



Professor Edwin Doran, Jr., was appointed AINA Adjunct Professor of Nautical Culture History a year ago. As a faculty member at Texas A & M University, Prof. Doran is vital to the Nautical Archaeology program there, where he teaches the cultural history of water craft, including both western and far eastern traditions. A specialist in the water craft of Oceania, Prof. Doran is uniquely suited to introduce AINA Newsletter readers to this topic.

EASTERN WATERCRAFT

For most of the same reasons which have led Western scholars, whether historians, classicists, geographers, or other, to study the West most intensively, so also nautical archaeologists thus far have spent the vast preponderance of their efforts on Western underwater sites. The exciting results, from mortises and tenons on the Kyrenia wreck, to new appreciation of Viking watercraft at Roskilde, to the oldest extant sea astrolabe recovered at Padre Island, are well known to readers of this newsletter. It may be appropriate, however, to point out that almost no attention has been paid to the watercraft of the rest of the world. The sketchy historic record on Chinese watercraft goes back about 4,000 years, but nautical archeological information is restricted to little more than Cantonese clay models of the first century after Christ and the remains of a 14th century patrol craft. In the island world of Indonesia and the Pacific there is only one nautical prehistoric date, about A.D. 800, for the outrigger craft of Boro Bodur. Until such time as archeological data begin to accumulate we must continue to rely for understanding on sparse historical data from China and on studies of present-day craft in the Pacific. In both areas land archaeology is progressing and nautical inferences occasionally are possible. Rath-

er than cataloguing what we know and can guess about watercraft in this part of the world, let us instead look at a series of puzzling questions, and in discussing them bring out a few significant aspects of Eastern watercraft.

During the couple of million years that men have inhabited the earth when was it that they first travelled on the water? The simplest craft we know at present are bundles of reeds lashed together into rafts; well-known examples are the balsas of Lake Titicaca and Heyerdahl's *Ra* (Fig. 1). Such reed rafts have a world-wide distribution, albeit a spotty one, and require

only reeds, string, and a cutting tool for their manufacture. Requisite mental ability and material culture have been available for at least 100,000 years, and man's first venture onto the water may have occurred that long ago. Certain evidence lies in the human remains found in Australia and dated by C¹⁴ at perhaps 35,000 years. Even during lowered sea levels of the Ice Age there were several channels of width exceeding 25 miles between southeast Asia and Australia; men must have paddled across them, perhaps on crude bark rafts such as those used by the Tasmanian aborigines.

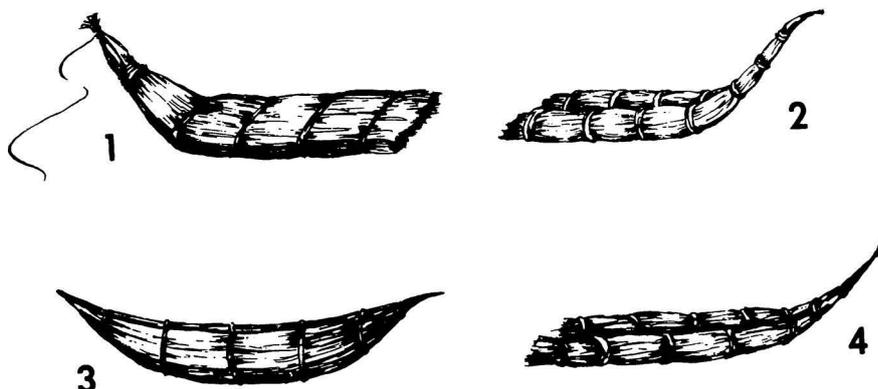


Fig. 1. Reed rafts, (1) Sudan (2) Lake Chad (3) Persian Gulf (4) Peru. (After Suder, 1930, Plate 10.)

