Sailing a Paleolithic Raft

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The *Nale Tasih 2* project involved designing and building a raft using Paleolithic technology, and field-testing the raft on the open sea. This illustrates how nautical archaeology can contribute to our knowledge of the past in ways significantly beyond the more customary concerns of this specialist discipline. Such work can decisively affect even the most profound and far-reaching aspects of archaeology and the study of prehistory.

The maritime capabilities of Pleistocene humans has been greatly neglected until now. Whereas replication experiments of seafaring exploits of the last two or three millennia have been conducted for much of the twentieth century, Pleistocene seafaring has until recently attracted no sustained research effort. However, ideas about the cognitive and technological evolution of humans can be affected significantly by the findings of archaeological work in combination with replicative sea journeys. The evidence indicates that seafaring began at least 800 ka (thousand years) ago. *Homo erectus* had the ability to reach and colonize several islands of Indonesia. The remarkable expansion of this species apparently had no precedent in hominid history, which suggests the involvement of a new adaptive tool, an ability not available to earlier hominids. Colonization by navigation virtually presupposes purpose-specific communication and symboling abilities in the population concerned.

Eventually, the long development of hominid navigational capabilities led to the settlement of distant lands in the Late Pleistocene, including the continent of Australia and numerous islands in the general region. These destinations remained invisible for much of the journeys required to reach them. We have evidence of Pleistocene navigation in two world regions, in the Mediterranean and from east Asia to Australia.

Middle Pleistocene stone tools at Sa Coa de sa Multa, Sardinia, provide the earliest known secure indication of seafaring in the Mediterranean, at perhaps 300 ka ago. Mousterian tools have been found on Kefallinía near Greece, and human skeletal remains from Crete combining both modern and Neanderthaloid features, about 50 ka old, indicate considerable seafaring ability in the late Middle Paleolithic period. A 20-ka-old human finger bone in Corbeddu Cave, Sardinia, and the discovery of obsidian from Melos, about 11 ka old, on the Greek mainland indicate Upper Paleolithic navigation. Similarly, obsidian from Kozushima on the main island of Japan reveals sea crossings in both directions by about 30 ka ago. Another and more distant Japanese island, Okinawa, has yielded skeletal human remains that are around 18 ka old. It has been considered from time to time that the Strait of Gibraltar may have been crossed by hominids, but the evidence remains circumstantial. Nevertheless, in view of the evidence of an initial crossing of the Wallace Line at Bali at least 800 ka ago, the possible crossing of the Strait of Gibraltar in Acheulian times needs to be reviewed.

However, the most astonishing seafaring feats of the Paleolithic were those in the vicinity (mostly to the north) of Australia. Prehistoric navigators settled many islands across up to 180 km of sea, and in most cases without being able to see the target shore at commencement of the journey. These maritime exploits suggest that the Middle Paleolithic sailors in the general region near Australia conducted relatively frequent ocean journeys with considerable confidence.

This extensive maritime navigation evidence, commencing in the final Early Pleistocene and leading through to the end of the Pleistocene, is based entirely on one factor: the appearance of colonizing humans on land masses that were not connected to any others for the entire duration of the Pleistocene. There is not a single scrap of direct, physical evidence of navigation available from the entire Pleistocene. The oldest such evidence, in the form of paddles, boat components, and (later) whole boats begins about 10,500 to 9,500 years ago. Recognizable rock art images of water craft are much younger still. The rising sea levels at the beginning of the Holocene have destroyed all earlier shorelines, and with them the evidence not only of navigation equipment and seaside settlements, but of Pleistocene marine economies generally. Many archaeologists do not appreciate that our evidence of the Ice Age is heavily distorted, as it is entirely of inland economies. The coastal economies of the Pleistocene are simply unknown to us.

