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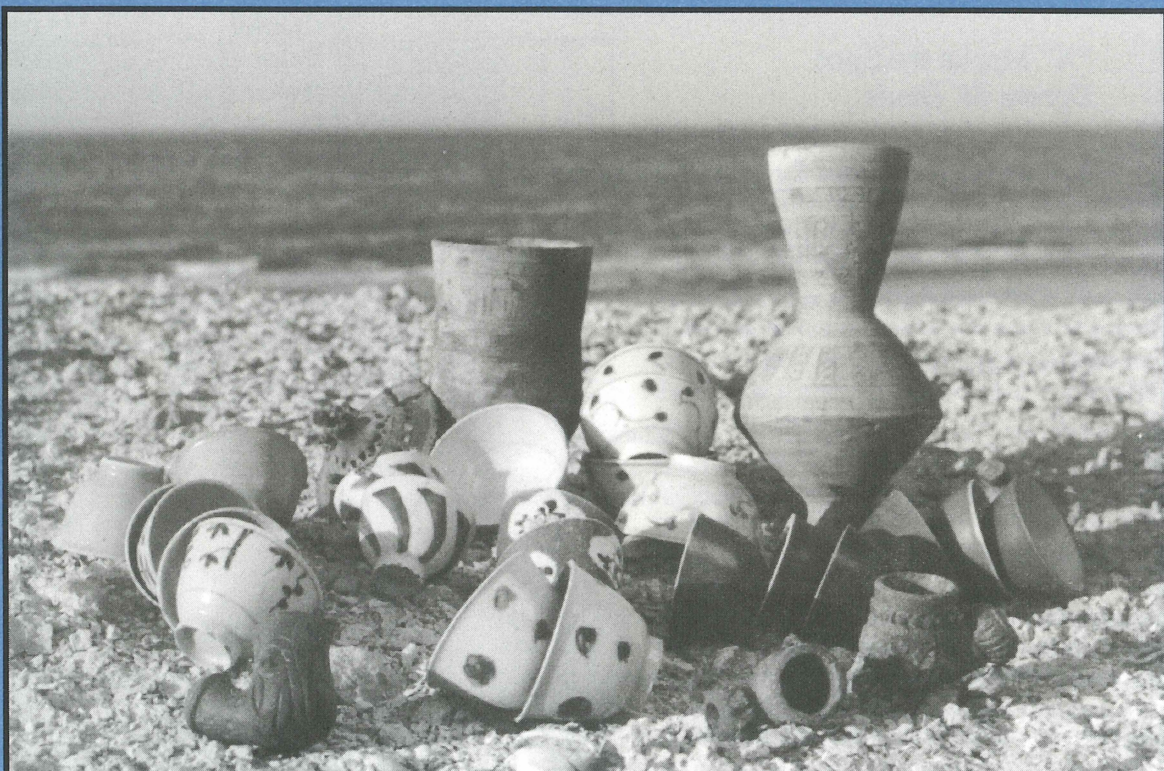

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On the cover: Excavated artifacts from the Sadana Island wreck provide an unprecedented look at international commerce and exchange in the mid-eighteenth century. Studies of personal effects, porcelain, ceramic, and many other objects will continue as we also unlock the secrets of the ship's unusual construction techniques. Photo: Meredith Kato

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Sadana Island Shipwreck: Final Season

By Cheryl Ward, Archaeological Director

Egypt's first shipwreck excavation in the Red Sea continued to provide unique and wide-ranging information about international trading relationships in the time just before the Industrial Revolution (see *INA Quarterly* 23.3 and earlier). The immense ship—more than 900 tons burden—remains the most enigmatic and fascinating artifact on site, and its study, along with that of the large collection of Chinese export porcelain for the Middle Eastern market (the first ever scientifically excavated), organic cargo from coffee and incense to coconuts and spices, and the handful of crewmen's possessions, will continue to contribute a great deal to understanding seafaring in the western Indian Ocean of the late seventeenth and eighteenth centuries.

The 1998 excavation of the Sadana Island Shipwreck off Egypt's Red Sea coast provided new and important information about the ship's construction, its cargo, and the site's history. An international team diving between 25 June and 14 August documented ship structure to provide a more comprehensive understanding of its construction, addressed questions related to objects and their stowage on the ship, as well as to the ship's origin. They also removed portable, attractive artifacts in an attempt to discourage looting.

The 1,270 dives made between depths of 20 and 40 m allowed us to establish three transverse trenches 8-10 m long and 2 m wide as well as a 13-m-long fore-and-aft trench along the deepest, best preserved part of the site (fig. 1). The ship's minimum beam is 18 m at midships, and its overall length is 49.8 m. A number of dives were made in the forward part of the ship. The resulting data point to similarities with the rest of the hull in terms of basic features, but most of the timbers are not accessible due to a thick coating of yellow aromatic resin, in some places up to 50 cm deep. In the stern and at midships, we found a fairly regular pattern of construction dependent upon heavy planking, massive composite futtocks beneath numerous, nearly square-sectioned stringers running fore and aft. Stringers are further reinforced by rider frames notched over their upper surface, especially in the lower third of the site. In the stern, a large, lattice-like iron concretion tops a series of transverse timbers that form the transom.

As in previous years, excavators worked carefully to recover organic remains and artifacts. We continued to find porcelain objects, both complete and broken, including unique types such as a small cup from trench 5.4 and a broken plate from near the anchors. Another exciting find from the anchors was a copper basin inscribed, "*Sahibihi Rais Musa Mahmoud*". Although the word *rais* has several meanings in Arabic, one of the most common is ship's captain, so we may have the captain's personal stew pot. The largest number of objects came from trench 1, and most are Type 4 porcelain cups. Ten clay pipe bowls, and one pair, add to our collection of personal objects from the galley area just aft of midships.

More prestigious items discovered in the midships bilge area include an ivory handle or pommel with some of its original three-color inlay remaining and a small fleck of gold foil. In the stern quarter, a gimbaled copper ring and a unique porcelain cup, a handful of porcelain sherds, a new type of resin (purple, and shipped in cakes), and more than 1500 *qulal* (earthenware jugs, fig 2) were excavated. The *qulal* remain on the bottom, but a representative

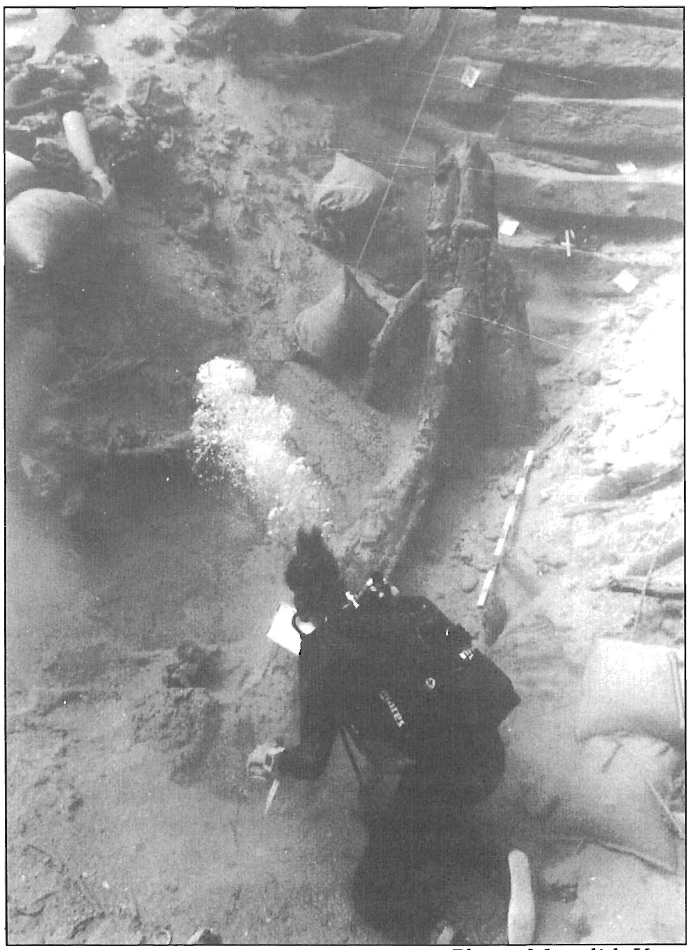


Photo: Meredith Kato

Fig. 1. *Excavations in Trench 1 uncovered massive knee and stringer structures, bolted together by iron fasteners more than half a meter long.*

sample of lids from the same area and two of the larger pitchers (Arabic *abri'*) add to our ceramic collection.

Interestingly, but not surprisingly, *qulal* were packed in ways that reflect their basic dimensions which previous seasons how to be roughly the same in terms of height and diameter with few clear instances of types being grouped together. The exception to this is perhaps found in those *qulal* packed between stringers in the bottom of the hull. Throughout much of the ship's length, including in the bow, stevedores nestled *qulal* along the centerline. In the stern, the 'goblet' type was laid down in a single layer on top of floor timbers, and then the standard size was inserted in a 'head-to-toe' layout above the goblets, but below the inner face of the stringers.

In addition to continued finds of rectangular, glass 'case' bottles, a new shorter, round glass bottle we immediately called a brandy bottle was recovered from the bow. In the same area were lead shot clumps, possibly for a musket. They provide the first evidence for any weapon remaining on the site. Folded lead fishing net weights, again from the midships area, were also new this season.

Recovery of organic remains continued to be an important part of the excavation. In addition to the familiar coffee beans and whole coffee cherries, we found multi-kilo lumps of a purplish resin with many inclusions of small twigs and branches. The new resin, previously seen only in amounts smaller than 1-cc from organic samples, occurs in both large, irregular lumps and in carefully shaped cakes or loaves of resin. All samples came from the bottom of the hull between stringers in the aft quarter of the ship. A yellow, aromatic resin previously recorded occurs in several areas of the hull, and archaeologists found a number of 'spills', where resin flowed across timbers during wreck formation.

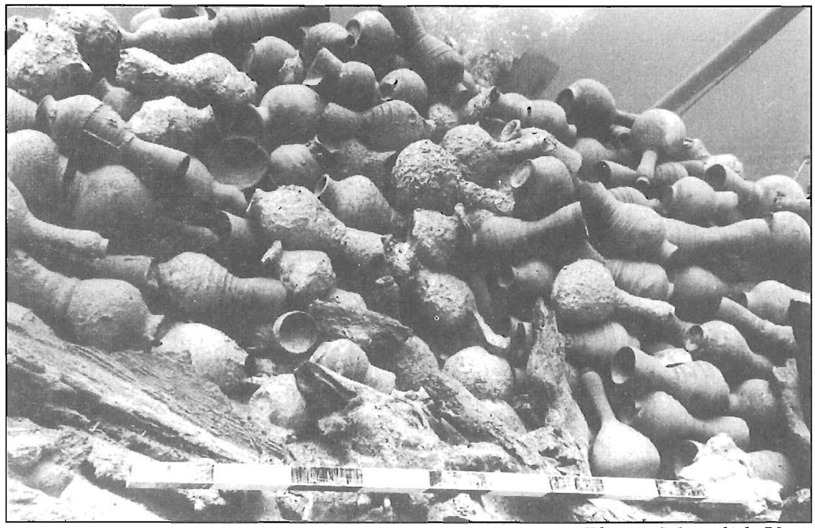


Photo: Meredith Kato

Fig. 2. *Several thousand water jars (*qulal*) on the wreck blocked access to the hull timbers beneath. Stacked by size and nestled in spaces between frames and stringers, the *qulal *resisted breaking, even after the giant ship struck the reef.*

At least 50 black-lipped, pearl oyster shells were counted from above the galley. This species provided mother-of-pearl for inlaid furniture and other decorative items as early as the Roman period in Egypt. A more curious cargo of branches covered about 20% of the wreck and may have been intended to serve as firewood. Because there is so much wood, however, and its position in the hull suggests it may have been part of the cargo, we are eagerly awaiting results of wood identification studies to try to determine where it might have been laden. Results will allow us to decide whether the wood was a special import, potentially for furniture or small item construction, or whether it was a species indigenous to watered regions of the Red Sea shores. If so, it was likely firewood, either as a cargo for Suez or for use during the voyage.

