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PLEISTOCENE SEAFARING IN THE MEDITERRANEAN

ABSTRACT: Archaeological evidence from many islands in the world indicates clearly that seafaring was widely practised in the Pleistocene, and may have commenced about one million years ago. The massive hiatus in the Pleistocene record that is attributable to eustatic sea level changes is briefly examined, followed by the evidence of human colonisation of various Mediterranean islands. Archaeological evidence also suggests that Acheulian hominids may have crossed the Strait of Gibraltar. A current project of replicating Pleistocene sea crossings is introduced and discussed.

KEY WORDS: Navigation – Hominids – Mediterranean – Replication

INTRODUCTION

One of the most decisive factors in Pleistocene archaeology is the simple fact that, due to the eustatic sea level oscillations, the archaeological data usually recoverable from that period are massively distorted. In nearly all cases, the data available to us from the Pleistocene refer to human groups of the inland regions. We know from ethnography (e.g. in Australia), even from contemporary demography, that more than half of human populations tend to be concentrated in coastal areas or along the lowest parts of major river valleys. As this tends to be where food resources are most concentrated and reliable there is no good reason to assume that this would have been dramatically different in earlier times. Hence it is reasonable to propose that we may have no information whatsoever about more than half the economies, technologies and life styles of the Pleistocene. We have no evidence of maritime ways of life, marine resource exploitation systems or navigation technology of that period, which has created the no doubt false impression that Pleistocene humans were inevitably hunters and foragers of the steppes, the savannas, plateaus, valleys and mountains of the inland regions.

Indeed, this massive taphonomic bias has created the false impression that the introduction of littoral and maritime ways of life was a hallmark of the Mesolithic. Almost certainly this is a result not of changed economic circumstances, but of rising sea levels that during the early Holocene approached those of today. Thus a taphonomic phenomenon was falsely interpreted as a cultural one. The fundamental fact that we have no ready access to probably more than half of all of Pleistocene hominid history has often not been considered in Pleistocene archaeology, which is likely to mean that our ideas about the humans of that time are so distorted that they should be expected to be significantly misleading.

Many Mesolithic settlements have been examined in shallow water, just off the present coast (e.g. Andersen 1985, Fischer 1988, 1995a, b, Skaarup 1983), yet we possess almost no knowledge about Pleistocene occupations of the vast regions now under the sea, but periodically exposed in the past. Similarly, we lack any hard evidence of Pleistocene seafaring. No boats, rafts, canoes, paddles, oars or other navigational artefacts have ever been recovered from Pleistocene deposits. While there is a wealth of depictions of watercraft to be found in the rock art of the Holocene, no such image has ever been

attributed to the Pleistocene, and I do not believe that any picture of a Pleistocene vessel has ever been discovered.

And yet, indirect archaeological evidence for Pleistocene seafaring is not only available from numerous sites, it indicates such capabilities extremely early, and it demonstrates beyond doubt incredible achievements of maritime colonisation tens and, indeed, hundreds of thousands of years ago. Seafaring began probably about a million years ago in the region of Java and Bali, and was certainly initiated by *Homo erectus* (Sondaar *et al.* 1994, Bednarik 1995, 1997a). Pleistocene evidence for it comes essentially from two world regions: from the east Asian to Australian region, and from the Mediterranean. It has been better explored in the first-mentioned area, where literally dozens of successful island colonisations have been demonstrated, as well as the first landfall in Australia. By comparison, very little is known about the maritime capability of Mediterranean humans of the Pleistocene. The purpose of the present paper is to examine this specific issue, to do so against the background of the better evidence available from Indonesia and Australia, and to present a project concerned with exploring Mediterranean seafaring in detail via replicative experiments.

HOLOCENE NAVIGATION EVIDENCE IN EUROPE

Material evidence, i.e. physical remains attributable to the use of watercraft, begins with very few finds from the Mesolithic, all from the coastal regions of northwestern Europe. The oldest claim made in this respect concerns a reindeer antler that has been fashioned in such a way that it resembles a boat rib of a skin boat. This tentative find comes from a German site of the Ahrensburgian, Husum in Schleswig-Holstein (Ellmers 1980), and is perhaps in the order of 10,500 years old. It was salvaged during harbour excavations in the 1950s.

More reliable are the finds of several wooden paddles, or remains tentatively identified as such. One paddle was recovered at the famous Mesolithic site of Star Carr, England (Clark 1971), another from a peat bog at Holmgaard, Denmark (McGrail 1978, 1991). The English find is about 9500 years old, and the Danish specimen might be of roughly similar age. Further finds of wooden paddles from this period have been reported from three sites in northern Germany: Duvensee, Gettorf and Friesack (Bednarik, Kuckenburg 1999).