Replication studies

Possibly the safest method of establishing the maximum capability of human populations or cultures of the distant past is to consider specifically maritime colonization. Pioneering sea journeys can be assumed to have been matters of survival, of life and death, and thus very close to what was technically possible at a particular point in history. In the known early colonization we can discern a pattern, according to which decreasing age of evidence seems to correspond with increasing mobility, ability to cross greater distances, or mastery of navigation. Clearly, sea travel capability improved gradually over time. It seems reasonable to assume that each first crossing succeeded fairly shortly after its distance and difficulty fell within the range of technological ability. Therefore, if we can establish how sophisticated maritime technology had to be in order to succeed with a given crossing, we would have a fairly accurate measure of technological capability at the time in question.

This procedure is similar to estimating the former size of an ocean gap in the distant past by determining the types of animal species that managed to cross it. Many land mammals cross seawater, but only up to a given distance (conditions other than distance may also affect this). For instance, pigs and deer are good swimmers and travel in herds, which is important in the case of establishing a new population. They might swim up to 10, perhaps even 15 km. Hippos can swim farther, but no land mammal comes anywhere near elephants, which manage 50 km sea distance. In the case of Lombok Strait, between Bali and Lombok (Wallace's Line), elephants were the only large land mammals to cross, which tells us that the distance was probably never less than 25 km.

Perhaps one of the best ways to determine the technological capability of a culture is to measure, somehow, the geographical distances it was capable of spaning. What renders this method particularly robust and reliable is that maritime colonization may well be the only major archaeological phenomenon over which taphonomy (the deterioration and destruction of archaeological evidence over time) has only limited influence. Although it is true that the occupation evidence in any region is itself subject to normal taphonomy, and must be subjected to taphonomic logic. Stone tools have a very short taphonomic lag time, they establish human presence on an island, and as a working hypothesis we can assume that archaeologists would sooner or later detect this presence.

There is, however, one problem with this method: our knowledge of primitive watercraft and their performance, and of the many other factors determining human ability to cross the sea, is severely limited. No comprehensive experiments have ever taken place to determine the best vessel design, materials, and size, or any other optimal conditions for sea crossings on Paleolithic vessels. Without acquiring this knowledge in a systematic fashion, any effort to determine maximum technological capacities by these means would be futile. In 1996, therefore, I decided to secure such data by starting a project to investigate Pleistocene navigation.We would build a series of individually designed rafts with stone tools, test them, and sail them across specific sea barriers (see *INA Quarterly* 25.3, pp. 7-15).

The first two rafts were built as Middle Paleolithic vessels, using Middle Paleolithic stone tool replicas, with the purpose of determining whether the rafts would be capable of reaching Australia from Indonesia. *Nale Tasih 1* was a 15-tonne, 23-m vessel built near the southern tip of Rote, a small island southwest of Timor. This vessel was taken for sea trials in March 1998, with a crew of eleven. A number of design shortcomings and material defects became apparent. Unfavourable winds and conditions, caused by the *El Niño* phenomenon, led to the abandonment of the attempt to sail the raft to Australia.

On the basis of these findings and the experience gained from the experiment, a radically different, simpler design was adopted for *Nale Tasih 2*, an 18-m bamboo raft of only 2.8 tonnes, exclusive of equipment and supplies. In contrast to *Nale Tasih 1*, whose design was based on the recommendations of leading marine architects, the second raft reflected the experience of indigenous and traditional boat builders in Indonesia. In its simpler design, the separation of structural from buoyancy components was eliminated, and the two problems of raising the deck sufficiently above the water and of meeting the impact of waves arriving from the beam were solved by curving the sides of the raft upwards (fig. 1). Apart from this one factor, *Nale Tasih 2* was as basic as a bamboo raft could possibly be: 87 bamboo stalks arranged in three layers were held in place by eight cross timbers made from naturally curved tree trunks.

