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THE IMPLICATIONS OF HOMINID SEAFARING CAPABILITIES

by

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INTRODUCTION

In recent decades the discussion of the cognitive faculties of hominids, particularly those of the Late Pleistocene, has provided an important impetus in reconsidering the dynamics of human evolution. Debates about symbolism, palaeoart, language origins, technological aspects of culture and a variety of related topics have featured prominently. Two distinct schools of thought have emerged, especially in recent years. According to one of these, capabilities such as hunting of large mammals, prismatic blade tools, non-lithic artefacts, 'reflective language', personal ornamentation, rock art, portable art – indeed any form of evidence suggestive of symbolism – are all typically restricted to fully modern humans. Whatever is encompassed by the term 'modern human behaviour' – and this includes a considerable range of interpretations of the 'archaeological record' – is attributed exclusively to the last thirty or forty millennia of the Pleistocene. In its purest form, this school refers prominently to an 'explosion' of human capabilities with the advent essentially of the Aurignacian of southwestern Europe and contemporary 'cultures' in eastern Europe (e.g. White 1989, 1992, 1993, 1995). It has derived particularly strong support from the hypothesis that extant humans originate exclusively from a small sub-Saharan population, and that all other forms of *Homo sapiens* became extinct, be it by competition or more drastic, genocidal processes. This 'African Eve' theory, which is entirely devoid of any archaeological evidence in its favour (Bednarik 1995a:606), is conveniently reinforced by the opinion that any form of cultural, cognitive or technological sophistication is limited to the hypothetical progeny of Eve, and especially to the final phase of the Late Pleistocene, because such a scenario provides a ready-made answer to explain the perceived superiority of these modern humans who poured out of Africa and overwhelmed their primitive cousins wherever these lived.

Over the last decade, the alternative school of thought has been similarly overwhelmed, by the popularity of the 'African Eve', and by the ready plausibility of a paradigm in touch with the cynicism and economic rationalism of the 1990s: the inevitability of the genetic triumph of Eve's descendants over the culturally, technologically, socially and cognitively inferior rest of Late Pleistocene humanity. During this decade, only a few scholars voiced objections to this scenario, much as the multiregional hypothesis of hominid evolution (Wolpoff 1997) came under sustained siege during the same time. Unable to match the popular appeal of what is best defined as the *short-range model of cultural evolution*, the *long-range model* survived with few vocal advocates.

Nevertheless, some authors did point out glaring empirical and logical shortcomings in the short-range model. Essentially, the long-range model perceives the evolution of communication, technology, complex social systems, symbolic systems, self-awareness, and intellect as a gradual process, taking hundreds rather then tens of millennia. Indeed, some of these developments may occupy much or all of the 2.5 million years of human history, and while there may well have been episodes of a punctuated equilibrium type, this model favours a gradualist over a cataclysmic view. What renders the great preference for the short-range model particularly fascinating is not just that it is implausible, empirically unsound and logically deficient in major parts, but that the heuristic dynamics of the discipline have allowed it to become the favoured model despite its readily evident major shortcomings. This surely needs to be examined closely if we are to understand the epistemology of Pleistocene archaeology. I have considered several aspects of this interesting phenomenon, commenting for example on the inadequate information available to various of the principal proponents of the short-range model (Bednarik 1992, 1995a:628), on the faulty logic of that model (Bednarik 1994a), or on the implications of such finds as Lower Palaeolithic beads and pendants (1997a), rock art (1993a) and sophisticated non-lithic artefacts (1992, 1995a). In the present paper I will focus on yet another test case to assess the short-range model.

It seems to be generally agreed that language is a fundamental prerequisite for humans to colonize islands through the use of maritime technology. It is self-evident that many conditions need to be met to achieve a successful long-term settlement of islands, of which actual landfall is only one. Even the most extreme protagonists of the short-range model of cognitive human evolution, such as Davidson and Noble (1989, 1990, 1992; Noble & Davidson 1996), are in complete agreement with me on the need for language in such achievements. After initially proposing that language beginnings must have been preceded by figurative depiction, of which we have no evidence prior to approximately 32,000 years (32 ka) BP (Clottes *et al.* 1995), Davidson and Noble (1992) declared that the earliest evidence of language is the first landfall of humans in Australia. This is currently thought to have occurred perhaps 50 or 60 ka ago (Roberts *et al.* 1990, 1993; *cf.* Allen & Holdaway 1995; Thorne *et al.* 1999). But firstly, this reasoning seems specious: before the final crossing to Australia, perhaps over the Timor Sea, the ancestors of these seafarers had to cross several other stretches of sea, including the biogeographically most important barrier in the world, the Wallace-Huxley Line. It seems unreasonable to assume that all these crossings were achieved in one single sweep from the Asian to the Australian mainland, and yet this is what this notion implies (*cf.* Bartstra *et al.* 1991). The African Eve model encounters some first problems here: if the people who first left the Asian mainland (which for long periods included Java and Bali) were the descendants of Eve, they did so at least 20 ka before they entered Europe to 'replace' the Neanderthals. While this would still seem possible, much earlier sea crossings, however, would render the proposal implausible; hence the insistence that Wallacea and Australia were colonized in one single sweep.

More importantly, there are two fundamental problems, one of which is fatal for the model. First, there is a widespread misconception that the 'replacement' of archaic forms of *H. sapiens* by *H. sapiens sapiens* coincided with the introduction of Upper Palaeolithic technology (blade industries, bone tools, art, decoration, burial of dead, subterranean mining, seafaring). Not only is this a complete fallacy (Bednarik 1995a), it must be emphasized that nearly all evidence of Pleistocene sea crossings we have today relates to sailors of a *Lower or Middle* rather than an *Upper* Palaeolithic technology. Second, and more importantly, we have sound evidence that the first sea crossings and subsequent long-term occupations of at least three, but probably *most* of the islands of Nusa Tenggara (Lesser Sunda Islands; Fig. 1), occurred significantly earlier than the first landfall in Australia. This is not only in sharp contrast with what all English-language commentators have persistently maintained until now, the early sea crossings occurred in fact in the Lower rather than the Middle Palaeolithic period, i.e. all these commentators were wrong by a chronological factor of at least ten. This knowledge alone, available to us for decades but ignored or misunderstood by all English-language commentators, is clearly fatal to the short-range model of cognitive evolution, and it is a mortal blow for the controversial African Eve model as well (e.g. Stoneking *et al.* 1986; Cann *et al.* 1987; Stoneking & Cann 1989; Hammer 1995; but see Nei 1987; Vigilant *et al.* 1991; Barinaga 1992; Goldman & Barton 1992; Templeton 1992, 1993, 1994, 1996; Ayala 1996; Brookfield 1997; *cf.* Wainscoat 1987; Hall & Muralidharan 1989). The proliferation of hypotheses contradicted by the information from Indonesia, available for the past forty years, is a phenomenon that is hard to explain.

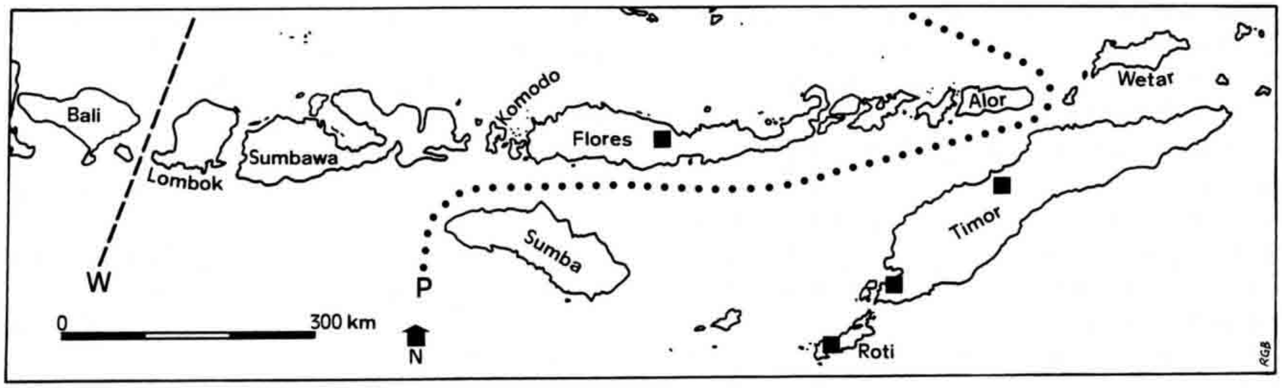

Fig. 1. Nusa Tenggara (Lesser Sunda Islands), southern Wallacea, Indonesia. The locations of confirmed occurrences of Lower or Middle Pleistocene stone tools are indicated by squares, and the presumed separation of the tectonic plates (P) and the Wallace Line (W) are shown.