Another 60 coconuts discovered during the summer bring our total to over a hundred, found mostly between futtocks below stringer level in the aft quarter of the ship. In addition,

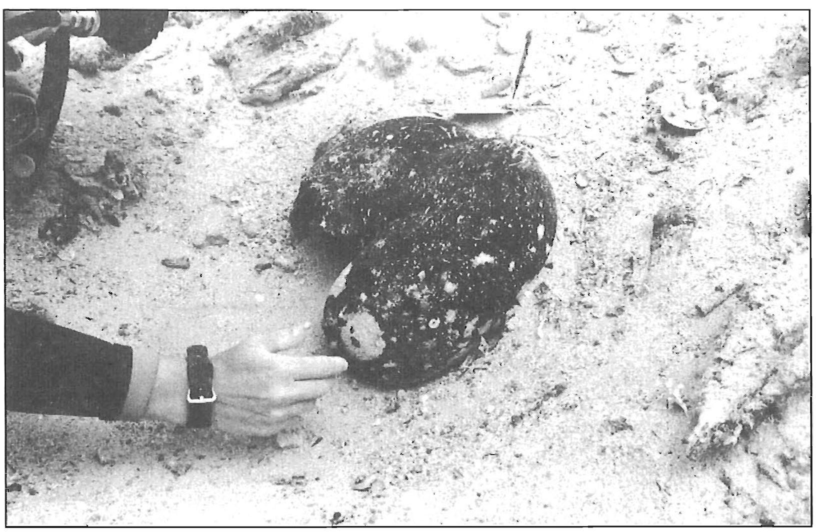


Photo: Meredith Kato

Fig. 3. *This bi-lobed coconut originally took 10 years to ripen and weighed over 50 pounds. Found only in the Seychelles Archipelago, this unusual specimen's voyage has finally ended at the National Maritime Museum in Alexandria.*

Photo: Meredith Kato

Fig 4. *Shattered porcelain cups remain to tell the story of this site's looting by sport divers. More than 10,000 cups may originally have been part of the ship's cargo—about three times the number of porcelain artifacts recovered during INA-Egypt/SCA excavations.*

we excavated a fabulous 33-cm-long, bi-lobed coconut from the disturbed area just aft of the anchors (fig. 3). The bi-lobed coconut grows only in the Seychelles Archipelago, and is a rarity even today. These are the world's largest seeds and weigh more than 20 kilos when ripe, a process which requires ten years. Its presence on the ship is probably due to its potential value as a curiosity. Europeans in the late eighteenth century found ordinary coconuts worthy of display in cabinets of curiosities; the bi-lobed coconut was four times the size and of an extraordinary shape.

Five wooden jar lids were recovered from area G5, below the largest concentration of *zila'* (large storage jars) on the site. This area also held cooking pots with evidence of charring, a used incense burner, and charcoal, suggesting that the galley was here. Most of the Turkish-style pipe bowls came from this square or just below it. Iron concretions above and below the 'galley' indicate the presence of iron objects originally weighing 50-100 kg. Some of them were probably spare parts for the ship (pintles and gudgeons for the rudder); others cannot be identified from their present form and remain on the seabed.

I first learned about the wreck from someone who led a team of unsanctioned divers in a 500-dive salvage operation on the Sadana Island ship. This summer, I spoke at length with one of those divers who provided photographs of finds made earlier on the wreck. These include at least ten boxes of porcelain cups, packed in tea. Each box held 900 to 1,000 cups. Many of these were broken during salvage attempts, and these remained for archaeologists to find while many of the complete objects were removed from the site (fig. 4.). I am trying to persuade owners of the several thousand looted objects from the wreck to donate those artifacts to the National Maritime Museum in Alexandria where all material from the Sadana Island Shipwreck is curated.

As in previous seasons, all objects were taken to the INA-Egypt/Supreme Council of Antiquities Alexandria Conservation Laboratory for Submerged Antiquities in Alexandria, Egypt, for further treatment and storage. In this final season, we were delighted to work closely with old and new friends from Egypt and other lands, and look forward to the opportunity to do so again.

Acknowledgements. The unflagging support of the Supreme Council of Antiquities for Egypt is greatly appreciated. SCA director Dr. Gaballah Ali Gaballah, the director of the underwater section Ibrahim Atiya Darwish, and the General Director for the Upper Egypt Inspectorate Hussein el-Afiouni proved to be wonderful hosts to the INA-Egypt team once again. We are grateful to SCA Inspectors Ayman Hindi, Wa'il Karam, Abdallah Muhammad, Sameh Ramses, Muhammad Mustafa, Muhammad Sayyid, Mustafa Desouki, Taimour Ismail, Magdi Ghazzala, Usama El-Nahas, Ehab Mahmoud, Ibrahim Mitwalli, Muhammad Abd al-Hamid, Abd al-hamid Abd el-Meguid, Ala' Mahrous and Ahmed Shukri for their patient and sincere efforts to help us record the shipwreck and its contents. We also thank the Egyptian Navy for allowing its officers Tarek Abu el-Ela, Hossam Hamza, and Mustafa Hassouna to join us.

The multi-year contributions of The Amoco Foundation, the John and Donnie Brock Foundation, Danielle Feeney, The Institute of Nautical Archaeology, Mark Easton and The American Research Center in Egypt, Orascom, Harry Kahn, Richard and Mary Rosenberg, George Lodge, Chip and Fran Vincent, The Arab Contractors, Scubapro, and Uwatec/Dynatron have made this excavation possible. We also deeply appreciate a grant from the Committee for Research and Exploration of The National Geographic Society, support from Stephen Lowder and a grant from Mr. and Mrs. John Stern and the California Community Foundation as well as the individual contributions of Bill and Cary Cavness, Patricia Cericola, Lyman Labry, Pamela de Maigret, Peter Revay, and John and Mary Villaume.

And here I offer all due honor, respect, and heartfelt thanks to the volunteers and staff of INA-Egypt for their unique contributions to the 1998 season: Basim Ahmed Ahmed (University of Alexandria), David Clarke, Bradford Eldridge, Adel Farouk, Dr. William Forest Farr, Doug Haldane, Jane Haldane, Jeff Hall, David Harrison, Heather Hart, Frederic Heller, Gwyn Johns, Marwa Kamal el-Din Helmy (American University of Cairo), Meredith Kato, Emad Khalil Helmi, Chris Kostman, Stephen Lowder, Marcus Manley, Steve Miller, Sherif Muhammad Abdou (University of Alexandria), Natasha Muldar, John Nichols, Robert Ossian, Miriam Seco Alvarez, Susannah Snowden, Howard Wellman, Mary Wiland, Aaron Wilson, and Jamie Winter.

The Logistics of the Sadana Island Shipwreck Excavation

by Douglas Haldane

We are just back from the the Sadana Island Shipwreck Excavation and finally catching our breath after the year's field operations to report on our progress in Egypt, so far.

The 1998 season at Sadana Island was an incredible success, I wish you had been there... literally, we could have used the help. In addition to the usual struggle to build camp (this year with a very small crew), during the winter of 1997 the sea finally demolished the platform we use at the reef edge for diver safety and excavation support. When we arrived at the site, the platform was upside down with one leg broken off and the others rusted through. A grim picture indeed, but with the entire team's help and workers hired from Safaga, we pulled off a two-part operation reminiscent of a Cecil B. De Mille production.

We jacked up and then dragged the platform off the reef edge, and carried it to the beach where a welder from town repaired it. Then, at low tide three days later, we carried the two-ton platform back to the reef edge in two pieces, and bolted it together in an afternoon. An amazing accomplishment that, had I not been there, I wouldn't have believed possible. At this point we were well into the third week of June, five weeks late, and ready to begin the excavation. Could we achieve our objectives by the last day of excavation diving on August 14th?

We could and we did. Our primary objective was to excavate to and record the ship's hull in the stern, midships, and an area just forward of midships. This objective could not be achieved with the handful of experienced people from INA-Egypt, however. Our final goal, stated in our permit proposal to the Egyptian Supreme Council of Antiquities (SCA), was to provide special training to inspectors from SCA's Underwater Section in nautical archaeological techniques. Fortunately, four of these people had worked with us before and helped their nine colleagues with translations of articles about ship construction and practical exercises to master skills.

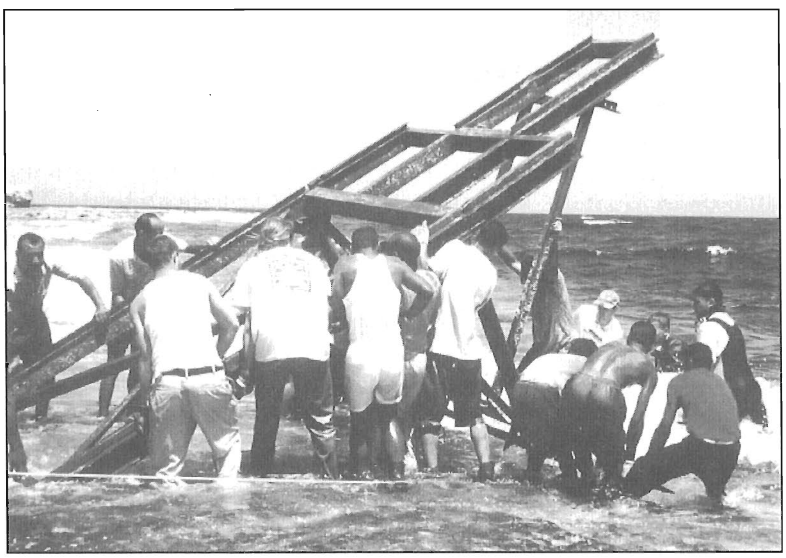


Photo: INA

Extensive renovations were carried out on the platform.

At one point during the excavation I found myself in the curious position of directing a project with seven SCA inspectors present. The SCA and INA-Egypt together with experienced people placed strategically throughout the site put in 1,270 dives totalling 1,268 hours in the water with 540 hours on the wreck. We not only achieved the primary and training objectives, but also added a two-meter wide trench running from the forward-most trench to the sternpost along the keel, explored the bow, and investigated an area above the wreck to record the outside of the hull.

While excavating we discovered a number of unique and intriguing artifacts that Dr. Cheryl Ward will be researching, along with finds from previous years, for final publication.

We achieved our excavation objectives of rescuing the information that would have been lost to looters and setting a scientific benchmark in the continuing exploration of Egypt's rich maritime involvement in the Indian Ocean luxury trade.