If men have been travelling on the sea so long when was it that they first crossed an ocean? Conventional wisdom in the west has now taken that honor away from Columbus and awarded it to the Vikings of about A.D. 1,000, but even if we avoid the controversial question of Phoenician crossings we must go farther back in time, to about 3,000 B.C. for the best current evidence. Traits in an Ecuadorian archaeological site (C-shaped villages, cotton, pottery) appear to be closely analogous to traits during the Jomon period of Japan. And present-day sailing rafts of Ecuador and Peru are curiously similar to sailing rafts in Taiwan and Vietnam. On both sides of the Pacific rafts are formed from an odd number of logs or bamboos, and sail very well, even to windward, with the aid of multiple daggerboards (Fig. 2). In both places sailing balance is altered by vertical manipulation of the boards, in Peru to the extent of eliminating use of a rudder.

A number of people find these similarities on opposite sides of the ocean persuasive evidence of early crossings; others, perhaps more numerous, do not.

On one point, that sailing rafts in the Orient are very old, there is unanimity. Many years ago James Hornell, the great authority on primitive watercraft, suggested that sailing rafts might be the ancestral form from which Chinese junks descended. More recently Needham has presented literary evidence, from Chou times particularly and in part from Shang, supporting Hornell's theory. Although the hundreds of rafts along the southwest coast of Taiwan now are mostly motorized and in some cases use plastic "logs" instead of bamboo, it has been possible to learn something of their present (and past?) sailing characteristics and seaworthiness from the few remaining rafts and their sailors. The rafts will certainly sail to windward, perhaps the earliest craft in the world to use this

technique, will last in salt water for many months before destruction by teredos and rotting, and can be righted by their crews in case of capsizing. A modern experimental raft analogue has been constructed and test-sailed recently in confirmation. The raft goes to windward nicely and can be steered without a rudder simply by raising and lowering the aftermost of two daggerboards.

The historical development of Chinese junks is known, but in outline only, from Han times to the present. The existence of the stern rudder in China by A.D. 100 is proved by the clay models already mentioned, thus preceding the first known stern rudders in Europe by more than a thousand years. More than a millennium of gradual development culminated in the Ming navy of the early 15th Century. Larger than all fleets of Europe combined (3800 ships, 400 warships) it was dominated by 250 great "Treasure" ships, alleged to have been 450 feet long with a beam of 184 feet and displacement of 1200 tons. If the figures are accurate these were the largest wooden ships ever built. A famous admiral, Cheng-ho, made seven voyages with large fleets in the first thirty years of that century, visiting such far-flung places as Java, Ceylon, the Red Sea, and the east coast of Africa.

It is a strange fact that the great ships of the Ming fleet differed in almost every imaginable way from European ships and yet functioned as well. Chinese ships then and now have transom ends and relatively flat bottoms without keel, in contrast to round or V-bottoms, keels, and pointed ends (until the 13th Century) of European ships (Fig. 3). Stern rudders (compared to European quarter rudders) and total dependence on massive wales for longitudinal strength (instead of keels) also contrast. The broadest point of the ship (master couple) in European ships lay forward of amidships because a ship was patterned after a fish. The Chinese placed the master couple aft of amidships because a ship should look "like a duck." (Modern tank testing, and a look at quarter-ton racing yachts in any marina, prove that the Chinese were correct in their assessment.) Multiple masts, absence of