I therefore propose to examine the subject of Pleistocene seafaring in some detail. I apologise for the frequent use of self-citation in this paper, but need to point out that virtually all academic publications focusing on this specific topic have been written by me. Moreover, much the same could be said about some of the closely related topics that are also discussed in this paper.

PLEISTOCENE SEAFARING

No direct physical evidence of navigation, such as fragments of water craft, paddles or oars, has ever been reported from the Pleistocene, and no credible depictions of vessels occur in the known corpus of Pleistocene palaeoart (Bednarik 1997b). The earliest such evidence is exclusively from western Europe, consisting of Mesolithic paddles from the peatbogs at Star Carr (c. 9500 years BP) and Holmgaard (McGrail 1987, 1991; Clark 1971:177). A worked reindeer antler from the Ahrensburgian at Husum has been suggested to be a boat rib of a skin boat, and may be in the order of 10 500 years old (Ellmers 1980). The canoe from Pesse (Zeist 1957) is, according to the recently re-calibrated date, 8265±275 radiocarbon years old (Bednarik 1997c). More recent boat finds are those from Noyen-sur-Seine (7960±100 BP) and Lystrup 1 (6110±100 BP) (Arnold 1966). The taphonomic factor of the rising sea level at the end of the Pleistocene has obliterated all earlier evidence. In the region of Scandinavia this is particularly well demonstrated, where coastal settlements of the early Holocene are now under shallow water, and where for this very reason much Mesolithic evidence is recovered by underwater archaeology (e.g. Andersen 1985; Fischer 1995).

Limited indirect evidence is available for earlier European seafaring in the Mediterranean. The presence of obsidian from the island of Mêlos at the mainland site Frachthi Cave around 11 ka ago indicates that a distance of about 120 km was covered by 'island-hopping' through the Cyclades (Perlès 1979). Considerably earlier is the Mousterian occupation of another Greek island, Kefallinía (Kavvadias 1984), presumably by Neanderthals, which has been suggested to have involved a sea crossing of 6 km (Warner & Bednarik 1996). Islands to the west of Italy, too, may have been occupied by Palaeolithic seafarers (d'Errico 1994), and from time to time the possibility has been considered that hominids crossed from Africa to Europe by navigating the Strait of Gibraltar (Freeman 1975; Johnstone 1980; Bednarik & Kuckenburg 1999). Although this was proposed without hard evidence, in the light of the seafaring capability of *Homo erectus* in Southeast Asia as enunciated below this question would be worth reconsidering now. The Gibraltar crossing was much shorter and may have been less difficult than that of the Lombok Strait with its treacherous currents. The principal reason for the initial assumption was the similarity of the Acheulian stone tool traditions in the Maghreb of northwestern Africa and on the Iberian peninsula, as well as the similar parallel development of lithic technology on both sides of the Strait of Gibraltar. Bearing in mind that at least the people of the late Acheulian in the Maghreb possessed highly complex cognitive and social systems (Bednarik 1997a) it seems very possible that they also had the technology and enterprise to undertake a sea crossing of, at low sea level, merely 5–7 km.

The earliest apparently secure evidence of Mediterranean seafaring relates to the islands of Sardinia and Crete. The stone tools from Middle Pleistocene deposits at Sa Coa de sa Multa in Sardinia have been suggested to be in the order of 300 ka old (Bini *et al.* 1993), while a human phalange from Corbeddu Cave, also in Sardinia, is 'merely' 20 ka old (Spoor & Sondaar 1986). Human remains from Crete (Facchini & Giusberti 1992) indicate that Middle Palaeolithic seafarers made two sea crossings totalling some 80 km to reach that island. This is the only known European seafaring feat of the Pleistocene that can in its magnitude be compared to the great maritime achievements of Ice Age navigators in the region of Indonesia and Australia.

In comparison to the sparse European evidence of Pleistocene seafaring capabilities, that from eastern Asia to Australia is decidedly much more impressive. The first landfall on practically dozens of islands, based on stone tool typology and preliminary dating evidence or reasonable deductions concerning the movement of first human colonizers, is attributable to people possessing a Middle Palaeolithic and not an Upper Palaeolithic technology. Indeed, many of these sea crossings in the general region even date from Lower Palaeolithic times and are clearly attributable to *Homo erectus* groups. (I should mention that I use these cultural divisions purely for the sake of convenience and conformity, I regard them as superseded pigeonholes that today need to be replaced by more relevant constructs.) The latter include the first landfall in Flores (Verhoeven 1958; Maringer & Verhoeven 1970; Sondaar *et al.* 1994; Bednarik 1995b, c, 1997b, c, d; Morwood *et al.* 1998), which according to Koenigswald occurred up to 830 ka ago (Koenigswald & Ghosh 1973); the presumably preceding settlement of Lombok and Sumbawa (which lie between Bali and Flores); the Middle Pleistocene settlement of Timor and Roti (Bednarik 1999); and the presumably preceding landfalls on Alor, Wetar and various smaller intermediate islands. There are also very tentative indications of early settlement in Sulawesi (Heekeren 1957:47–54) and apparently even in Ceram (Hadiwisastra & Siregar 1996).

Subsequent navigation by marine colonizers of a Middle Palaeolithic technology led to landfall in Australia by perhaps 50 or 60 ka ago (Robert *et al.* 1990, 1993; the evidence recently tendered from the Jinmium site is here disregarded as being unsound); on Gebe Island (Golo and Wetef Caves) prior to 33 ka; on the Bismarck Archipelago (Matenkupkum and Buang Marabak on New Ireland) at about the same time; and also on the Solomon Islands (Kilu Rockshelter on Buka Island) (Allen *et al.* 1988; Wickler & Spriggs 1988). The sea distance between Buka and New Ireland is about 180 km, although there are small islands along the way, but these are of low visibility. The Monte Bello Islands, now 120 km off the northwest coast of Australia, are very small and they were settled before 27 ka ago (Noola Cave on Campbell Island) (Lourandos 1997:119). Between 20 and 15 ka ago, obsidian from New Britain was taken to New Ireland, and the cuscus, an Australian land mammal, appears in the Moluccas (e.g. on Morotai and Gebe), almost certainly having been transported by sailors from Sahul (Pleistocene Greater Australia) for food (Bellwood 1996). Finally, sea journeys to and from Kozushima, an island about 50 km from Honshu, Japan, were undertaken at least 30 ka ago (Anderson 1987).

The past ideas of 'accidental' drift voyages, implausible as they always were, are incompatible with this extensive evidence of navigation abilities. All currently available evidence probably refers to successful long-term colonizations, and not merely to individual trips, and we have to assume that essentially Middle Palaeolithic navigators had developed the competence to travel the high seas almost habitually, sometimes targeting tiny, far off islands, and often travelling to coasts that remained beyond the horizon for much of the journey (as in the case of Australia, which only became visible shortly before landfall). These many journeys were thoroughly intentional, planned and competently executed expeditions, and if any researchers still hold contrary opinions they really ought to try crossing the sea on randomly drifting vegetation matter.

Not that any of this should surprise us. The history of maritime navigation in the region began at least 800 ka ago, at a time of distinctly accelerated cognitive and technological evolution (Bednarik 1990, 1992, 1993b, 1994b, 1995a). It would be entirely unrealistic to assume that the great subsequent innovations in wood working (Belitzky *et al.* 1991), hunting equipment (Jacob-Friesen 1956; Howell 1966:139; Wagner 1990; Thieme 1995, 1996, 1997), bead and pendant making (Bednarik 1997a), harpoon design (Narr 1966:123; Brooks *et al.* 1995; Yellen *et al.* 1995; Bednarik 1997b:36), mining and quarrying (Bednarik 1986a, 1995d; Gábori-Csánk 1988; Vermeersch *et al.* 1989), the refinement in stone tools or the proliferation of palaeoart and pigment use over the subsequent hundreds of millennia (Bednarik 1992) had simply no parallels in seafaring technology. The first seafarers, who crossed Wallace's Barrier well over three quarters of a million years ago, were probably hominids of a maritime economy who had already invented the use of flotation equipment earlier, perhaps much earlier, to develop off-shore marine exploitation. Perhaps this was in response to population pressure and diminishing coastal resources, which would also explain the desperate initial bid to reach the opposite shore (the coast of Lombok is well visible from Bali even at present sea level).

