapter 7). The Dry Zone, with its higher rainfall variability, would have experienced much more pronounced oscillations in effective environment and it is hypothesised that the population densities varied between 0.8 and 0.25 individuals per km^2 (cf. Vaddas of Sri Lanka, Chenchu of India), with exceptionally high densities of up to 1.5 in its resource-rich prograding coasts (cf. Andaman Islanders).

Settlement data suggest that Sri Lanka's communities were based primarily on the nuclear family as the effective subsistence procurement unit (Deraniyagala 1991: Chapters 5 and 7). The carrying capacities of the ecozones were never, apparently, conducive towards larger agglomerations of individuals constituting the basic subsistence units, except perhaps in the case of the Dry Zone's coastal tracts. Vadda and Semang ethnography provide valuable insights as to how these communities would have functioned for the hinterland, and the Andaman data are relevant for the interpretation of the coastal facies.

Prehistoric faunal evidence from the caves indicates a non-specialised exploitation strategy involving a wide spectrum of forms with a concentration on small game. There are no obvious shifts in this strategy from at least 34,000 BP. It appears as if this has also been the case with the food-plants such as the nut *Canarium zeylanicum* and the wild breadfruit *Artocarpus nobilis* which probably supplemented the *Dioscorea* yams which are known to have been the staple among the Vaddas. The ability to make fire, or at least its availability, is attested at Fa Hien's Cave at *c.*34,000 BP and this is likely to have extended much further back in time. The grasslands of ecozones D3 and E seem to be anthropogenic, created to facilitate hunting efficiency in prehistoric times. It is proposed that the grasslands of the Horton Plains (Maha-eliya), for instance, were subjected to periodic firing at least as early as 34,000 BP. Radiocarbon dating combined with the analysis of pollen from the swamps in the Horton Plains could conceivably clarify this point.

The technology that was employed to apply the subsistence strategy sketched out above comprised the use of quartz and occasionally chert tools, supplemented by artefacts of bone and antler from at least 28,000 BP. Deposits of quartz are ubiquitous on the island except in the extreme north with its limestone country-rock and absence of alluvial gravels. Hence, raw material for the manufacture of tools apparently did not impose a constraint on settlement. These tools (Deraniyagala 1991: Chapter 5) progressively became smaller and more refined, as is evident from the progression from a Middle Palaeolithic technological phase to that of the Mesolithic in the Iranamadu Formation and the cave deposits.