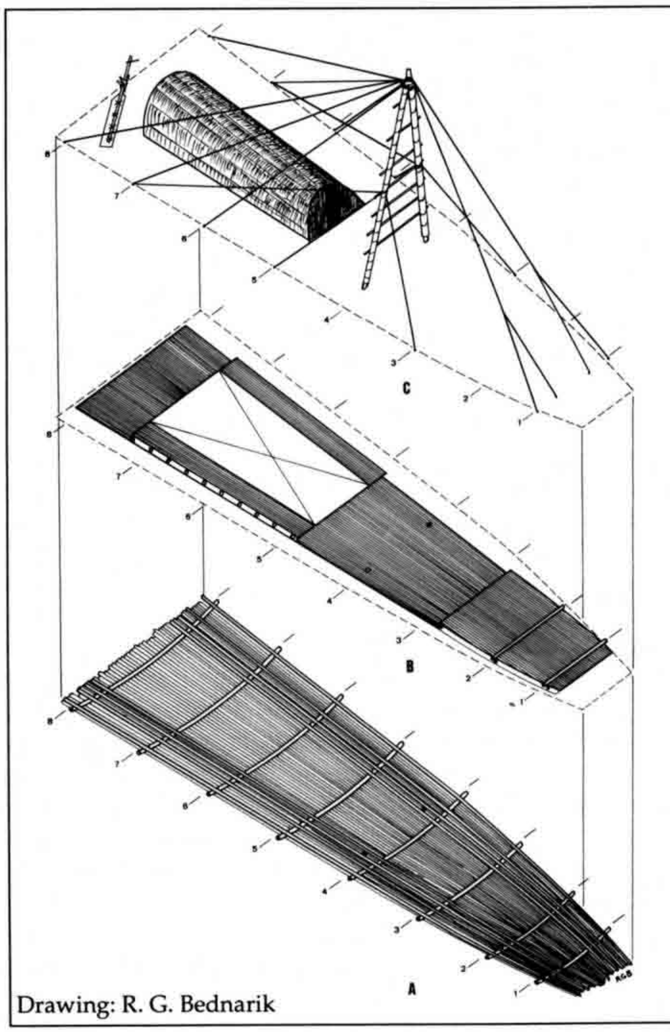


Fig. 1. *Exploded view of the bamboo raft* Nale Tasih 2, *showing the arrangements of raft structure (A), deck (B) and superstructures (C).*

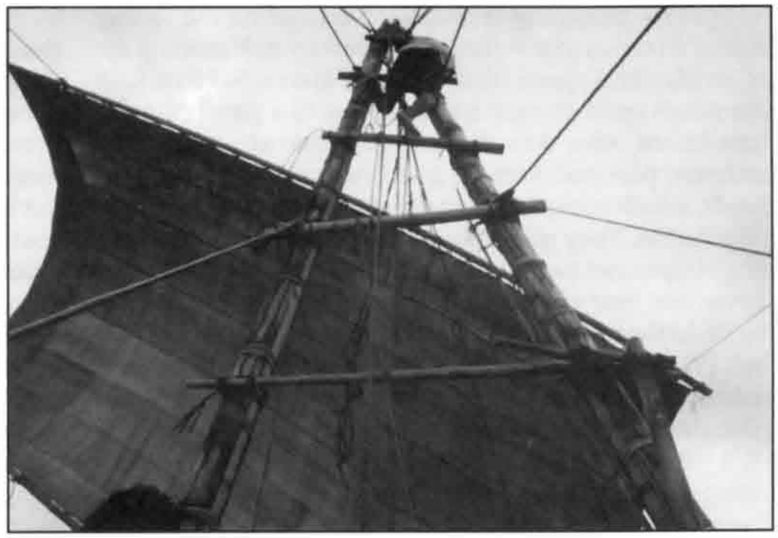


Fig. 2 (left). *The two hollow mangrove trunks containing drinking water. A lowered steering board is visible in the background, and the dugout is on the right.*

Fig. 3 (above). *The A-frame mast with the square sail of* Nale Tasih 2 *(consisting of woven palm leaf fibers). The rigging is of forest vines.*

Photos: R. G. Bednarik

Construction of *Nale Tasih 2* began in August 1998 near Kupang, West Timor, and involved the work of eight boat builders for three months. The primitive raft was launched in mid-November and left Kupang harbor with a crew of five on 17 December. It was constructed entirely from materials available in Indonesia to Middle Paleolithic people, but in contrast to *Nale Tasih 1*, critical rope bindings consisted of full rattan vines. In particular, most mast guy ropes were rattan, and the individually lashed bamboo lengths were collectively tied to the thwart timbers by rattan forest vines. These are more difficult to terminate than ropes, but they are of extraordinary tensile strength.