The oldest watercraft ever found is the fairly complete dugout canoe from Pesse, Holland (Zeist 1957), which is about three metres long. It has recently been radiocarbon-dated to about 8300 years BP (Bednarik 1997b). Other boat remains have been reported from Noyen-sur-Seine, France, and Lystrup 1, Denmark (Arnold 1996). The ages of both were estimated by radiocarbon analyses: the French find is around 8000 years old, the Danish boat only 6100 years. Beginning with the mid-Holocene, finds of boats and other navigational equipment become more common, particularly with evidence from Pharaonic Egypt. For comparison in Japan, the five paddles and a possible canoe from Torihama are 6000–5500 years old, and the six paddles and partial canoe from Kamo date from about 5100 BP (Aikens, Higuchi 1982: 124, Ikawa-Smith 1986).

The quantitative distribution of these finds over time seems to form a parabolic curve, of a rapidly increasing frequency with decreasing antiquity. The traditional way of interpreting such a pattern of occurrence is that the frequency of the phenomenon, in this case navigation artefacts, is a function of the frequency of their production: the practice of navigation was introduced gradually, slowly at first, becoming more frequent with time. I completely and emphatically reject this logic of interpreting the "archaeological record", on logical as well as empirical grounds. The statistical properties of all material finds in archaeology are subject to taphonomic logic, which defines the theoretical survival profile of a cumulative population of specific archaeological evidence forms that are subjected to progressive taphonomic processes. This form of logic decrees that there must be a point in time, the *taphonomic threshold*, when the surviving population of a phenomenon "species" approaches nil (Bednarik 1994: *Figure 2*), and that this *must* be later than the historical commencement of the phenomenon in question. In fact, for most phenomenon categories, it is very significantly later. In the case of the phenomenon of seafaring, the taphonomic threshold occurs after 99 percent of the historical duration of the practice. We know that seafaring began well before 800,000 years ago (Bednarik 1995, 1997a, b, c, 1998, 1999, Bednarik, Kuckenburg 1999), yet the direct physical evidence only commences 8500 years ago, i.e. one percent of the historical duration of the practice. In the language of taphonomic logic, the taphonomic lag time is 99 percent; the age of the practice appears to be totally unrelated to the time of its first material evidence. And yet, the two are related by taphonomic logic, which can be quantified in the form of integral functions (Bednarik 1994). Without the use this form of logic, a scientific approach to the interpretation of archaeological evidence of the Pleistocene is entirely impossible, because without it such material will always be severely misinterpreted, in terms of both qualitative and quantitative implications.

In short, the pattern of occurrence of the first physical evidence for navigational practices is in no way related to the frequency, or even existence, of the practices themselves. It is simply an expression of taphonomic logic applied to these particular forms of evidence. To learn about Pleistocene seafaring, orthodox archaeological methods cannot be expected to be of much help. And this, too, was fully predictable by taphonomic logic.

PLEISTOCENE HUMAN OCCUPATION OF MEDITERRANEAN ISLANDS

The "hard" evidence for Ice Age seafaring consists of occupation residues on islands that were never connected to any mainland during the Pleistocene, and could thus only be reached either by swimming or by the use of watercraft. Dozens of islands as well as the continent of Australia have provided such evidence (for comprehensive review see Bednarik 1997c). It consists of the remains of about 200 humans, most of them in Australia, seven from four islands (Santa Rosa Island off California, Okinawa, Crete and Sardinia); of occupation evidence such as stone tools; and in some cases of the presence of Pleistocene rock art. In the Mediterranean, evidence of Pleistocene colonisation comes from at least four islands: Sardinia, Crete, Kefallinía and Melos (*Figure 1*).

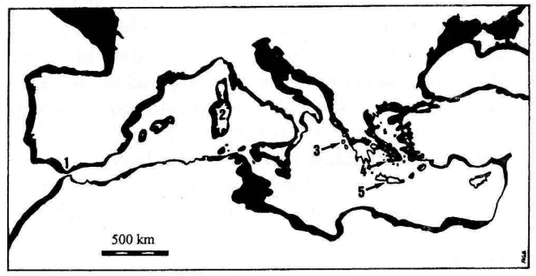

FIGURE 1. Mediterranean locations of Pleistocene sea crossings inferred from archaeological evidence: 1 – Gibraltar, 2 – Sardinia, 3 – Kefallinía, 4 – Melos, 5 – Crete. The black areas, above –120 m, were exposed during the Last Glacial Maximum (adapted from van Andel 1989).

