Maritime navigation in the Lower and Middle Palaeolithic

La navigation maritime au Paléolithique inférieur et moyen

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Abstract — The evidence for Pleistocene maritime colonisations in the Mediterranean and in eastern Asia is reviewed. On present indications, seafaring may have begun in Indonesia about a million years ago, leading to the hominid settlement of several islands during the late part of the Early Pleistocene. This development is being studied by archaeological and replicative means, the latter involving experimentation with sea-going rafts and various technological factors. (© Académie des sciences / Elsevier, Paris.)

navigation / maritime technology / replicative archaeology / Lower Palaeolithic / Indonesia

Résumé — Les données concernant les colonisations par voie de mer durant le Pleistocène en Méditerranée et en Asie orientale sont recensées. D'après les documents actuellement connus, les traversées maritimes ont pu commencer en Indonésie il y a un million d'années environ. L'étude d'un tel événement est abordée à la fois par l'archéologie et par l'expérimentation. Cette dernière inclut l'usage de radeaux adaptés à la haute mer et fait appel à des facteurs technologiques variés. (© Académie des sciences / Elsevier, Paris.)

navigation / technologie navale / archéologie expérimentale / Paléolithique inférieur / Indonésie

1. Introduction

One of the most significant finds in the history of Pleistocene archaeology is the discovery that hominids of 800 000 years ago managed to cross the sea to colonise a number of Indonesian islands. The islands east of Bali (Wallacea) have never been connected to either the Asian or the Australian plate, but they were found to have been occupied by *Homo erectus* as well as by several endemic species of Stegodontidae at the end of the Early Pleistocene. The seafaring capability of this hominid, first proposed in this journal (Sondaar et al., 1994), effectively refutes the widely accepted hypothesis of a very recent origin of language and 'modern human behaviour' (Bednarik, 1997a).

The initial evidence for the marine navigation capability of *Homo erectus* is from the Soa Basin of central Flores. It was found by Theodor Verhoeven in the 1950s and 1960s (Verhoeven, 1958, 1968; Maringer and Verhoeven, 1970), who believed that his discovery disproved the Wallace Line, the biogeographical filter separating the Asian and Australian biotopes. Sondaar et al., (1994) provided a set of nineteen palaeomagnetic determinations from two of the Soa Basin sites, demonstrating the presence of hominids at the end of the Lower Pleistocene, and recognised that these must have crossed several sea barriers to reach Flores. More recently, the age estimates were broadly confirmed by fission track dating of zircons from sediments above and below the fossiliferous layer of Mata-Menge, one of the Flores sites (Morwood et al., 1998). Continuing work at more than ten sites in the Soa Basin of central Flores suggests that hominids arrived there 850 000 to 800 000 years ago (Bednarik and Kuckenburg, 1999).

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While we do know that these sea journeys occurred, and we know approximately when, we do not know how they were accomplished. This paper summarises not only the relevant evidence, it specifically examines how this question is being addressed. A number of rafts, each designed differently, is constructed with Lower Palaeolithic stone tool replicas, and it will be attempted to sail such vessels from Bali to Lombok. The scientific data collected from this project are to form the basis of a multiple scenario study that should yield adequate information to determine how the first sea crossings were most likely achieved (Bednarik, 1997b).

The project, however, has a second purpose as well. We also know that, after many of the Indonesian deep-water islands were colonised, and the maritime technology had been developed for three quarters of a million years, much more recent humans managed to cross from Timor or Roti to Australia. This is thought to have taken place around 60 000 years ago. In contrast to all earlier sea crossings, this time the target land remained out of sight for most of the journey.

Replicative nautical experiments are being undertaken here too, but this time the vessels are constructed with Middle Palaeolithic stone tool replicas. Every aspect of the experimental rafts must pass rigorous scientific authentication, in that all materials and technology used must presumably have been available 60 000 years ago.