Homo erectus was not the first large land mammal to cross Wallace's barrier. Proboscideans had been doing this for quite some time, having developed endemic speciation characteristics on many islands of eastern Indonesia by the Early Pleistocene (Sondaar *et al.* 1994). Several fossil species of Stegodontidae and elephants are found in Wallacea (the islands between Wallace's and Lydekker's Lines; Wallace 1890; Lydekker 1896; *cf.* Bednarik 1997a:Fig. 2) and beyond, including three species on Sulawesi (Groves 1976) and others on Flores (Hooijer 1957; Verhoeven 1958), Timor (Verhoeven 1964; Glover 1969) and other islands east of Flores, as far as Ceram and Irian Jaya (Hantoro 1996), and to the north on Luzon and Mindanao (Koenigswald 1949). These include very large species as well as examples of extreme dwarfism (which is common in endemic populations of proboscideans, *cf.* Malta and Santa Barbara Islands). Like elephants, Stegodontidae were probably superb long-distance swimmers, and their habit of travelling in herd formation was important in their ability to establish island populations. Modern African elephants have been observed to swim in groups continuously for 48 hours across freshwater lakes. Individuals may then resort to 'rafting', i.e., placing their front limbs on the back of another individual to rest for some time, and then in turn towing the other animal. The excellent buoyancy of these animals, even greater in salt water, and their long trunks would assist them greatly in crossing turbulent sea barriers. In this way elephants had been island-hopping along the Indonesian island chains long before hominids. It is tempting to speculate that increasing populations on small islands may have faced starvation and been motivated by seeing the green vegetation on the other shore to undertake these sea journeys in sufficient numbers to found new populations there.

Hominids, however, lacked buoyancy, trunks and long-distance swimming ability, and to travel as a group, with an adequate number of females to found a new population (McArthur *et al.* 1976), they had to use watercraft. They could have used elephant or *Stegodon* bladders, or bundles of lightweight logs, or bamboo bundles and rafts. Of these, the latter are by far the easiest to procure and use, and ever since the question of the initial colonization of Australia has been considered seriously, bamboo rafts were the preferred explanation (Birdsell 1957, 1977; Thorne 1980, 1989; Jones 1976, 1977, 1989; Butlin 1993; Flood 1995; Bednarik 1995b, c, 1997b, c, d). This explanation has the additional benefit of accounting for the relatively impoverished navigation technology of ethnographic Australia, because the thick-stemmed bamboo species of Southeast Asia do not occur in Australia (Jones 1989; Bednarik 1997b). Watercraft observed in Australia were limited to bark canoes (Massola 1971), rafts from driftwood, bark bundles (Jones 1977) or mangrove logs (Flood 1995), suitable only for coastal journeys. Large log rafts seen on the Sepik River of New Guinea (Jones 1989) may have been seaworthy, but bamboo has much greater buoyancy and is significantly easier to fell with stone tools and to assemble.

THE FIRST SAILORS

In January 1957, having worked in the area for many years (Verhoeven 1952; Verhoeven & Heine-Geldern

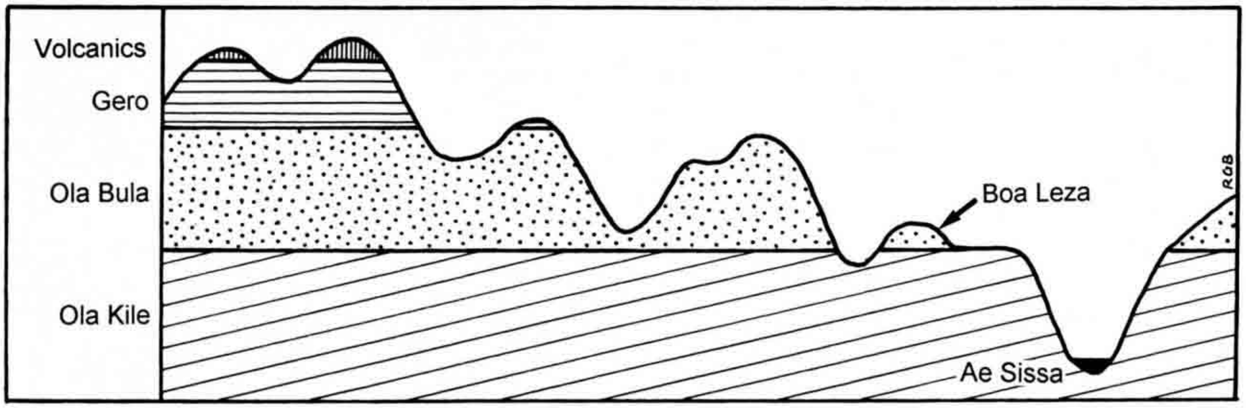

Fig. 2. Schematic depiction of the principal sediments forming the Soa plain near Boawae, Flores.

1954), Dr Theodor Verhoeven observed the first remains of Stegodontidae found in Wallacea, near the abandoned village Ola Bula on the Soa plain of central Flores (Hooijer 1957; Verhoeven 1958). Two months later he recorded stone blades, flakes and cores eroding from a deposit nearby (Verhoeven 1968:400) and notified the relevant Indonesian authorities. The material he then collected with Professors Wegner and Dyhrberg of the Museum Zoologicum Bogoriense was sent to Dr Hooijer in Leiden, Holland. Henri Breuil, then the world's foremost prehistorian, recognised a number of Lower Palaeolithic stone tool types among it (Verhoeven 1958), mentioning to Verhoeven that A. de Almeida had found similar lithics in Timor. Koenigswald immediately suggested that the finds were of the Middle Pleistocene (1958:44–46). In 1963, Verhoeven located further stone tools at nearby Boa Leza, but this time *in situ*, and in the same layer that produced the *Stegodon* remains (the Ola Bula Formation). The possibility that the cultural and faunal components had been mixed by fluvial action could be excluded on the basis of the material's description, and because it was subsequently found together at several other sites nearby, so Verhoeven (1968) had satisfactorily demonstrated the coexistence of the *Stegodon*-dominated fauna and the hominids. In 1968 he was joined by Professor Johannes Maringer, an archaeologist from the Anthropos-Institut in Germany, and later that year the two scholars excavated with three large crews at Boa Leza, Mata Menge and Lembah Menge. The first of a series of reports by Maringer and Verhoeven validated all of Verhoeven's observations completely (Maringer & Verhoeven 1970a, b, c), and were followed by further work detailing many aspects of the Pleistocene history of Flores (Maringer & Verhoeven 1972, 1975, 1977; Maringer 1978). Koenigswald qualified his initial age estimation, postulating the age of the fossiliferous deposit to be between 830 ka and 500 ka, nominating his preferred estimate as 710 ka, on the basis of geology, palaeontology and the presence of tektites (Koenigswald 1973; Koenigswald & Ghosh 1973:3–4; Ashok Ghosh pers. comm. August 1996). This age estimate was confirmed through a series of 19 palaeomagnetic analyses, which suggested that the Matuyama-Brunhes reversal to normal polarity (780–730 ka BP) occurs just 1.5 m below the artefact and fossil-bearing facies at Mata Menge (Sondaar *et al.* 1994). A very different and earlier fossiliferous facies at another site in the area, Tangi Talo, appears to be of the Jaramillo normal polarity period, and thus about 900 ka old. It contains no stone artefacts, and the pronounced faunal change has been suggested to be attributable to the arrival of hominids (Sondaar 1987; Sondaar *et al.* 1994).

The Soa plain sequence (Ehrat 1925; Hartono 1961) comprises four principal facies (Fig. 2): a volcanic deposit called Ola Kile, followed by the discordant Ola Bula Formation, with distinctive white tuffaceous sediments at its base and an average thickness of about 80 m. The lower part of the Ola Bula Formation, just above the white tuff and usually only

1.0–1.5 m thick, contains the numerous bone remains and cultural lithics, its upper components contain leaves and molluscs. The overlying series of the Gero limestones is heavily eroded, and the uppermost volcanic sediment even more so. Maringer and Verhoeven recognised the similarity of their lithics from Ola Bula and elsewhere on Flores to those of early Java (Koenigswald 1936, 1939; Movius 1944, 1948), attributed to *Homo erectus*. The fossil remains occurring with them are dominated by *Stegodon trigonocephalus florensis*, an endemic subspecies (Hooijer 1957, 1972), with minor numbers of crocodiles and giant rats (*Hooijeromis nusatenggara*) (Musser 1981). The tuffaceous mudstone these remains are embedded in comprises two definable horizons. Both the stone tools and the bones show some wear in the lower, sandy horizon, but in the silty upper layer they possess fresh appearance and sharp edges. Moreover, many osteal remains in the silty upper layer were recovered in articulation, with limbs occurring together with pelvis or vertebrae in correct arrangement (Maringer & Verhoeven 1970a). It was therefore conclusively demonstrated 30 years ago that *Homo erectus* coexisted with *Stegodon* on Flores, an island that has never been connected to Sumbawa and Lombok, which in turn has never been joined to Bali and thus to the Asian mainland.