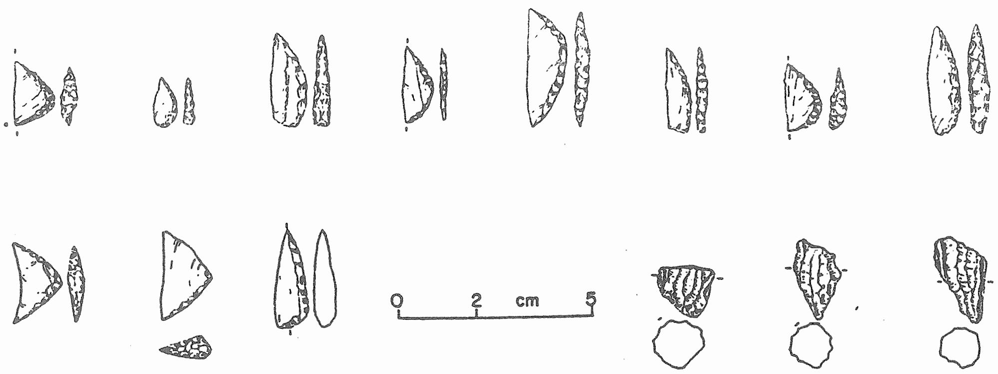

FIGURE 3: GEOMETRIC MICROLITHS FROM BUNDALA, 28,000 YEARS BP

What is significant, however, is that Sri Lanka provides one of the earliest known occurrences of the techno-tradition referred to as geometric microlithic (Figure 3) which is the hallmark of the European Mesolithic. This evolutionary stage in lithic technology has long been assumed to have made its first appearance at the end of the Pleistocene at *c.*10,000 BP, but Sri Lanka has provided unequivocal evidence that microlithic stone tools made an appearance as early as 28,000 BP, as exemplified at the four widely separated sites of Bundala-Patirajawela, Bundala-Wellegangoda, Batadomba and Kitulgala. This has been corroborated by discoveries of similar tools of similar antiquity in Zaire (van Noten 1977) and southern Africa (Sampson 1974). It is tempting to see catalysts in the low-latitude environments of Asia and Africa which gave rise to this technological phenomenon at a date *c.*18,000 years earlier than in Europe. One could, for instance, speculate whether there was a correlation between the phenomenon of technological microlithisation and the development of the motor area of the brain and the opposability of the thumb into a precision grip for tool manipulation. But beyond such rarified propositions one cannot so much as surmise at what the causative factors might have been. What can be postulated, however, is that by 28,000 BP the human animal had developed to such a degree of complexity that its expression, as in the stylistic elements of stone tools, could be almost entirely a matter of cultural choice as against being purely a product of the environment.

The facility of cultural choice would have diminished increasingly as one retraces one's steps back through the Pleistocene to the beginnings of lithic technology a couple of million years ago. By 600,000 BP, a rough estimate of the age of the earliest Acheulean techno-tradition of making stylised stone handaxes and cleavers in peninsular India, cultural choice over environmental pressures *per se* were already in the ascendant. This distinctive tradition ranged from western Europe to southernmost Africa and then on to peninsular India. But something hindered its manifestation in the extreme south of India, south of the Kaveri river, and in Sri Lanka. The challenge is to work out what these inhibitors could have been. I (Deraniyagala 1991: Chapter 7) have hypothesised that a combination of environmental factors produced this barrier. These included

(a) the lack of suitable sedimentary quartzite for tool manufacture, this having been the preferred material, almost to the exclusion of all others, for handaxe manufacture, and

(b) the relatively low biomass of exploitable herbivores that would have characterised Sri Lanka's ecozones throughout the Pleistocene, since the Acheulean tradition is invariably represented in regions which would have maintained a high density of herbivores (usually large or medium-sized ungulates).

These factors could have sufficed to relegate Sri Lanka and southernmost India to a cultural backwater which the sophisticated bearers of the Acheulean tradition eschewed. Several hundred millennia afterwards, when it came to geometric microlithic technology, Sri Lanka had an abundance of appropriate raw material in the form of quartz and a fauna of small game that was exploitable with adequate cost-effectiveness in terms of labour input with the new technology. Hence the new tradition manifested itself even in the most inhospitable parts of the country which thereby rose above the status of a cultural backwater with anatomically modern humans in occupation at *c.*28,000 BP. But it was sufficiently a backwater that it retained a remarkable continuity in the physical traits of its human populations, as observed by Kennedy *et al.* (1987), from at least 16,000 BP to 6500 BP with strong survivals in the Vadda hunter-gatherers of recent times. This appears to signify lack of intrusion into the gene pool during this period.

In addition, there is the strange anomaly that despite the occurrence of several hundreds (perhaps thousands) of Stone Age sites of this period as open-air habitations in the Dry Zone, very few indeed have been found in otherwise eminently habitable, large, well ventilated caves in close proximity to the open-air sites. The situation is quite different in the Wet Zone, where practically every cave has rich deposits of late Quaternary cultural material. It is probable that the Dry Zone environment did not require the shelter of caves and that the open-air siting of camps provided a degree of flexibility in food procurement that more than offset the advantages of living in caves; whereas shelter was of prime importance in the Wet Zone with its incessant rains. However, such speculations as these merely hint at the enormous complexities of human/environment interactions even as early as 600,000 years ago.

NOTES

[1] The number and configurations of the cold/warm oscillations prior to Eem are currently being re-examined. The Günz-Riss terminology is adopted here as a matter of convenience until consensus has been reached on this subject by Quaternary geologists. It is noteworthy that the Milankovitch radiation model for explaining the Quaternary climatic fluctuations (Zeuner 1959) is once again in favour, thereby lending some validity to the continued use of the venerable four-fold glaciation scheme, if only as a heuristic device.