2. Pleistocene seafaring

The first Indonesian crossings of several sea barriers involved the use of watercraft. This was the first time in human history that our ancestors entrusted their destiny to a contraption designed to harness the energies of nature: wind, waves, currents and buoyancy. All human development followed on from that first technological triumph, it set the course of the human ascent up to the present day. In this sense, the Indonesian evidence marks the beginning of the technological and cognitive processes that have determined human development ever since. These processes created the cultural systems that effectively 'domesticated' natural systems. The project described here seeks to establish the technological context of this crucial advancement.

There are no known depictions of watercraft in Pleistocene art, and no physical remains suggestive of navigation older than 10 500 years have ever been found (Bednarik, 1997b). Nevertheless, indirect evidence of Pleistocene seafaring is available from two regions, the Mediterranean and eastern Asia. The occurrence of obsidian from the island Melos in Frachthi Cave, on the Greek mainland, indicates wide-ranging seafaring in the eastern Mediterranean by about 11 000 BP (Perlès, 1979). Much earlier are the human remains from Crete, combining Neanderthaloid and modern features, and apparently about 50 000 years old (Facchini and Giusberti, 1992). Crete was not connected to the mainland during the Pleistocene, nor was another Greek island, Kefallinía, where Mousterian tools have been found (Kavvadias, 1984). But the earliest European evidence of island colonisation comes from Sardinia, which was at times connected to Corsica, but not to the mainland. At Sa Coa de sa Multa near Perfuga, Clactonian-like stone tools have been excavated in Middle Pleistocene sediment, suggesting that even Lower Palaeolithic hominids managed to reach Mediterranean islands (Bini et al., 1993).

This raises the issue of having to account for the similarities between Acheulian artefact traditions in northwestern Africa and on the Iberian Peninsula, which Freeman (1975) already attributes to an ability of Acheulian hunters to cross the Strait of Gibraltar. Although 14 km today, its width is thought to have been as little as 5–7 km during times of lowest Pleistocene sea levels. The proposition of a hominid crossing at Gibraltar may remain tenuous, but the late arrival of handaxe traditions in southeastern Europe is conspicuous. Moreover, the evolutionary trajectories of the Maghreb and Iberian handaxe industries seem identical. This issue needs to be re-examined in the light of the evidence from Indonesia, where maritime navigation capability evidently developed towards the end of the Lower Pleistocene.

There is evidence of Pleistocene seafaring elsewhere in eastern Asia. For instance, Japan may have been settled via a landbridge from Korea, but the presence of obsidian from the Japanese island Kozushima on the main island of Honshu some 20 000 to 30 000 years ago indicates considerable navigational ability (Anderson, 1987). The sea distance is about 87 km today. At that time, much greater distances had already been traversed by colonising mariners further south. Their cultural remains have been detected in Golo and Wetef Caves on Gebe Island (between Sulawesi and New Guinea), up to 33 000 years old, and from around the same time on some Pacific islands: in the Bismarck Archipelago (Matenkupkum and Buang Marabak on New Ireland) and Solomons (Kilu Rockshelter, Buka Island) (Allen et al., 1988; Wickler and Spriggs, 1988). The distance from New Ireland to Buka is close to 180 km. The Monte Bello islands are 120 km from the northwestern coast of Australia, and were first settled prior to 27 000 years ago (Lourandos, 1997: 119). Between 20 000 and 15 000 years ago, obsidian from New Britain was transported to New Ireland, and the cuscus, a Sahulian species, was introduced in the Moluccas at that time (Bellwood, 1996). Importantly, all Pleistocene seafarers in the general region of Australasia possessed an essentially Middle rather than Upper Palaeolithic technology.

3. Replicative experiments

Collectively, this evidence suggests that Middle Palaeolithic mariners north of Australia crossed the sea frequently, sometimes traversing distances exceeding 100 km, often without seeing the target land for most of the journey. There is evidence that they managed to cross in both directions in at least some cases. Clearly, at this stage seafaring was not only soundly established, it had become a well developed skill. During the Final Pleistocene it would have been based on the experience accumulated over at least three quarters of a million years of maritime technology.