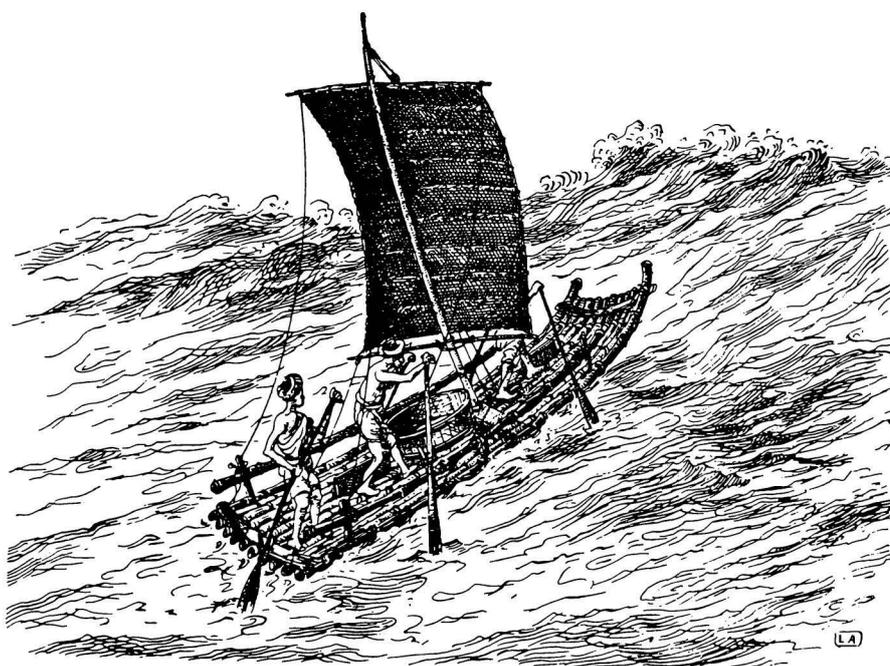


Fig. 2. Sailing raft of southeast China. Similar rafts in Taiwan carry batten lug sails, those in Vietnam use rectangular lugs, and those in early Ecuador had Oceanic sprit sails. (After Audemard, 1957-63, by permission of Maritiem Museum "Prins Hendrik," Rotterdam.)

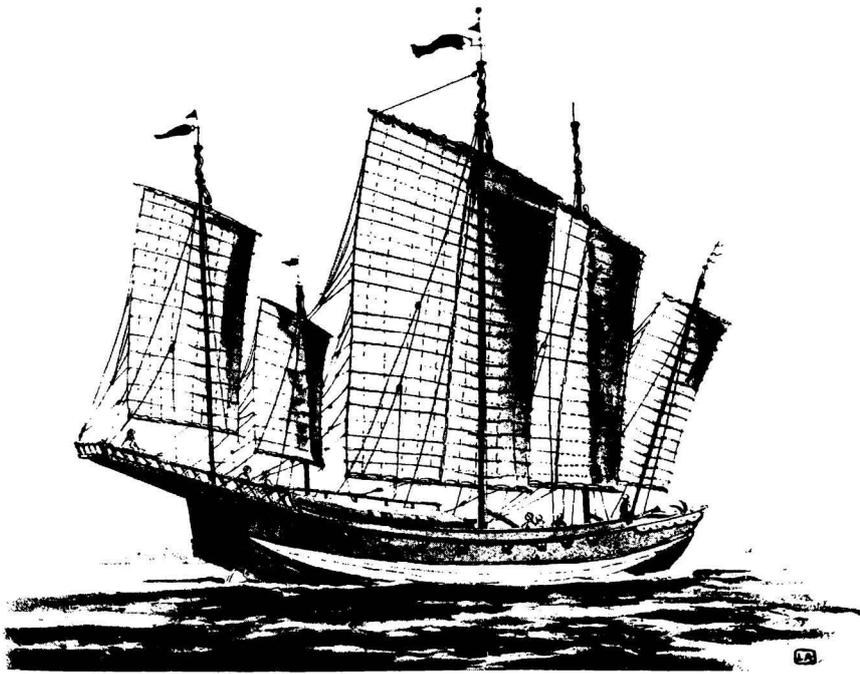


Fig. 3. A small north Chinese junk. The "Treasure Ships" are thought to have been similar but far larger. (After Audemard, 1957-63, by permission of Maritiem Museum "Prins Hendrik," Rotterdam.)

shrouds, batten lug sails with multiple sheets, windlasses, anchors — all of these are different on Chinese ships and yet all are as functional as the European solutions to the same problems. In many ways Chinese ships were more efficient than their contemporaries in Europe at any given time; their use of the mariner's compass, stern rudder, fore and aft sails, windlass, and watertight bulkheads preceded European adoption of these features by anywhere from a hundred to well over a thousand years.

