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The Theory of the Archaeological Raft: Motivation, Method, and Madness in Experimental Archaeology

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Between 1947 and 2006, nearly forty expeditions set out in recreated maritime drift vessels to demonstrate hypotheses with varying levels of relevance to archaeology and cultural diffusion. This paper divides the motivations of these expeditions into four major categories; examines more closely the expeditions that were based on serious scientific hypotheses; and establishes criteria for ranking the eleven expeditions deemed to have produced archaeologically significant results.

> The imitative focus on the Heyerdahl-inspired balsa and reed ships has almost entirely obscured other, potentially more valuable vessel types and natural materials from the body of experimental nautical archaeology.

Introduction

In the aftermath of Thor Heyerdahl's Kon-Tiki expedition in the summer of 1947, thirty-seven similar expeditions sought to employ Heyerdahl's method of recreated maritime technology in order to reach widely varying goals (See Table 1).

The motivations behind these goals can be ascribed to four distinct categories: science; pseudo-science; adventure; and survival. The expeditions identified as having a core of scientific intent, were largely those that most closely identified their method with the examples of Kon-Tiki (if a balsa raft expedition) and Ra II (if a reed ship expedition).

Of the two survival expeditions, one used a rubber boat and the other was created by salvaging water barrels carried on a previous raft. Of the nine expeditions whose motivation was exclusively adventure, five used balsa rafts and all of these operated in the Pacific. Of the six expeditions whose motivation can be seen as wholly pseudo-scientific, one used Chilean cedar, while four employed modern plywood and one even more modern fiberglass.

Science as motivation: Heyerdahl as method

The Kon-Tiki expedition single-handedly transformed the oceans of the world into a kind of gigantic archaeological laboratory. The repeated target of critics both inside and outside the academy who rely on cursory readings of the popular account of the expedition, Kon-Tiki: Across the Pacific by Raft (1950), and not the scholarly theoretical discourse, American Indians in the Pacific: The Theory behind the Kon-Tiki Expedition (1952), the expedition laid the foundation for modern experimental archaeology in recreated watercraft.

A year in the Marquesas in the 1930s had led Heyerdahl to a radical hypothesis concerning the peopling of Polynesia. In 1941, he advanced the idea of a dual migration into Polynesia from the Americas. The first, he wrote, was led by a "pre-Incan civilization, with its centre near Lake Titicaca and along the Peruvian coast below, [which] seems to have swept the islands at a comparatively early period, via Easter Island (Heyerdahl 1941)," while a second wave arrived from the northwest coast of North America aided by northeast trades and currents.

Yet his notion that pre-Incan maritime cultures of South America could have influenced the area was dismissed. The only watercraft considered available to prehistoric voyagers - the balsa raft - was believed capable of no more than a few days of flotation. Heyerdahl realized that his ideas would never be taken seriously unless he could prove the seaworthiness of the pre-Incan balsa raft. The method he chose to demonstrate his belief in his hypothesis, a living

experiment on a transoceanic raft in which he subjected himself and several crewmembers to a mission considered suicidal by some, removed diffusion studies from the purely theoretical and from 1947 onwards made them dependent upon the experimental.

The three significant expeditions led by Heyerdahl - Kon-Tiki, Ra II, and Tigris - made increasingly sophisticated experiments based on finer and finer variables. Kon-Tiki sought largely to demonstrate that a balsa raft could cross an ocean, a fairly simple and straightforward proposition. Ra II, undertaken twenty-three years after Kon-Tiki, sought to do the same for papyrus reed vessels, but also sought to test refined reed ship construction and navigation methods learned from the failure of the first Ra expedition.

Tigris, in 1977-78, confronted a whole series of variables. These included the nature of berdi reed harvesting; long-term buoyancy; the efficacy of the circumferential rope in holding the reeds together; rudder design efficiency; keel design and use; river, estuary and ocean navigation; and the nature of ancient world maritime and trading relationships. The performance of the Tigris led Heyerdahl to conclude that a reed ship could carry a cargo of as much as fifty tons. Later reed boats expeditions, like those of Mata Rangi and Viracocha, would use Heyerdahl's experience to both detriment and profit.

The Mata Rangi expedition used Heyerdahl's belief that a ship carving on the breast of Moai No. 263 on Rapa Nui represented a three-masted reed ship to build such a vessel in 1997. Heyerdahl had learned that to form an effective reed ship the reeds themselves must be harvested at a specific time in their growth cycle (the berdi reeds of southern Iraq that time was late summer) in order to preserve their buoyancy. Mata Rangi, an enormous reed ship nearly forty meters long, was constructed entirely of reeds harvested in the crater lake of the extinct volcano of Maunga Terevaka on Rapa Nui. It was allowed to remain on a Rapa Nui beach for so long that these reeds very likely became brittle and rotted, losing both their flexibility and their natural buoyancy.

The very size of the vessel, as well, seemed to contradict the lessons learned by Heyerdahl and his crews in the design, construction, and sailing of the Ra ships and the Tigris. Reed ships bigger than twenty meters seemed to work themselves apart and lose buoyancy quickly. The lack of a rope wrapped around the length of the reed bundles, a so-called circumferential rope, allowed the reed bundles to work apart longitudinally. Heyerdahl employed such a rope on all three of his reed ships, and not one of them worked apart longitudinally. Mata Rangi lasted less than three weeks at sea before the ship broke apart and the crew had to be rescued.