As in previous seasons, the artifacts discovered during the 1998 season at Sadana Island finally arrived in Alexandria, over two hundred years late, for conservation and study in the Alexandria Conservation Laboratory for Submerged Antiquities. The laboratory, located in the National Maritime Museum, is run by the SCA and INA-Egypt as a cooperative partnership for conservation and training. The laboratory's equipment will be complete by this December, thanks to funding from USAID through The American Research Center in Egypt's Egyptian Antiquities Program.

Mariners of the Pleistocene

Robert G. Bednarik

In the dynamics of human evolution, two distinct schools of thought have emerged, especially in recent years. According to one of these, capabilities such as hunting of large mammals, the making of prismatic blade tools and 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 behavior"—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. 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 processes (i.e. genocide). This "African Eve" theory, which is entirely devoid of any archaeological evidence in its favor, 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. We can conveniently define these two, fundamentally opposed models as the *short-range* and the *long-range models of cultural evolution*. The long-range model essentially coincides with the multiregional hypothesis of hominid development. It 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 favors 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 favored model despite its readily evident major shortcomings. This surely needs to be examined closely if we are to understand the epistemology of Pleistocene archaeology.

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 are in complete agreement with the author on the need for language in such achievements. They have proposed 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, and that the earliest evidence of language is the first landfall of humans in Australia. This is currently thought to have occurred per-

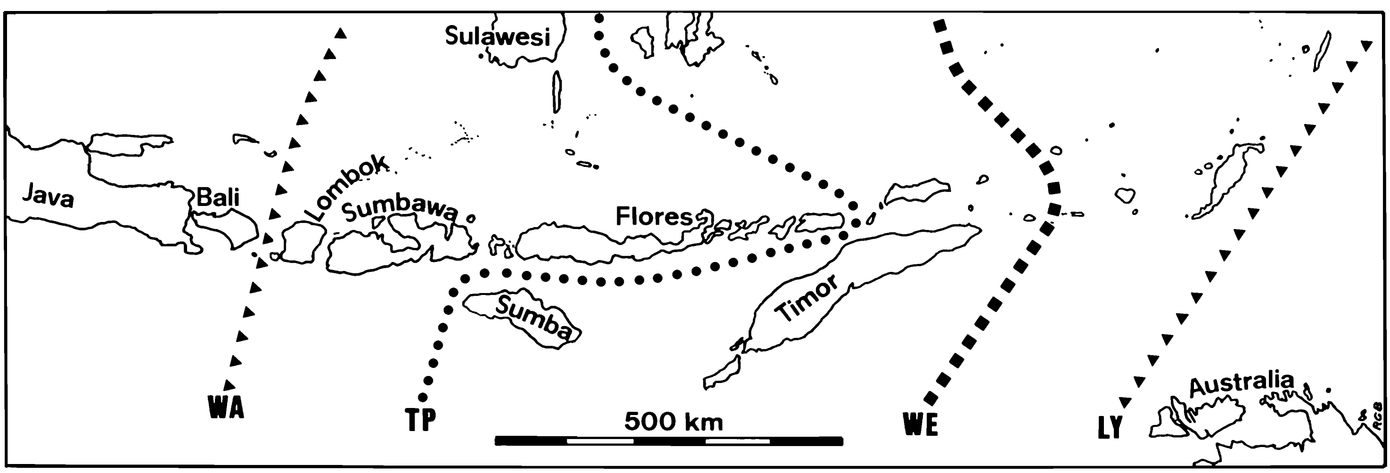


Fig. 1. *The locations of biogeographical filters in Nusa Tenggara: WA = Wallace's Line; TP = presumed tectonic plate separation between Asian and Australian plates; WE = Weber's Line; LY = Lydekker's Line.*

haps 50 or 60 ka (thousand years) ago. 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 (fig. 1). 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. 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 by the proponents of the Eve scenario that Wallacea and Australia were colonized in one single sweep.

Pleistocene navigation in Europe

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 Paleolithic technology (blade industries, bone tools, art, decoration, burial of the dead, underground mining, seafaring) and "modern human behavior." Not only is this a complete fallacy in every respect, 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* Paleolithic 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 (formerly Lesser Sunda Islands, in Indonesia), occurred significantly earlier than the first landfall in Australia (fig. 2). This is not only in sharp contrast with what most commentators have persistently maintained until now, but the early sea crossings occurred in fact in the Lower rather than the Middle Paleolithic 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 many, 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. The proliferation of hypotheses contradicted by the information from Indonesia, available for the past forty years, is a phenomenon that is hard to explain.

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 paleoart. The earliest such evidence is exclusively from western Europe, consisting of Mesolithic paddles from the peatbogs at Star Carr, England, and Holmgaard, Denmark. A worked reindeer antler from the Ahrensburgian at Husum, Germany, has been suggested to be a boat rib of a skin boat, and may be in the order of 10,500 years old. The canoe from Pesse, Holland, is 8265 ± 275 radiocarbon years old. More recent boat finds are those from Noyen-sur-Seine and Lystrup 1 (6110 ± 100 BP).

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 Franchthi Cave around 11 ka ago indicates that a distance of about 120 km was covered by 'island-hopping'. Considerably earlier is the Mousterian occupation of another Greek island, Kefallinía, presumably by Neanderthals, which has been suggested to have involved a sea crossing of perhaps 6 km. Islands to the west of Italy, too, may have been occupied by Paleolithic seafarers, and of greatest importance is the occupation evidence from the island of Sardinia, which is clearly of the Middle Pleistocene period. Sardinia was connected to Corsica at times, but never to the mainland. In addition, the possibility has been considered occasionally that Lower Paleolithic hominids

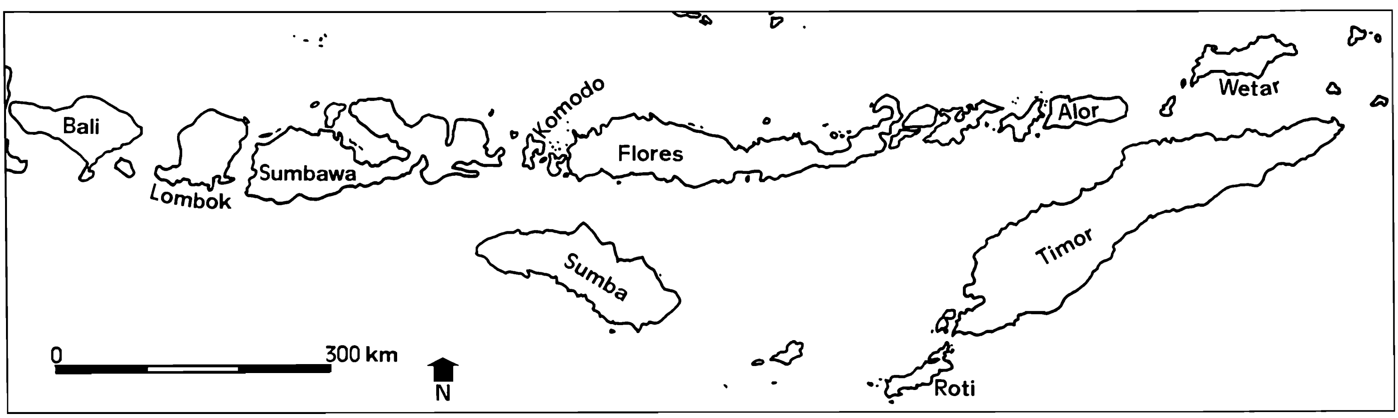


Fig. 2. *Nusa Tenggara, or the Lesser Sunda Islands, Indonesia.*

crossed from Africa to Europe by navigating the Strait of Gibraltar, but there is no solid evidence for this. However, in the light of the seafaring capability of *Homo erectus* in Southeast Asia that is discussed below, it would be worth reconsidering this question. The Gibraltar crossing was probably shorter and may have been less difficult than that of the Lombok Strait with its treacherous currents.

Pleistocene navigation in Indonesia and Australia

In comparison to the sparse European evidence of Pleistocene seafaring capabilities, that from Indonesia and 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 Paleolithic and not an Upper Paleolithic technology. Indeed, many of these sea crossings in the general region even date from Lower Paleolithic times and are clearly attributable to *Homo erectus* groups. The latter include the first landfall in Flores, which according to Koenigswald occurred up to 830 ka ago; the presumably preceding settlement of Lombok and Sumbawa (which lie between Bali and Flores); the Middle Pleistocene settlement of Timor and Roti; and the presumably preceding landfalls on Alor, Wetar and various smaller intermediate islands. There are also very tentative indications of early settlement in Sulawesi and reportedly even in Ceram.

Subsequent navigation by marine colonizers of a Middle Paleolithic technology led to landfall in Australia by perhaps 50 or 60 ka ago—the evidence recently tendered from the Jinmium site is disregarded here 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). 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). 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.

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 Paleolithic 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. If any researchers still hold contrary opinions, they really ought to try crossing the sea on randomly drifting vegetative matter.

Not that any of this should surprise us. The history of maritime navigation in the region began at least 800,000 years ago, at a time of distinctly accelerated cognitive and technological evolution. It would be entirely unrealistic to assume that the great subsequent innovations in wood working, hunting equipment, bead and pendant making, harpoon design, mining and quarrying, the refinement in stone tools, or the proliferation of paleoart and pigment use over the subsequent hundreds of millennia 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).

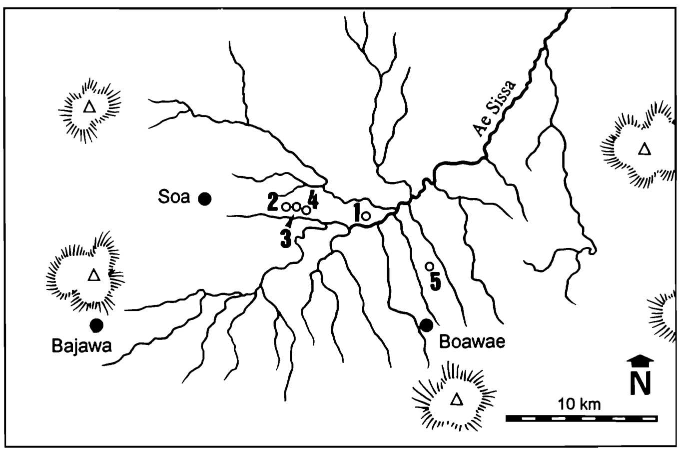
Hominids, lacking the buoyancy, trunks and long-distance swimming ability of elephants and stegodonts, who also colonized Nusa Tenggara, had to use watercraft to achieve these crossings. They could have used elephant or *Stegodon* bladders, or bundles of lightweight logs, or bamboo bundles and rafts. Of these, the latter are by far the easiest to procure and to use, and ever since the question of the initial colonization of Australia has been considered seriously, bamboo rafts have been the preferred explanation. 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. Watercraft observed in Australia were limited to bark canoes, rafts from driftwood, bark bundles, or mangrove logs, suitable only for coastal journeys. Large log rafts seen on the Sepik River of New Guinea may have been seaworthy, but bamboo has much greater buoyancy and is significantly easier to fell with stone tools and to assemble.