Another great boat tradition, that of the Oceanic canoe, diverges from the raft-junk tradition at a very early date, perhaps 9,000 B.C. and under conditions still mostly obscure. Early Austronesian speakers, related to the Thai-Kadai linguistic groups of south China, probably moved across to Taiwan using double canoes, then southward through the Philippines. From northern Kalimantan (Borneo) and Sulawesi (Celebes) they

moved both southwest into the Greater Sunda Islands and east into the Pacific. This reconstruction, it must be noted, is based on limited linguistic and archaeological evidence, but the preliminary evidence is intriguing.

There is reason to believe that exciting developments in understanding the culture history of Southeast Asia and Indonesia will take place in the next decade or so. For example, it may be that the oldest use of bronze in the world lies in Thailand rather than Mesopotamia and it is equally possible, based on Gorman's work and Sauer's prescient guesses of a quarter century past, that the world's earliest agriculture developed in Southeast Asia. Civilization may have spread west toward India and north into China rather than the conventionally accepted southward movement of early Chinese culture. Archaeologically this area is about as well known as the eastern Mediterranean was before Schliemann

discovered Troy; the Pacific area is little more advanced.

Although ethnologists have worked intensively from Indonesia to Easter Island during the last century it is only in the last two or three decades that archaeology has begun to refine and to date some of the earlier studies. We now are aware of what seems to have been a very rapid push of people, users of a distinctive type of pottery called Lapita, from the Admiralties as far as Fiji about 2,000-1,500 B.C. After a period of consolidation and the development of proto-Polynesian culture, pottery users moved on to Tonga, Samoa, and eventually the Marquesas. Well before A.D. 1,000 the far corners of the Polynesian triangle, Hawaii, Easter Island, and New Zealand had been reached by people using seaworthy watercraft.

Although there is no archaeological evidence for boats it was clearly the double canoes and single outriggers of Polynesia, both using Oceanic sprit sails and tacked head to wind (as our yachts tack), which were the craft used in these last and outermost voyages. They probably represent the oldest types of watercraft in the Pacific (Fig. 4). The single outriggers (and rare double canoes) found

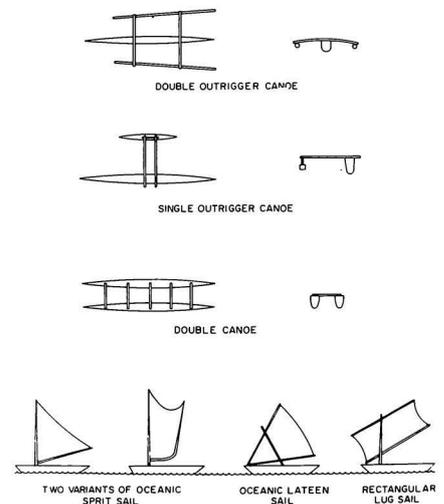


Fig. 4. The three hull and sail types of the Pacific. (After Doran, 1974, by permission of the Journal of the Polynesian Society.)

from Palau to Fiji by earliest explorers appear much the same in form but are sailed completely differently. They "shunt" to windward, alternating ends of the boat as they tack, and thus always keep the outrigger float (or smaller hull in the case of double canoes) to windward. They are propelled by Oceanic lateen sails, and are much faster than

Polynesian canoes. This new technique of sailing seems to have intruded from the west and moved rapidly eastward. In historic times the change to the new idea was noted in Tonga, Samoa, and the Ellice Islands, and the tacking technique had been adopted by some people as far east as the Tuamotus. The most recent configuration is that of the double out-

rigger canoes of Indonesia, craft with one central hull, balancing floats out to both sides, which are tacked head to wind rather than shunted. These new craft were just beginning to move eastward out of Indonesia (to the Cape York peninsula of Australia and to one island in Melanesia) when Europeans appeared on the scene (Fig. 5).

