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[**REFERENCES**]

1
INTRODUCTION

For over 30 years, archaeologists have noted similarities in artefacts recovered from two widely-separated regions of the New World; Western Mexico and North-western South America. The slow but steady increase of archaeological knowledge has made it possible at present to call upon several lines of evidence to support the proposition that these similarities are the result of sustained pre-Columbian contact between these regions. Such contact appears to have been carried out on large balsa rafts sailing a round-trip maritime route of more than 5,000 miles.

The Manteño Voyage has the objective of exploring the options and constraints which would have conditioned the behaviour of these pre-Columbian mariners by building a replica of one of their vessels, and sailing this route. This expedition entered the field in June 1998, and, at this writing (May 1999), continues despite two major setbacks.

The expedition team core is currently composed of:

John Franklin Haslett III; Dallas, Texas ; Leader
Alejandro Martinez-Carvajal; Bogota; Colombia Medic
Cesar Alarcon; Medellin, Colombia; Ecologist
Annie Biggs-Haslett; Dallas, Texas; Coordinator
Cameron McPherson Smith; Vancouver, Canada; Archaeologist

Crew on the first leg of the expedition, described in this report, included:

Dowar Medina; Salango, Ecuador; Mariner
Scott Siekierski; Dallas, Texas; Quartermaster
David Moorer; San Francisco, California; Paramedic
Chiu Liang Kuo; Tainan, Taiwan; Assistant

Siekierski left the expedition with medical complications in December 1998. Moorer left the expedition in December 1998, citing personal inability to adapt to life on the high sea. Kuo assisted in many thankless tasks during the first arduous month in Ecuador, then returned to Oregon, USA, to continue his doctoral studies in biochemistry. Dowar Medina left the expedition at the end of the first leg to return to his wife and son in Salango, Ecuador. Smith (author of this report) left the field element of

ore was not transported North from Ecuador to West Mexico, metallurgical technology was, probably in the form of smiths physically transported aboard merchant ships. A comprehensive treatment of the large body of metallurgical data confirming this pre-Columbian communication is found in Hosler, Lechtman and Holm (1990).

The lack of evidence for aboriginal sailing craft North of Ecuador, and the long record of historic accounts of native sailing craft operating from Ecuador, suggests that contact was initiated by Ecuadorean mariners headed North, rather than West Mexican mariners headed South. It is clear that an active, organised maritime trade operated out of Ecuador, dating to at least 1500BC (Paulsen 1977), and possibly as early as 2500BC (Zeidler 1991). By the time of the Ecuadorean archaeological Regional Integration Period (AD 800-1530), this trade was apparently monopolised by a Îleague of merchantsâ synonymous with the Manteño culture of the Manabi province of Western Ecuador, and likely including the Huancavillca culture complex immediately to the South of the Manteño chiefdom (Marcos 1977, 1978). This monopoly on marine traffic and control of certain ritually-important trade items obtained from the ocean (see Cordy-Collins 1982) were probably what allowed the Manteño to avoid assimilation by the Inka (Zeidler 1991:252). Our expedition is named the Manteño Voyage (under the aegis of the larger project, the Illa Tiki Expeditions) because it reconstructs a vessel of the type used by this culture group in its maritime explorations and trade.

The presence of these varied lines of evidence in these disparate regions, without appearance in the intervening regions, strongly suggests that a maritime route was used to carry out this cultural contact. Such a route has been proposed by many authors, being widely suggested first by West (1961). A one-way journey, rather closely following the coast, between Ecuador and West Mexico, is a voyage of roughly 2,400 miles; such a voyage would require substantial vessels and maritime knowledge. The focus of the Manteño Voyage is on the sailing characteristics of the vessels which would have made these journeys possible, as well as the knowledge necessary to carry them out safely and efficiently.

2.2 Aboriginal Sailing Rafts of Northwestern South America

Documentary evidence in the various records pertaining to Spanish exploration of the New World (conveniently referred to as the ÎSpanish Chroniclesâ) consistently indicates the presence of native sailing vessels on the Northwest coast of South America. In the first quarter of the 16th Century, the explorer Vasco Nunez de Balboa was first to be told, by natives of Darien, that in the then-undiscovered ÎSouth Seaâ (the Pacific Ocean), people sailed vessels almost of the size of Spanish vessels, equipped with paddles and sails (Anderson 1941:73). Many other descriptions of such vessels are found in the Spanish Chronicles; excellent comprehensive discussions of such may be found in Edwards (1965), E. Estrada (1955), J. Estrada (1988), Heyerdahl (1955), Heyerdahl in Heyerdahl, Sandweiss and Narvaez (1995) and Lothrop (1932). Here we focus on the single most important document for our expedition, the Relacion Samaano-Xeres. Table 1 summarizes the most important points of the most important early documents describing these vessels.

2.3 The Relacion Samaano-Xeres

The Relacion Samaano-Xeres is a well-known description of pilot Bartholome Ruizâs discovery and examination of an aboriginal balsa (raft) off the Northwest coast of Ecuador in 1526. Ruiz was a very experienced pilot and explorer who, at the time of the encounter, was exploring South while Pizarro and his men waited in Colombia. Although the author of the relacion remains unknown, it is clear that it is a genuine document, and that it derives from an eyewitness aboard the Ruiz vessel (Edwards 1998, personal communication to the author). An in-depth review of this document, and the entire Ruiz voyage of 1526, may be found in Szazsdi (1979). The most relevant passages of the Relacion are presented below:

Î...[Pizarro's crew] took a ship which came up to twenty men, of which eleven of them threw themselves into the water...[Pizarro's pilot] put the others ashore so that they might go; and these...were kept for interpreters...[with Pizarro's expedition] and treated well.