This technology is the subject of a series of replicative experiments being undertaken in Indonesia. In the absence of any direct archaeological evidence about Pleistocene seafaring, replication is considered to be the best method of creating a realistic empirical framework within which to test multiple scenarios. In such a procedure, the confidence that the most probable scenario can be identified is a function of the number of variables or determinants accounted for satisfactorily. This involves a large number of experiments under strictly controlled conditions, dealing not only with maritime design, but also with numerous other questions: the origin of the stone tool material, the method of carrying water on board, the logistics of harvesting the required quantities of bamboo with the appropriate stone tools, the question of food sources and their exploitation with Palaeolithic technology (e.g. means of fishing at sea (*figure 1*) cooking at sea (*figure 2*)), and many other issues.

Figure 1. Replica of a bone harpoon, original found at Ngandong, Java. This specimen was made with Middle Palaeolithic stone tool replicas, and set in a bamboo shaft with tree resin, beeswax and rattan vine.

Reproduction d'un harpon en os (l'original a été découvert à Ngandong, Java). Ce modèle a été confectionné en reproduisant des outils en pierre du Paléolithique moyen, puis fiché dans une tige en bambou à l'aide de résine d'arbre, de cire d'abeille et de liens en rotin.

The project was begun in 1996, and construction of full-size experimental vessels began in August 1997. The *Nale Tasih 1*, an ocean-going bamboo raft 23 m long and about 15 tonnes plus cargo, was launched in southern Roti in February 1998. The result of numerous experiments in replicative archaeology, it was built and equipped with 'Middle Palaeolithic' tools. Its design was based on five pontoons and on steering oars. The overall objective of the experiment was to establish whether the raft would be capable of travelling from Roti to Australia in a reasonable time. On 6 March 1998, the *Nale Tasih 1* sailed with a crew of eleven from Oeseli Lagoon, Roti, and after three

Figure 2. Boiling of native millet gruel in bucket made of lontar palm leaf over a fire box on board the *Nale Tasih 1*.

Cuisson, à bord du *Nale Tasih 1*, d'un gruau de mil local, dans un récipient constitué par une feuille de palmier lontar, au-dessus d'un casier pour le feu.

days of sea trials on the Timor Sea (*figure 3*) returned to be beached at Oeseli for destructive material sampling. Some aspects of the raft were judged to be unsuitable, particularly under the prevailing unfavourable conditions brought about by the El Niño effect. The entire vessel was dismantled, a pontoon sectioned with a chainsaw, and the various component materials were tested.

Figure 3. The *Nale Tasih 1* **sailing on the Timor Sea.**

Le *Nale Tasih 1* voguant sur la mer de Timor.

A smaller raft, 18 m long and of very different construction, was then built near Kupang, Timor, and sea-tested with a crew of only five men. The *Nale Tasih 2* sailed from Kupang harbour on 17 December 1998, with the purpose of reaching northern Australia in the vicinity of Darwin, making use of the northwest monsoon. It consisted of three layers of Timorese bamboo, lashed with split vine to eight curved thwart timbers. Forest vines provided the rigging, the sail was of palm fibre, drinking water was carried in two hollow mangrove logs, and the food consisted mostly of a native millet and ocean fish harpooned with replicas of Middle Palaeolithic artefacts (*figure 4*). This vessel took six days to reach the continental shelf of Australia, which represented the coast line for much of the Pleistocene.

Figure 4. Food preparation on the *Nale Tasih 2*.

Préparation d'un repas sur le *Nale Tasih 2*.

Figure 5. Emergency repairs on the *Nale Tasih 2*. The wind has broken the sail and the spare sail is rigged up.

Réparation d'urgence à bord du *Nale Tasih 2*. Le vent a cassé la voile, et on monte la voile de secours.

Subsequently it travelled in heavy seas and tropical storms for several days, during which time the design of the vessel was tested to its limits. Emergency repairs (*figure 5*) and improvements were successfully carried out with some of the 65 stone implements on board, often under extreme conditions. On the evening of 29 December, as the raft was blown towards the crocodile-occupied southern shore of Melville Island, the crew was evacuated as a precaution, having travelled nearly 1 000 km from Kupang. The *Nale Tasih 2* is now on public exhibition in Darwin and will eventually be moved to a museum.