Having been aware of the work by Verhoeven and colleagues since the late 1970s, and prompted by the palaeomagnetic dating results, I raised the issue of the greater implications of his findings (Bednarik 1995b, c), but only one Australian archaeologist took a serious interest in the matter. Morwood recorded stratigraphic sections at Mata Menge in January 1997, again confirming the crucial claims made over the previous 40 years. Subsequent dating by zircon fission track analysis provided approximate ages from sediments immediately below and above the artefact-bearing sediments at Mata Menge (Morwood *et al.* 1998). Accordingly, the *Homo erectus* artefacts should be between 880±70 ka and 800±70 ka old (at 1 standard deviation; Paul O'Sullivan pers. comm. March 1998). A third fission track estimate, of 900±70 ka BP, was obtained from the fossiliferous layer at Tangi Talo. Thus the earlier age estimates were once more broadly confirmed, as was the seafaring capability of the Mata Menge hominids.

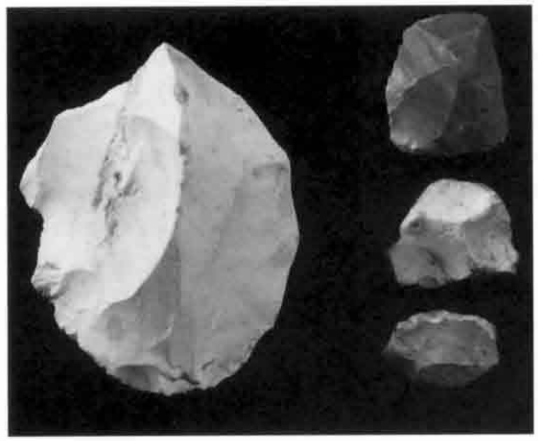

Fig. 3. Heavily patinated and disintegrating stone tools from a Middle Pleistocene deposit near the Roshi Danon jasperite quarry, Roti. Scale 1 : 2.

Verhoeven (1964) had also discovered Stegodontidae on Timor, although not in combination with stone implements. After commencing a research project on West Timor and neighboring Roti, I am currently engaged in examining evidence of the early hominid occupation of this region, besides collaborating with the work by Morwood *et al.* in Flores. Roti is now separated from Timor by shallow sea but the two islands of the 'outer arc' were obviously connected for much of the Pleistocene. A spectacular find was a huge, 800-m jasperite quarry complex at Roshi Danon, with nearby stratified occupation evidence (Fig. 3). Both Timor and Roti consist largely of calcareous formations, particularly of the Tertiary, with strongly folded Permian and mesozoic limestones and, occurring together with the older sedimentary rocks, outcrops of crystalline schists. Exposures of stone suitable for implement knapping are rare, and this quarry has evidently been in use since the Middle Pleistocene. Its discovery also solved the difficulty of explaining where the Middle Palaeolithic seafarers of Timor/Roti could have acquired their stone tool materials for creating the kinds of watercraft they would have needed to cross to Australia. Their quarries had been used already by their predecessors, who arrived presumably either from Flores or the islands to the immediate east of Flores, after crossing the Sawu Sea or Timor Strait, or they may have even arrived along the outer arc via Sumba.

In late 1998 I explored a series of sites with Middle Pleistocene sediment sequences in the Weaiwe valley near Atambua, Timor. This led to the location of further *Stegodon* remains, and at Motaoan I located a Lower Palaeolithic stone implement *in situ* from the same stratum, just 2 m from a *Stegodon* molar. At To'os, another site nearby, I found a fragment of a large marine mollusc shell (probably *Ostrea sp.*) that had been smashed and bore extensive evidence of burning on one end. Therefore it has now been established that hominids were also on Timor at the time of the Stegodont-dominated fauna. At the time of writing, sediment samples from these sites are being processed in an isotope laboratory for the purpose of estimating their radiometric ages.

The cumulative evidence from Flores, Timor and Roti suggests that of the alternative routes considered for the initial settlement of Australia (Birdsell 1977), the southernmost continues to be the most favoured. Thus we would expect the first crossing of Lombok Strait, between Bali and Lombok, to most likely represent the first event of seafaring. As yet we have no early occupation evidence from Lombok (nor have we looked for it), but it is logical that in order to reach Flores, hominids would have proceeded via Lombok. Nor do we have any skeletal evidence from Wallacea to tell us what kind of people the first seafarers in the world were, but since they began their maritime exploits almost a million years ago, only one species/subspecies can be responsible to the best of our knowledge, *Homo erectus*. Evidence of archaic *Homo sapiens* is at this stage limited to the last half a million years, and there is certainly no clear physical demarcation between these two hominid forms, with several 'intermediate' fossils (e.g. Hathnora, Miaohoushan Locality A, Yanhuidong, Jinniushan, perhaps Maba; for a detailed discussion of the hominid remains from the Asian catchment area relevant here, see Bednarik 1997b:24–28). In Java, connected to Bali for much of the Pleistocene, hominid remains have been unearthed for a full century now (Dubois 1894; Theunissen *et al.* 1990), and they fall into two broad groups: the early *Homo erectus* specimens from the Pucangan and Kabuh beds (Dubois 1894; Ninkovich & Burckle 1978; Suzuki *et al.* 1985) which have been suggested to be up to 1.81 million years old (Swisher *et al.* 1994); and the much later hominids from the High Solo Gravels (Santa Luca 1980; Bartstra *et al.* 1988), which have often been compared, in terms of their skeletal architecture, to Pleistocene Australians (Weidenreich 1943, 1945, 1951; Larnach & Macintosh 1974; Thorne 1980; Thorne & Wilson 1977; Thorne & Wolpoff 1981; Wolpoff 1980, 1989, 1991, 1997; first proposed by Klaatsch 1908, i.e. before the discovery of Ngandong hominids in 1931). Their dating remains controversial (Swisher *et al.* 1996; Bednarik 1997b:27), but various results place them between about 300 and 30 ka ago. They are often described as very late *H. erectus*, but are more correctly seen as representatives of archaic *H. sapiens.*

The emerging picture is that *H. erectus* experimented with flotation devices at least a million years ago, at the furthest end of the world then settled by hominids, most probably in the vicinity of Java. The initial impetus to develop small watercraft, presumably bundles of bamboo, was perhaps the ability to fish for off-shore species. Development of this technology seems to have led to the confidence of crossing the Wallace Line, apparently by navigating Lombok Strait, in sufficient numbers to found a new colony on the first island of Wallacea. If we are to believe present dating evidence this should have occurred in the order of 900 or 800 ka ago. Crossings to the remaining Sunda Islands of the 'inner arc' were much easier and shorter than the 20–40 km journey across the strong currents of Lombok Strait (for tectonic history, see Bednarik 1997b:21–24), so the eastward expansion of these seafaring people could have been rather swift, and eventually, perhaps at a low sea level, they crossed to the 'outer arc', most likely from Alor to Timor. After further developing their navigation technology for hundreds of millennia, venturing progressively further out to sea and learning to understand the behaviour of the tropical trade winds, they were poised, for the first time, to cross the sea without seeing land for most of the journey, and thus reached Australia.

In view of the above data it is reasonable to speculate thus far. Traditional archaeology can tell us about the presence of hominids, and perhaps even provide an inkling of their lithic technology. It cannot tell us how these incredible achievements of Pleistocene hominids were accomplished. A different research approach is required.

REPLICATIVE NAUTICAL ARCHAEOLOGY

In the absence of any direct (material) evidence of maritime technology from the entire Pleistocene we have just two realistic strategies to learn about this subject: by reference to other aspects of technology (such as, for instance, wood working) of the chronological windows in question, and by applying the methods of replicative archaeology. By pursuing both of these approaches I have commenced the difficult process of reconstructing Pleistocene seafaring capabilities in the absence of actual material evidence. My replicative work in stone tool knapping (Bednarik 1973, 1980), butchering, fire making, bone harpoon making, petroglyph production (Bednarik 1998), bead and pendant manufacture (Bednarik 1997a), and wood and bamboo working (Bednarik 1997b) has provided me with many insights into the technology particularly of Lower Palaeolithic hominids. As the Chief Scientific Adviser of two expeditions (The *Nale Tasih* Expedition and The First Sailors Expedition) of maritime specialists seeking to 'replicate' specific Pleistocene sea crossings I have commenced the acquisition of a vast amount of data concerning all conceivable empirical variables involved in such feats, including raft design and size, materials and tools used in construction, sea performances of such vessels under various conditions, carrying capacities, sources of construction and stone tool materials, means of carrying food and water as well as replenishing both at sea, and the technologies involved in all of these factors, even psychological standard tests of crews under conditions of stress and anxiety (e.g. Impact of Event Scale; Horowitz *et al.* 1979; Zilberg *et al.* 1982; or the Beck Anxiety Inventory). This research program, commenced in 1996, includes a series of actual raft constructions in various locations of Indonesia, and their sailing by experienced crews with the objective of crossing a particular sea barrier in each case. These rafts comprise various materials and are of a range of sizes and designs. I am involved in their construction and it is my responsibility to ascertain that all components and equipment could be procured by either Middle or Lower Palaeolithic hominids, as the case may be, and could be worked with their respective stone implements to produce such craft. I expect to travel on each vessel to ensure strict adherence to these requirements, and to monitor all possible variables of the performance of each raft. The overall purpose of this detailed research program of replicative archaeology is to provide the data to create probability scenarios for some of the earliest successful (in the sense that they resulted in viable new populations) sea crossings of the Pleistocene – including the one that led to landfall in Lombok more than 800 ka ago, and the one that resulted in the first presence of humans in Australia. It is not the aim of these journeys to 're-create' these early achievements, but merely to attempt the crossings under various conditions. The data so acquired should ultimately facilitate the creation of a probability framework permitting the determination of the highest probability in respect of all crucial variables relating to these maritime accomplishments. Under the circumstances this is as far as science can take us in this respect.