This ship which I say he took seemed to have the capacity of up to thirty tonoles [about 25 tons]; it was made in plan and keel of canes [actually, balsa logs] as big as posts, bound with ropes of what they call sisal, which is like hemp, and the upper [deck] of lighter canes tied with the same ropes, where the people and their cargo travel together dry because the lower part [the logs which form the hull] is awash. Her masts and lateen yards were of very fine wood and sails of cotton of the same appearance as our ships, and very good rigging of the said sisal, which I say is like hemp, and some pierced stone weights (potales) for anchors in the manner of barbers' grinding stones.

The author goes on to describe the cargo carried aboard the raft:

And they were carrying many items of silver and of gold personal ornament to exchange with those whom they were going to trade, including crowns and diadems and belts and gauntlets (ponietes) and leg armor (greaves?) and breastplates and tweezers and jingling bells and strings and bunches of beads and [other beads of a clear, rosy colour] and mirrors mounted with the said silver and cups and other drinking vessels; they carried many mantles of wool and of cotton, and shirts and [tunics?] and [alarmes = not translated] and many other garments, most of them embroidered and richly worked in colours of scarlet and crimson, and blue and yellow, and of all other colours in different kinds of work and figures of birds and animals and fish and trees; and they brought some tiny weights to weigh gold, like Roman workmanship, and many other things. On some strings of beads there were some small stones and pieces of crystal and chalcedony, and other stones and crystal...All this they brought to exhange of some shells from which they make coral red and white beads, and they had the vessel almost laden with them...â

(translation from Currie 1995: 511)

2.3 Use of the Relacion Samaano-Xeres in Building La Manteña-Huancavillca

The most important points to be learned from the document, regarding aboriginal sailing raft design elements, are:

1. The use of a hull composed of logs tied together to form a floating platform
2. The use of more than one mast, and more than one sail
3. The use of some type of fore-and-aft rigged sail, rather than a square sail
4. The absence of a rudder
5. Mention of the size of the vessel, estimated at Î30 tonolesâ, with a crew of c.20 persons

The first point is echoed in many other reports which describe a hull so radically different from the open hulls of European vessels. In the log-hull construction lies the tremendous security of this vessel; waves and swells which come onto deck, rather than swamping the vessel, simply slip between the logs (Îlike water through the tines of a forkâ (Heyerdahl 1947)). Our vessel was built with nine logs of balsa wood (*Ochroma* spp.) as the hull. Details regarding construction are noted below in section 4, CONSTRUCTION). The second point is the result of carefully reading the Relacion, which mentions Îsailsâ and Îmastsâ (both plural) while describing the single vessel intercepted by Ruiz; we therefore fitted two sails, a main and a mizzen.

We agree with Edwards (1965:67-69) that the sails, the third important point mentioned above, would have been fore-and-aft rigged -- that is with the long axis of the sail aligned with the long axis of the vessel, rather than transverse to the vessel -- for the following reasons. First, the sails are described as being Î...of the same form of those of our shipsâ, referring to those of the Ruiz vessel, or vessels commonly used by the Spanish. Precisely what sort of vessel Ruiz was sailing, and how he was rigged, is a topic worthy of a separate paper (see APPENDIX D) , but it is most likely that he was sailing a small bergantine or caravel of roughly 40 tons (Szaszdi 1978), and that for the tricky work of coastal exploration, the experienced Ruiz would have favored the use of a lateen rig; this is because the lateen, fore-and-aft rigged vessel is able to sail closer to the wind than the square-rigger. Second, Edwards points out that while many later records of the native vessels of this coast were indeed square-rigged, all of the early records indicate some sort of triangular, fore-and-aft rigs (Edwards op cit, and Table 1 this report).

Much of the confusion here stems from many authorsâ acceptance of W.H. Prescottâs assumption that the Ruiz vessel was square-rigged, and his subsequent printing, in the very influential ÎHistory of the Conquest of Peruâ (Prescott 1905:222) that the vessel encountered by Ruiz was square-rigged, with a bipod mast. Prescott also seems to have used later illustrations of Ecuadorean balsa rafts, such as those presented by Benzoni (1565 in Smyth 1857), Juan and Ulloa (1748) and von Humboldt (1816) as his mental model of native rafts. These are indeed square-rigged with a pair of sheer masts, but they reflect the adoption of the square rig and sheer mast arrangement after the use of lateen or other fore-and-aft rigs evidenced in the early records, such as the Relacion Samaano-Xeres (1526), Oviedo (writing in the 1530âs), Zarate (writing in the 1540âs) Cieza de Leon (writing in the 1540âs), Guttierez (writing in the 1540âs) and Spillbergen (writing in the first quarter of the 17th Century) (see Table 1 and Figures 11, 12 and 13). Heyerdahl, in using Prescottâs mistaken ideal of aboriginal raft form for his Kon Tiki, set the precedent for subsequent expeditions, which have all used sheer masts and a square sail.

We furthern note that the Relacion in no way mentions a pair of sheer masts, an arrangement which would have been completely unfamiliar and witnessed for the first time by the Spanish, and thereby likely worthy of comment. And, finally, we find it hard to believe that the mariner describing the native raft would have made such an error as to say that it was equipped with Îantenasâ (plural for Îantenaâ, which normally refers to the yard of a lateen sail whereas the word Îvergaâ refers to the yard of a square sail) if the vessel were square-rigged.

In short, we concur with Edwards that both the Ruiz vessel and the native vessel were fore-and-aft rigged; the Ruiz vessel would have been lateen rigged, with a single long yard, and the native balsa probably rigged very similarly. Edwards feels that the native sailing rafts may have been equipped with some variant of a lateen rig, or the fore-and-aft, triangular ÎOceanic Spiritsailâ (1998 personal communication to the author); we chose to use two lateen sails, expecting them to be most like those used on the Ruiz vessel.

The fourth point, concerning the lack of a rudder, indicates that the vessel was steered by some other mechanism. This was undoubtedly the guare (pronounced ghoo-AH-rey) system, indigenous to the West coast of South America (Edwards 1965), in which guares, or planks, are inserted through gaps between the hull logs. The resistance of these planks to water beneath the vessel change the sailing balance, and thereby allow the crew to steer the raft. The method has been detailed by Heyerdahl (1957), although he did not use it in his Kon Tiki voyage. Our vessel was fitted with 24 guares in the rear, to act as a keel, in parallel rows near either beam; several other guares were used for steering, operated by the helmsman near the main mast (further details of vessel handling are noted below).