Viracocha, on the other hand, used a smaller, Ra II-like design as well as a tightly bound circumferential rope to hold the reed hulls together. The ship left Arica, Chile, on February 25,

2000, and with steady trade winds from the South and South-East averaged about two knots an hour. Over the course of the next forty-four days, the reed boat continued to average about fifty miles a day. It reached Rapa Nui on the afternoon of April 9th, and anchored at Hanga Piko. Viracocha, by following the experience of the Tigris expedition, had sailed over 2,000 miles and was still in excellent condition. The cumulative effect of Heyerdahl's experience, then, reveals the potential global reach of the reed ship when the reeds are properly harvested and constructed.

Like Heyerdahl, Eric de Bisschop, who organized the Tahiti-Nui expedition in 1957 in opposition to the results of Kon-Tiki, had little patience for academics with no practical maritime experience upon which to base their theories of Polynesian origins and migrations. De Bisschop was equally at odds with prevailing views of maritime geography as essentially static, railing against anthropologists who "blandly assume that the geographical features of the Pacific and Indian Oceans, with all the lands which emerge from them or border them, have not budged an inch for thousands of years - an assumption based on nothing except perhaps man's subconscious reluctance to admit that he inhabits an unstable and ever-changing crust" (de Bisschop 1959: 7).

Bisschop saw a Polynesian sphere of influence extending from Easter Island and perhaps the shores of South America in the east, to Madagascar off the coast of Africa in the west, a span more than half the distance around the world. To study this enormous problem of cultural geography, de Bisschop envisioned a new field of maritime ethnology, where scholars would use recreated voyaging technologies in order to study ancient diffusions.

Like Heyerdahl before the Kon-Tiki expedition, de Bisschop came to believe that no attention would be offered to his ideas unless he took them to sea, on an actual transoceanic voyage. While Bisschop's bamboo raft Tahiti-Nui, like Tim Severin's later bamboo junk Hsu Fu, demonstrated that a bamboo craft possessed the range to bridge almost an entire ocean, both craft broke apart and sank before they reached their objectives. In an attempt to follow up this initial observation a year later, Bisschop would lose his life, perhaps remarkably the only death during such experiments over the course of six decades.

A series of scientifically meaningful balsa raft expeditions over the past thirty-five years have all patterned themselves after Kon-Tiki. Two of these - the La Balsa expedition of Vital Alsar and the La Manteño expedition of John Haslett - patterned their balsa rafts after the prehistoric cultural model the Huancavilca Indians of Ecuador. Alsar cited the work of the Argentine anthropologist Juan Moricz in supporting his belief that the prehistoric Ecuadorian mariners were no strangers to the islands of the Pacific.

'[Moricz] points out that the Huancavilcas thought of the ocean as "a forest of rivers," with

predictable currents to and from the Polynesian islands. They also knew about "friendly and unfriendly" winds and the use of astronomy in navigation. Commenting on the presence of South American cocoa trees, quecha kuka, in the far-off Mexican highlands, Moricz concludes that the Ecuadorian natives had sailed all the way to Mexico long before the conquest of Montezuma by Hernán Cortés' (Alsar 1973: 23).

The third scientifically meaningful balsa expedition, the Tangaroa experiment of Torgeir Higraff in 2006, outperformed Kon-Tiki on several levels. After experimenting with the correct placement of the guaras, which were too long and had to be cut down to maintain the raft's sailing balance, the Norwegian crew settled on a course of 270º, which took them more or less directly towards the west. Compensating for the northward drift of the Humboldt Current, the raft was kept on a north-westerly course but in a flatter, more southerly arc than that taken by Kon-Tiki.

Tangaroa reached the islands of eastern Polynesia a month faster than Kon-Tiki in 1947. In the end, it drifted farther and faster than Kon-Tiki, and landed at Polynesia's ancient cultural center of Raiatea, demonstrating that an improved sail rig and active use of the guara centerboards allowed a balsa raft to be steered on a direct and rapid course from Peru to Polynesia. Tangaroa, along with Viracocha, stand as the logical scientific outcomes of the experiments in recreated maritime technology begun by Thor Heyerdahl with Kon-Tiki in 1947 and continued with Ra II in 1970 and Tigris in 1977.

Pseudo-science as motivation: the essentially non-scientific

After the sinking of the bamboo raft Tahiti-Nui, Eric de Bisschop intended to build a copy from the same materials for a return voyage to Tahiti. But with no bamboo available in Chile, where Bombard was rescued, he instead had a new raft built from buoyant Chilean cypress wood. There was no experimental reason for this choice. It was made simply because there was no other suitable wood available.

For this reason, despite the success of Tahiti-Nui as a drift experiment from Tahiti to the offshore waters of South America, the Tahiti-Nui II expedition can be seen as one of half a dozen raft expeditions based not on science but on absurd notions that were at best pseudo-scientific. Bisschop could at least claim a long and detailed interest in the problems of Polynesian diffusion. The other pseudo-scientific expeditions could claim no such distinction.