Seafaring *Homo erectus*

In January 1957, 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 (fig. 3). Henri Breuil, then the world's foremost prehistorian, recognized a number of Lower Paleolithic stone tool types among the finds. Von Koenigswald immediately suggested that the finds were of the Middle Pleistocene (fig. 4). 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, called 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 had satisfactorily demonstrated the coexistence of the *Stegodon*-dominated fauna and the hominids. In 1968 he was joined by Professor Johannes Maringer and the two scholars excavated with three large crews at Boa Leza, Mata Menge and Lembah Menge. All of Verhoeven's observations were validated completely. 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, paleontology, and the presence of tectites. This age estimate was confirmed through a series of 19 paleomagnetic 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. 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.

Mike Morwood from the University of New England recorded a stratigraphic section 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. Accordingly, the *Homo erectus* artefacts should be between 880 ± 70 ka and 800 ± 70 ka old (at 1 standard deviation). 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 and Boa Leza hominids. This work is currently continuing, with the author's collaboration, and has produced a whole series of further dating results from several sites in the area.

Verhoeven had also discovered Stegodonts on Timor, again together with stone implements. After commencing a research project on West Timor and neighbouring Roti, the author is currently engaged in examining evidence of the early hominid occupation of all three islands—Flores, Roti, and Timor. Roti is now separated from Timor by shallow sea but these two islands of the "outer arc" were obviously connected for much of the Pleistocene. A spectacular find on Roti was a huge, 800-m jasperite quarry complex at Roshi Danon, with nearby stratified occupation evidence (fig. 5 & 6). Exposures of stone suitable



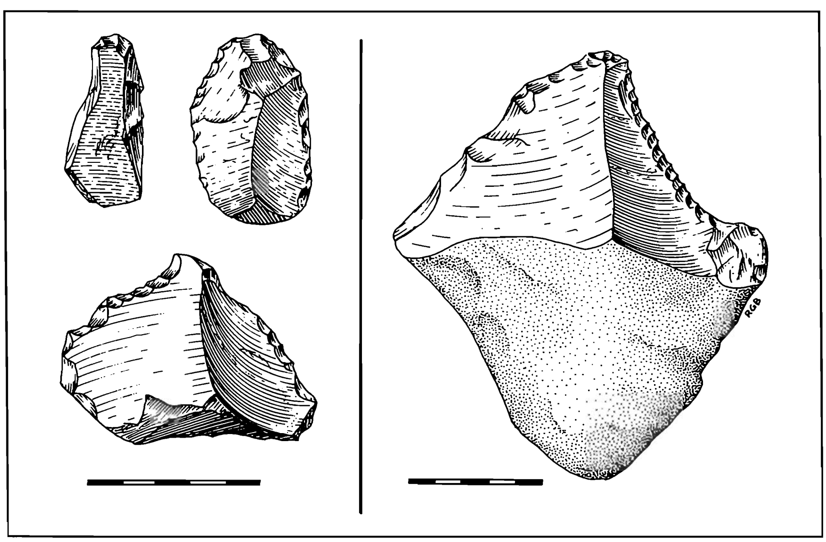


Fig. 3 (above). *The Soa Basin in central Flores, Indonesia. Occupation sites of* Homo erectus *are shown.*

Fig. 4 (left). *Stone implements of* Homo erectus, *Soa Basin, Flores. These were covered by over 100 m of sedimentary rock formations.*

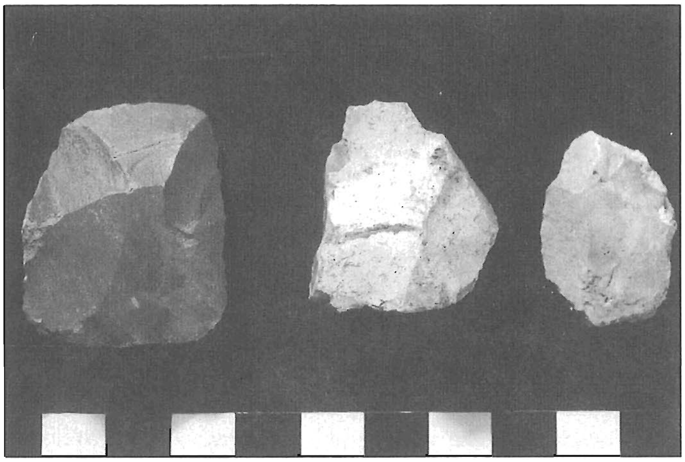


Fig. 5. *Large jasperite stone implement from Middle Pleistocene deposits at the jasperite quarry of Roshi Danon, Roti, Indonesia. The deep-red stone has been patinated white.*

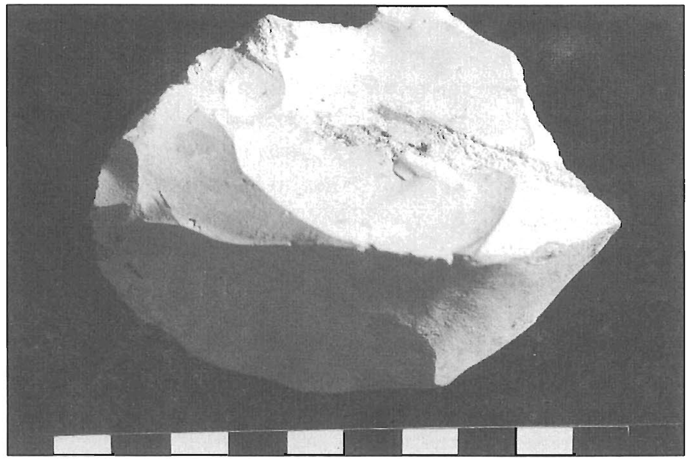


Fig. 6. *Three jasperite stone implements from Middle Pleistocene deposits at the jasperite quarry of Roshi Danon, Roti, Indonesia.*

for implement knapping are rare on the islands, and this quarry has evidently been in use since the Middle Pleistocene. Its discovery also solved the difficulty of explaining where the Middle Paleolithic seafarers of Timor or Roti could have acquired their stone tool materials for creating the kinds of watercraft they would have needed to cross to Australia.

The cumulative evidence from Flores, Timor, Roti, and possibly also Sulawesi suggests that of the alternative routes considered for the initial settlement of Australia, 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 (or subspecies) can be responsible, *Homo erectus*. In Java, connected to Bali for much of the Pleistocene, hominid remains have been unearthed for a full century now, and they fall into two broad groups: the early *Homo erectus* specimens from the Pucangan and Kabuh beds which have been suggested to be up to 1.81 million years old; and the much later hominids from the High Solo Gravels, which have often been compared, in terms of their skeletal architecture, to Pleistocene Australians. Their dating remains controversial, but various results place them between about 300 ka 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* probably experimented with flotation devices at least a million years ago, at the easternmost end of the world then settled (to best of our knowledge) by hominids, in the vicinity of Java (fig. 7). 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 suf-

Fig. 7. *Artist's impression of* Homo erectus *building a bamboo raft on Bali to reach Lombok.*

ficient numbers to found a new colony on the first island of Wallacea. This occurred in the order of 850 ka or 800 ka ago. Crossings to the remaining Sunda Islands of the "inner arc" were much easier and shorter than the 20-30 km journey across the strong currents of Lombok Strait, 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 developing their navigation technology for hundreds of millennia, venturing progressively further out to sea and learning to understand the behavior 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.

Replicative maritime archaeology

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. However, it cannot tell us how these incredible achievements of Pleistocene hominids were accomplished. A different research approach is required.

In the absence of any direct (i.e., 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, the difficult process has been commenced of reconstructing Pleistocene seafaring capabilities in the absence of actual material evidence. This includes replicative work in stone tool knapping, butchering, fire making, bone harpoon making, petroglyph production, bead and pendant manufacture, and wood and bamboo working, which have provided us with many insights into the technology particularly of Lower Paleolithic hominids (fig.8). (Some archaeologists are surprised to hear of beads or petroglyphs of the Lower Paleolithic, which only shows that one cannot trust the textbooks, for they are far too often wrong.) The *Nale Tasih* Expedition and the First Sailors Expedition both seek to "replicate" specific Pleistocene sea crossings. They 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. The projects study the technologies involved in all of these factors, even standard psychological tests of crews under conditions of stress and anxiety.

The author is the chief scientist of both these expeditions, commenced in 1996, which include 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

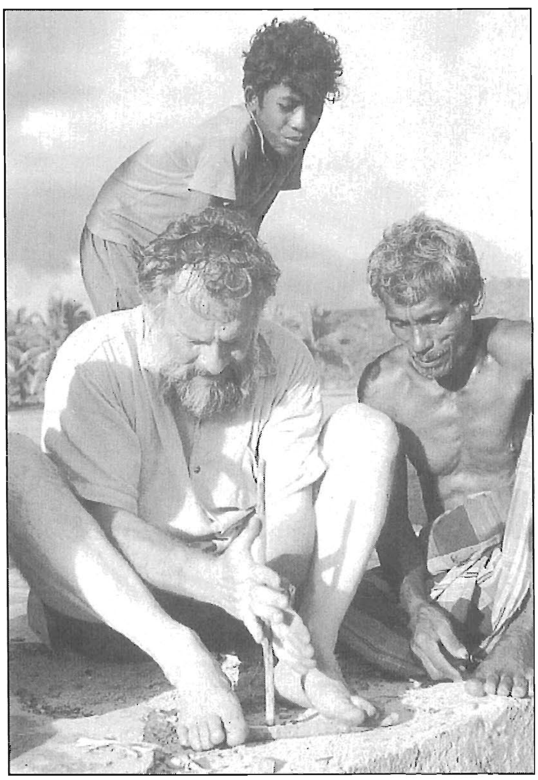


Fig. 8. *The author is taught to make fire with two sticks, by an old Rotinese craftsman who could still remember using this skill in his youth. This is one of countless replication experiments conducted as part of this project.*

Fig. 9. *The* Nale Tasih 1, *15 tons and 23 m long, is anchored in Oeseli Lagoon, Roti, Indonesia, shortly before departure.*

designs. All components and equipment could be procured by either Middle or Lower Paleolithic hominids, as the case may be, and could be worked with their respective stone implements to produce such craft. All of this must be practically demonstrated. The overall purpose of this detailed research program of replicative archaeology is to provide the data to create probability scenarios for at least two of the earliest successful sea crossings of the Pleistocene—the one that led to landfall in Lombok more than 800,000 years 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.

The first of the major replicative experiments was completed in March 1998 and the next are well under way. 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 (fig. 9). The raft consisted of 11 tons of bamboo forming five pontoons, lashed together with *rattan* and hand-made ropes, such as *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 (fig. 10). One hut contained a traditional fire box and most of the food supplies, 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 fig. 11). 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 Paleolithic technology, and this was demonstrated on camera. All materials used were likely to have been available in Nusa Tenggara during the Late Pleistocene.