The fifth point, regarding the size of the vessel, indicated a rather larger vessel than constructed by previous expeditions. Ruizâs vessel, if roughly 40 toneladas (roughly 35 modern tons; the 16th Century Spanish tonel is a unit of measure deserving of a separate paper; see notes in Romoli 1951), would be roughly 60 feet in length, according to the the size and resulting bulk of the modern caravel reconstructions of R.F. Marx (in 1963) and J. Patrick Sarsfield (see Barker 1993). The balsa, described by the Spanish as being roughly 10 tonoledas less than the Ruiz vessel, would have been of comparable size, between 50 and 60 feet. The balsa was also crewed by up to 20 persons, indicating it was, whatever the case, not small. We therefore chose to build with the central log at 61 feet, tapering to roughly 50 feet on each beam. The vessel thus built was large enough for six, in the casita, though it is difficult to accomodate 20 people. This point is under investigation, but it may reflect some space-saving method, such as bunk-bedding inside the native raft, or simply a temporarily large crew on a vessel normally with a smaller complement. Regardless, the size of our vessel is certainly in agreement with those of many vessels described in the historical record.

3
OBJECTIVES

1. To build the most accurate replica possible of a Manteño-Huancavillca culture complex trade vessel, and to launch this vessel from Salango, Ecuador, believed to be a pre- Columbian balsa port.

To be carried out by construction of a replica vessel, using careful reading of the early historical descriptions of these vessels, in particular that description provided in the Relacion Saamano-Xeres (see above); this includes the use of as many indigenous and original materials and methods as possible.

2. To sail the vessel NW on the Pacific coast of South and Central America, as far North as Acapulco in West Mexico (roughly 17degrees N), and while en route to evaluate sailing characteristics of the vessel and to estimate constraints and options which would have conditioned ancient marinersâ behaviour on this voyage.

To be carried out by the crew of six, including one local crewmember familiar with these waters.

3. To sail the vessel from Acapulco, Mexico, to the Hawaiian Islands, as a further test of the seaworthiness of the vessel in long distance voyaging.

As above.

4. To disseminate the information generated by this expedition in a variety of media, and to a large audience, such that both scientific findings and the heritage of the descendants of the Manteño are promoted.

Carried out through expedition exposure on internet (www.balsaraft.com, and www.sfu.ca/~csmith*), in film (documentary currently in production), in print (RGS expedition report, popular magazine articles, South American newspapers) and in scientific journals (current production of article for International Journal of Nautical Archaeology). Our expedition also continues to support heritage awareness in the fishing village of Salango, Ecuador, by reporting to the villagers there on the status of the expedition.*

Objectives 1 and 2 are considered the scientific element of the expedition; they have produced, at this writing (May 1999), copious information regarding the hypothesized Manteño maritime trade voyages, and will continue to produce valid information on this topic. Technically, our vessel may be considered a Îfloating hypothesisâ or a Îreconstructionâ; the journey itself, involving the re-living of an ancient way of life, a Îrecreationâ (see Editorâs Note, International Journal of Nautical Archaeology 1993:22:197).

While the results of Objective 3 will be of interest to nautical archaeology, our voyage to Hawaii is intended only as a challenge to the vessel and the crew, without any attendant theories regarding pre-Columbian trans-Pacific travel. Our expedition has no interest in examining theories regarding this topic.

Objective 4 is well underway, with the expedition receiving wide exposure, which, according to inhabitants of Salango, has done well for their community by bringing tourists to visit the archaeological museum and the once-thriving Îbalsa portâ. In terms of scientific results, the expedition is a valid experimental archaeology project (see Goodburn 1993). It will produce at least one article in a refereed journal (being written at present by C.M. Smith) and at least two papers to be presented on experimental archaeology, one at Simon Fraser University and one at the 2000 annual meeting of the Society for American Archaeology. Public education regarding the ancient Manteño sea trade, and archaeology in general, has been carried out in the USA and othe countries by a

One of the main keys to success in this expedition was the general preparedness of all personell to learn and speak Spanish. Few people outside of the larger cities speak, or are willing to speak, English. The crew each taught themselves basic Spanish before the expedition, and carried Spanish pocket dictionaries (rather than the somewhat useless Îphrasebooksâ). Of particular importance is the ability to speak Spanish with at least something approximating the correct pronunciation. With only few exceptions we found the Ecuadoreans to be very pleasant, generous (particularly with the volatile caña liquor) helpful and accomidating. In all situations a respectful, reserved and rather quiet introduction of oneself and onesâ aims is best; crashing in as loud tourist-types was completely off the schedule. In return we were treated with hospitality and being financially cheated was rare, though it did occur. I am happy to report that, in general, the expedition enjoyed very good relations with natives of Ecuador.

4.2 Construction of the Vessel

As mentioned, construction took place at Salango, Ecuador (1 deg35min S 83deg43minW), which was very probably a balsa raft port in Manteño times, and where important archaeological excavations have exposed numerous Manteño-period antiquities (Norton, Lunnis and Nailing 1983). Construction was largely carried out by the crewmembers, assisting the expert woodsmen employed by Maestro Enrique Guillen, Salangoâs most respected shipwright. Guillenâs grandfather was among the last of the local Salangenos to sail balsa rafts to and from Panama on merchant voyages. The latest known reports of the use of large coastal sailing rafts are found in a sketch of a raft at Paita, Peru, in the first decade of the 20th Century, and a photograph of a balsa off Ecuador in 1925 (Peixotto 1913:45 and Murphy, 1941:19, respectively).