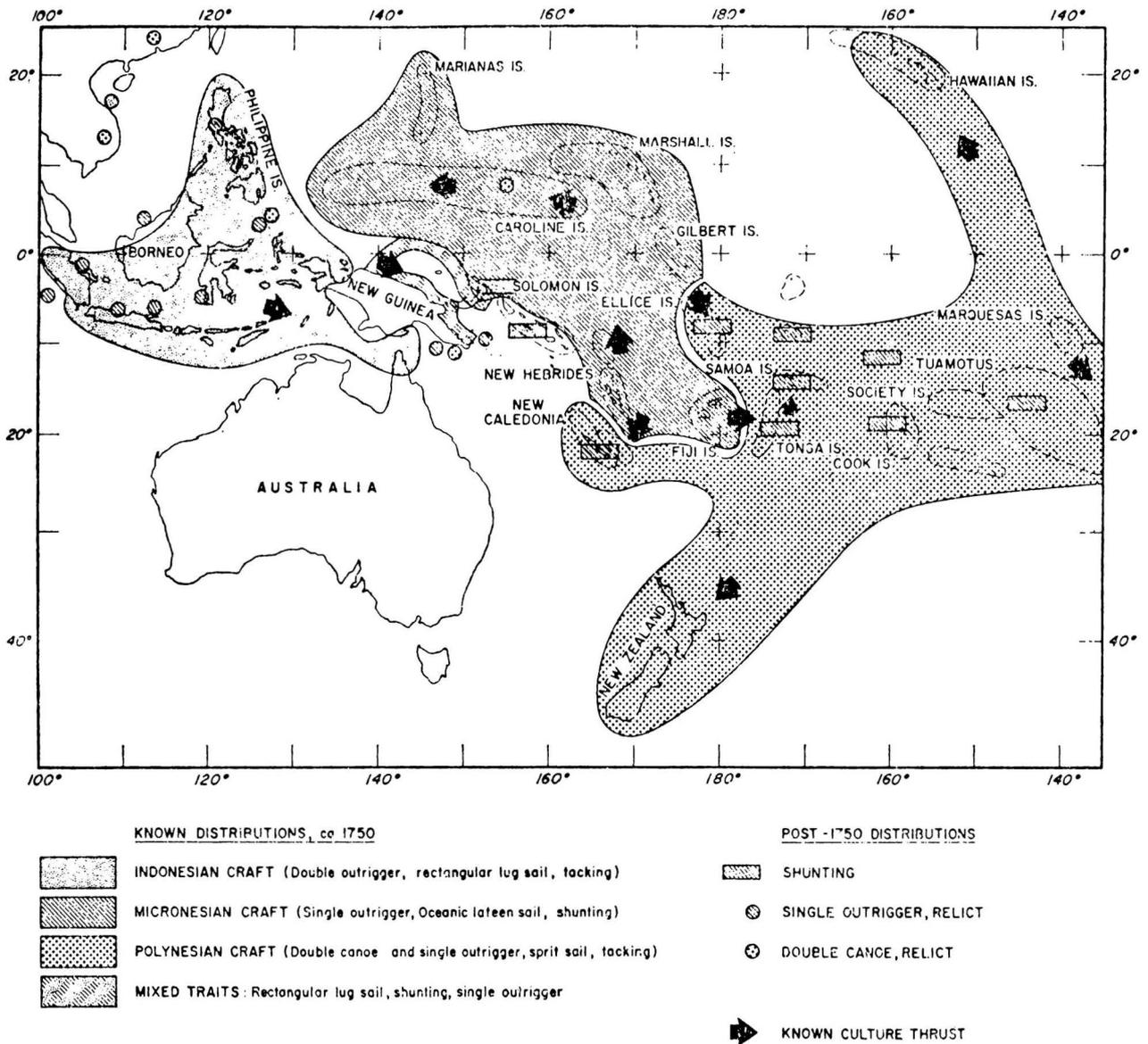


Fig. 5. Distribution of the three principal canoe types in the Pacific. (After Doran, 1974, by permission of the Journal of the Polynesian Society.)