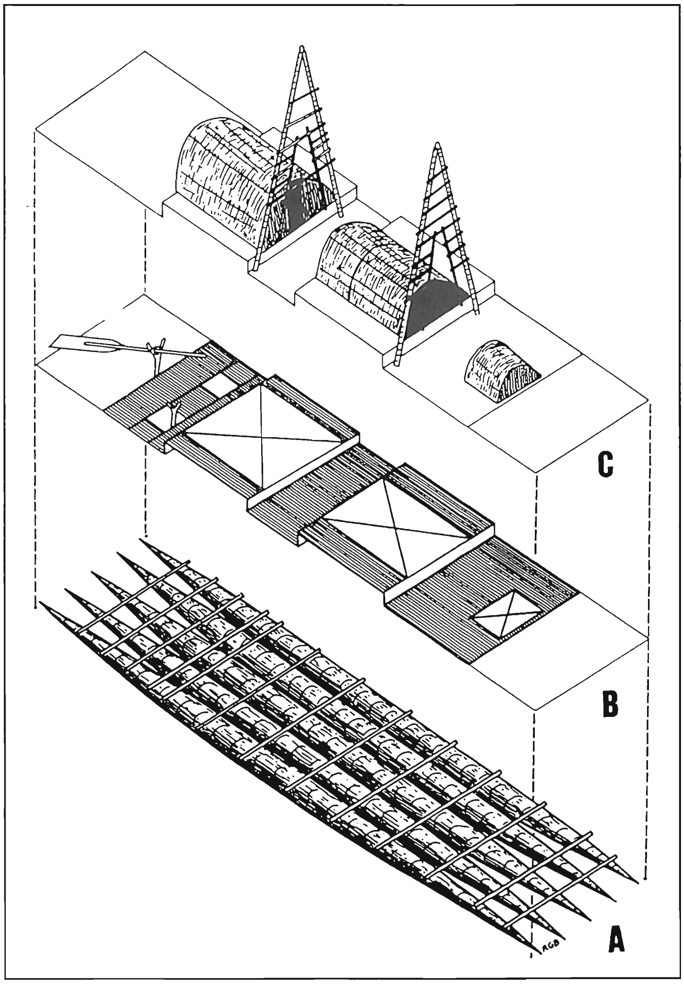


Fig. 10 (above). *Exploded view of the* Nale Tasih 1 *bamboo raft, showing the pontoons (A), decks (B) and superstructures (C).*

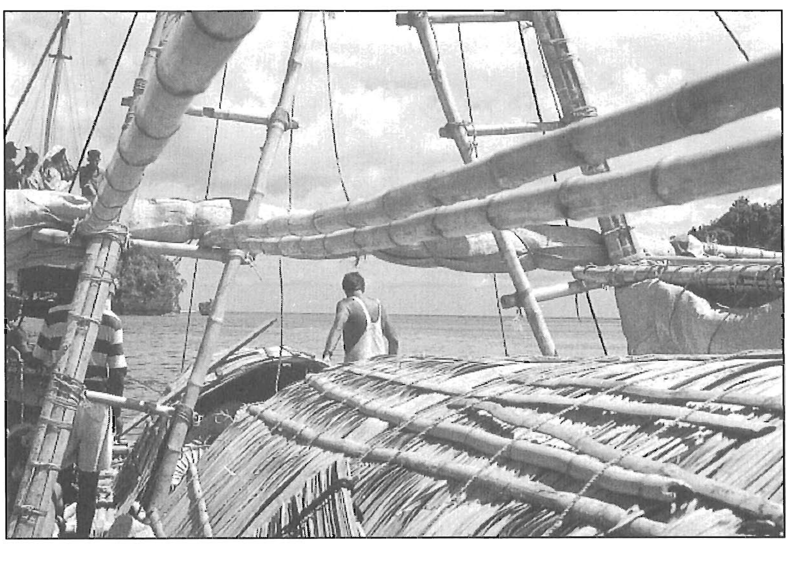


Fig. 11 (left). *The* Nale Tasih 1 *departs from southern Roti through the heads of Oeseli Lagoon, 6 March 1998.*

Fig. 12. *The* Nale Tasih 1 *is dissected by chainsaw as part of a program of destructive testing, 12 March 1998.*

After sea trials the 15-ton *Nale Tasih 1* was sailed back to Roti and beached at Oeseli for destructive sampling of all components. It was cut up with a large chainsaw to remove samples of bamboo for testing, and totally dismantled to the last part (fig. 12). The knowledge gained from this will significantly assist the future experiments in this series.

Conclusions

Some preliminary implications of this ongoing research have already become apparent. First and foremost, the *Nale Tasih 1* experience has shown with forceful clarity one fundamental truism that should have been apparent to us all along. A modern expedition of highly experienced and motivated mariners has failed to sail a primitive raft to Australia (fig. 13). 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. We know that seafarers of Middle Paleolithic 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 labor 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, 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, moderated by intuitive ethnographic analogy. 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.

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 Paleolithic seafarers whose descendants populated Australia had inherited

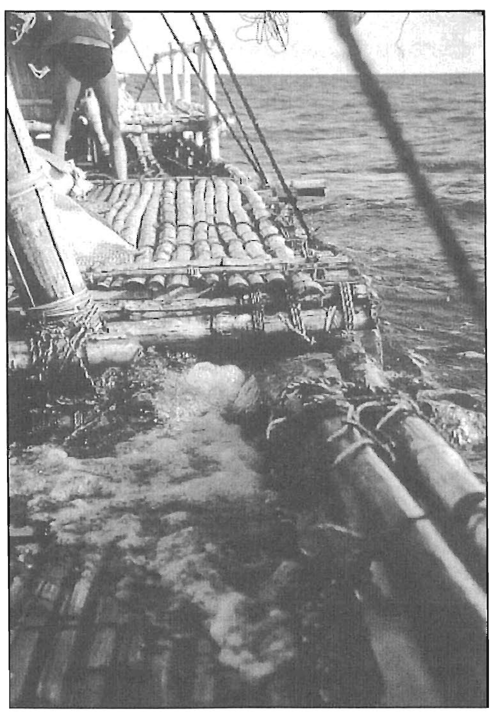


Fig. 13. *The* Nale Tasih 1 *on the Timor Sea, 8 March 1998. Most of the split bamboo deck is awash.*

Fig. 14. *The sail, made of palm leaves, is raised on the* Nale Tasih 1, *off the south coast of Roti.*

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 Paleolithic culture renders it most unlikely that this observation was not utilized, leading to the realization that the greater the windsail area, the greater its propelling effect (fig. 14). Cordage, in some form or other, was certainly used by Lower Paleolithic hominids, as were knots, 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.

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 paleoart; 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. 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—flotation, wind, water current and wave action. This was the moment in human history when man first became fully dependent on his technological creation. From here it was only a small step to Neil Armstrong's "giant leap for mankind."

Suggested Readings

Bednarik, Robert G.
1995 "Concept-mediated marking in the Lower Palaeolithic," *Current Anthropology* 36, 605-634.

Bednarik, Robert G.
1997 "The earliest evidence of ocean navigation," *International Journal of Nautical Archaeology* 26, 183-191.

Bednarik, Robert G.
1997 "The origins of navigation and language," *The Artefact* 20, 16-56.

Morwood, Mike J., Paul B. O'Sullivan, Fachroel Aziz and A. Raza.
1998 "Fission-track ages of stone tools and fossils on the east Indonesian island of Flores," *Nature* 392, 173-179.

The author, Robert G. Bednarik, can be contacted at Convener, International Federation of Rock Art Organizations (IFRAO), P.O. Box 216, Caulfield South, Vic. 3162, Australia, e-mail *aurawww@sunspot.sli.unimelb.edu.au* Figures property of R. G. Bednarik.

Conservation of Seventeenth-Century Canvas Using Silicone Oils

by C. Wayne Smith

C. Wayne Smith has been an important contributor to the Institute of Nautical Archaeology and the Nautical Archaeology Program at Texas A&M University for many years. His work in developing new techniques for archaeological conservation is internationally recognized.

Of particular interest is Dr. Smith's research in using silicone oils to preserve organic materials. This article describes the meticulous procedures required to conserve even relatively small and simple archaeological artifacts. Multiply this effort times the thousands of artifacts found in an INA excavation, and one can see why the post-excavation phase of a project can take several times longer than the excavation itself.

One of the challenges for nautical archaeology is providing adequate resources to finish the job that our archaeologists only begin. Without the support of groups like INA, this would be impossible. The Quarterly *is therefore glad to share this aspect of the Institute's work with its members.*

Excavations by Dr. D. L. Hamilton at the site of Port Royal, Jamaica, unearthed a large assemblage of artifacts from the seventeenth-century provenance of the colonial city. The unexpected catastrophic earthquake of 1692 that plunged a large portion of the city into Kingston Harbor has resulted in an archaeological site almost frozen in time. Silt, staghorn coral and modern debris have protected the sunken community from harsh degradation processes usually associated with underwater sites. As a result, many recovered artifacts are in excellent condition.

A gudgeon plate (artifact PR90 2074-17) from an ill-fated vessel that was being careened at the time of the earthquake is one such object. A powerful seiche wave had carried the vessel crashing into a building at the corner of King and Lime Street. At the time of recovery, this heavy metal plate was heavily concreted. Accordingly, the first stage in the conservation process entailed carefully removing the hard calcareous outer layer with a pneumatic chisel. Inspection of the interior surface of the plate revealed that a long strip of pitch-soaked canvas had been used as a backing between the gudgeon plate and the outer planks of the hull. To conserve an artifact containing varying types of organic and metallic components requires that each material be conserved individually. Only after each has been stabilized is it possible to reassemble the artifact for analytical purpose and display.

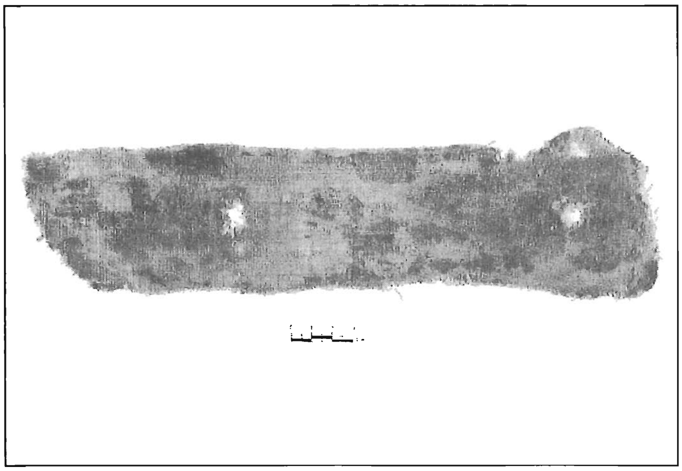


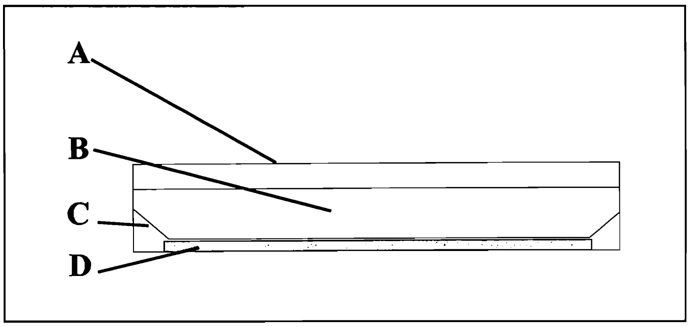
Photo: INA

Fig. 1. *The long, pitch soaked piece of canvas from the gudgeon plate after treatment with silicone.*

The canvas was carefully removed from the surface of the metal plate. Its relative good condition made this process easier. The rough edges of the fabric suggest that the canvas had been crudely cut to follow the form of the iron plate. Two squared holes were present in the section that was to be treated using silicone oils. These holes lined up with the remains of two large bolts, used to fasten the gudgeon to the hull. Using a low-magnification microscope, the warp of the fabric was counted at 20 strands per inch, while the weft averaged 14 strands per inch. The variance in warp and weft counts, as well as the grossly uneven shape of the strands, suggests that this material was of a low quality, produced for chandlery purposes rather than for fashionable clothing.