The design of the vessel was developed from the historical records, but the Maestro directed our work and often made useful adjustments ot our plans. Twenty-eight days of construction, with 3-8 men working per day, resulted in the greater part of *La Manteña-Huancavillca*. Modifications, additions, and sea trials, took place in the Bay of Salango. Note that in this report, metric dimensions are not used; tape measures, rulers and so on, in Salango, were mostly Imperial rather than metric. Also, most workers used folk methods, such as using the foot, palm, or forearm of an individual worker as an increment of measurement.

Every attempt was made to use natural, indigenous materials during construction. We were very succesful in this aim, employing only minimal modern materials, and these exceptions were functionally trivial; they included polypropelene Îbolt ropesâ and halyards for the sails and metal blocks (pulleys) for the sails. In both cases, a functional equivalent would have been necessary for the Manteño. We suggest that the bolt ropes and halyards (see below) would have been of non-shrinking, tarred natural fiber. While there is no evidence that the wheel was a concept known to the Manteño, we feel that our pulleys simply take the place of wooden blocks with a smoothed eye. In each of these cases, basic problems (providing sail strength and the ability to raise and lower the sails) are addressed, which would have had functional equivalents in Manteño times.

Materials used in the construction of the raft included manila rope, bamboo, balsa logs, cotton sails and tropical hardwood trunks. Some general notes regarding these materials are found in Table 2, which indicates the indigenous nature of these materials, and provides references for further research.

4.3 Hull Logs and Crossbeams

The hull of the raft was composed of nine balsa trunks. After securing governmental permission, the balsa trees were felled in the INIAP experimental forest near Quevedo, in the Los Rios province of central Ecuador (1degS 79deg30min W). They were trucked to the building site at Salango. A previous river survey by the expedition identified obstacles to building the raft in Los Rios and floating it to the Pacific for launch: see APPENDIX A. Logs 10 and 11 were used as transversely-placed 'sawhorses' on which to build the raft, raising it 2 feet off the beach and allowing easy access to the underside during building. Log 12 was a spare which was never used; it was donated to Maestro Enrique when the work was completed. Of the nine logs used in the raft, the 'Pope' was longest, at 60 feet 11 inches. The shortest logs (port and starboard beams) were 50 feet in length.

The logs were offloaded in Salango and moved into position on the 'sawhorse' logs. Most of this work was done by tractor. In 1995, Haslettâs Illa Tiki team used only levers and wedges to manhandle the logs into position; on the present expedition, the schedule was tighter, making the use of some modern equipment mandatory (nevertheless, one of our objectives is to understand the labor costs of constructing these vessels, and this is being done by reviewing labor records which may be supplemented by data from the Illa Tiki expediton). Once in place, with the 'Pope' (central log) flanked by four logs on the port and four on the starboard, the team began a two-day labour session of removing hundreds of pounds of heavy, wet bark from the logs. This was done with machetes, axes and wedges (in the singular, wedges and levers were interchangeably referred to as Îwankaâ by Maestro Enrique and his woodsmen). The stripped logs were leveled with wedges so that their top edges were flush. The balsas were then ready for notching to allow the crossbeams to sit down into the balsas (preventing fore-and-aft movement of the individual balsas) and attachment of crossbeams in the notches.

Seven main crossbeams of the very dense and durable cocobolo wood were used to bind the main hull logs together, accomplished with nearly half a mile of 1-1/4" manila rope. The crossbeams were set into notches cut out with hand axes or machetes. Each crossbeam itself was notched on the end to provide a bollard or 'mushroom' for securing the rope. Tension was achieved by using a crowbar to pry all slack from the rope. Roping the raft consumed two full days. The roping method is best comprehended graphically, and may be seen in Figures 2 and 3. Where others have built their rafts while floating in a harbor, we built on land; this was to prevent shipworm infestation during the building process. Also, ropes tightened on land were further tightened by swelling with water when the raft was put to sea, ensuring an unbreakable bond between the crossbeams and the balsa hull logs.

The cocobolo crossbeams, laying in notches perpendicular to the long axis of the hull logs, were arranged as follows: two at the aft, placed a foot apart longitudinally, and commencing nine feet forward of the aft end of the Pope; four evenly spaced between the aft and the fore of the vessel (about 8 feet apart from each other), and one final crossbeam at the fore, 15 feet aft of the fore tip of the 'Pope' log. This arrangement is best seen in Figure 4.

Five crossbeams of caña guadua bamboo were also used; these were lashed into notches in the same manner as the cocobolo crossbeams, and these were placed between the cocobolos. Caña guadua, also known simply as Îguaduaâ or Îcaña bravaâ, is a heavier and more robust bamboo than the normal Îcaña finaâ used in much local construction. Local knowledge in Salango, Ecuador, as well as Bahia de Solano, Colombia (see below) held this variety of bamboo to be particularly strong.

Lashed adjacent to each cocobolo was a 1-foot diameter balsa log, on which the first piso (the deck) was built (see below). These balsa crossbeams provided an elevated platform on which the deck was constructed.

4.4 Piso

The piso (deck or floor) was built of 37 bamboos (Îcaña finaâ) laid along the long axis of the raft, and lashed to the six balsa crossbeams which served to raise this floor off the water. The space between the piso and the hull logs was used to transport spare lumber, garbage bags and other miscellaneous items. A second deck was built inside the aft 2/3 of the casita, serving to raise the sleeping area even further above the waterline.

More spare lumber and other supplies were stored under the sleeping area of the casita.

Sharp edges of the bamboo deck were sanded down. Petates, thick and soft mats of vegetable fibre (species unknown at present), were spread on the deck immediatedly behind the binnacle, and in the space between the binnacle and the casita doorway; this is a high-traffic area. Petates were also spread on the entire sleeping area of the casita.

Near the port and the starboard beams we left a gap in the bamboos for the guares (see below) to slide down betwen the balsa hull logs. This 'guare slot' was useful, but quite treacherous, being precisely the width of a human foot. In general, the bamboo flooring was acceptable and the crew worked barefoot most of the time.