In 1954, a drift expedition across the Pacific was used by a devout Mormon by the name of Devere Baker to turn Thor Heyerdahl's thesis of a bearded white god bearing the gifts of civilization into the second coming of Jesus Christ. Incongruously, Baker built a plywood raft in San Francisco in order to test an idea from The Book of Mormon that a 'great, fair, highly cultured race of people [had] sailed from the Old World to the New World on "caves of wood"'

(Baker 1959: vii).

Rather than set himself adrift from the Old World to the New, Baker instead sought to drift from California to Hawai'I, for no apparent reason other than convenience. The raft, called Lehi, was abandoned just a week after its launch from San Francisco. The second Lehi expedition, like the first, was also abandoned soon after its launch from San Francisco.

Baker's Lehi III raft succeeded in making a voyage from San Francisco down the California coast to Los Angeles. Finally, on July 14, 1958, Baker launched Lehi IV from Redondo Beach, California, and reached Maui two months later on September 20, 1958. Feeling himself vindicated, Baker announced plans for a new drift expedition from the Red Sea to the Central American birthplace of the ancient Olmecs via the Indian Ocean and the Japan Current. The expedition never materialized, but Baker's antics contributed almost single-handedly to decades of academic dismissals of even well-designed archaeological experiments. The final expedition to take to the ocean for dubious reasons of presumed scholarly research was that of Santiago Genovés, a Mexican social scientist who had been a crewmember on board the Ra I and Ra II expeditions. In 1973, Genovés, with four other men and six women set out to test human compatibility on a raft voyage across the Atlantic. Genovés envisioned the Acali as a kind of "floating laboratory, a real sea adventure in which volunteers agreed to participate with the consequent risks, to obtain firsthand data about aggression, conflict, misunderstandings, and possibilities for harmony in a world of violence" (Genovés 1980: xv). The scientific nature of the experiment, however, was undermined from the start, when Genovés decided that he himself would be one of the humans trapped on the raft.

The raft, made of fiberglass and nearly forty feet long and twenty-one feet wide, was named Acali. It drifted away from the Canary Islands in May 1973. In late July, the experiment was brought to a halt in the Caribbean. By then, Genovés himself seemed at a loss to explain the meaning of his audacious experiment. What exactly had he explored? What kinds of data had he really produced? Given the ill-conceived nature of the 'experiment,' it is not surprising that it has never been replicated, except for its modern reincarnation as 'Survivor' type television programming.

Adventure as motivation: The non-scientifically essential

One can trace the basic motivation of a good adventure to at least nine of the expeditions that followed Kon-Tiki. Of the expeditions whose motivation can be described as essentially adventurous, that is, with little or no serious scientific component, seven took place in the Pacific Ocean. Of these seven, five used some version of a balsa raft.

These adventures were typified by William Willis' solo balsa raft voyage on Seven Sisters in 1954. Willis was certainly interested in the effects of prolonged isolation on the raft on the

endurance of his body and mind. But during the 115 days it took him to drift from central Peru to Samoa, the 61-year-old American was mostly interested in recreating the feeling of being young, alive and healthy; in other words, of reliving the sensation of childhood adventure, only on a massive trans-Pacific scale. It was a similar motivation to that Willis used again in 1963, when he again set sail alone, at the age of 71, to "prove that age is no barrier to physically challenging tasks" (Willis 1966). The corollary to this notion, of course, is that youth is a natural inducement to take on challenging tasks. Over two years from 1963-64, Willis sailed his makeshift aluminum raft from Peru to Australia, a distance of 9,800 miles in an elapsed time of 200 days. An spiritual as well as physical adventurer, Willis had spent a considerable amount of time just prior to leaving Peru to convince his wife that they would be able to communicate telepathically while the raft drifted thousands of miles at sea ("distance means nothing in electricity and in thought even less" (Willis 1966: 59).

Five other expeditions in the Pacific can trace their motivation almost exclusively to the desire for adventure. If William Willis was the most introverted and thoughtful of the adventurous raft expedition leaders, Eduardo Ingriš was certainly the most colorful and cut the most carefree profile (See Fig 1).

Ingriš was described as "a cheerful curly-haired Czech" (Danielsson 1960: 133). In 1955, Ingriš built a balsa raft named La Cantuta and drifted from northern Peru toward the Galapagos Islands. Ingriš had assembled a crew that consisted of men from Argentina, Holland, and Peru, as well as a woman from Lake Titicaca, the high altitude lake and home of master reed boat builders. When the raft approached the Galapagos, it was snagged for three months in the Equatorial Counter Current. Unable to proceed east or west, Ingriš and his crew had to be rescued. Three years later, when Eric de Bisschop's raft Tahiti-Nui II landed at the Peruvian port of Callao in March of 1958, Ingriš begged to be included in de Bisschop's crew for its planned drift to Polynesia. "Despite the unfortunate result of [his 1955 expedition], Ingriš was so eager to begin again that he came back every day and tried by new and ingenious arguments to persuade us to take him with us" (Bisschop 1959: 133). When de Bisschop decided against taking Ingriš in his crew, the Czech built another balsa raft for himself.

In 1959, La Cantuta II carried Ingriš and a new crew from Callao all the way to Matahiva in central Polynesia. Along the way, Ingriš occupied himself making a movie of the expedition and writing the theme music for it (See Fig 2).