On board were two mangrove logs, hollowed out by termites and sealed off with wood, beeswax, bark, and tree resin, and containing 350 liters of drinking water (fig. 2). The one A-frame mast bore a 24-square meter sail woven from palm leaf (fig. 3). A single steering oar on the stern was effective at reasonable velocity, augmented by six steering boards. The latter were not found to improve steering ability greatly. *Nale Tasih 2* was well equipped with spare parts, including two sails, a steering oar, vines, ropes and other cordage. To effect repairs at sea it carried 65 stone artefacts, replicas of Middle Paleolithic types made from black sedimentary silica stone. A large stone mortar and pestle were used in food preparation. A wooden anchor, weighted down with a limestone block, was on board, along with a fire box, a quantity of firewood and coconut husks used as fuel and tinder. Finally, the raft carried an old dugout of 4.77 m length strapped across the stern, for the purpose of permitting the cameraman to film the vessel from some distance during the journey. It was only used on one occasion, as it would have been unsuitable under rough conditions.

Food provisions included 30 coconuts, several bundles of bananas, a basket of mangoes, some melons and cassava, salted meat, a basket of native millet, about seven litres of palm sugar, some salt, and a few

Fig. 4. *Om Mberu (left) and Ifé gutting a 5-ft dorado with stone knives on* Nale Tasih 2.

limes, carrots, and cucumbers. However, these were supplementary supplies, as it was intended to derive most food from the sea. For this purpose the raft was equipped with several harpoons and fish spears. Utensils were made from coconut shells, and buckets from folded lontar palm leaves. Food was cooked in such containers.

Fish up to 1.5 m length were harpooned or speared on the journey, including dorado, yellow fin tuna, and angel fish. They were immediately gutted and filleted with stone knives (which were found to be as effective as steel knives; see fig. 4) and roasted on the fire. Sharks followed the raft persistently but their hard skin proved a good defence against harpoons. A sea turtle tried to board *Nale Tasih 2* but was not killed for food. Two poisonous sea snakes were encountered, and various marine birds were sighted daily, as well as butterflies.

Nale Tasih 2 travelled without an escort boat, and the crew's only contact with the outside world was via a satellite telephone, reporting its position twice a day to a contact in Darwin. With the exception of this item and equipment for navigation, recording, and scientific purposes, all equipment on the vessel would presumably have been available to sailors 50-60 ka ago.

The experimental raft reached the continental shelf of Australia, which formed the continent's shore during most of the Late Pleistocene, on the sixth day of the voyage. It thus completed its primary objective. To gain more knowledge in the handling of the craft, the crew continued on towards Darwin (fig. 5). On the eleventh day, the seas became rough and the raft was sailed under extreme conditions for two days. The steering oar broke, a yard broke in two, and at one stage, all forward guy ropes of the mast snapped in unison. However, all repairs were effected successfully in heavy seas. On the thirteenth day, waves of 4-5 m forced the raft towards Melville Island, north of Darwin, the coast of which is heavily populated by saltwater crocodiles. The Australian coastguard insisted that, as a precaution, the crew be taken from board three hours before the raft was to reach the shore. The crew of *Nale Tasih 2* transferred to the oil tender *Pacific Spear* on the evening of 29 December 1998. Three days later, the raft was recovered in calmer seas from where it was beached on the south coast of Melville Island, and towed to Darwin. It had survived without significant structural damage and was in fact in better condition than when it left Timor, having been improved at sea. After fumigation by Australian quarantine, it was released for public exhibition.