At the time of writing this paper, the first five of the major replicative experiments have been completed and the next is well under way. In the present paper, only the first two experiments of this series are considered. Construction of the 23-m raft *Nale Tasih 1* commenced in August 1997 at the remote Oeseli base camp, near the southern tip of Roti. The raft consisted of 11 tons of bamboo forming five pontoons, lashed together with *rattan* (split forest vine of extraordinary strength) and hand-made ropes of the *lontar* palm (*pipa lontar* and *gemuti*). These were held fast by 13 cross-members which in turn supported the deck and superstructures: three weatherproof huts of palm leaves, two raised deck sections of split bamboo, two A-frame masts and three alternative rudder supports. One hut contained a traditional fire box and most of the food supplies (Fig. 4), the second held communication, recording and scientific equipment, the third provided shelter for the crew of eleven (two Rotinese seafarers, eight European sailors, which included three females, and one scientist). All parts of the structure of, and equipment carried on, the *Nale Tasih 1* were capable of being procured, worked and assembled with purely Middle Palaeolithic technology, and this was demonstrated on camera. All materials used were likely to have been available in Nusa Tenggara during the Late Pleistocene.

Besides the several bamboo species used and the locally available fibres and lashings, other materials on the raft included large sections of mangrove

Fig. 4. Galley of the *Nale Tasih 1*, with Willem Kiki cooking millet gruel (*pottok*) in a bucket (*haik*) made from a *lontar* palm leaf.

trunks, hollowed out by termites, closed off with wood and caulking and sealed with bees wax, in which 600 litres of drinking water was stored. Food was carried in bamboo tubes, capped with wax-dipped woven leaf covers. Few components of the raft were of wood, which was found to be much harder to work than bamboo: paddles, rudder supports and the mast joints, but wood was also carried as fuel for the hearth. Fire was made by friction in the traditional Rotinese method (drilling softwood with hardwood), using coconut husks as tinder. Coconut shells served as eating and drinking cups, and there was a variety of baskets, buckets, mats and hats woven from palm leaves on the vessel. Food included meat preserved in palm sugar, native millet, live shellfish carried in baskets alongside the craft, liquid *lontar* sugar in gourds, *kusambi* fruit and a large supply of half-ripe coconuts. This was to be supplemented by marine food to be speared or harpooned at sea (we have no evidence of fish hooks or nets from the time in question). For this purpose, the *Nale Tasih 1* carried eleven bone harpoons, made with stone tools from freshly-butchered long bones, and modelled on the Pleistocene specimens from Ngandong (Narr 1966) and Katanda (Brooks *et al.* 1995). Those from Katanda are assumed to be of an age similar to the first human presence in Australia, while the Ngandong specimen may precede that event but remains undated. Bone harpoons were set with plant resins (which were used in Middle Palaeolithic technology; Mania & Toepfer 1973; Bosinski 1985; Hayden 1993; *cf.* Boëda *et al.* 1996) in bamboo shafts and bound with *rattan* vine skin strips set in bees wax (Fig. 5). The raft's sail cloth was hand woven from fine *lontar* palm fibre, while the anchor consisted of a boulder of perforated Tertiary limestone.

Finally, the raft was equipped with a total of 170 stone tools. Most of these were made from a dark-grey, microcrystalline sedimentary silica, and all were typologically modelled on Middle Palaeolithic specimens, especially from southern Asia. The stone implements ranged from very thin, razor-like flakes to chopping tools for felling bamboo, some over 20 cm long. Most were multi-purpose flake tools, suitable for repairing equipment on board, cutting up coconut kernels, filleting and gutting of fish, cutting ropes, and for emergency repairs or modifications of the raft while at sea. As part of the overall research program,

Fig. 5. Manufacture of bone harpoon, modelled on a specimen from Katanda, being set in bamboo shaft with plant resin. The bone point took four days to make with stone tools, starting from a freshly butchered bone.

heavily worn stone tools are to be subjected to microwear study eventually.

Nale Tasih 1 was launched on 14 February 1998, when it was lifted and carried by about 400 Rotinese, and placed in the water of Oeseli Lagoon, a natural harbour. After final fitting-out work it was loaded, and towed by the *Dai Dau*, a local fishing boat, through the heads of the lagoon on 6 March, and out to sea for sea trials. The objective was to determine whether the vessel, whose displacement was considerably greater than anticipated, would be capable of reaching the Australian coast, a distance of some 800 km.

Not only did the raft float so low that the deck was constantly under water, which added significantly to the drag, design problems in steering and rigging became soon evident. Moreover, the direction of both wind and sea (wave action) were unfavourable, and the current was, contrary to expectations, opposing us. A primitive craft such as the *Nale Tasih 1* offers almost no scope to compensate for such adverse conditions. Although at one point we managed to achieve a speed of 1.7 knots, the average speed was considerably lower, in the order of 0.5 knots (Fig. 6). Once it had become apparent that El Niño had caused us to miss the tail end of the northwest monsoon, and that it would take far in excess of 20 days to reach Australia, captain Bob Hobman decided to turn back to the base camp late on 8 March, about 25 km off the coast of Roti. The raft was beached at Oeseli at high tide, for inspection, destructive testing, and ultimate dismantling. Various components were closely examined to determine how they had performed, and in particular to establish why the craft had been so low in the water. Analytical work included the destructive sectioning of a whole pontoon by chainsaw, to remove a 30-cm cross-section. This led to the detection of several defective material components. The performance of different types of bamboo was given particular attention, as were the extent and effects of bamboo borer infestation. This work led directly to the design of *Nale Tasih 2*, and once complete, the first raft was entirely dismantled. All reusable materials were salvaged. *Nale Tasih 1* had served its purpose and outlived its usefulness.

Fig. 6. The *Nale Tasih 1* sailing 15 miles south off Roti.

The design of *Nale Tasih 1* had been based on expert advice from marine engineers and designers, whereas that of *Nale Tasih 2* evolved from the traditional knowledge of Indonesian boat builders and from the experience gained with the first vessel. The second raft was significantly different, much simpler and lighter (Fig. 7). It weighed only about 2.8 t, exclusive of equipment and supplies, although it was not much shorter at 18 m effective length. The materials used in the construction of *Nale Tasih 2* were largely similar to those in the preceding raft, but most structurally crucial ropes were replaced with full *rattan* forest vines. *Pipa lontar* was limited to stress-free bindings, and of 22 guy ropes, only three were of *gemuti*. The entire structure depended heavily on the performance of eight naturally curved thwart timbers, which supported the raft body, 87 bamboo stalks arranged in three layers. At both sides, another eight stalks were tied under the ends of the thwart timbers, to help prevent capsizing, but this feature was found to be quite unnecessary. Similarly, six lee boards, arranged along both sides of the large cabin and intended to assist in steering, were found to be of limited effect, and the single steering oar proved most effective at a reasonable speed. Windsail area was increased by a 24 m^2 rectangular sail of hand-woven palm fibre, supported by an A-frame mast of 6.4 m height, made from reinforced bamboo.

Apart from the curved cross-section, the raft was about as rudimentary as possible, but this feature permitted the deck to be raised well above the waterline, and it had the added benefit of offering the waves approaching from the sides a smoothly curved surface instead of an easily submerged straight edge. This feature was found to be highly effective in high waves and strong winds. The raft carried a good supply of repair materials, including spare sails and steering oar, *rattan* vines and 65 stone tools. Water containers, food, equipment and utensils were similar to those on *Nale Tasih 1*, with some minor changes.