Motivation-Survival: Deliberate and accidental death and near-death

Given the nature of transoceanic raft expeditions, with their inherent danger and long-term challenges to physical and psychological survival, it is perhaps surprising that only two of the nearly forty such efforts after only two can be regarded as essentially experiments in survival. And only one of these two was planned specifically as such.

In the spring of 1951, a French doctor by the name of Alain Bombard combined a series of laboratory experiments in the comparative compositions of seawater and the water squeezed from various species of fish, with historical research into the psychological and physical state of shipwreck survivors. With this data, he obseved that ninety percent of shipwreck survivors died within three days, even though a human being could survive far longer than that even if completely deprived of food and water. He concluded that if one could overcome initial despair and eventual thirst - the latter by drinking water squeezed from fish flesh and supplemented with a pint and a half of seawater per day - the major factors causing death amongst shipwreck survivor could be reduced.

Four years after Kon-Tiki, Bombard deliberately set out use Heyerdahl's global ocean a scientific laboratory. "If my theory was to be something more than a hypothesis, if it was to serve some real purpose, it was essential to reduce the experiment to human terms in an actual sea voyage. I had to find some way of isolating myself on the ocean for a period of between one and three months" (Bombard 1953: 30).

As with Kon-Tiki, word of Bombard's plans caused most experts to say that an inflatable boat could never remain afloat on the open ocean more than ten days, which in the event would not matter because Bombard would likely be dead by then anyway.

After a false start in the Mediterranean, Bombard started from the Moroccan the port city of Tangier in mid-summer, 1952. Reaching Casablanca on August 20th, he set out on August 24th on a drift towards the Canary Islands to the southwest. Eleven days later, he landed near Las Palmas in the Canaries. On Sunday, October 19th, 1952, Bombard was towed to sea and cast adrift. The raft set into in the current and its small sail began to catch the northeast trade winds that would push it towards the Caribbean.

In the end, Bombard and his raft landed on the island of Barbados on December 22, 1952. He had demonstrated that a castaway could in fact survive on the most meager of diets from the sea, could in fact survive death by thirst by drinking small quantities of seawater each day. He had lost fifty-five pounds and become anæmic, but he was alive.

The second raft expedition to experience a similar, though unplanned, survival experiment, was that of the Tahiti-Nui III. In the summer of 1958, Eric De Bisschop's Tahiti-Nui II experiment - the pseudo-scientific follow-up to his moderately successful Tahiti-Nui voyage of 1957, was drifting into the central Pacific and toward disaster. The raft, ill-conceived and constructed from cedar wood, had become thoroughly water-logged as it passed the Marquesas Islands. The increasingly disturbed crew had taken to living together on the top of the cabin of the sinking hulk.

On August 6th, when the raft was within 250 miles of Starbuck Island, the crew decided it was time to forsake the large raft, and build an escape raft out of a series of aluminum water tanks. Large tanks served as a main hull while ten smaller ten-gallon tanks were divided equally to serve as the port and starboard outriggers.

The crew abandoned the Tahiti-Nui II and set it adrift in mid-August, but the escape raft Tahiti-Nui III missed Starbuck Island by twenty-nine miles. After a series of mutinies by the crew during the remainder of August, the windward reef at the island of Rakahanga came into view on August 30th.

When the raft was swallowed by the surf that evening, the entire crew was thrown into the ocean. Eric de Bisschop was later found bobbing in the waves, having suffered a severe trauma to the back of his head and a broken neck. In death, Bisschop had perhaps shown the possible impact of accidental voyagers on an alien island.

At the cost of his life, his experiment revealed that a raft crew, in extremis and attempting merely to survive, will lighten their load and increase their raft's buoyancy by throwing overboard anything they can. Secondly, the culture-bearers amongst the voyagers - like de Bisschop with his vast knowledge of the sea and navigation - may have died en route. This would have the effect of leaving the survivors little in the way of a cognitive tool-kit with which to attempt to create a new and stable society. Even if the voyagers still possessed the knowledge to create pottery or voyaging boats, the raw materials for such works may have been unavailable on their newly-gained islands.

Lastly, voyagers landing on a remote and sparsely populated island at the end of such a horrendous voyage would be lucky to be alive. They would have been unlikely in such a state to exert a profound effect upon a well-established population, other than to be quickly assimilated or eliminated. Tahiti-Nui III had washed ashore on an island with a population of only one hundred souls. But the raft crew was only four, and their leader was now dead. It was hardly the most auspicious way to enter a New World.

Analysis: Establishing the archaeological significant expedition

Expedition	Method	Significance
Kon-Tiki	Balsa	Establishes experimental nautical archaeology as a sub-field; supports hypothesis that prehistoric maritime vessels built from balsa wood have global reach.
Tahiti-Nui	Bamboo	A bamboo raft can survive for up to six months, even in the mid-latitudes of the South Pacific Ocean.
Ra II	Papyrus	A crescent-shaped reed ship of prehistoric design can cross an ocean.