Credible evidence of Upper Palaeolithic sea crossings in the Mediterranean is provided by the occurrence of obsidian from Melos in Franchthi Cave. This site is located on the Greek mainland, but Melos, now 100 km off-shore, could only be reached by "island hopping" via a former large Cycladic island that disappeared under the rising sea during the final Pleistocene. The evidence in Franchthi Cave is about 11,000 years old (Perlès 1979, Renfrew, Aspinall 1990), at which time the sea level had remained significantly lower than today. Nevertheless, three sea crossings were still required at that time, and since the presence of the Melos obsidian on the mainland implies that return journeys must have been made, it might be taken to indicate a well-developed maritime navigation capability, involving vessels with provision for steering. Conversely, we have a second case where Late Pleistocene seafaring is demonstrated by the presence of island-derived obsidian. It concerns finds of obsidian from Kozushima, Japan, whose presence at the Tsukimino site, Kanto plain, Honshu, necessitates sea journeys of perhaps 50 km each way by 21,000 BP (Anderson 1987). The sea transport of obsidian has also been demonstrated from New Britain to New Ireland, between 20,000 and 15,000 years ago.

The second clear-cut indication of a Pleistocene human presence on a Mediterranean island comes from Sardinia, which at times of low sea level was joined to Corsica, but not to the Italian mainland. It consists of a human phalange excavated from the Late Pleistocene deposits of Corbeddu Cave and is thought to be about 20,000 years old. The same site has also provided a series of stone tools from more recent levels, dated from 16,000 to 10,000 years BP (Sondaar *et al.* 1995). D'Errico (1994) has proposed that islands off the western Mediterranean north coast may have been visited by Upper Palaeolithic hunters seasonally to harvest seabirds, but without providing any empirical evidence supporting this proposition. The presence of a 20,000-year-old ochre mine on Thakos, Greece (Gerd Weisgerber pers. comm. 1999), is probably not relevant here, as this present island may have been joined to the mainland at that time; the strait separating it now is only 60 m deep.

However, another Greek island, Kefallinía, has provided much earlier evidence for seafaring. Stone tools of the Mousterian have been found on it, and it has never been connected to the European mainland during the Pleistocene (Kavvadias 1984, Klavs Randsborg pers. comm. 1999). The distance to be crossed in this instance is not clear, partly because no dating is available for these finds. If they relate to a low sea level, they are likely to be between 70,000 and 40,000 years old. Van Andel (1989) suggests the sea distance may have been at least 20 km, Warner and Bednarik (1996) suggest 6 km.

Crete has not been connected to either the Greek or Turkish mainland during the Pleistocene. Even at lower sea levels, a sea journey of at least 35 km was required to reach Crete via the small island of Andikíthira. The distances to be mastered were considerably greater from the Turkish shore, and much greater again from Africa. The island has yielded cranial and post-cranial remains which have been attributed to a morphologically almost modern human, a *Homo sapiens sapiens*, but one retaining clearly neanderthaloid features (Facchini, Giusberti 1992). Radiometric analyses place these remains at approximately 50,000 years BP, and if these results are correct the finds might represent the currently earliest essentially modern human remains from Europe.

But to consider the earliest evidence we presently have of seafaring in the Mediterranean we have to return to Sardinia. In addition to the Late Pleistocene finds already mentioned, the island has also provided ample evidence of human presence from the Middle Pleistocene. Estimated to be about 300,000 years old, a series of stone implements has been excavated from three different occupation horizons at the site Sa Coa de sa Multa, near Perfugas, northern Sardinia (Martini 1992, Bini *et al.* 1993, Sondaar *et al.* 1995). Discovered by Fabio Martini from Siena University, these tools resemble the Clactonian, a Lower Palaeolithic industry first identified in England. Although their dating still remains to be reliably secured, they constitute important evidence in the context of early Mediterranean seafaring.

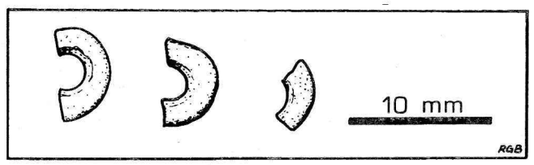

FIGURE 2. Three finely made ostrich eggshell beads from a major Acheulian occupation deposit in Libya (after Bednarik 1997d).