More rudimentary rafts are being built in Bali to see how Lombok Strait may have been crossed. They are constructed with Lower Palaeolithic stone tool replicas similar to the artefacts found on Flores. In addition to this extensive replication program, these expeditions comprise detailed archaeological research in Timor, Roti and Flores. Lower Palaeolithic stone tool traditions similar to those excavated at six sites in the Soa Basin of Flores have been found in Middle Pleistocene deposits in Timor and Roti, and a large jasperite quarry at Roshi Danon in southern Roti (*figure 6*) has been mined since Lower Palaeolithic times (Bednarik, 1998). Sedimentary analyses have been conducted by the author at hominid occupation sites in Flores, Timor and Roti, providing environmental information and details about the sedimentation of the deposits containing the stone tools and *stegodon* remains found together at several sites so far. Further dating work will be undertaken, using not only fission track analysis, but also optically stimulated luminescence, argon-argon and uranium-series analysis. The latest and most important developments in this work are discoveries made in late 1998 near Atambua, West Timor. At the sites Motaoan and To'os, hominid occupation evidence was recovered in the Weaiwe Formation, a fossiliferous conglomerate stratum containing also remains of *stegodon*. This includes a retouched stone tool found together with a *stegodon* molar, and a burnt *stegodon* bone.

The evidence so far assembled warrants a number of important propositions. The presence of *Homo erectus* populations at several Indonesian deep-water islands indicates the navigational ability of that species, which probably commenced about a million years ago in the region of Java and Bali. It presents sound evidence of 'reflective' communication, most probably in the form of speech. Replicative experimentation has shown unequivocally that island colonisation by maritime navigation is impossible without numerous interdependent technological capabilities, long-term forward planning, the support of a social system, and effective communication. Such replication studies have resulted in the complete rejection of the concept that the settlement of Wallacea

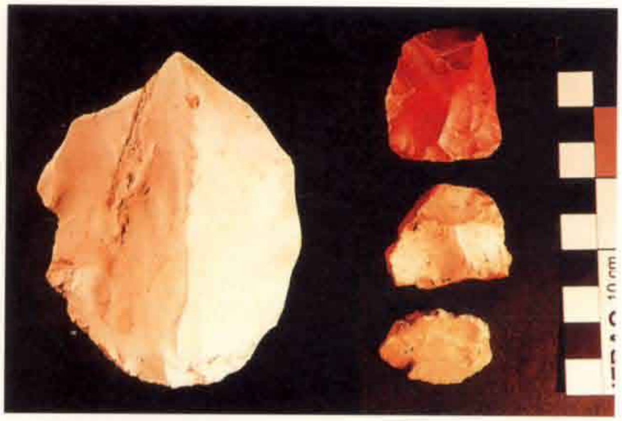

Figure 6. Stone tools made of red jasperite, but heavily patinated, from Middle Pleistocene sediment at Roshi Danon, Roti, Indonesia.

Outils en pierre confectionnés à partir de jaspe rouge, mais fortement patinés. Ils proviennent des couches du Pleistocène moyen, à Roshi Danon, Roti, Indonésie.

could have occurred unintentionally or accidentally. We can only know about sea crossings that resulted in successful colonisations capable of being visible on the very coarse and taphonomically distorted 'archaeological record'. To achieve such crossings, a sufficient number of males and females to found a new population had to survive the journey, in each and every case. This required adequate vessels to convey these people, their supplies and equipment. To suggest that such sea-going vessels were built without a deliberate plan, and that an adequate number of people was in each case swept out to sea on them against their will is not just illogical, it is symptomatic of a discipline that perceives hominids as culturally, technologically and cognitively inferior, much in the same way Europeans once treated indigenous peoples in other continents. These kinds of minimalist arguments, which permeate many aspects of Pleistocene archaeology, indicate a lack of knowledge about the practical aspects of the human past. To appreciate the circumstances in which the 'archaeological record' formed requires understanding derived from practical experimentation with the materials in question, under the conditions in question, and it involves appreciation of taphonomic processes and metamorphological biases (Bednarik, 1995).

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