Once removed from the back of the gudgeon, the canvas was placed into a vat of fresh tap water, and its surfaces were lightly cleaned using soft brushes to remove loose debris and concretion. To assist in removing fine sediments, the fabric was placed on a sheet of glass; a slow stream of tap water was used for surface rinsing. Still mounted on glass, the fabric was then dehydrated in a vat of acetone. Dehydration served two purposes. First, acetone assisted in softening and dissolving pitch on the surface of the fabric. This allowed us to remove additional debris that could not be removed using water. Second, the acetone helped remove pitch from the canvas. With most of the pitch removed, the fabric was rinsed in several fresh water baths to remove soluble salts. Treatment continued using a bath of 5 percent hydrochloric acid in water to assist in removing oxide stains and minute specks of concretion. The fabric was then placed into a 5 percent solution of hydrogen peroxide for a brief period of time to remove heavy sulfide stains that were present. After additional rinsing in fresh water, the fabric was ready for treatment using passivation polymers.

In archaeological conservation using polymers, it is essential to remove free-flowing water from the artifact in treatment. This dehydration, or water/acetone exchange process, is necessary since silicone oils will not displace water in the matrix of an artifact. In this case, the process of water/acetone exchange was accelerated by placing the container holding the fabric and acetone into a vacuum chamber. A 20-mm vacuum was applied to the fabric until all bubbling ceased. The fabric was then placed between two sheets of lint-free paper and quickly blotted to remove some of the acetone in the fabric. After gentle blotting, the fabric was placed into a large, flat dish containing 500 mg of PR-10 passivation polymer with a 3 percent addition of CR-20 crosslinker (by weight). A mesh screen was placed on top of the fabric in solution as a means of keeping the cloth submerged in solution throughout the bulking process (fig. 2). The beaker was then placed back into the vacuum chamber, and as before, a 20-mm vacuum was applied to the artifact in solution for two hours. It was noted that vigorous bubbling ceased after 20 minutes, and no bubbles were noted after one hour of applied vacuum.



Drawing: C. W. Smith

Fig. 2. *Canvas in silicone oil treatment, A) flat container, B) PR-10/CR-20 silicone oils and crosslinker solution, C) friction fit aluminum screen, D) canvas artifact.*

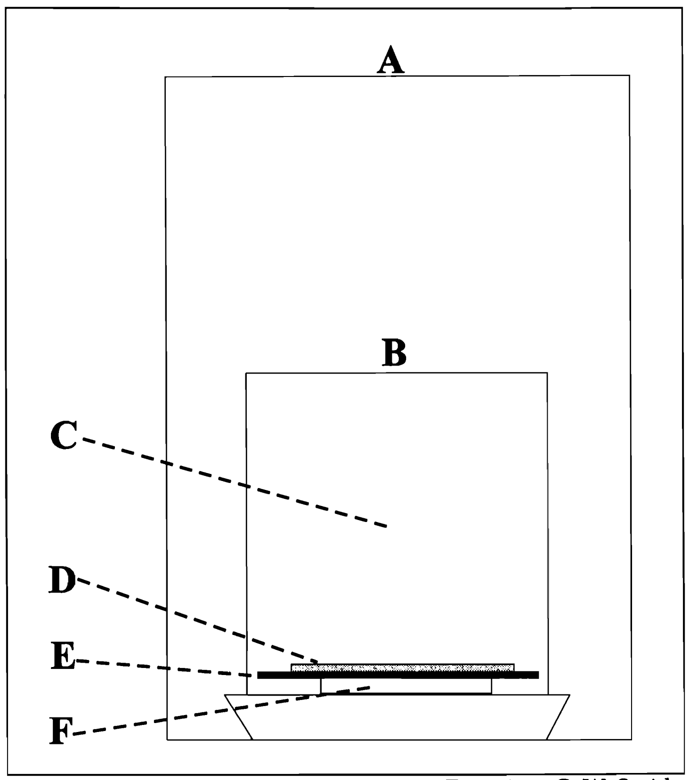
The addition of a catalyst is required to polymerize the PR-10/CR-20 solution within the matrix of the fabric. One effective means of adding catalyst evenly to an artifact is to warm the tin-based material sufficiently to create a vapor. To keep vapors in close contact with the artifact being treated, it is necessary to create a nearly air-tight containment chamber in which the artifact and the catalyst can be placed during the warming process. In this process, a containment chamber was created by using a polypropylene pail with a tight fitting lid. When inverted, the lid of the pail acted as the base of the chamber. A flat dish containing 2 ounces of CT-32 catalyst was placed in the center of the lid. A large mesh screen was placed over the dish to act as a platform on which the fabric could be placed. This allowed all surfaces of the fabric to be uniformly exposed to vapor fumes (fig. 3).

After placing the fabric and two ounces of CT-32 catalyst into the chamber, the chamber was tightly sealed and then placed into a vented warming oven for 24 hours. After two days of polymerization, the containment chamber was removed from the oven, and the fabric was allowed to sit in fresh air. Initially, the canvas felt slightly damp. After approximately 20 minutes, however, the artifact felt dry, flexible, and natural in coloration.

Observations

Care was taken to remove pitch, insoluble salts, and soluble salts without causing damage to the artifact. Accordingly, the fabric was only left in acetone dehydration long enough to remove surface deposits of pitch. As a result, diagnostic iron stains are clearly visible in the treated artifact. Experience has shown that extended periods of water/acetone exchange are not necessary for thin, open-weave materials such as canvas. During treatment of other artifacts, dehydration processes have been completed in as little as four hours.

Pre-treatment tracings and measurements of the canvas are interesting when compared to post treatment measurements. Data indicates that no determinable shrinkage occurred as the result of treatment. Measurements taken around and between the nail holes also suggests that no



Drawing: C. W. Smith

Fig. 3. *Containment chamber configuration, including A) warming oven, B) containment chamber, C) warmed catalyst fumes, D) canvas, E) aluminum screen, and F) catalyst tray holding tin-based catalyst.*

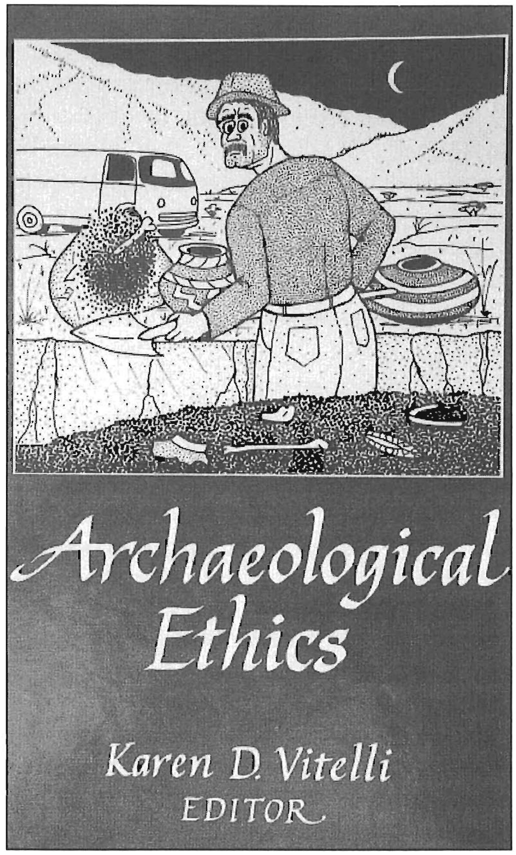
distortion of diagnostic attributes has occurred as the result of treatment. After five years of assessment and handling, the fabric is both flexible and reasonably supple. More important, this artifact has traveled to numerous conferences and has been handled by hundreds of conservators. It has been effectively stabilized with polymers, and thus does not require special curation.

Recently, J. David McMahan, an archaeologist with the Department of Natural Resources in Anchorage, Alaska visited the Archaeological Preservation Research Laboratory at Texas A&M University. During his week-long training, he preserved numerous samples of fabric and wicker basketry from the Castle Hill site in Alaska using a slightly modified version of the Port Royal canvas artifact process.

Review

by Donny C. Wood

Archaeological Ehtics
by Karen D. Vitelli, editor and introduction.
Walnut Creek CA: Altamira Press, 1996.
Appendices, resource guide.
ISBN 0–7619–0531–6, 272 pages. Price: $18.95, paper.



This easy to read collection of essays presents an excellent overview of the range of ethical issues in the field of archaeology. The essays, all chosen from *Archaeology* magazine, are well-selected. They are arranged in several sections including: looting and collecting, cultural materials in time of war, and reburial and repatriation. While the lion's share of the book is given to looting and collecting issues, including ownership of artifacts and the spoils of war, the selection and arrangement, and the fine variety of writing styles and personal opinions of the authors, results in a very concise presentation of the range of issues and complexity of standpoints concerning the treatment of archaeological sites and the materials contained within.

The editor has designed the book in such a way that, rather than proposing to offer any final words on "ethical archaeology," it serves to perpetuate and enlighten the ethical dialogue of which it is a part. One way this is achieved is by including lists of questions following each essay, addressing the main points that the author has brought into the continuing discussion. These questions bring the reader back to the often sticky ethical issues at hand, and also help to tie many of the essays together.

In the preface, the editor makes it clear that the book does not provide much coverage of ethical issues in nautical archaeology. Vitelli suggests that professionals in the field might recognize the need for more "articulate and compelling presentations" of the scientific archaeological side of these issues as pertaining to nautical excavation by reading this collection. One brief reference to nautical matters does appear in Vitelli's introduction concerning her personal excavations in Greece, when she explains that looters nearly destroyed precious data which led to the documentation of Paleolithic sea travel. Although nautical excavation is not expressly addressed by the book, all of the issues presented should be of interest to anyone engaged in any type of archaeological work.

One particularly outstanding essay, Spencer P. M. Harrington's "The Looting of Arkansas" cuts right to the heart of much of the current ethical issues addressed by this collection: the fact that archaeology as a science has changed dramatically over the last century, but that "looters" and "collectors" haven't, so archaeology has effectively divorced itself from these elements of its own past. As a cap on this collection of thought-provoking essays, the editor has included, in appendix form, professional statements on archaeological ethics and a resource guide including a basic bibliography.

"X" Marks the Spot

By Doreen M. Danis

In the deserts of New Mexico, part of our national heritage is being preserved using today's latest technology. Global Positioning Systems (GPS) are being used to record the locations of petroglyphs in Petroglyph National Monument. The petroglyphs, early attempts at written communication, were etched by the Anasazi Indians in the fifteenth century. Congress established the monument to preserve them in 1990. It is maintained by the National Park Service (NPS).

The locations of these petroglyphs can be recorded and studied using a combination of Geographic Information Systems (GIS), and GPS. Petroglyph National Monument sits on the edge of the rapidly growing city of Albuquerque, New Mexico, so it is particularly important to preserve the heritage left by the Native Americans from increasing urban sprawl.