4.5 Casita

The casita (little house) was constructed of bamboo around the mizzen mast. A basic box-framework was walled with split bamboo (Îcaña picadaâ). Various stabilizing reinforcements were added at sea. The mizzen mast passed through a hole in the roof. The roof was constructed of cade, a heavy leaf traditionally used for roofing in Ecuador (it is at present unclear whether the word cade referred to the method of roof-plaiting, or the plant from which roofing leaves are taken). This was woven between split and hammer-flattened bamboo strips which provided extra support for crew working on the casita roof during adjustment of the mizzen sail. A flexible solar panel was often placed on the roof to help recharge the raft's single, 12-volt radio battery.

A mat doorflap prevented most spray from entering the casita. Just inside the doorway, to the starboard, was hung a map board. This allowed one to view the local chart as well as look out the doorway to see the compass on the binnacle, and the immediate waters and/or coastline. To the port was situated the radio table, with the rechargable 12-volt battery secured to the table. The two main radios (a HAM transciever and a marine-band transciever) were also secured to the desk. The two spare radios were also stored on the radio table, shrink-wrapped at the factory and further sealed in watertight cases. The desk was also the storage area for a variety of instruments (including sextant, hand-sighting compass and binoculars) and books (including almanacs, numerous Aids to Navigation lists, Gattyâs famous ÎRaft Bookâ and Chapmanâs ÎPilotingâ). Charts were stored in a waterproof tube, hanging next to the map board. Finally, adjacent to the desk were stored a variety of saftey items, such as a fire extinguisher, an EPIRB unit and lanterns; these were kept ready to be retrieved quickly. The extensive medical supplies (contained in two large, watertight Pelican suitcases) were stowed beneath the radio table, as were electrical supplies and a tool kit.

4.6 Guares

A guare is a 10-foot long, inch-thick, 16-inch wide wooden board made of the heavy and durable guayacan wood. These boards are perforated with a hole near the top and one near the bottom, through which is inserted a wooden pin, a foot long and two inches in diameter. A guare is passed downward into a slot, between the bamboo floor and between the balsa hull logs, to provide surface area, and resultant drag, in the water beneath the vessel. The guare is prevented from slipping all the way through the slot between the hull logs by the insertion of the guare pin which acts as a stop to prevent the guare falling all the way through the slot.

The guares are the key to steering the raft; the method is described in section 6, DISCUSSION. A set of 12 guares were placed on each side of the casita, providing two 'keels' of 24 total guares. These were relatively fixed. To prevent guare pins working free with the constant motion of the vessel, and subsequent loss of the guare between the logs, guare pins on the relatively fixed, aft keel guares were tied off with string. The steering guares were placed forward, near the main mast and the binnacle. Several spare guares were carried beneath the casita.

4.7 Masts and Rigging

Two masts were erected, each roughly 30 feet in height. These are of the durable and very dense cocobolo wood. Each mast was roughly 10 inches in diameter at the base and roughly eight inches in diameter at the peak. Each mast was stepped into a foot excavated 4 inches into the 'Pope', the central log of the raft. Above and around this small well is a cocobolo zapato (shoe), consisting of a wooden block on either side of the mast. The middle of the shoe is perforated with a large hole through which the mast passes. The zapato is bound to the Pope log with 1-1/4 inch manila. The zapato provides resistance to the mast when it leans away from vertical; most of the mast stability, however, is provided by the stays. Figure 6 illustrates the principle of the zapato and mast stepping. This method was invented by Maestro Guillen. We do not know whether this method in any way resembles the aboriginal method of mast stepping. To date, the arrangement has not failed.

Each mast was fitted with four stays. Port and starboard forestays were 1ä-diameter manila, while port and starboard backstays were 1-1/4ä manila. Stays were tied off to the balsa beam logs. On the peak of the mast, stays were attched with a clove hitch. Stays had to be tightened almost daily, due to changing strains on the stays and the natural stretch of the rope. At sea, we used tourniquets and other traditional methods of taking slack from the stays rather than repeatedly adjusting the larger stay tie-off at the balsa.

To the main (fore) mast peak was attached a radar reflector to make us visible to the 'big iron' (large freighters) equipped with radar. To the mizzen peak we attached a navigation light, also to make ourselves known. In the vicinity of Northern Ecuador and Columbia, however, due to heavy pirate activity, we ran without light most of the time, using the navigation light only when a large fishing boat was upon us in the darkness.

The lateen yards were attached to the masts with a 1-1/8ä polypropelene halyard which ran through a large block (pulley) suspended from the peak of the mast. On one side of the block, the halyard ran down the mast to the deck, where it was secured to a loop of rope tied around the central, ÎPopeâ log. When the sail was raised the halyard was tied off at this point. On the other side of the block, the halyard runs down to a 3-point bridle which distributes the weight of the yard and the sail to three points (rather than one point) of the yard. The bridle attached to the yard with a steel carabiener for ease in working with the sail. A fairlead (a loop of rope around the mast, free to slide up and down the mast) was clipped to the halyard near the bridle to prevent the sail and yard blowing too far away from the mast. The fairlead was often greased to prevent it hanging up on the mast, which made lowering and raising the yard difficult.

Each sail had a port and starboard tack sheet and a port and starboard clew sheet. These were 11mm climbing rope, which is easy to tie, easy to handle and holds knots well. The sheets were generally clove-hitched to the beam end of a cocobolo crossbeam, or slippery-hitched to some other convenient point.

4.8 Lateen Sails and Yards

The design and construction of the sails was the personal responsibility of the writer. Two sails were constructed in Guayaquil, Ecuador, by the family of Jose Guererro B., a canvas vendor and industrial tent-maker. The writer supervised every element of the construction, spending 6-8 hours a day with the family for the six days required to make the sails.

The sailcloth used was 100% cotton, made by Rushi Fabrics, India. A 'guage' or 'caliber' for this fabric was unavailable (Sr. Guerero simply purchased the heaviest roll of canvas he could find) though its thickness is estimated as twice (or slightly more than twice) than that of a pair of Levi's jeans. The cloth arrived in the form of a roll 71ä wide and 89.30 yards in length. Earlier, we were advised by Will Marten, a master New

England traditional sailmaker, that de-siezing the sailcloth (removing the starch added at the factory) was probably not necessary, and that more important was to dye the sail with an anti-mildew and UV-resistant treatment of metal salts; this was done in Salango and is described below.