Continued studies in ethnology, the newer studies in conventional archaeology, and the newest work in experimental archaeology are beginning to suggest answers to questions which have plagued Europeans since Captain Cook first changed his mind on the subject: whence, when, and how did the people of the Pacific come to settle on their far-flung islands? *Whence* and *when* have been sketched above and are being answered in more and more detail by studies in linguistics and archaeology. *How* is being elucidated by ethnology and experimental archaeology. David Lewis found native navigators still making bluewater voyages of hundreds of miles in the Western Pacific. He sailed with them, learned their skills, and has presented convincing evidence that their navigational abilities were amply good to guide them anywhere in the Pacific. A computer simulation of 100,000 drift voyages by Levison and colleagues has demonstrated the utter unlikelihood of drifting accidentally from central Polynesia to any of its three corners. The voyages of discovery must have been intentional, and the only remaining question is whether they were continued back and forth. Finney's demonstration with the *Hokule'a* that a doublecanoe analog is adequately seaworthy and, aided by Lewis and Piailug, that navigation is precise enough to sail from Hawaii to Tahiti did not prove that roundtrip voyages were made — but they surely could have been.

Some descriptive detail, based on the literature and on modern experimental work, may add strength to our current impression that Pacific canoes were amply capable of voyages of 2000 miles. First, the term canoe is deceptive and tends to make Westerners think of small boats. Actually the craft often were small ships; canoes over 100 feet in

length and equal in size to Captain Cook's *Endeavour* are known from half a dozen places in the Pacific. (I paced off dimensions of a *basnig*, a large double outrigger canoe, near Zamboanga: length overall 115 feet, "wingspan" from float to float 110 feet; depth from gunwale to bottom of basal log 8 feet.)

Seaworthiness is a useful but somewhat ambiguous term, and there have been disagreements about Pacific canoes and their ability to make long voyages. Certainly stability, resistance to capsize, is one element of seaworthiness which has had to be solved by all persons who have built ships. Westerners and Chinese approached the problem by compromising between the increased stability (but also increased resistance) which occurs with wider ships and the speed which goes with long and narrow vessels. In each case the compromise was a length to beam ratio of about 3:1, a relationship which is almost constant in the sailing ships of both areas throughout their history. Oceanic islanders, however, increased stability by outrigger appendages or by doubling of hulls and thus achieved the capacity to carry sail without sacrificing fast hulls of perhaps 10:1 length to beam ratio. Some recent calculations also indicate a surprising bonus in multihulled craft: as the angle of heel increases their stability *increases* for awhile before ultimate capsize. This makes possible flying the hull of a modern catamaran under sail and also flying the float of a single outrigger canoe. (The seeming paradox comes from the fact that with increased angle of heel the wind force on the sail decreases with the cosine squared of the heel angle, whereas stability of the hull decreases only with the cosine of the angle.)

Another aspect of seaworthiness is speed, and we know with some certainty that prior to the development of modern

catamaran yachts the canoes of Oceania were the fastest sailing craft ever built by man. Gilbertese canoes have been measured at a speed of 17 knots, proas in the Marianas reached estimated rates of 22 knots, and an express canoe once sailed from Guam to Manila in four days, averaging over 14 knots. Only the clipper ships of mid-19th Century ever rivalled these speeds, and the clippers were anywhere from twice to eight times as long. The explanation for such speeds, far exceeding the visiting ships of European explorers, lies in long and slim hulls with low resistance to movement through the water. Only in the last 25 years, with the advent of modern multihulled analogues to Pacific craft, have such records been surpassed. (For comparison, the fastest sailing vessel in history is *Crossbow*, a modern British proa, which has sailed at 31 knots.)

A third aspect of seaworthiness is ability to sail close to the wind making good progress to windward. One example from the Pacific will suffice. An early European ship took nine days to tack from Kuria up to Abemama in the Gilberts. They were followed in by a fleet of canoes which had beat up overnight from the same starting point. Modern measurements, on various kinds of aboriginal boats and on experimental analogues, confirm earlier estimates. In short, Pacific watercraft were amply capable of making the long voyages attributed to them.

Our greatest lack in knowledge of Oceanic and Indonesian watercraft is good time perspective. The advent of nautical archaeology now makes it possible for this gap to be filled, and I look forward to the time when AINA scientists and students begin to work on submerged wrecks in the western Pacific.

—Edwin Doran, Jr.



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