THE ISSUE OF THE GIBRALTAR CROSSING

Nevertheless, the Sardinian finds may not refer to the first sea crossing in this world region. The idea that Acheulians might have reached Iberia directly from Africa by crossing the Strait of Gibraltar is not new, having been presented many years ago, and discussed by various authors (e.g. Freeman 1975, Johnstone 1980: 3). It has even been suggested that there could have been a landbridge from Tunisia to Sicily (Brown 1973: 117), although that seems unlikely. While it is difficult to speculate about the effects of sea level oscillations on the widths of narrows, due to the unknown effects of tectonic adjustment (isostatic compensation), present contours would suggest a former gap in the order of 50 km here. Just west of Gibraltar, between El Hauma and Tarifa, the distance is about 14 km today, but at lowest Pleistocene sea levels it may have been in the order of only 7 to 10 km.

Nevertheless, traditionally this proposition was based on only one line of argument: the spatial and chronological distribution of "handaxe" industries in the Maghreb and on the Iberian Peninsula, and in the greater theatre of Europe; and their similar trajectory of development on both sides of the Mediterranean. Not only do these two regions appear to form a "distinct and interrelated 'cultural area' during the Lower Palaeolithic" (Freeman 1975: 662), the absence of handaxe-based technologies in initial industries of southeastern and central Europe is most conspicuous. In Europe, Acheulian types appear first in the southwestern part of the continent, and become well established in Spain, France and Britain. They are described as being practically identical to the early to middle Acheulian of northwestern Africa. These industries occur also in the Levant, but they are entirely lacking in much of Europe, most notably in the Balkans and in the east, where they appear later, if at all. The Acheulian emerges only very late in central Europe (e.g. in the late Riss in Gudenus Cave, Austria), and its distribution favours an introduction via Spain rather than from the east.

Recently this scenario has received considerable support from three types of evidence. First, the earliest known occupation sites of Europe, leaving aside the one claim from the Caucasus (Dmanisi), are all from the continent's southwest, notably from Spain (e.g. Atapuerca). Second, there is now evidence of a relatively high cultural sophistication from the Acheulian of northwestern Africa. Most especially, the three ostrich eggshell beads from the Fezzan site El Greifa E, a major Acheulian occupation deposit dated by uranium-thorium isotope analysis (Ziegert 1995). These disc beads (*Figure 2*) are not just the earliest ever found, they are of outstanding workmanship and formal perfection, and imply the existence of a complex cultural and cognitive system (Bednarik 1997d). Centrally perforated disc beads have also been reported from the Acheulian of France (Bednarik in print) and Israel (Goren-Inbar *et al.* 1991). A culture of such sophistication can reasonably be assumed to have developed navigational skills, particularly as maritime technology already existed in one other part of the world.

The third development that renders an Acheulian crossing at Gibraltar likely is the discovery that *Homo erectus* colonised several Indonesian islands: Flores, Timor and Roti have provided such evidence (Bednarik 1997c, 1998, 1999, Bednarik, Kuckenburg 1999), and there can be no doubt that various other Wallacean islands must have also been reached during Lower Palaeolithic times (Lombok, Sumbawa, Alor, possibly Sulawesi). Various types of dating and the distribution of these finds suggest that seafaring, initially probably for the purpose of fishing, began about a million years ago, most likely in the region of Java and Bali, and the first actual island colonisation was most probably that of Lombok, immediately east of Wallace's Line. Several projects are currently examining this matter in some detail (Sondaar *et al.* 1994, Bednarik 1997c, Morwood *et al.* 1999), focusing on Timor and Flores (*Figure 3*). None of these islands were ever connected to either the Asian or the Australian tectonic plate, and they could only be reached by watercraft.

In addition to the archaeological research currently conducted in Indonesia, there is also a project of exploring the seafaring capability of hominids in the area of Indonesia. The "First Mariners Project" is engaged in constructing a series of bamboo rafts with Palaeolithic stone implement replicas, equipping them with means available to Pleistocene seafarers, and sailing them across specific stretches of sea. A number of such sea trials has been conducted in 1998 and 1999, with the purpose of establishing the technological minimum requirements necessary to achieve specific crossings. In December 1998, the 18-m raft *Nale Tasih 2* (*Figure 4*) succeeded in crossing from Timor to Australia with a crew of five (Bednarik 1999, Bednarik, Kuckenburg 1999, Bednarik *et al.* 1999). This 13-day journey showed how a vessel built and equipped with Middle Palaeolithic tools could travel almost 1000 km, and under extremely rough conditions (at about the same time, six sailors perished in an Australian yacht race). The distance needed to reach Australia 60,000 or more years ago, when first landfall may have occurred (Thorne *et al.* 1999), was only about 200 km. Nevertheless, the Australian shore only came into vision on the last 20 km of the trip, due to the extreme flatness of the continental shelf.