Two sails were constructed in Guayaquil, giving a total (unreefed) sail area of 742 square feet. This figure was considered appropriate based on the experience of the Illa Tiki expedition in 1995 (APPENDIX B), and our limits on bamboo yard length. Sail area was found to be adequate, although we feel an increase, to about 800-820 square feet, may be appropriate, particularly if reliable, strong yards could be obtained. The dimensions of the sails constructed in Guayaquil were:

La Manteña sail dimensions in feet.	MAIN	MIZZEN
Luff	41	37
Foot	25	22
Leech	33	30
Area (unreefed)	412	330
Area (reefed)	329	247

The main sail was constructed of 13 vertical panels (with seams parallel to the leech). Panels one through 12 (with panel one at the leech, and moving towards the luff) were 30ä in width, and panel 13 was about 15ä in width (the mizzen used 11, 30-inch wide panels). Conventional sailmaking wisdom dictates that narrower panels would have been perferable, but this was considered impractical for a variety of reasons; in any case, the sails worked very well at sea and the slightly wide panel width never presented problems.

The sail templates were chalked on the road in front of the Guererro home at full scale. The canvas was then rolled out and cut into strips at the proper lengths to fit a given template. The canvas strips were laid on the chalked template (with three-inch overlap per panel) and the luff edge angle was drawn in pen on the canvas, connecting the sail peak and the sail tack at an angle of roughly 50 degrees from the foot. A three-inch margin was added to the luff (and other edges) for tabling and sewing in the bolt rope. Scissors were used to cut the luff angle. All spare canvas was, of course, kept for repairs and other purposes.

The sail panels were sewn together with an industrial sewing machine and #3 nylon thread. Cotton thread would have been preferable, but was unavailable at the time. The three-inch overlap at each panel union was sewn with five straight seams; the sails were to be built as heavy, voyaging, storm sails. The tabling (hemming) around all edges was sewn with three seams for the first pass, and another two seams through a second layer of canvas stripping added to the entire sail perimeter to provide extra strength and chafe resistance. Further strength was added to each sail corner, where triangular canvas patches were added to take some of the considerable strain generated underway. To date, no seam or panel has failed.

The entire perimeter of each sail was roped with 1/2ä polypropelene rope; again, this was not our choice, but was the only available option in Guayaquil at the time (it turns out that this rope was very well suited to its task). A non-shrinking perimeter (or 'bolt') rope is necessary in any traditional sail, providing the basic strength of the sail. Non-shrinking 'Belgian Brown' cordage is the choice for natural, traditional sails, but we were not able to obtain this before the expedition left the USA. Tarred hemp may also have worked, but at the time, only 1/2ä polypropelene was available in Guayaquil. The mainsail required 125 feet of roping; the mizzen required 100 feet. At the peak, tack and clew the rope was exposed through a reinforced 'window'. At the peak, a simple, unsiezed bight was left exposed; this was lashed directly to the yard. At the clew and tack, a figure-eight on a bight was exposed for attachment of sheets (these were 11mm climbing rope, attached to tack and clew with a siezed cowhitch). The bitter ends of the perimeter rope were exposed at a reinforced window just aft of the tack, where they were tied together with a double fisherman's knot, and siezed.

Finally, in Salango, Dr. Don Wilhelmus (an expedition patron) and the writer spent a full day sewing heavy fishing line through the four layers of heavy canvas and 1/2" hard-laid polypropelene, to secure the perimeter rope to the sailcloth at each corner. We sewed about 1 yard away from each corner and broke 15 of the heaviest available sailmakers' needles in just a few hours; this was a difficult, difficult job and the novice is warned to prepare accordingly. Note that a marlinspike kit is essential for such voyages; it must be equipped with at least one seaming palm per crewmember (so that all may work at once in emergency conditions), and a wide variety of tools, including needles, fids, wax, threads and leather; see Marino (1995) for the basics, and supplement the suggested kits with any and all tools which may be of use. Consider the handedness of the crew when making or buying seaming palms. Smearing all metal items with grease is important to prevent salt spray corrosion.

A reinforced rope 'window' was added 3 feet up the leech of each sail and in the same position on the luff. The perimeter rope exposed here was tied with an overhand knot, thus providing reef tacks and clews. Reefers (furling twines) have not, at this writing, been attached to the sails, but would be a useful addition.

On the luff edge of each sail (and on the foot of the mizzen), grommets were applied every 12ä. Only the most inferior grommets were available in Guayaquil at during the expedition, and these at a scandalously high price. Despite coating with grease, most of these grommets came apart within a week at sea, leaving a ragged hole needing repair. Rope grommets would have been preferable, but there was not enough time to make them. The foot of the mizzen was grommeted for the possibility of attaching a club-foot, though this has yet to be found necessary.

With the sails sewn, roped and grommetted, they were bundled and transported to Salango, by bus, for the application of the mildew-inhibiting and UV-reflective dye. With the aid of Dr. Don Wilhelmus (a opthamologist and patron of the expedition) and Annie Biggs-Haslett (Expedition Coordinator), the writer prepared a dye which was basically a tannin bath using the bark of our cocobolo and balsa logs. It has subsequently been determined that balsa bark is not of much value for this exercise, containing little tannin (Record and Hess 1943:97-98); cocobolo bark, however, is perfectly suited to this task. To the 100 gallons of water (50% fresh, 50% salt) heated in a large vat on the beach (over an open fire), we added the following substances as mordants and dyes, after the water had turned a deep brown with the bark: 7lb of aluminum sulfate (alum); 1qt. urine; assorted heavily-rusted scrap metal; 5lb bicarbonate of soda; 3lb wood ashes. The solution was boiled for several hours, allowed to cool slightly, and applied warm. The strange dye thus produced had a metallic sheen and massaged into the sails by hand or scrubbed in with a broom. The sailcloth was dampened with seawater before application of the dye. We were careful to apply the dye to all areas of the sail, particularly the seams.