Nautical archaeologists in the Tortugas National Park have also benefited from these systems. First named "Las Tortugas" by Ponce de Leon in 1513, this scattering of islands lies southwest of the Florida tip. Due to its location and natural features, the area has been the focus of much human activity. The arrangement of the islands results in a safe, natural harbor, but vessels traveling the outlying Florida Straits have made the islands the location of numerous maritime casualties.

The consequential rich deposits of archaeological remains have captured the attention of the Submerged Cultural Resource Unit (S.C.R.U.) of the National Park Service. In their efforts to inventory, map, and assess the underwater cultural resources in the Tortugas National Park, S.C.R.U. has relied heavily upon GPS and GIS technology. They have developed an exhaustive database that integrates cultural and natural resources data. This will greatly aid in evaluation, management, and future preservation of resources within the park boundaries.

The Nautical Archaeology Program at Texas A&M University hosted a seminar on GPS and GIS technologies on October 11, 1997. The seminar, with ten graduate student participants, was taught by Karen Steede-Terry, a Trimble Certified GPS trainer and former student of Texas A&M. The first half of the seminar included an introduction to Global Positioning Systems and the mapping/surveying technology previously available. Standard uses of GPS were discussed, along with its combined applications with Geographic Information Systems. The latter half of the seminar involved a practical application using these technologies. First, the class designed a data dictionary for field data collection using software that accompanied the GPS unit. Then the class went outdoors to collect an almanac and GIS features using Trimble Pro-XR and Geoexplorer equipment. These data could be downloaded and transferred into the GIS system.

What is GPS?

GPS is an abbreviation for Global Positioning Systems, a constellation of 25 satellite that orbit over 12,000 miles above the earth. These satellites are operated and maintained by the Department of Defense, and orbit the earth every 12 hours. Using the principles of triangulation, these satellites can pinpoint a location on the earth's surface, and give the information back to a special GPS receiver in the form of a latitude/longitude coordinate. The receiver uses at least 4 satellites to calculate a 3-D position (latitude, longitude, and elevation) and 3 satellites for a 2-D position without the elevation.

How accurate is GPS data?

The latitude/longitude reading indicated on a GPS receiver will not be a true position. The U.S. Government purposely degrades the accuracy of the signal from the satellite for national security reasons. This is called Selective Availability, or S/A. The S/A effect can cause a latitude/longitude position to be off by up 100 meters. This is a completely random error. In other words, S/A is very dynamic and cannot be predicted.

Photo: D. Carlson

Fig. 1. *Karen Steede-Terry (standing) lectures faculty and students at the two-day seminar on GIS and GPS held at Texas A&M University.*

Differential GPS

Fortunately, there are ways to get around S/A. Differential GPS (DGPS) can be applied to improve positional accuracy. A stationary GPS receiver at a known location (surveyed coordinate) can be used as a "base" or "base station." GPS positions at the base station can be logged 24 hours a day. The base station knows both its true surveyed location and its GPS indicated location and can calculate the offset between the two. Using this offset, it is possible to correct the GPS readings made by a mobile receiver in the vicinity of the base at the same date and time.

These differential corrections provided by the base station can be broadcast to the GPS units in the field (real-time DGPS), or applied to the collected positions back in the office (post-processing). DGPS can reduce the S/A error to anywhere from five meters to under one meter, depending upon the GPS receiver.

What is GIS?

GIS, or Geographic Information Systems, are computerized maps linked to a database. When features such as streets, trees, or land areas are queried on-screen, information about the feature stored in the database is displayed. For a street, this could be the name of the street, whether it is a boulevard or a drive, if it is paved or not, and if it has two or four lanes. For a petroglyph, this could be what the petroglyph is depicting, and its size.

When the NPS decided to record the Petroglyph National Monument features in a GIS, they were first located and recorded using the GPS. Over time, a significant historical database was collected, using the GPS to populate the GIS database. Once the positions were transferred to the GIS, it was easy to count how many total petroglyphs were in the National Monument.

The advantage of using a GIS is that the spatial relationship of features (objects) in the database can be analyzed. Geographic Information Systems can answer questions such as "What is on what?" "What is near what?" and "What is the relationship of this to that?" Using the information collected, it was easy for the Park Service to query the GIS to display areas where particular petroglyphs were grouped. For instance, petroglyphs depicting snakes were found closer to ancient water features than figures of lizards. The archaeologists also discovered that certain groups of Native Americans traveled together, as indicated by locations of petroglyphs depicting trading or bartering scenes. One recurring petroglyph, Kokopelli, the ancient fertility god, was blamed for crop failures and other catastrophic events.

At Tortugas National Park, the GIS database of the Submerged Cultural Resource Unit is able to display wrecks of specific periods with a keystroke. The display includes photo images and any relevant information of key points of interest on each wreck. The team records all magnetometer surveys and collected anomalies in the same database.

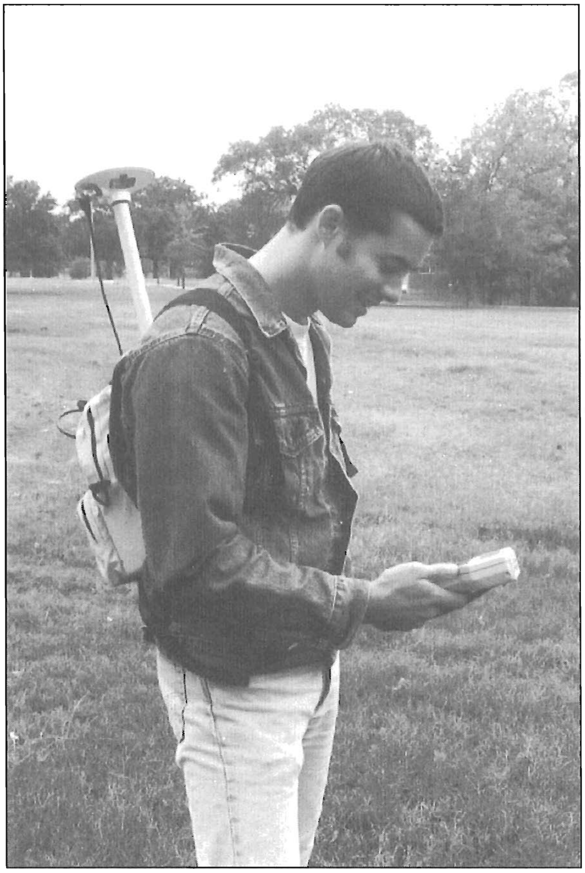


Photo: D. Carlson

Fig. 2. *Graduate student, Mike Scafuri, takes readings in the practical exercise.*

Acknowledgments. Trimble Navigation, Ltd., has been generous to the Nautical Archaeology Program and the Institute of Nautical Archaeology in loaning and contributing their equipment. Karen Steede-Terry deserves particular credit for her efforts and remarkable "know-how" in training our graduate students in these new systems.

For Further Information

Fletcher, M. and D. Sanchez
1994 "Etched in Stone: Recovering Native American Rock Art." GPS World (October), 20–24.

National Park Service
http://www.nps.gov/scru

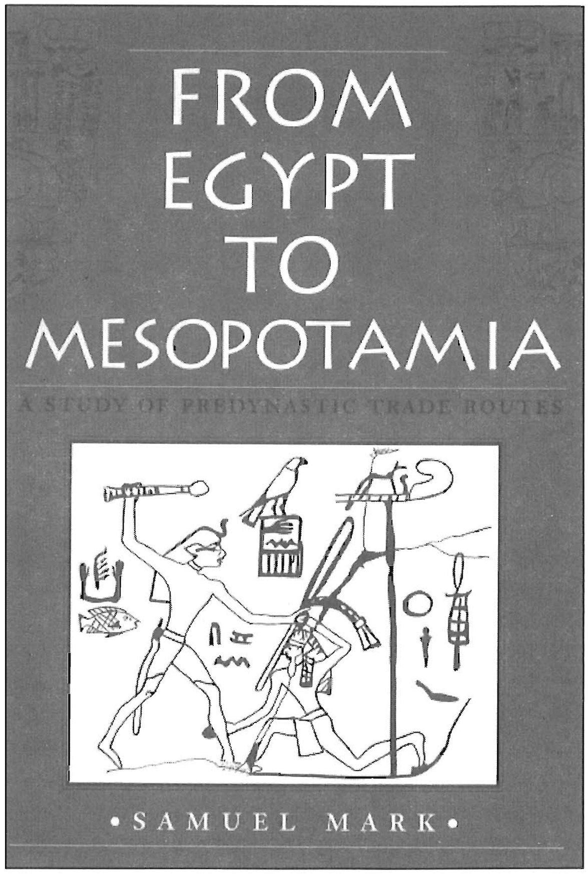
Steede-Terry, K.
http://www.concentric.net/~Cms1/

Trimble Navigation Ltd.
http://www.trimble.com

Just Released

by Dale A. Rye

From Egypt to Mesopotamia
by Samuel Mark
College Station: Texas A&M University Press, 1997
ISBN 0-89096-777-6, 181 pages, 57 illustrations, references, bibliography, index, hard cover.



How many times was "civilization" invented? That question has fascinated historians and archaeologists for centuries. Complex cultures with urbanism, advanced agricultural technology, centralized government, and record keeping now dominate the world, but they had to start someplace. Was that one place... or many?

Samuel Mark, the Mr. and Mrs. Ray H. Siegfried II Graduate Fellow in the Nautical Archaeology Program at Texas A&M University, has made an important contribution to this ongoing debate. *From Egypt to Mesopotamia* moves beyond speculation to investigate the actual evidence for contacts between two ancient civilizations. This is a study of the predynastic trade routes that linked prehistoric Egypt with protoliterate Mesopotamia. However, it also serves as an introduction to these two nascent civilizations and the possible links between them.

Mark admits that the evidence is scanty. Most of the traffic in finished goods, and the transfer of artistic motifs, moved from Mesopotamia to Egypt. Possible cultural influences seem, therefore, to have primarily gone in that direction. This would seem to support those who claim that civilization began in Sumer and was exported to Egypt and ultimately throughout the world. However, it seems likely that much of the trade moving out of Egypt consisted of raw materials such as gold, which leave few identifiable traces in the archaeological record once they have been processed at their destination. This makes it very difficult to study these intercultural contacts from the Mesopotamian end.

The argument of the book must thus be based primarily on Mesopotamian items and motifs found in Egypt and intermediate sites. It is clear that Egypt had very strong cultural traditions of its own in both Lower (northern) and Upper (southern) Egypt. Those cultures grew primarily on their own or through interaction between themselves, and any Mesopotamian influence was subtle. The bulk of Mark's effort is devoted to unraveling these subtle clues. He concludes that the contacts were substantial, but that they mostly came through the Delta. He gives persuasive arguments to dismiss earlier claims of direct contacts between Mesopotamia and Upper Egypt by a water route around southern Arabia.

However, he also shows that sea transport was likely to have played an important part in this trade. Before the domestication of the camel, the direct land routes from southern Mesopotamia towards Palestine were impractical. So, the most important routes seem to have led up the rivers from southern Mesopotamia, then across to the coast of northern Syria. From there, trade could move north into Anatolia or south towards Egypt. The evidence suggests that a large part of this trade moved by ship rather than land transport. The famous counter-clockwise pattern of trade in the eastern Mediterranean moves from Egypt north along the Syro-Palestinian coast, then west along Anatolia, and finally south with the prevailing winds and currents back to Egypt. Mark concludes that this pattern dates back into prehistory.