The First Mariners Project is currently engaged in examining the minimum conditions necessary to cross

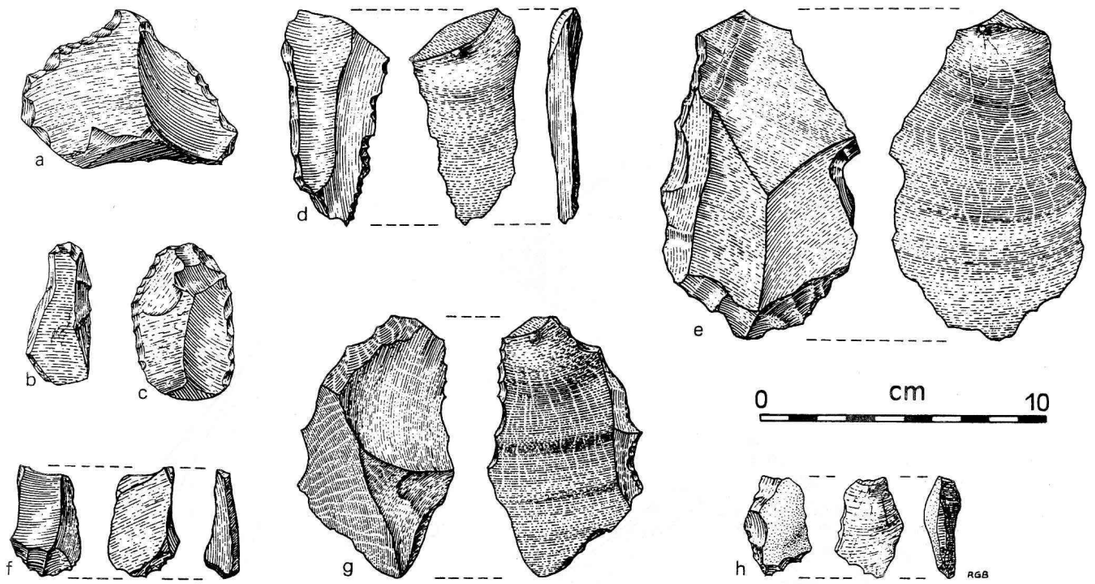

FIGURE 3. Stone artefacts of the final Early Pleistocene of Flores, believed to be in the order of 750 to 840 ka old, from Mata Menge (a-e, g) and Boa Leza (f, h).

Lombok Strait between one million and 800,000 years ago. The first attempt, with the 11–m raft *Nale Tasih 3*, failed in March 1999, the next attempt is scheduled for February 2000.

WERE THE FIRST EUROPEANS SEAFARERS?

During 2000, the question of a possible Acheulian crossing of the Strait of Gibraltar will be examined in detail. For this purpose, the First Mariners Project will re-examine the relevant archaeological evidence on both sides of the Mediterranean, to evaluate its strength independent of previous work. This will involve research into the typology and particularly the microwear of stone implements, in the light of the experience gained from the study of Lower Palaeolithic stone tools of Indonesia, and the data from the extensive replicative experiments already conducted with such tools. But other avenues will also be investigated. For instance, claims of Acheulian beads in Europe are to be examined (Bednarik in print). The Maghreb Acheulian implements will be replicated, and the question of suitable raft designs is to be considered in some detail. It would appear that there were essentially three possibilities available in Middle Pleistocene Maghreb: inflated animal skins (which were not realistically available in Flores), reed bundles, and wood. At this stage, the first two options are favoured, although the third cannot be excluded and must also be experimented with.

Ultimately, this is not a proposal seeking to reinforce a favoured point of view, but a scientific attempt to refute the proposition that Europe was settled via land, from the east. It is based on Occam's Razor, and will simply review all relevant evidence and assess the probability of competing hypotheses against the background of what we have learned about Pleistocene maritime technology in the Indonesian experiments. I am perfectly happy to accept, at the end of the investigations and all aspects having been fully considered, that the eastern route into Europe is to be favoured as the more realistic option. I do not set out to prove that Europe was first settled at Gibraltar, i.e. via the sea, as I regard that impossible to do, and as unscientific. Science works through refutation, not through assembling confirming evidence.