The *Nale Tasih 2* was built by a team of eight indigenous boat builders in three months near Kupang, Timor. On the morning of 17 December 1998 it left Kupang harbour with a crew of five men. Six days later it crossed the margin of the Sahul continental shelf, which is where the Australian coast was at the time the continent was first settled. It continued its journey to Australia, and experienced very rough conditions with waves of 4–5 m and frequent rain storms. During this time the vessel was tested to its very limits, some parts broke and the crew had to effect repairs under sometimes extreme conditions. These experiences were the scientifically most important of the experiment, as they taught us many important lessons about the design of Pleistocene vessels (Bednarik & Kuckenburg 1999).

Throughout the journey, fish were harpooned and they provided the principal food supply for the crew. The raft travelled without an escort vessel, the crew relying entirely on their own Stone Age resources. For instance, fish were gutted and filleted with stone tools (Fig. 8), repairs were carried out with other stone implements (Fig. 9). On 29 December, three hours before the *Nale Tasih 2* was to reach the south coast of Melville Island, north of Darwin, the Australian emergency service decided to withhold permission to land on the crocodile-occupied coast, and as a safety precaution directed the crew to board a ship, the *Pacific Spear*. The *Nale Tasih 2* was recovered after the storm, three days later, and towed to Darwin, fumigated by quarantine officers, and prepared for public exhibition.

SOME IMPLICATIONS

The remaining raft experiments of the continuing research program of the expeditions will be conducted under similar rigorous guidelines and controlled conditions, but the designs and technical circumstances will be varied systematically. For example, the crossings of Lombok Strait (Bali to Lombok) were conducted using Lower Palaeolithic artefact types, those of the Timor Sea with Middle Palaeolithic replicative tools and equipment. In one or two cases, two rafts are expected to travel together, each designed differently. These experiments will not necessarily be continued until crossing attempts succeed, but preferably until adequate quantitative and qualitative data have been acquired to formulate informed models of how the initial sea journeys may have been accomplished.

However, some preliminary implications of this ongoing research have already become apparent, and they are the principal topic of the present paper. First

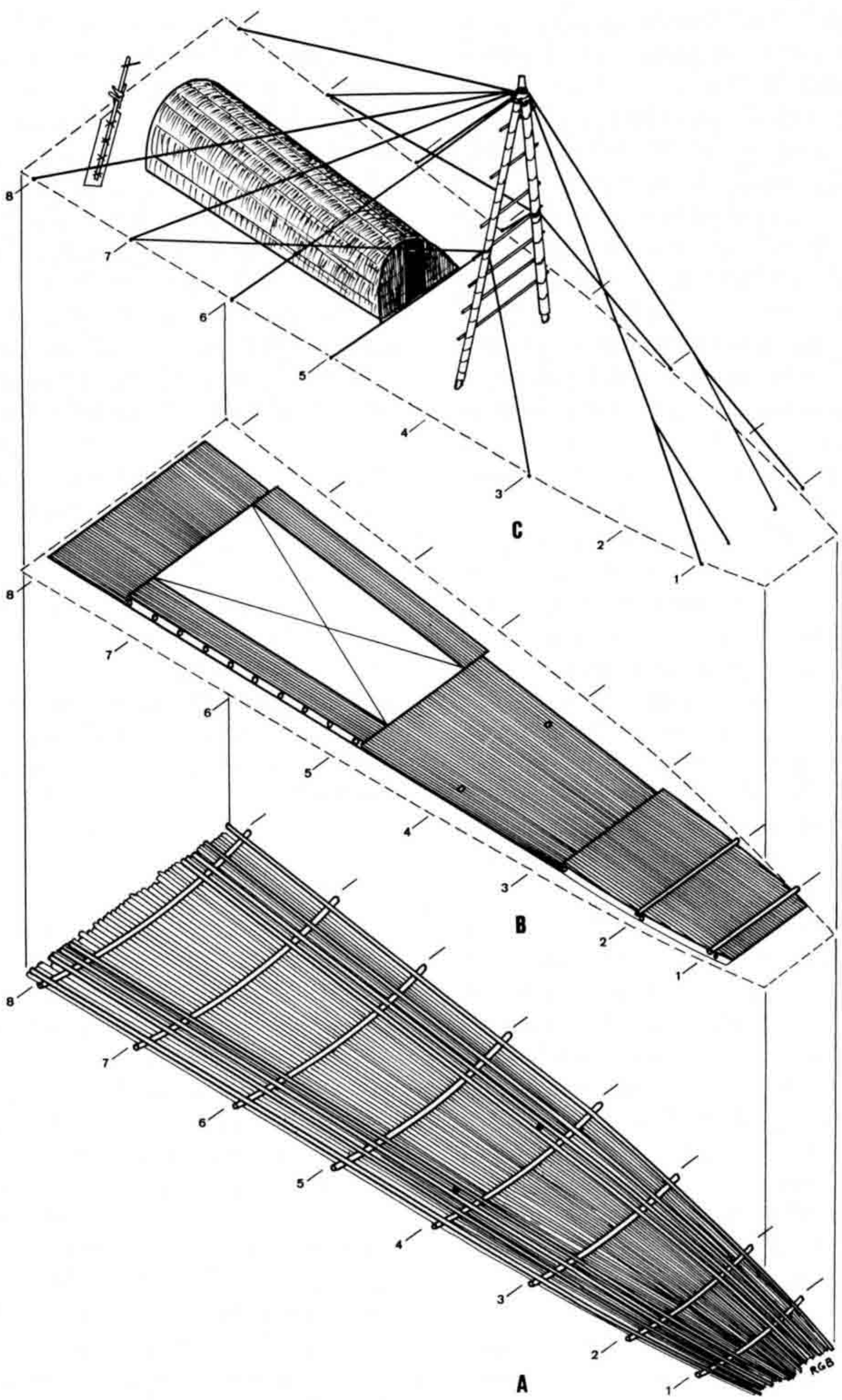

Fig. 7. Exploded view of the *Nale Tasih 2*. A=raft structure, B=deck, C=superstructures.

Fig. 8. Filleting of a 1.4-m-long dorado with stone knives on the *Nale Tasih 2*. Note the sedimentary silica flake in the foreground.

Fig. 9. Emergency repairs to the rattan vine rigging of the *Nale Tasih 2*, using stone implements. Traditional boat builder Emmanuel F. Littik (left) and captain Bob Hobman, about 300 km from Darwin.

and foremost, the *Nale Tasih 1* experience has shown with forceful clarity one fundamental truism that should have been apparent all along. A modern expedition of highly experienced and motivated mariners has failed to design and build a primitive raft, and to sail it to Australia. The team was simply unable to match the understanding of materials inherent in Pleistocene people, and their technical expertise in extracting the maximal performance from these materials. Our comparative competence in survival strategies was not even put to the test in this instance, but we can be certain that it would have fallen considerably short of that possessed by the ancestors of the Aboriginal people of Australia. We know that seafarers of Middle Palaeolithic technologies managed to populate dozens of islands, criss-crossing the seas near Australasia with apparent ease and confidence. Their technology, social organization, cognitive abilities and long-term forward planning capacities must have been significantly more advanced than even the boldest archaeological commentators have suggested so far. Maritime feats such as the crossing to Australia or to Buka Island by ultimately successful founding populations were only possible through thoroughly planned, highly focused efforts by social groups. They could never have been achieved without the support of dozens, indeed hundreds, of specific skills in procuring, transporting, processing, curating, fashioning and assembling numerous materials for one singular, totally abstract goal: to reach a still invisible shore, at immense cost in labour and hardship, and with a perseverance to be maintained over periods of many months.

Only a few decades ago the initial landfall in Australia, then still thought to have occurred during the Holocene (although non-archaeologists had long recognised the Pleistocene presence of humans in Australia; e.g. the geologist Basedow [1914]), was considered to have been the result of accidental drift, of individuals having been washed out to sea helplessly, perhaps clinging to some log or floating vegetation. The absurdity of this desperate scenario was symptomatic of a neocolonialist, Eurocentric attitude to alien societies, a form of epistemology that still determines attitudes to, and interpretations of, archaic *Homo sapiens* populations. Concepts of relative primitiveness dictate our Darwinist thinking, as if Pleistocene hominids had been simple organisms exercising no control whatsoever over their individual destinies. Such a metaphysical framework is deeply rooted in the universal theory of orthodox archaeology, an inductive form of uniformitarianism (Tangri 1989; Cameron 1991), moderated by intuitive ethnographic analogy (Huchet 1991). Uniformitarianism, however, may be a superb tool in understanding the processes of purely 'natural' systems, such as they exist in geology or astronomy, but it may be less appropriate in forming an understanding of what is often described as the 'archaeological record'. In particular, Pleistocene cultural systems should be considered inaccessible to uniformitarianist interpretation. To illustrate with an example: selective breeding through cultural factors has never seriously been considered as a determinant in hominid evolution, and whilst there may be no evidence in its favour, it needs to be considered as a realistic possibility. We have in fact assumed, without justification, that uniformitarianism is a valid universal theory for this discipline, and yet when it does not suit us we refuse to apply it. After all, we know very well that historical human societies engage in culturally determined selective reproduction on a scale that could over periods of tens of millennia produce variations within a species comparable to those of *Canis familiaris*, but it never seems to enter our uniformitarianist minds that the physical variations among Pleistocene hominids are significantly smaller than those among dogs. So before we accept the pronouncements of palaeoanthropologists about the detailed processes of Pleistocene hominid evolution we ought to demand of them to demonstrate satisfactorily that none of the physical differences *they* perceive had anything to do with the influence of cultural or social patterns of breeding (e.g., 'beautiful people' tending to pair with others so endowed, whereby any perception of beauty is always culturally determined).