La Balsa	Balsa	A balsa raft can drift across the entire Pacific Ocean from South America to Australia.
Tigris	Berdi reed	A reed ship of ancient design can remain afloat for six months or more, and link the ancient culture centers of Mesopotamia, Dilmun, Indus Valley and Egypt. Demonstrates the efficacy of the circumferential rope in reed ship construction.
Hsu Fu	Bamboo	The Chinese junk-style bamboo raft is capable of crossing an ocean. It is not the bamboo that wears down, but the rattan lashings that hold the raft together that must be replaced often.
Mata Rangi	Totora reed	A three-masted reed vessel twice the length of *Ra II* and based directly on the carving of Moai 263, it worked itself to pieces very quickly and sank less than 200 miles from its launch point on Rapa Nui.
Illa-Tiki	Balsa	A balsa raft used in coastal waters is open to rapid destruction by *Teredo navalis* worms.
La Manteña	Balsa	A balsa raft attempting to cross from South to Central America risks capture and destruction in the Gyre west of Panama.
Viracocha	Totora reed	A reed ship can make a rapid passage connecting the culture area of the Inca/pre-Inca with Rapa Nui (Easter Island). Confirms that the circumferential rope is essential in the construction of the reed ship.
Tangaroa	Balsa	A guara-equipped balsa raft held on a straight-line course in the Humboldt Current can cross from Peru to Polynesia in just two months, an entire month faster than *Kon-Tiki* in 1947.

TABLE 2. THE EXPEDITIONS OF ARCHAEOLOGICAL SIGNIFICANCE.

Of the total number of drift expeditions in recreated maritime technology that began with Kon-Tiki, eleven can be seen as producing significant results for studies of experimental archaeology and cultural diffusion (See table 2). Of these eleven, only two - Ra II and Tigris - were not conducted in the Pacific Ocean.

Each of these eleven expeditions contributed to the evaluation of unique variables in prehistoric voyaging by watercraft essentially aligned with the prevailing winds and currents of the planet. The first three, Kon-Tiki, Tahiti-Nui, and Ra II, demonstrated the durability of long-distance watercraft constructed from three materials - balsa, bamboo, and [papyrus] reed - previously thought incapable of such range and endurance. The next three expeditions, La Balsa, Tigris, and Hsu Fu, more than doubled the range of the first three expeditions, and thereby demonstrated that these same materials - balsa, [berdi] reed, and bamboo - possess enough durability that they would have allowed prehistoric mariners to encircle the globe.

The next three expeditions, Mata Rangi, Illa-Tiki, and La Manteña, were expeditionary failures but experimental successes. The massive reed ship Mata Rangi broke apart soon after its launch from Rapa Nui, providing evidence to believe that reed ships of prehistory must have

been built more within the parameters of Tigris. It also provided support for archaeologist Arne Skjølsvold's belief (personal communication, March 14, 2000) that the unique Rapa Nui moai statue known as No. 263 and used as the basis for Mata Rangi probably represents not a prehistoric Rapa Nui ship but a historic European sailing vessel. (If Skjølsvold is correct, then it is possible that the moai 263 carving shows not humans on the deck of a three-masted ship, but flames, and represents the burning of a European vessel. Depending on the amount of time it took for the downslope movement of soil to cover the lower part of the monolith, it is perhaps even a representation of the destruction of H.M.S. Bounty by Fletcher Christian and his fellow mutineers on nearby Pitcairn Island in 1789.)

The Illa-Tiki and La Manteña expeditions of John Haslett (Haslett 2006) demonstrated the very great struggle to successfully navigate a balsa raft northwards along the coasts of South America to Mexico. This route, speculated as an avenue for the transmission of the knowledge of metal-working in prehistory (Dewan and Hosler 2008), is fraught with dangers. These include oceanographic dangers such as the spiral of currents near Panama known as the Gyre, as well as the evident risk to balsa wood from the marine invertebrate teredo navalis.

The final two expeditions of experimental significance - the 2000 reed ship Viracocha and the 2006 balsa raft Tangaroa - extended our knowledge of the speed with which prehistoric mariners could have traveled across vast distances. Viracocha showed that a reed ship launched from the west coast of South America could reach Rapa Nui in as little as six weeks. This suggests the possibility of frequent round trips between the megalithic cultures of Rapa Nui and the reed ship building cultures of Lake Titicaca in Bolivia. Similarly, Tangaroa made the journey from Peru to Polynesia a full month faster than did Kon-Tiki in 1947.

The imitative focus on the Heyerdahl-inspired balsa and reed ships has almost entirely obscured other, potentially more valuable vessel types and natural materials from the body of experimental nautical archaeology. Only two transoceanic bamboo voyages have been undertaken and both with the object of reaching the Americas. The idea that Asian mariners could have crossed the Pacific two thousand years ago naturally leads one to consider the very origins of maritime travel. Could late Pleistocene-era bamboo rafts have sailed or drifted out from the low-lying settlements of continental Asia and across to the northern coast of New Guinea. Who was the first human to take to the sea? What did their vessel look like? Where were they going? Did they know - could they see - where they were going? How would one explore this idea experimentally? Localized voyages should provide be able to provide experimental data for the evaluation of innumerable and fundamental questions of Pleistocene human migrations.