I merely point out that elsewhere in the world, hominids had developed seafaring capability shortly before Europe was, on current indications, entered. Therefore the possibility that the first settlement of Europe was related to humanity's attainment of maritime technology is not to be discounted. Many years ago, Freeman (1975: 733) had this to say: "Improbable though it may seem, this observation suggests that one route of expansion of Acheulian hunters from Africa to the Iberian Peninsula may have been direct, including passage of the Strait of Gibraltar". A quarter of a century ago this claim would have seemed rather bold. Since then, the practice of the "New Archaeology" to reject any indication of early human sophistication, and the spectacular rise of the "African Eve"

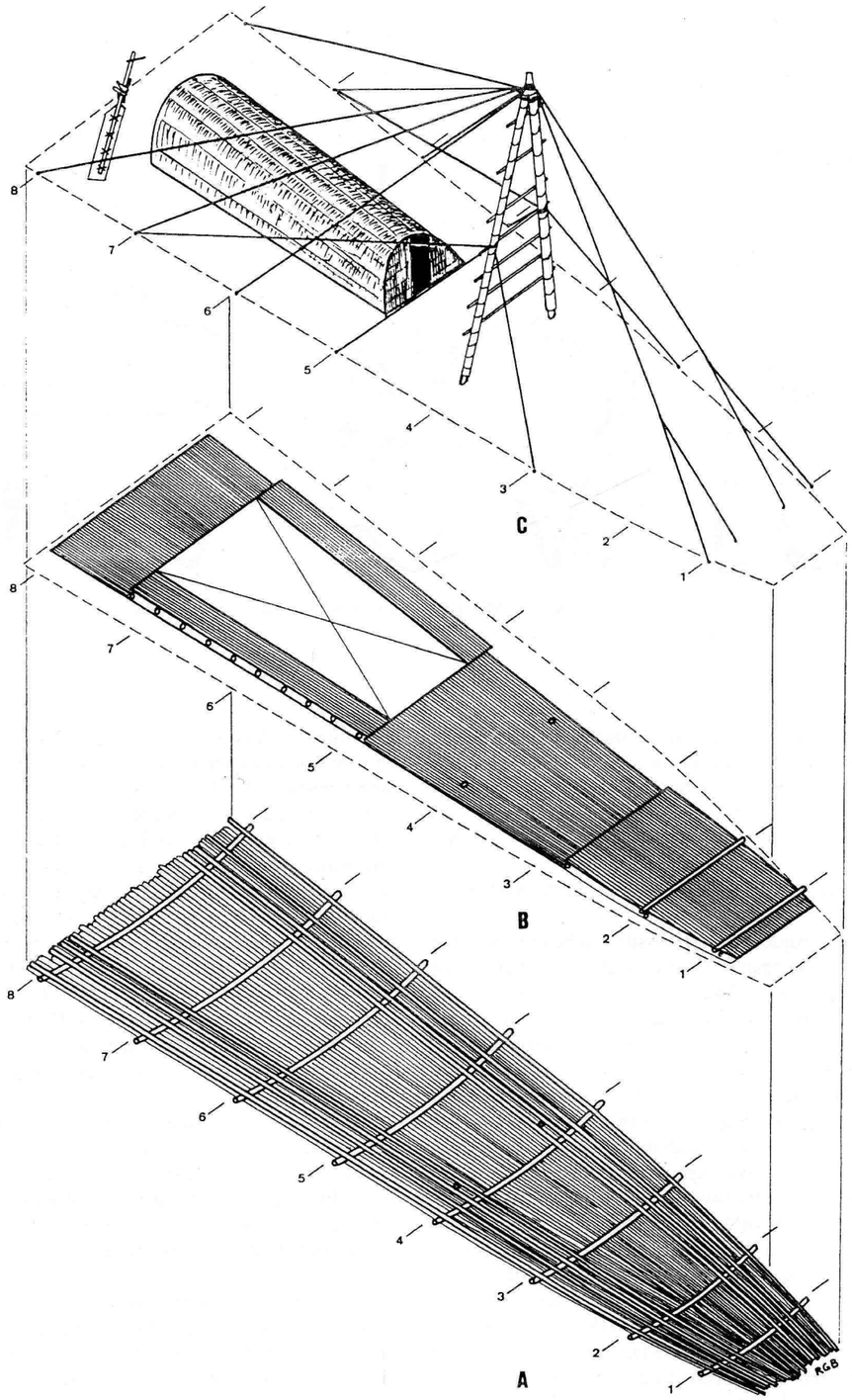

FIGURE 4. Exploded view of the *Nale Tasih 2*, the 18–m bamboo raft built with stone tools that was sailed from Timor to Australia at the end of 1998, showing arrangement of raft body (A), deck (B), and superstructures (C).

hypothesis have rendered this idea not just improbable, but quite unrealistic. The recent refutation of the "African Eve" model (Bednarik, Kuckenburg 1999), however, and the clear evidence of Lower Palaeolithic seafaring from several Indonesian islands render it entirely appropriate that this idea be re-investigated thoroughly — even if that may lead to its eventual rejection.