In the next experiment we will attempt to cross Lombok Strait on an even more primitive raft. We hope to determine the minimum requirements necessary for the presumably first sea crossing in human history, which occurred more than 800 ka ago. At the time of writing, preparations for this expedition are well advanced.

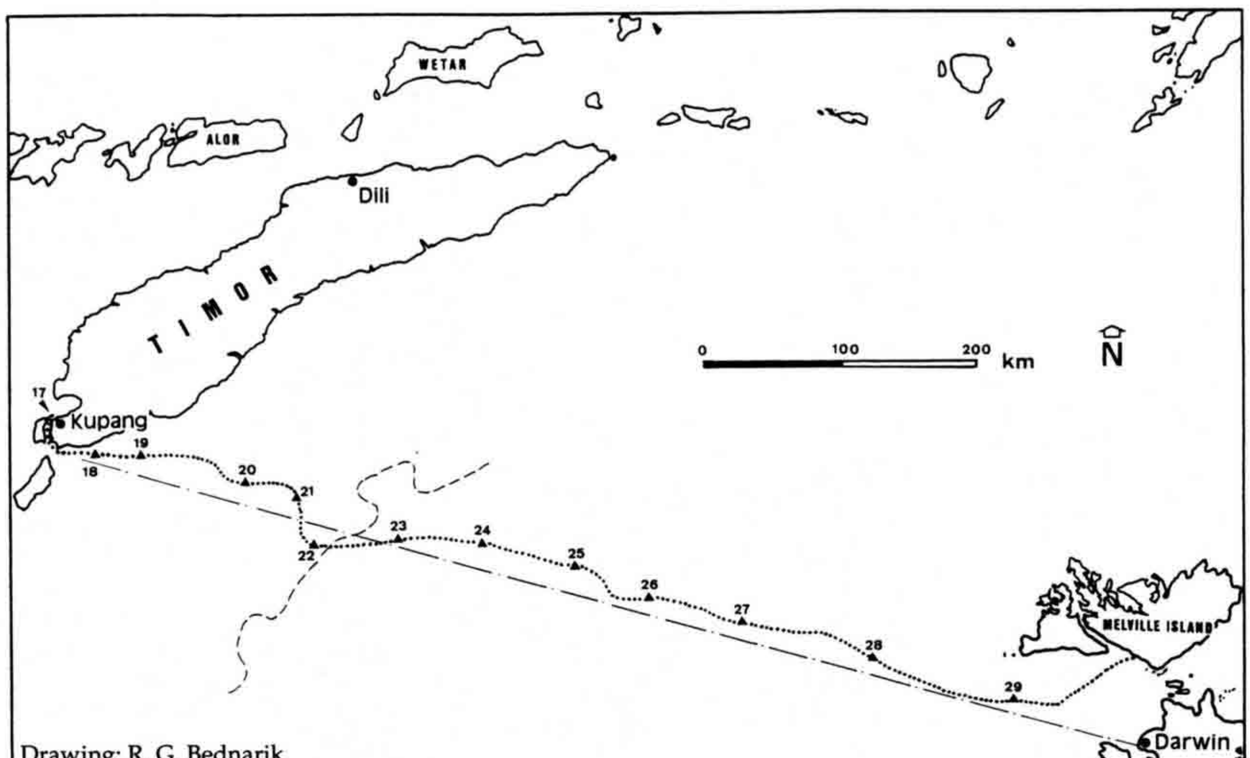


Fig. 5. *The route taken by* Nale Tasih 2, *from the southernmost tip of Timor to the southern coast of Melville Island. The numbers refer to the days of December 1998, 08.00 a.m. of each day; the broken line crossed on 22 December is the edge of the Sahul (Australian) continental shelf, the continent's former coast line.*

Introducing taphonomic logic

The project is not expected to be complete for another three years. It would be premature to present any concluding observations here, and that is not my intention. However, even the preliminary findings could have profound effects on our ideas about human evolution. For the past decades there has been an increasing acceptance of the "African Eve" model by paleoanthropologists, particularly those in the English-speaking countries. Some advocates of that model claim that there must have been an abrupt qualitative change in the level of cultural, technological and social sophistication with the appearance of morphologically modern humans. Where evidence exists of similar sophistication among earlier hominids, it has often been explained away or dismissed as an exception to the rule.