During an archaeological expedition to the Indian Ocean archipelago of the Maldives Islands

in the mid-1980s, Thor Heyerdahl himself spotted a large, abandoned bamboo raft in a lagoon at the island of Viringili. This particular type of raft was foreign to the Maldives, and locals told Heyerdahl that some fishermen had discovered the raft the day before, on the outer reef off the east coast of the island. Heyerdahl arrived at the bamboo vessel just as it was being torn apart in order to sell the pieces at a local auction. "It was a raft indeed: large, and built from giant bamboo. I had never seen bamboo as thick as this. Thick as telegraph poles and tied together in three layers under eight cross beams of wood with another layer of thick bamboo as a deck well above the water... Twelve meters long and three wide (39 feet by 10 feet approximately) with a freeboard of 40 centimeters (16 inches), the whole structure recalled the balsa raft Kon-Tiki which had been large enough to carry me and five companions across the Pacific" (Heyerdahl 1986: 188). The only clues as to the origins of the raft were two paper labels, which Heyerdahl later identified as Burmese candy wrappers. The raft had most likely therefore floated nearly 2,000 miles from Burma, through the Bay of Bengal, and into the Indian Ocean to the Maldives. From his own rafting experience Heyerdahl looked at the barnacles growing on the bamboo and estimated that the vessel had been at sea about two months, pushed ahead of the Northeast Monsoon.

How such bamboo vessels could have carried the migrations of early peoples is a matter of intense interest to archaeologists. J.B. Birdsell identified five different routes from the ancient southeast Asian continent of Sunda to the combined Australian-New Guinea continent of Sahul (Birdsell 1977). It seemed probable to Birdsell that "the watercraft used in the late Pleistocene were superior to those found in recent times in Australia and Tasmania. It is highly probable that there was a constant if somewhat straggling trickle of small groups of human beings over all or most of the routes. The size of the watercraft likely to have been used suggests that the groups consisted of small biological families" (ibid, 123).

Birdsell identified thirty-five different species of bamboo along these routes, indicating both the possible raw materials that prehistoric mariners may have used to construct rafts and the paths for which they were set adrift. Such varieties of both routes and raw materials provided scores of testable hypotheses. As Birdsell noted, assuming these many species of bamboo existed during ice age times of lower sea levels, they offer "a useful role for experimental archaeology" (ibid: 144). One could readily imagine a fleet of different bamboo rafts exploring dozens of possible routes for early humans in coastal Asia, especially in the lightly-studied Bay of Bengal, to Sahul.

There is already a model for such voyages. In January of 2000, a dozen men led by Robert G. Bednarik paddled a forty-foot bamboo raft called Nale Tasih 4 from the east coast of the Indonesian island of Bali across eighteen miles of open ocean to the neighboring island of Lombok (Bednarik 2003; Bower 2003). This expedition continued Bednarik's experimental attempts to support a theory that Homo erectus and not Homo sapiens was the first hominid

species to possess both the tools and maritime technology to cross to Wallace Line, some 800 kya. In 1998, in a fifty-eight-foot-long bamboo raft, Bednarik and crew sailed from Timor to Australia, 600 miles in thirteen days. Bednarik's experimental nautical archaeology suggested that an optimal length for a bamboo raft was, like the bamboo raft found in the Maldives by Heyerdahl, about forty feet. This fascinating series of experiments connecting Indonesia to Australia should lead scholars of prehistoric population movements to a focus on underrepresented yet equally significant maritime domains such as the Bay of Bengal and the Andaman Sea.

Conclusions

More than half of the expeditions in recreated maritime technology following Heyerdahl's 1947 Kon-Tiki experiment traced both their motivation and their method to that expedition or to the pioneering work done by Heyerdahl in the recreation of reed boat technology in the late 1960s. In these twenty expeditions, the motivation was based in the perceived application of the scientific method to problems of prehistoric technology; to prehistoric maritime drift/sailing routes; and to questions of cultural diffusion.

Fourteen of these twenty expeditions took place across or in the coastal areas of the Pacific Ocean, by far the most popular arena for experimental maritime archaeology studies. Of these fourteen, six used balsa rafts and six used reed ships for their experiments. The remaining two used bamboo, and one of those - the Tahiti-Nui expedition - was carried out in direct scientific opposition to Kon-Tiki. Kon-Tiki, then, along with the Ra expeditions, can be seen both as establishing the method by which experimental archaeology expeditions would be carried out, and as influencing nearly every experimental archaeology expedition that followed.

Taken as an experimental whole, the eleven expeditions seen as producing significant experimental results have offered a convincing case that the ancient Pacific Ocean was an arena of dynamic and rapid exchanges of people, technology and culture. Future experiments should shift to a fuller examination of the nature and development of the bamboo raft and its role in the coastal movements of prehistoric populations along the complex and under-studied maritime domains from the Bay of Bengal to the Andaman Sea.

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Gallery Image

Science	Pseudo-science	Adventure	Survival
Kon-Tiki	Lehi I	Seven Little Sisters	L'Heritique
Tahiti-Nui	Lehi II	La Cantuta I	Tahiti-Nui III
Feathered Serpent	Lehi III	L'Egare I	
Ra	Lehi IV	L'Egare II	
Ra II	Tahiti-Nui II	La Cantuta II	
La Balsa	Acali	Age Unlimited	
La Tres Balsas		Pacifica	
Tigris		Celeusta	
Uru		La Enduriencia	
Hsu Fu			
Illa-Tiki			
Chimok			
Mata-Rangi			
La Manteña			
Abora			
Titi			
Kota-Mama			
Viracocha			
Tangaroa			
Total: 20	Total: 6	Total: 9	Total: 2

TABLE 1. MOTIVATIONS FOR EXPERIMENTAL ARCHAEOLOGY RAFT EXPEDITIONS, 1947- 2006. SOURCE: CAPELOTTI (2001).