Part of the purpose of this project will be to establish the feasibility of crossing Gibraltar Strait on extremely primitive rafts made with Acheulian replicate tools, using several models under fully controlled conditions, much as the current work in Indonesia is conducted. The early settlement of Kefallinía, Crete and Sardinia will also be investigated in depth, and again by the use of replicative experiments. Especially the quite early evidence from the last-named island is highly relevant, and it is much in need of reasonably reliable dating. The First Mariners Project may not be able to determine whether Acheulians crossed the Strait of Gibraltar before any land-based major occupation of Europe had taken place, but it *can* be expected to present detailed probability scenarios on this question. Together with the work at Sardinia and elsewhere, relating to very early maritime colonisation, it will certainly result in a greatly increased understanding of the circumstances of Pleistocene seafaring in the Mediterranean.

REFERENCES

AIKENS C. M., HIGUCHI T., 1982: *Prehistory of Japan*. Academic Press, New York.

ANDERSEN S. H., 1985: Tybrind Vig. A preliminary report on a submerged Ertebølle settlement on the west coast of Fyn. *Journal of Danish Archaeology* 4: 52–69.

ANDERSON A., 1987: Recent developments in Japanese prehistory: a review. *Antiquity* 61: 270–281.

ARNOLD B., 1996: *Pirogues monoxyles d'Europe centrale*. Neuchâtel.

BEDNARIK R. G., 1994: A taphonomy of palaeoart. *Antiquity* 68: 68–74.

BEDNARIK R. G., 1995: Seafaring *Homo erectus*. *The Artefact* 18: 91–92.

BEDNARIK R G., 1997a: The initial peopling of Wallacea and Sahul. *Anthropos* 92: 355–367.

BEDNARIK R. G., 1997b: The earliest evidence of ocean navigation. *International Journal of Nautical Archaeology* 26: 183–191.

BEDNARIK R. G., 1997c: The origins of navigation and language. *The Artefact* 20: 16–56.

BEDNARIK R. G., 1997d: The role of Pleistocene beads in documenting hominid cognition. *Rock Art Research* 14: 27–41.

BEDNARIK R. G., 1998: An experiment in Pleistocene seafaring. *International Journal of Nautical Archaeology* 27: 139–149.

BEDNARIK R. G., 1999: Maritime navigation in the Lower and Middle Palaeolithic. *Comptes Rendus de l'Académie des Sciences Paris* 328: 559–563.

BEDNARIK R. G., in print: Beads and the origins of symbolism. *Semiotica.*

BEDNARIK R. G., HOBMAN B., ROGERS P., 1999: *Nale Tasih* 2: journey of a Middle Palaeolithic raft. *International Journal of Nautical Archaeology* 28: 25–33.

BEDNARIK R. G., KUCKENBURG M., 1999: *Nale Tasih: Eine Floßfahrt in die Steinzeit*. Thorbecke, Stuttgart.

BINI C., MARTINI F., PITZALIS G., ULZEGA A., 1993: Sa Coa de Sa Multa e Sa Pedrosa Pantallinu: due "Paleosuperfici" clactoniane in Sardegna. In: *Atti della XXX Riunione Scientifica, "Paleosuperfici del Pleistocene e del primo Olicene in Italia, Processi si Formazione e Interpretazione", Venosa ed Isernia, 26–29 ottobre 1991*. Pp. 179–197. Istituto Italiano di Preistoria e Protoiostoria, Firenze.

BROWN D., 1973: Der Mensch, der in die Kälte ging. In: E. White, D. Brown (Eds.): *Die ersten Menschen*. Pp. 111–123. Time-Life International (Nederland) B.V.

CLARK G., 1971: *Excavations at Star Carr*. Cambridge University Press, Cambridge.

D'ERRICO F., 1994: Birds of Cosquer Cave. The Great Auk (*Pinguinus impennis*) and its significance during the Upper Palaeolithic. *Rock Art Research* 11: 45–57.

ELLMERS D., 1980: Ein Fellboot–Fragment der Ahrensburger Kultur aus Husum, Schleswig-Holstein? *Offa* 37: 44–47.

FACCHINI F., GIUSBERTI F., 1992: *Homo sapiens sapiens* remains from the island of Crete. In: G. Bräuer, F. H. Smith (Eds): *Continuity and replacement*. Pp. 89–208. A. A. Balkena, Rotterdam/Brookfield.