Similarly, the ideas archaeologists have occasionally expressed about Pleistocene seafaring were generally determined by uniformitarian minimalist reasoning of one form or another. For instance, the thought that sails or some method of steering might have been used in the Pleistocene is hardly acceptable to such a mode of thought, and yet we know that the Middle Palaeolithic seafarers whose descendants populated Australia had inherited a maritime technology acquired cumulatively over hundreds of millennia. The effects of wind resistance are readily noticed on small watercraft, even a person standing up can increase speed. Holding up a palm leaf, as can be observed in the Indonesian islands still today, adds further momentum, and the technological sophistication of other facets of Lower Palaeolithic culture (Bednarik 1995a, 1997a) renders it most unlikely that this observation was not utilized, leading to the realization that so greater the windsail area, so greater its propelling effect. More importantly, without at least some steering ability these sea crossings were impossible, as demonstrated by experiment, and steering is almost entirely dependent upon some propelling force. Cordage, in some form or other, was certainly used by Lower Palaeolithic hominids (Bednarik 1997a), as were knots (Warner & Bednarik 1996), and cordage was in any case necessary for constructing any type of raft. The manufacture of wooden paddles, too, would have been well within the capabilities of Middle Pleistocene hominids (Belitzky *et al.* 1991; Bednarik 1997b).

During the period from 800 ka BP to 60 ka BP, hominids developed the ability to create personal ornamentation, such as beads and pendants, they began to create rock art and other forms of palaeoart, they developed social structures and began to hunt the largest land animals of their time, they developed a conscious appreciation of the self, and most importantly, they created constructs of reality (for detailed data and discussions, see Bednarik 1986b, 1990, 1992, 1993b, 1994b, 1995a, 1997a). In comparison to these momentous changes in hominid abilities – by far the most important in the history of our genus – the corresponding development in navigation skills seems to have been rather incremental and unremarkable, otherwise it should not have taken three quarters of a million years to manage the crossing of the Timor Sea. The basic preconditions for it were already established by the first crossing of Wallace's Barrier. The most momentous development in maritime history probably took place at Lombok Strait, and it could easily be seen as the most significant step in the evolution of human technology. It appears that this is where humans, for the first time, entrusted their lives to a contraption harnessing the energies of nature – the moment in human history when man first became fully dependent on his own technological creation. From here it was only a small step to Neil Armstrong's 'giant leap for mankind'.

This may be an important realisation from the information presented above. However, in the sense of the potential effect on our understanding of the nature of archaeological evidence, this information can lead us to much more fundamental issues.

THE EFFECTS OF TAPHONOMIC LOGIC

Known material evidence of seafaring, we have seen, does not extend beyond the Holocene. The phenomenon category's *taphonomic threshold* (Bednarik 1994a) is at 8000 to 10 000 years. Indirect evidence extends to 100 times as long back, hence the *taphonomic lag time* amounts to 99 percent of the phenomenon category's historical duration. In the case of seafaring we do have indirect sources of knowledge, which is not the case in most other phenomenon categories of archaeology. Taphonomic logic decrees that the lag time can never be 100 percent, nor can it be 0 percent, it must be between these two extremes (even for material evidence consisting of gold or of water; even a snowman built by Neanderthal children can theoretically survive, although the probability of this may be infinitesimal small). Stone tools, for instance, have a relatively short lag time, but it would be quite wrong to assume that they are entirely inert or indestructible; flint and other silica rocks can disintegrate fully under natural chemical conditions within some tens of millennia (Bednarik 1980). However, the vast majority of all remains of phenomenon categories thought to represent human history must be expected to have taphonomic lag times well in excess of 90 percent. They may be of wood, bark, leaves, resin, fibre, sinew, skin and so forth, materials whose taphonomic lag times would match or approach that known from seafaring. This means, in simple terms, that we ought to expect that such materials were in use between 10 and 100 times as long as their taphonomic thresholds imply. The taphonomic threshold is not usually the time when a find category first *appears* on the 'archaeological record', but the time when it first *appears frequently*. The reason for this is that probability of survival can never be nil, hence one has to expect isolated finds from a lag period. What is most important to understand, if we are to comprehend the meaning of archaeological data of the Pleistocene, is that the spatial and chronological occurrence of finds from their lag period is almost irrelevant to the explanation of the phenomenon the evidence is thought to relate to, and that their quantity is totally irrelevant in that context. To appreciate the reason for this, one needs to consider the reason for the behaviour, in Figure 10, of curve β relative to α (Bednarik 1992, 1994a *et passim*). For instance, the number of hominids found in east Africa vs their number found in India is completely irrelevant to any demographic considerations, because both samples are derived from the taphonomic lag period of the phenomenon category in question. The numbers are entirely determined by factors that are irrelevant to questions of hominid distribution, movement, diffusion, etc., they are determined by factors of taphonomy. All Pliocene and Pleistocene hominid remains of the world are preservational flukes, and they occur only in most exceptional preservation conditions. The world map of hominid finds does not reflect anything other than the distribution of places where the greatest probability of preservation (high pH sediments, sequences with rapidly laid down volcanic or calcareous facies, etc.) coincided with the actual presence of hominids at preservationally crucial times. Therefore the use of statistical data of the frequency of such finds in ideas about past population densities, migrations and so forth must be entirely misleading.

Much the same applies to nearly all other material remains in Pleistocene archaeology, and to the interpretations invented for their variables of occurrence, distribution and statistics. Moreover, the degree of distortion is obviously a function of time: so older the material, so greater the systematic distortion, and so greater the potential for archaeological misinterpretation through failing to consider the systematic effects of taphonomy (Bednarik 1994a) and other metamorphological factors (Bednarik 1995e). The misinterpretation of the 'archaeological record' (whatever this term is intended to mean) of the Pleistocene period has led to such a number of absurd interpretations and models that Pleistocene archaeology now has a significant problem of credibility. This is attributable to several factors:

1. *The discipline's susceptibility to fads.* Archaeological fads are the result of unfalsifiable, but forcefully proclaimed hypotheses, sometimes promoted by charismatic personalities whose knowledge of the subject matter was limited at the time they wrote their major works, sometimes coming from tentative models of other disciplines, such as art history or genetics. These fads are often attuned to contemporary society's ideological priorities. An example is the African Eve hypothesis, which is based entirely on an unlikely assumption (that a small human population became unable

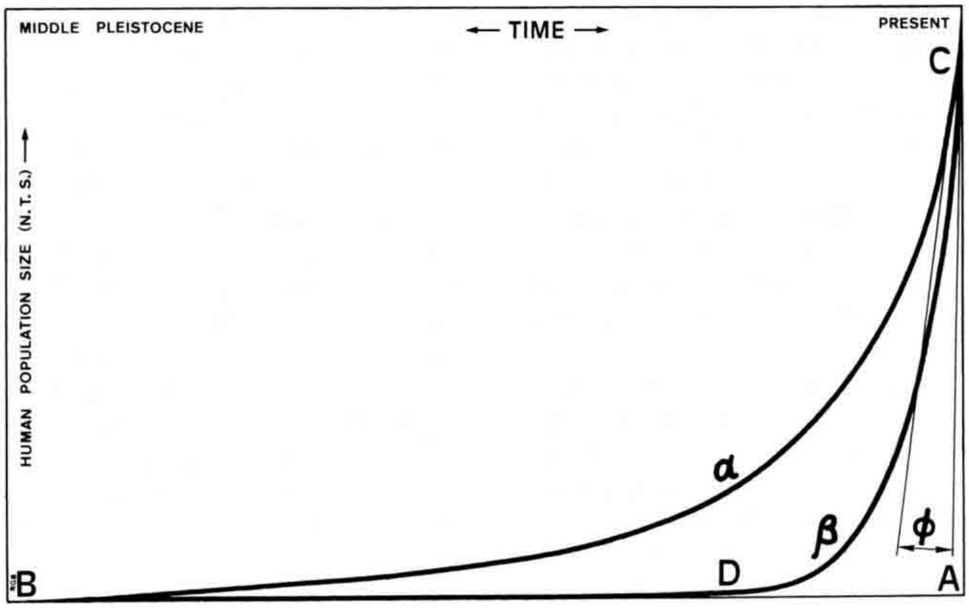

Fig. 10. Graphical depiction of the principle of taphonomic logic, showing the predicted survival characteristics of a cumulatively increasing corpus of material evidence of a specific category: A=present time, B=historical commencement of the activity thought to result in the find category in question, D=taphonomic threshold, which archaeologists often falsely perceive as the historical commencement of the activity resulting in the occurrence of the find category, α=produced instances of find category, β=surviving instances of find category as determined by taphonomic factors. Consequently the area below α represents the total number of find category produced, the area below β the total number of surviving specimens. I posit that it is entirely impossible to understand the role of archaeological forms of evidence without understanding why curve β behaves relative to α as depicted in this graph. This is not a theory presented for testing; it is an irrefutable axiom of logic, and it is the role of archaeology to present propositions for testing within this framework of logic.