FIG 1. THE CZECH ADVENTURER AND SONGWRITER EDUARDO INGRIŠ.

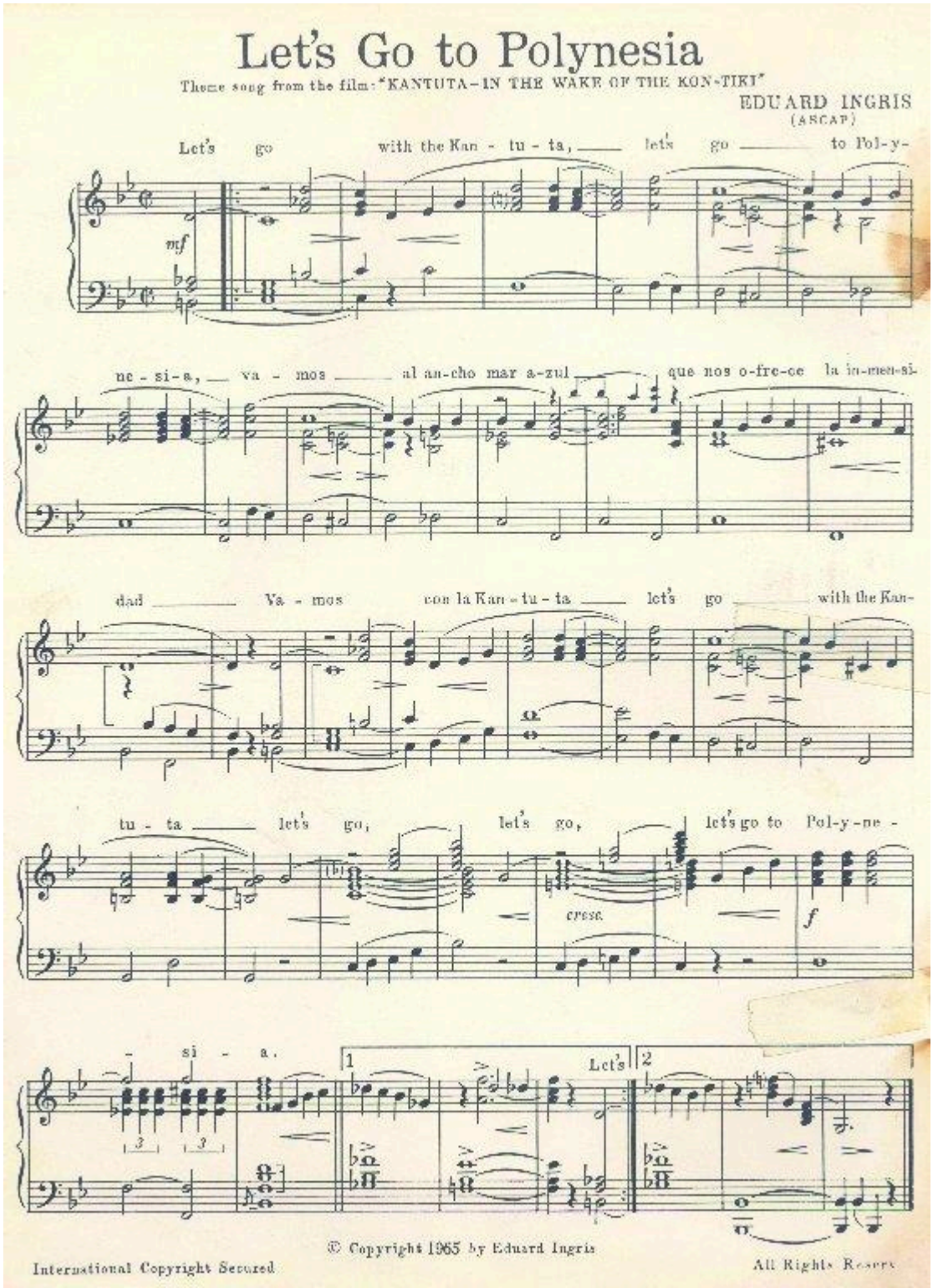

FIG 2. “LET’S GO TO POLYNESIA,” THE COMPOSITION BY EDUARDO INGRIŠ FOR HIS LA CANTUTA II EXPEDITION.