FISCHER A., 1988: Exploring submerged Stone Age sites in Denmark — or the field of Mesolithic research is as deep as the ocean. *Mesolithic Miscellany* 9: 9–10.

FISCHER A., 1995a: Epilogue to the Man & Sea Symposium. In: A. Fischer (Ed.): *Man and sea in the Mesolithic. Coastal settlement above and below present sea level*. Pp. 431–435. Oxbow Monograph 53, Oxbow Books, Oxford.

FISCHER A., 1995b: An entrance to the Mesolithic world below the ocean. Status of ten years' work on the Danish sea floor. In: A. Fischer (Ed.): *Man and sea in the Mesolithic. Coastal settlement above and below present sea level*. Pp. 371–384. Oxbow Monograph 53, Oxbow Books, Oxford.

FREEMAN L. G., 1975: Acheulian sites and stratigraphy in Iberia and the Maghreb. In: K. W. Butzer, G. I. Isaac (Eds): *After the Australopithecines*. Pp. 661–743. Mouton Publishers, The Hague/Paris.

GOREN-INBAR G., LEWY Z., KISLEV M. E., 1991: Bead-like fossils from an Acheulian occupation site, Israel. *Rock Art Research* 8: 133–136.

IKAWA-SMITH F., 1986: Late Pleistocene and Early Holocene technologies. In: R. J. Pearson, G. L. Barnes, K. L. Hutterer (Eds): *Windows on the Japanese past: studies in archaeology and prehistory*. Pp. 163–198. Center for Japanese Studies, Ann Arbor.

JOHNSTONE P., 1980: *The sea-craft of prehistory*. Routledge & Kegan Paul. London, Henley.

KAVVADIAS G., 1984: *Palaiolithiki Kephalonia: O politismos tou Phiskardhou*. Athens.

MCGRAIL S., 1987: *Ancient boats in NW Europe*. Longman, Harlow.

MCGRAIL S., 1991: Early sea voyages. *International Journal of Nautical Archaeology* 20: 85–93.

MARTINI F., 1992: Early human settlements in Sardinia: the Palaeolithic industries. In: R. H. Tykot, T. K. Andrews (Eds): *Sardinia in the Mediterranean: a footprint in the sea. Studies in Sardinian archaeology presented to Miriam S. Balmuth*. Pp. 40–48. Monographs in Mediterranean Archaeology, Sheffield Academic Press, Sheffield.

PERLÈS C., 1979: Des navigateurs méditérrannéens il y a 10,000 ans. *La Recherche* 96: 82–83.

RENFREW C., ASPINALL A., 1990: Aegean obsidian and Franchthi Cave. In: C. Perlès (Ed.): *Les industries lithiques taillées de Franchthi (Argolide, Grèce). Tome 2: Les industries lithiques du Mésolithique et du Néolithique initial*. Pp. 257–270. Bloomington and Indianapolis.

SKAARUP J., 1983: Submarine stenalderbopladser I Det sydfynske Øhav. *Antikvariske studier* 6: 137–162.

SONDAAR P. Y., VAN DEN BERGH G. D., MUBROTO B., AZIZ F., DE VOS J., BATU U. L., 1994: Middle Pleistocene faunal turnover and colonization of Flores (Indonesia) by Homo erectus. *Comptes Rendus de l'Académie des Sciences Paris* 319: 1255–1262.

SONDAAR P. Y., ELBURG R., KLEIN HOFMEIJER G., MARTINI F., SANGES M., SPAAN A., DE VISSER H., 1995: The human colonization of Sardinia: a Late-Pleistocene human fossil from Corbeddu Cave. *Comptes Rendus de l'Académie des Sciences Paris* 320: 145–150.

THORNE A., GRÜN R., MORTIMER G., SPOONER N. A., SIMPSON J. J., McCULLOCH M., TAYLOR L., CURNOE D., 1999: Australia's oldest human remains: age of the Lake Mungo 3 skeleton. *J. of Hum. Evol.* 36: 591–612.

VAN ANDEL T. H., 1989: Later Quaternary sea-level changes and archaeology. *Antiquity* 63: 733–745.

WARNER C., BEDNARIK R.G., 1996: Pleistocene knotting. In: J. C. Turner, P. van de Griend (Eds): *History and science of knots*. Pp. 3–18. World Scientific, Singapore.

ZEIST W. VAN, 1957: De mesolitische Boot van Pesse. *Nieuwe Drentse Volksalmanak* 75: 4–11.

ZIEGERT H., 1995: Das neue Bild des Urmenschen. *Uni hh forschung* 30: 9–15.

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