Each sail absorbed between 30 and 50 gallons of dye. Application was somewhat uneven and often difficult to make uniform due to wrinkles in the canvas. The mainsail took one heavy coat, while the mizzen received two lighter coats. Both sides of each sail were dyed, leaving them an off-white color about 5% darker than the original, white canvas; this slight change in hue is considered to have significant preservational qualities for canvas sails.

The luff edges of the sails were bent to yards of caña guadua. The mainsail yard was 44 feet long, while the mizzen yard was 39 feet long. The yards were approximately 6ä in diameter at the tack, tapering to about 4 or 5 inches at the peak. We carried several spare yards; a good thing, as broken yards were one of the most common problems at sea until we devised a method for eliminating the dynamic motion by immobilizing the tack from excessive upward or downward movement; this prevented the upper end of the yard from whipping to and fro, and solved the problem. We further reduced strain on the yards by distributing the load with a bridle: see 4.7 above)

Each sail was attached at the peak by a 20-foot section of 7mm-diameter synthetic rope which bound the exposed bight of the perimeter rope to the bamboo yard, beginning with a clove hitch and ending with a square knot sewn through with fishing line to prevent working free. The sail was then laced to the yard by a continuous length of 1/2ä polypropelene rope (the same type used in perimeter roping) using a self-tightening modified spiral such that the sail would not tend to slip downwards on the yard when raised. This lacing technique worked very well.

The most valuable book consulted in the production of these sails is the comprehensive volume, ÎThe Sailmakerâs Apprenticeâ (Marino 1995). This book supplies all general and specific knowledge necessary for the hand production of sails of almost any type.

4.9 Anchoring System

Our ground tackle consisted of two anchors: a 45lb Danforth 'lunch hook' (used for short-term anchoring) and a 145lb Danforth anchor used for longer-term anchoring. One hundred yards of 1-3/4" Dacron rope (tensile strength 26,000 lbs) was used as the rode, allowing proper scope for our 60-foot vessel in most moorage waters. The anchor rode was tied (with a siezed anchor bend) to the foremost cocobolo crossbeam of the vessel, which never suffered any visible damage as a result (the foremost cocobolo was also used as a connection point when under tow, and likewise suffered no damage). A 20-foot section of heavy anchor chain (weighing roughly 70lbs) was connected to the anchor rode by a large pin shackle at the anchor stock, keeping the load on the anchor at a low angle and reducing chafe on rough terrain. The chain and rode near the anchor were wrapped with a 10-foot length of old fire hose to prevent chafe. A piece of twine was used to secure the pin shackle pin, which worked itself free if not secured.

This anchoring system worked flawlessly, securing *La Manteña-Huancavillca* in sandy, grassy and rocky bottom terrain (the exact tonnage of our raft has not been determined, though we estimate it at 11-20 tons). Addition of a tripper bouy is the only modification being considered; even the 145lb Danforth can be tripped manually by a diver in up to 60 feet of water. The writer personally dove to and manually tripped the 145lb Danforth, in 36 feet of water; this exercise was found to be challenging, but not unduly dangerous or difficult.

We used no mechanical advantage in weighing anchor. Experiments with stone anchors, of the type used by the Manteño, were, unfortunately, logistically impossible given time constraints. Raising the 145lb Danforth anchor required at least three men; two men raising the tackle and one taking out slack from the anchor hitch securing the rode to the foremost cocobolo crossbeam. This was slippery, heavy and dangerous labour, manually hauling at least 250lb (145lb Danforth + 70lb of anchor chain + 2lb pin shackle + 30+ feet of 1-3/4" wet Dacron rope) up through 30+ feet of water. One man often had to jump overboard to manually heave the anchor and chain into a better position during the last few moves, when the anchor was being dragged onto deck. In short, getting the 145lb anchor on deck was dangerous and difficult, but with care and coordinated effort no-one has yet been injured during this operation.

4.10 Binnacle and Watch Station

A 3-foot balsa stump, approximately 1m in idameter, was turned on end and used as a binnacle. This was placed directly aft of the main mast; it was also secured to the mast with a rope. In the center of the stump a top-sighting compass was mounted in a 4-inch deep well cut from the wood; this protected the compass from being knocked off the binnacle during various work on deck. The compass had a large 4-inch card which was easy to read. The card was graduated in 10 and 20-degree increments.

A bench, made from a guare laid across two stumps (one port and one starboard) served as the watchmen's seat. This was placed directly aft of the binnacle, so that the watchmen sitting at the bench could use the binnacle as a table.

4.11 Anti-Shipworm Experiment and Log Treatment

Because Haslettâs 1995 Illa Tiki journey ended in Panama, with his vessel devoured by the shipworm Teredo navilis, we were determined to deter these marine mulloscs in the present expedition. No early historical record provided us with details regarding the native means of achieving this goal, but local knowledge told us that the application of the juice of a fruit (barbasco) to the logs would prevent shipworm infestation; even Maestro Enrique suggested the method, as well as the unusual method of hanging bags of barbasco beneath the vessel, in the sea, to provide a Îcloudâ of barbasco juice to deter the shipworms. Barbasco (*Paullinia pinnata* and *Serjonia mexicana*) is common name for the the widely known fruit used to stupefy poison fish before collecting them to eat; the active substance involved is rotenone, which inhibits the ability of the fish to derive oxygen from the water, and they effectively suffocate. The fish are then earten with no ill effects to the human. Barbasco (also known in

Latin America as gordolobo or verbasco) is also discussed in APPENDIX C and some notes regarding it are found in Table 2.