The evidence of widespread seafaring by pre-modern humans is too solid to regard as a mere anomaly. In the author's opinion, the *Nale Tisih 2* project shows that the knowledge and technological skills required to sail the open sea are far in excess of the capabilities conceded to early hominids by these paleoanthropologists. Therefore, the evidence squarely refutes their model of human evolution. The contradiction has less to do with seafaring itself, than with the preconditions for successful maritime colonization.

To bring to a distant shore a group of males and females large enough to succeed in founding a new population involves the construction of watercraft large enough to carry these people and their supplies. Such a vessel can take months to build, and involves the organized labor of several people for an abstract goal. It obviously involves complex and effective communication, most probably verbal communication (language or speech). But more importantly, it involves literally hundreds of culturally transferred skills. Until I tried to build and sail such a vessel, I had no idea of the complexity of such a project, and the cultural infrastructure necessary for it. The knowledge we gained from local boatbuilders about selecting materials with appropriate properties, and finding, acquiring, harvesting, transporting, treating, processing, curating, curing, storing, using, working, and preserving these materials was entirely cultural; none was passed on genetically. Constructing such sea craft required the abilities to make informed decisions, to anticipate future events and contingencies, and to convey these matters to a group, to motivate such a group, and to steer such a complex project to a successful completion. These are all ample evidence that earlier hominids, back to a million years ago, possessed many of the same capabilities as anatomically modern humans.