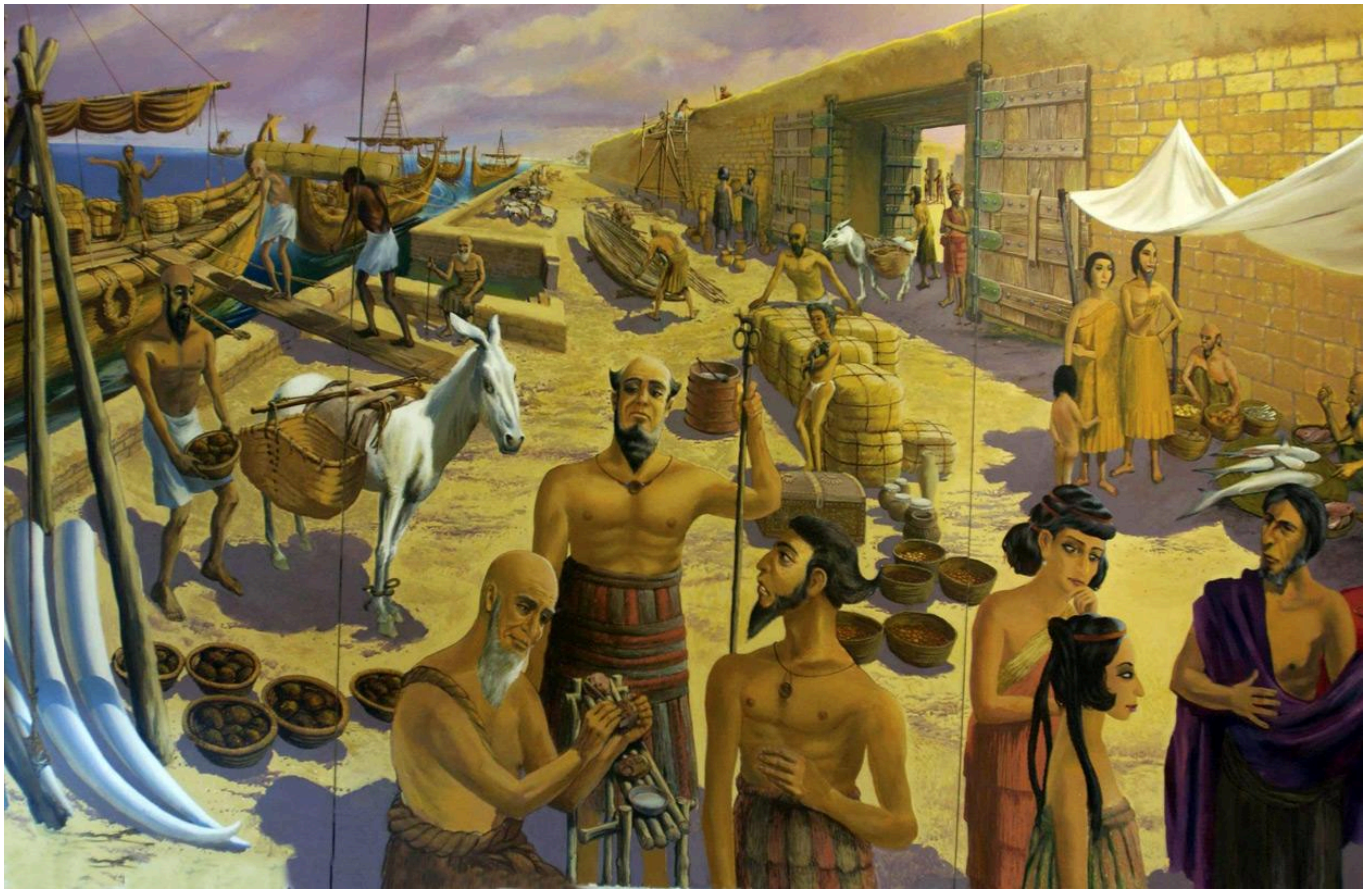

FIG 3. MURAL IN THE BAHRAIN NATIONAL MUSEUM DEPICTING REED SHIPS ENGAGED IN MARITIME TRADE IN THE PERSIAN GULF.

Expedition	Method	Significance
Kon-Tiki	Balsa	Establishes experimental nautical archaeology as a sub-field; supports hypothesis that prehistoric maritime vessels built from balsa wood have global reach.
Tahiti-Nui	Bamboo	A bamboo raft can survive for up to six months, even in the mid-latitudes of the South Pacific Ocean.
Ra II	Papyrus	A crescent-shaped reed ship of prehistoric design can cross an ocean.
La Balsa	Balsa	A balsa raft can drift across the entire Pacific Ocean from South America to Australia.
Tigris	Berdi reed	A reed ship of ancient design can remain afloat for six months or more, and link the ancient culture centers of Mesopotamia, Dilmun, Indus Valley and Egypt. Demonstrates the efficacy of the circumferential rope in reed ship construction.
Hsu Fu	Bamboo	The Chinese junk-style bamboo raft is capable of crossing an ocean. It is not the bamboo that wears down, but the rattan lashings that hold the raft together that must be replaced often.
Mata Rangi	Totora reed	A three-masted reed vessel twice the length of Ra II and based directly on the carving of Moai 263, it worked itself to pieces very quickly and sank less than 200 miles from its launch point on Rapa Nui.
Illa-Tiki	Balsa	A balsa raft used in coastal waters is open to rapid destruction by Teredo navalis worms.
La Manteña	Balsa	A balsa raft attempting to cross from South to Central America risks capture and destruction in the Gyre west of Panama.
Viracocha	Totora reed	A reed ship can make a rapid passage connecting the culture area of the Inca/pre-Inca with Rapa Nui (Easter Island). Confirms that the circumferential rope is essential in the construction of the reed ship.
Tangaroa	Balsa	A guara-equipped balsa raft held on a straight-line course in the Humboldt Current can cross from Peru to Polynesia in just two months, an entire month faster than Kon-Tiki in 1947.

TABLE 2. THE EXPEDITIONS OF ARCHAEOLOGICAL SIGNIFI CANCE.