to interbreed with others) and on genetically controversial ideas and data (e.g., Stoneking *et al.* 1986; Cann *et al.* 1987; Stoneking & Cann 1989; Hammer 1995), and yet it was so widely accepted, particularly in Anglo-American palaeoanthropology, that it became world archaeology's standard model of Pleistocene hominid evolution. That its ideology of competitiveness is in tune with the economic rationalism of Western society of the 1990s is no coincidence, as Kuckenburg (1997) has so eloquently demonstrated.

2. *The discipline's treatment of outside dissenters.* All major corrections and finds in the field of hominid evolution were made by non-archaeologists, and they were almost universally rejected by the shamans of archaeology. The outsiders included the individuals who discovered Palaeolithic stone tools, Palaeolithic rock art, Neanderthal man, *Homo erectus* and Australopithecus, and their experiences (which included driving them into a premature death, driving them out of archaeology, or prompting them to withhold crucial specimens from specialists for 30 years) are similar to those who offered methodological or theoretical improvements to archaeology. In contrast to scientific disciplines (e.g. astronomy or palaeontology), archaeology rejects the contributions of 'amateurs', often indignantly, yet it is so dominated by such powerful dogmas that correction of fundamental issues seems impossible from within the professional discipline. Verhoeven's work, for instance, was almost ignored for 40 years, partly because he lacked formal qualifications in archaeology, and archaeologists maintained as recently as 1996 that his claims needed to be checked by 'qualified archaeologists'. Yet they had been checked by several scholars (Breuil, Koenigswald, Maringer, Sondaar) who were clearly senior to the people who made these demands (without doing anything for 40 years to meet them).

3. *Ignorance about existing knowledge in archaeology.* This is a major component of metamorphology (Bednarik 1995e), and it is readily quantifiable. To continue with

the example of Verhoeven's claims: until 1995, all publications about the early evidence from Flores and Timor, both archaeological and palaeontological, had appeared in German, Dutch and French journals, in nearly all cases written in German. No English-speaking commentator had understood them, and on the few occasions these data were briefly mentioned in English-language works they were misquoted or mistranslated.

4. *The discipline's neglect of taphonomic logic.* Nearly all types of find categories from the Pleistocene are from the lag times of their respective categories, and the tendency of archaeology to treat such finds as if they were random samples of culture or technology is the greatest single methodological error of Pleistocene archaeology. From the Lower and Middle Pleistocene, even categories such as bone or ivory artefacts predate their taphonomic thresholds, hence interpretations of their number or even their 'absence' are quite meaningless. Some authors have pointed out the scarcity of certain types of finds, such as those indicating symboling capacities (e.g. Chase & Dibble 1987, 1992), when in fact the frequencies *of all find types* of the early periods are entirely a function of the cumulative reduction characteristics of a cumulative record. Others have tried to explain away the very early occurrence of finds that were perceived to be too far "ahead of their times" (Vishnyatsky 1994), when in fact these early finds are the most valuable indication of the early development of specific hominid capabilities. This is a particularly specious circular argument, because in order to confirm the perceived cultural pattern, we are asked to systematically ignore the most decisive contrary evidence. While this kind of accommodative thought admits the existence of 'Upper Palaeolithic' characteristics in the Lower Palaeolithic, it quite deliberately explains them away rather than admitting that the cultural pigeonholes themselves and the Darwinist view of culture may need to be reassessed: it claims "that archaeological materials cannot serve for the direct inferences about intellectual and other capabilities of ancient people" (Vishnyatsky 1994:139). In this intellectually corrupt archaeology, the dogma has precedence over the evidence and has become a belief system.

In effect what is proposed in this belief system, in order to save its dogma, is that a particularly gifted individual 'invented' symboling ability and manufactured, for instance, ostrich eggshell beads for his own enjoyment, in a complete cultural and technological vacuum and hundreds of millennia before symboling became communal. Yet symboling can only exist communally, its very function is to communicate, and only repeated and 'structured' use can confer meaning on symbolic entities (Bednarik 1997a). Thus every correctly identified evidence of cultural sophistication in the Pleistocene indicates the *minimum* capabilities of the population in question, and not a "running ahead of time". Most importantly, the extreme paucity of such early finds is not just explained by taphonomic logic, it is *demanded* by it – and in contrast to the intuitive interpretations of orthodox archaeology, taphonomic logic is a valid system of testing the scientific relevance and veracity of hypotheses. If archaeology continued to pervert its findings to uphold a dogma, a pre-conceived blueprint of the past, it should cease to have any scientific relevance or credibility.

SUMMARY

This paper includes no summary in the traditional sense of the term. The discipline can either continue into the new century in the same way it has floundered through the old, unaware of the currents determining its haphazard progress (Bednarik 1994c), the historic fads and follies, and the faulty epistemology that remains its hallmark; or it can accept that a scientific revolution (cf. Kuhn 1962) is overdue. I have offered a universal theory, based on taphonomic logic and similar reasoning, to replace the default theory of traditional archaeology, intuitive uniformitarianism. In this paper I have attempted to show that mainstream archaeology has fundamentally misunderstood the evidence the Pleistocene has provided, by reading it as a random sample. There is absolutely nothing random about this sample, it is systematically skewed, and massively so, as is its recovery, as is its interpretation, as is even its dissemination. Not only is what we claim to know about this topic mostly false, it is much more fragmentary than archaeology perceives it to be. Understanding the immensity of the time spans we are dealing with in Pleistocene archaeology may help to come to terms with scholarly humility in this discipline, and to appreciate the futility of our search for truth about the past. To understand, to *really understand*, what it would have been like to venture across the Timor Sea on a primitive raft to reach a new continent one may have known about only from cloud formations, forest fire smoke and migratory animals is entirely impossible unless one tries it. Only then can one appreciate the stupendous enormity of such an incredible quest. Only by practical experiment can one even begin to appreciate the myriad of skills and forms of knowledge that had to be harnessed for such an apparently simple project as the building and sailing of a bamboo raft. And only by practical experiment is it possible to experience the diminutiveness of a Pleistocene raft at sea, and to appreciate the brilliant audacity of convincing the members of one's clan to partake in such a desperate mission.

The essentially Middle Palaeolithic people who sailed the seas near Australia between 60 ka and 30 ka ago were not much different from us, in their cognitive, technological and linguistic capabilities. Their constructs of reality may have differed significantly from contemporary ones, but since our own are still merely conceptual artefacts we are in no position to judge the merits of theirs. *Homo erectus*, the greatest colonizer among the mammals of this planet, began this seafaring tradition perhaps a million years ago. It should not need to be demonstrated that he, too, had language at that stage – that should be self-evident. He had earlier successfully occupied a great variety of environmental niches in many parts of the Old World, which we think no hominoid managed to do. This in itself suggests the acquisition of some unique new tool, which may well have been a proliferation of cultural capabilities, including skilled communication. The late Pliocene human upper incisor and the two stone tools from Longgupo Cave (Huang & Fang 1991; Huang *et al.* 1995; Wood & Xu 1991; Wood & Turner 1995; Wu & Poirier 1995; Ciochon 1995), found with a mandibular fragment first described as *Homo ergaster*, but perhaps of a pongid such as *Lufengpithecus* (Bednarik 1997b:24), may well be the oldest finds of *H. erectus* currently known, at least as old as any in Africa. The dice are not yet cast on the course of early human evolution, and any confidence in a number of glib major syntheses in recent decades would be misplaced even before taphonomic logic is applied to them. But the application of such an epistemological framework instantly converts a great deal of the received knowledge about human evolution, particularly cognitive and technological evolution, into idle rhetoric.

Pleistocene archaeology must adopt taphonomic logic and general metamorphology as its universal theory, and it must enlist replicative experimentation at every possible opportunity. Without meeting these simple requirements it has little of value to contribute to the knowledge of humanity.

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