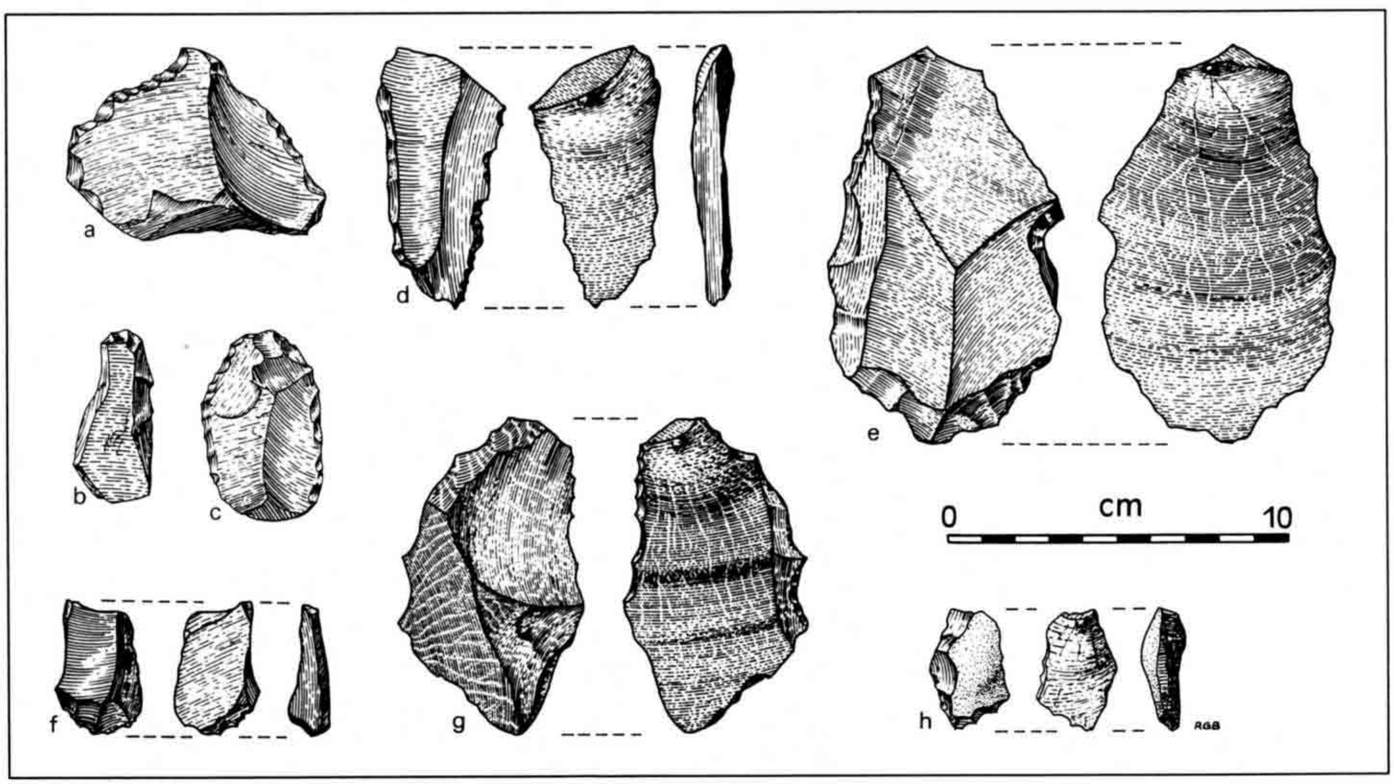
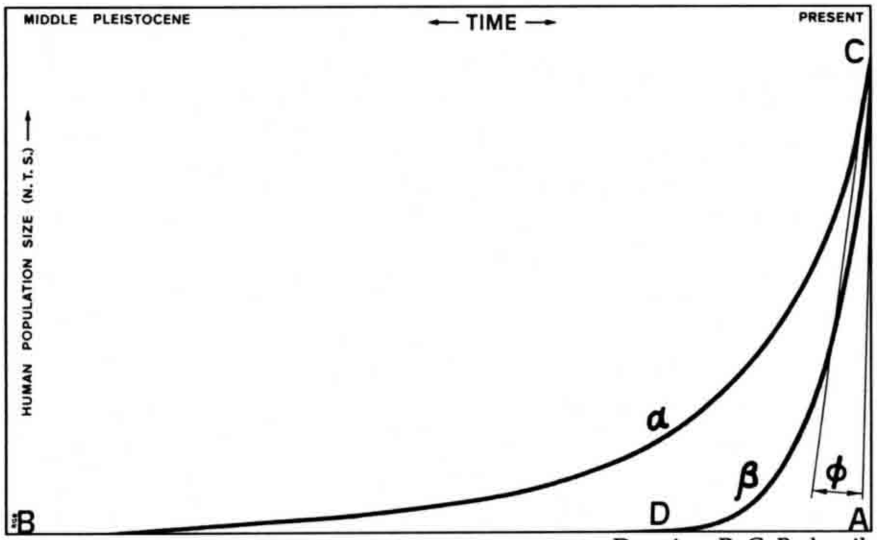


Fig. 6. *Stone artefacts of the final Early Pleistocene of Flores, believed to be in the order of 750 or 800 ka old, from Mata Menge (a-e, g) and Boa Leza (f, h).*



Drawing: R. G. Bednarik

Fig. 7. *The principles of taphonomic logic, showing the predicted survival characteristics of a cumulatively increasing corpus of material evidence of a specific phenomenon category: A = present time, B = historical commencement of the activity thought to result in the find category in question, D = taphonomic threshold, α = produced instances of find category, β = surviving instances of find category as determined by taphonomic factors. The area below α thus represents the total quantity of find category produced, the area below β the total quantity of surviving specimens. To understand the principles it is essential to appreciate why β curve behaves relative to as depicted in time.*