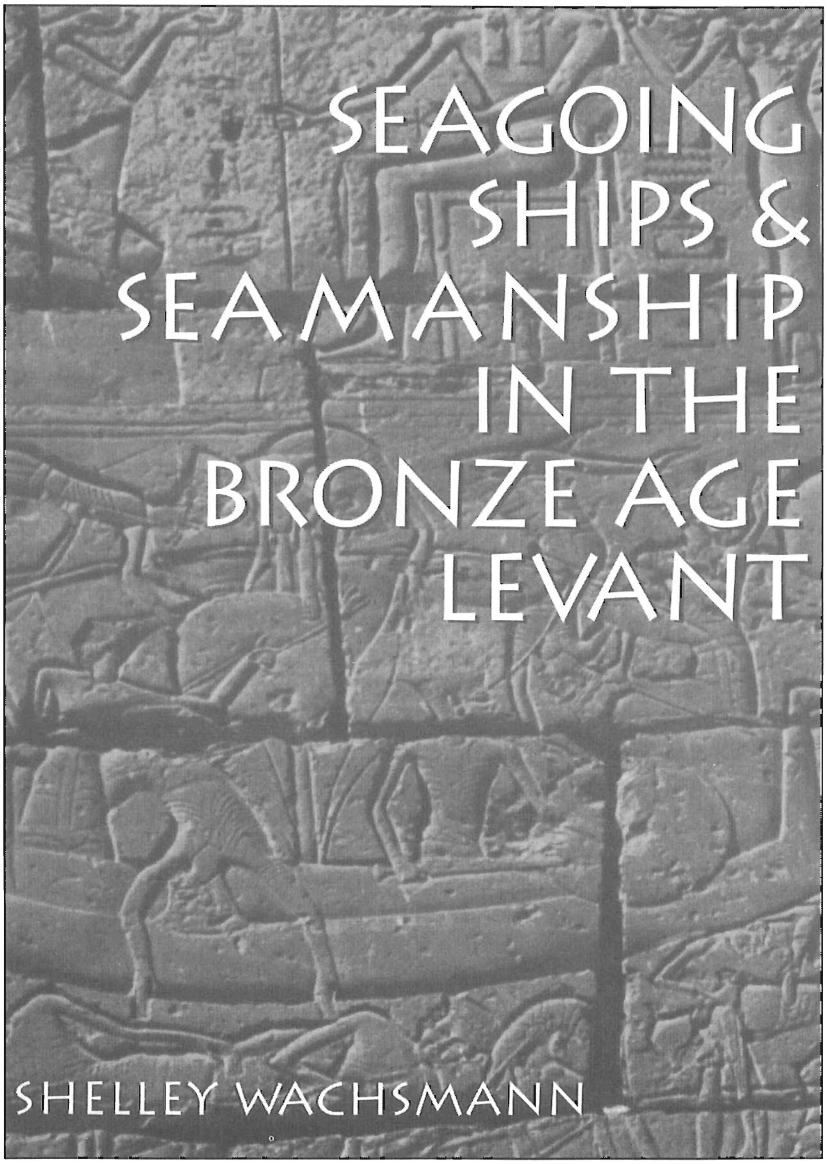
As the author points out, trade in raw materials tends to leave very few traces in archaeological sites on land. Organic materials decay and precious metals are looted. What remains are mostly manufactured items that point to their place of assembly, rather than to the origin of their materials. We know as much as we do about Bronze Age trade because of two factors: we have some of their written records and a few shipwrecks with preserved cargoes. For the prehistoric and protoliterate eras, we have neither records nor cargoes. However, if Sam Mark is right, much of the early trade between Mesopotamia and Egypt was carried by ship. Perhaps INA will find and excavate one of those ships someday. We can always hope!

This is the fourth volume in the *Studies in Nautical Archaeology* series from Texas A&M Press and Chatham Publishing in London. The book meets the high publishing standards set by its predecessors. It is richly illustrated with fifty-six line drawings done by Mark himself. INA members should buy this book, particularly since it is available to them at a substantial discount.

Just Released

by Dan Davis

Seagoing Ships & Seamanship in the Bronze Age Levant
by Shelley Wachsmann
College Station: Texas A&M University Press, 1998
ISBN 0-89096-709-1, 417 pages, 439 illustrations, references, glossary, bibliography, index, hard cover.
Price: $80.00 (INA members $68.00)



INA's own Assistant Professor Shelley Wachsmann has met a long-felt need with his new book, *Seagoing Ships & Seamanship in the Bronze Age Levant*. Copiously illustrated, articulately written, and rich in text references, this highly organized *corpus* provides the general or specialist reader with a comprehensive account of Bronze Age Eastern Mediterranean seafaring. Wachsmann's succinct, sound writing tells the tale of the earliest seafarers, their craft, and their impact on the course of history by employing three forms of evidence: textual (including inscriptions, papyri, and tablets), archaeological (shipwrecks and related terrestrial sites), and iconographic (pictures on pottery, murals, models, and reliefs). For the last-mentioned, because it is enticing to view each image as somehow close to reality, Wachsmann provides a sagacious warning: "In ship iconography, we see not ships but representations of ships "refracted" through the eyes, culture, schooling, mental attitudes, and skills of their creators."

The book is organized into two parts; the first surveys the ships of different regions of the Mediterranean in counter-clockwise fashion, beginning with Egyptian ships (chapter 2), then proceeding to the Syro-Canaanite littoral (3), Cypriot ships (4), early Aegean ships (5), Minoan/Cycladic ships (6), Mycenaean/Achaean ships (7), then finally the ships of the Sea Peoples (8).

Wachsmann provides a convenient appendix on the Pylos Rower Tablets, while J.R. Lenz contributes another on Homer's *νηῦσι κορωνίσιν* ("bird-beaked" or "curved" ?), an epithet often assigned to ships in the *Iliad* and the *Odyssey*. Summaries of current scholarship in each area help the reader fit each facet of evidence into context. Iconography of ships has been the subject of much debate in specialist scholarship; Wachsmann deftly balances the extremes by introducing the reader to each side of specialist scholarship. Here the reader may not agree with some conclusions. However, as a man who has spent a considerable amount of time trying to come to grips with the realities behind the sometimes-meager evidence, it must be said that Wachsmann's researches in this regard carry considerable weight.

Of fascinating interest is Wachsmann's interpretation of the Theran ship-procession freeze in chapter six. The dead bodies littering the water amongst the ship have long been interpreted as victims of military action, although the ships and people on land appear not to exude a militaristic purpose. In light of recent discoveries indicating the existence of human sacrifice in nearby Minoan Crete, Wachsmann assigns to them a cultic significance whereby victims were intentionally killed in ritualistic fashion, then dumped into the water. The answer, however, is probably not so simple, as the entire freeze is filled with complex and often cryptic symbolism.

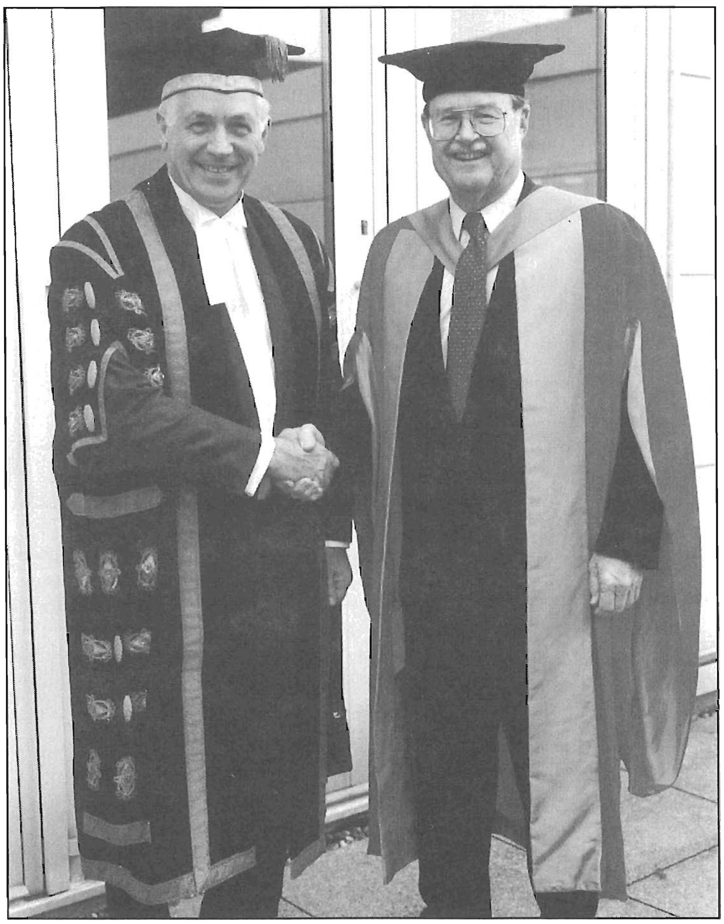
The second part of the book covers other aspects of maritime activity. A chapter on ship construction critically treats each individual piece of evidence and successfully outlines the different methods with detailed illustrations. INA Associate Professor F.M. Hocker contributes an appendix entitled, "Did Hatshepsut's Punt Ships Have Keels?", referring to the famous ship relief and inscription detailing the Red Sea trade journey of the XVIIIth dynasty Egyptian queen to lands south of Egypt.

The next three chapters–propulsion, anchors, navigation–cover the practicalities and physical nature of seafaring. Those interested in anchors (the "brake" of the ancient world) will appreciate the bountiful use of scaled line drawings and photographs of excavated anchors, as well as the detailed survey of their find context.

Finally, chapters 14–16 sketch the peripheral effects of seafaring that permeate a region that is inextricably linked to the sea. Wachsmann draws parallels to the piratical raids of the Northern European Vikings to elucidate one aspect of the Bronze Age collapse around 1200 B.C. A short treatment of sea laws is a first of its kind for this period.

Of flaws there are few. Although strewn throughout with text references, the book's end-note format causes inconvenient page turning. Ethnographic parallels, though intriguing, sometimes fail to enlighten. But these are minor criticisms better left to the reader to judge. For a book that ranges across centuries and cultures, Wachsmann has succeeded in producing a highly organized and excellent resource that surely will be used for years to come. It is punctuated with pointed personal essays, clear insights and sharp judgements while at the same time staying true to its theme, that of getting to the roots and evolution of the region's nautical heritage.

News & Notes



Bass Honored

On July 8th 1998, INA President George F. Bass was awarded the Degree of Doctor of Letters (*honoris causa*) by the University of Liverpool, England, in recognition of his accomplishments within the field of archaeology. As our readers know, the excavation of the Bronze Age shipwreck at Cape Gelidonya in 1960 was the first scientifically-controlled exploration of an underwater archaeological site. Dr. Bass, as the director of that excavation, has often been called "the Father of Nautical Archaeology." The excavations he subsequently directed at Serçe Limanı, Uluburun, and elsewhere have revolutionized our knowledge of ancient seafaring. Not least of his accomplishments has been his twenty-five years of leadership in the Institute of Nautical Archaeology. He has mobilized public support for the discipline, even in the face of the glamorous press attention often given to treasure hunters.

Vice-Chancellor Love (left) of the University of Liverpool with Dr. George F. Bass on the occasion of Dr. Bass' honorary doctorate.

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