[2] The term Iranamadu Formation has been used by me (Deraniyagala 1976; 1991) to supersede Red Earth Formation as employed by Cooray (1967). The latter can be misleading since (a) these

beds are frequently buff-coloured where the associated soil is a Yellow Latosol and (b) the basal member of this formation consists of gravels that are distinct from the overlying earth of weathered dune sands. Standard stratigraphic practice as regards nomenclature has been adhered to in designating and describing Iranamadu as the type site (Deraniyagala 1991: Appendix 3).

[3]The Pleistocene epoch is periodised thus: Lower, 2.5-0.7 million years BP; Middle, 700,000-150,000 BP; Upper, 150,000-10,000 BP.

[4]This is possibly one of the first and very few instances where the effects of the glacial/interglacial (hypothermal/altithermal) oscillations in the higher latitudes have been gauged with any reliability for South Asia.

[5]The occurrence of remains of lion in a deposit radiocarbon dated to *c.*14,000 BP (Würm upper pleniglacial) in Batadomba cave need not signify much environmentally, since this animal is known to have a wide range of habitats in Africa. It could, however, imply conditions that were drier than those prevailing today, the lion being typically a dry-habitat form, which would be in agreement with the general view that the tropics witnessed a pronounced dry phase during the Würm upper pleniglacial.

REFERENCES

Cooray, P.G. 1967. *An Introduction to the Geology of Ceylon*. Spolia Zeylanica 31(1).

Deraniyagala, S.U. 1976. The geomorphology and pedology of three sedimentary formations containing a Mesolithic industry in the lowlands of the Dry Zone of Sri Lanka (Ceylon). In K.A.R. Kennedy and G.L. Possehl (eds), *Ecological Backgrounds of South Asian Prehistory*, pp.11-27. Cornell University: South Asia Program.

---- 1991. *The Prehistory of Sri Lanka: an Ecological Perspective*. Sri Lanka: Archaeological Survey Dept., Memoir 8. (Unrevised version of 1988 published by University Microfilms, Ann Arbor).

Domrös M. 1974. *The Agroclimate of Ceylon*. Wiesbaden: Franz Steiner.

Fairbridge, R.W. 1976. Effects of Holocene climatic change on some tropical geomorphic processes. *Quaternary Research* 6:529-56.

Gans, C. 1990. Amphibian and reptilian burrowers as biogeographic indicators. Unpublished manuscript (and pers. comm.).

Gaussen, H., Legris, P., Viart M., and Labroue L. 1968. *Explanatory Notes on the Vegetation Map of Ceylon*. Sri Lanka: Government Press.

Kennedy, K.A.R., Deraniyagala, S.U., Roertjen, W.J., Chiment J. and Disotell T. 1987. Upper Pleistocene fossil hominids from Sri Lanka. *American Journal of Physical Anthropology* 72:441-61.

Kennedy, K.A.R., and Deraniyagala S.U. 1989. Fossil remains of 28,000-year-old hominids from Sri Lanka. *Current Anthropology* 30(3):394-99.

Mueller-Dombois, D. 1968. Ecogeographic analysis of a climate map of Ceylon with particular reference to vegetation. *Ceylon Forester* 8(3,4):39-58.

Sampson, C.G. 1974. *The Stone Age Archaeology of Southern Africa*. New York: Academic Press.

Singhvi, A.K., Deraniyagala S.U., and Sengupta D. 1986. Thermoluminescence dating of Quaternary red sand beds in Sri Lanka. *Earth and Planetary Science Letters* 80:139-44.

Thambyaphillay, G.G.R. 1958. Secular fluctuations in the rainfall climate of Colombo. *University of Ceylon Review* 16(3,4):93-106.

---- 1967. Climatological research and agricultural development in the Dry Zone. In O.S. Peries (ed.), *Proceedings of a Symposium on the Development of Agriculture in the Dry Zone*, pp. 18-28. Colombo: Ceylon Association for the Advancement of Science.

Van Noten, F. 1977. Excavations at Matupi Cave. *Antiquity* 51:35-40.

Zeuner, F.E. 1959. *The Pleistocene Period*. London: Hutchinson.