There are other relevant points to consider. There is now clear evidence that the Middle Pleistocene hominids in Timor cooked *Stegodont* (an ancient elephant). The frequent discoveries of stone tools in situ with *Stegodont* remains in Flores, now at six sites (Koba Tuwa, Mata Menge, Boa Leza, Ngamapa, Kopo Watu, Pauphadhi), suggests that this animal was a major food source. At around 700 or 800 ka, this is among the world's earliest evidence of elephant killing by hominids. Moreover, the stone tools found in Flores, Timor, and Roti are among the most advanced Lower Paleolithic stone tools in the world (fig. 6). Subsequent Lower Paleolithic hominids in Europe, notably in Germany, also provide a great deal of evidence of their cultural and technological sophistication. They, too, hunted elephants (e.g. at Lehringen) and rhinos (at Bilzingsleben) successfully and probably frequently, and they produced engraved art. Yet for many years, some advocates of the African Eve model have rejected any evidence of hunting in the Lower Paleolithic, defining these hominids as subhuman carrion eaters. It will be interesting to see how they will account for the maritime navigation prowess of *Homo erectus* and later archaic *Homo sapiens*.

Part of the problem probably lies in inadequate theory regarding the preservation of archaeological evidence. To explain, let us briefly consider the taphonomy of seafaring evidence. We have absolutely no direct physical evidence of navigation older than 9500 years, but we do have indirect evidence (human tools on the far side of the treacherous Lombok Strait) that navigation must be much more than 800 ka old. So the taphonomic threshold (the point at which evidence first occurs and can be dated) of the evidence of the phenomenon is demonstrated to occur at 9500 years before present. The taphonomic lag time (the gap between the first occurrence of the phenomenon and the first datable archaeological evidence of it) is about 99 percent of the phenomenon's historical duration.

All types of archaeological evidence are subject to taphonomic logic, according to which there must be a point in time when theoretically all (in practice nearly all) instances of the specific phenomenon had been eliminated from the record (fig. 7). Without understanding the taphonomic lag, it is entirely impossible to understand the significance of quantitative aspects of Pleistocene archaeology, and even its qualitative aspects. Interpretation of archaeological finds of the Pleistocene is not just difficult without this understanding, it is impossible.

Taphonomic logic explains why we have no physical evidence of Pleistocene seafaring, when the archaeologically demonstrated occupation evidence on many islands and in Australia indicates clearly that humans reached them during Pleistocene times. It also shows us that the archaeological record must be expected to be significantly distorted, and distorted in systematic ways. The older the evidence, the greater the systematic distortion, until a point in time is reached, when quantitative, sometimes even qualitative, information loses all relevance. It is, for example, totally irrelevant how many garments we have recovered from the Mousterian. Even if not a single one has been found, this cannot be submitted as proof that these people went naked. Absence of evidence is not evidence of absence. Similarly, it is illogical to claim, as some archaeologists have done until now, that the evidence of symbolism before the Upper Paleolithic is numerically inadequate to indicate the capacity for symbolic thinking. Such claims are also taphonomically unsound. In the author's experience, the complexity of seafaring as a group activity requires the use of language, which is a form of symbolism: vocal sounds stand as symbols of concepts.

Conclusion

All of this shows the importance of learning about the circumstances under which Pleistocene navigation occurred. Such knowledge can help us establish realistic upper limits of what humans were capable of, technologically, culturally, cognitively and intellectually, at a given point in time. It may well be a more reliable measure of sophistication than any other to which archaeology has access. This source of information tells us that hominids were vastly more sophisticated than some advocates of orthodox archaeology would have us believe.

Due to the taphonomic lag, the traditional reliance on preserved artifacts can only measure the minimum capabilities of a culture, not its actual achievements. Replicative experiments have demonstrated beyond reasonable doubt that hominids had mimimum capabilities very significantly in excess of what many authorities have conceded. Specifically, "primitive" humans possessed the considerable skills necessary to build the functional equivalent of *Nale Tasih 2*.

Acknowledgments: The most important data collected on the *Nale Tasih 2* expedition were only made possible by the courage of the crew, and their willingness to risk life and limb in the process. For this, I thank Bob, Peter, Ifé and Om Mberu from the bottom of my heart. I regard them as heroes of science. I owe special gratitude to Peter Rogers, for his heroic act, and to Bob Hobman, whose sheer persistence and dedication made this work possible. Finally, I thank Silvia Schliekelmann, without whom the *Nale Tasih* expeditions would not have been .

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