To test the local ideas regarding the use of the barbasco juice, a four-week experiment was conducted in the bay of Salango, in which five pieces of balsa were anchored to the sea floor in roughly 20m of relatively calm water just South of Punta Mala, to the North of the village of Salango. The balsa chunks were tied to rock anchors such that the balsa was submerged, but only a few feet between the mean sea level. The individual balsa chunks were treated as follows: (a) no treatment, (b) a heavy coat of barbasco juice, (c) a lighter coating of barbasco juice, (d) nothing, but with a bag of crushed barbasco fruit suspended beneath the balsa chunk, (e) a light coating of new machine oil and (f) a heavy coating of machine oil (the machine oil was also considered by some locals to deter shipworms, though it would not have been aboriginal).

After four weeks the balsa chunks were raised and examined. In cases (a)-(d), shipworms had infested the wood regardless of the barbasco. In case (e) the oil had similarly done nothing to prevent infestation. Sample (f) could not be found and was presumed to have worked free of itâs anchor tether.

The shipworms were thus proven to be difficult to control. It was decided to make a compromise which would deter the shipworms while testing out the barbasco on a larger scale; we would paint seven of the hull logs with a standard shipâs antifoliant paint, and treat the two beam logs (port- and starboard-most logs) with a rotenone-based solution. In the event of failure on the two beam logs, they could be quickly replaced, and the vessel would be able to move on.

The seven logs were painted a day before launch with a blue antifoliant paint obtained in Puerto Lopez. The rotenone, brought to Ecuador by Annie Biggs-Haslett, was applied to the two beam logs with a sponge, in a strong mixture of rotenone (20%) and water (80%). Results of these procedures will be described below in the account of the journey.

4.12 Provisioning and Miscellaneous Items

Food and water were stored in plastic barrels lashed to the sides of the casita. Food staples consisted of rice, beans, flour, oil, pasta, onions and carrots. We carried sufficient stores for six men for two months. Our diet was supplemented with condiments, as well fish caught on a daily basis. Fishing employed a lure (any bright or shiny object) and hook tied to a line; the lure was cast out by hand and reeled in quickly; fish tended to strike the most rapidly hauled-in lures. Larger fish (see Figure 7) were fought to alongside the vessel, and then speared to be hauled aboard.

Some fishing was done by a swimmer overboard with a speargun, or a Hawaiian sling. Cooking was done on a 2-burner propane stove. Three 50-gallon propane tanks were carried. These metal tanks were smeared with grease to prevent corrosion in the salt spray.

Each crewmember carried aboard roughly two duffel bags of personal goods and clothing; this could be reduced considerably. The most valuable items were found to be books, knives, swim fins and goggles and hats (for rain and sun). Flashlights in the form of head-lamps were also of great value. Personal goods were stored inside the casita on shelves, or secured to the walls and on the floor. Each man had a light, synthetic sleeping bag, and several spares were always kept drying after being splashed by water or rain. With two men on watch at the binnacle at all times, up to four men would be asleep at a given time in the casita; there was just enough room to accomodate this size of crew. Light was provided by headlamp, flashlight and kerosene lamp. Fish-oil lamps were later custom-built on board.

5
FIRST VOYAGE OF
LA MANTEÑA-HUANCAVILLCA

The vessel was launched into the Bay of Salango on 28 September 1998. The launch incorporated the use of several roller logs on which the raft was pulled by 100 or more local people, inching forward into the Pacific Ocean. At several points we were assisted by a bulldozer, pushing from the rear, to speed the process; however, we know that the raft could be rolled to sea on logs, as the method was working well, and in fact Haslettâs 1995 *Illa Tiki* was pulled into the sea entirely by human muscle.

Fourteen days of provisioning and sea trials followed the launch, at which time the vessel was anchored in 36 feet of water, roughly 200 yards from shore, just North of the mouth of Rio Salango. During this time we obtained second-hand plastic barrels, previously used to contain bulk cooking oil or shampoo, and loaded them with food, keeping careful lists per barrel. This allowed us to go to a numbered barrel and retrieve an ingredient rather than to search among the barrels. The eight food barrels and five water barrels were loaded aboard the raft and secured with ropes to the deck or the deck-house. Sea trials are described below.

On 12 October 1998 the expeition was ready to put to sea. In the morning we experienced a four-hour period of utter panedmonium as the local inhabitants, celebrating their annual Balsa Festival, literally stormed the vessel at anchor and clambered on all surfaces as they examined the ship. At this time we were also inspected by a member of the Ecuadorean Armada, who approved our saftey items and the seaworthiness of the vessel, issuing our Îzarpeâ (permit); however he had left this in his office and had to send a junior officer to retrieve it, thus prolonging the wild situation of having roughly seventy people aboard a ship built for six. The zarpe was finally brought to deck, and the tow vessel, a fishing boat, towed us roughly two miles out; we were still surrounded by a flotilla of smaller craft and well-wishers. Cut loose at roughly 1pm, local time, we raised sail and began the journey North, waving good-bye to the boats as they turned for shore and the colorful fiesta. Spirits were high all round as we commenced the voyage, aboard the first vessel of true Manteño form to ply these waters for several hundred years.

Here we do not supply a popular account of the voyage, which will be provided in a forthcoming article; rather, we report on the main technical aspects of the voyage, commenting on life on board, sailing characteristics of the vessel, and so on. Once underway, we established two-person watches of 10 hours each, such that the helm was always manned and that adequate rest was available to the crew between watches. ÎSpare timeâ was consumed with the continual adjustments and repairs necessarily conducted on a wooden ship. Our main shipboard routine consisted of the following activities:

1. Watch
2. Vessel maintenence and repair
3. Sleep
4. Kitchen duty
5. Fishing to supplement stores

Our plan at this point was to sail to roughly 30 miles from shore in a WNW direction to pass Isla de la Plata at roughly 1degS 81degW before heading NNE along the coast of Ecuador and Colombia. Arriving in roughly 2degS 80degW we would turn roughly N to make a crossing to the Azuero Peninsula of Panama, centered at 7degN 80deg40minW. We would then turn W and continue up the Pacific coast of Mesoamerica towards Acapulco, Mexico, at roughly 17degN 100degW.

The first week at sea was characterized by heavy swells from the W with moderately good but often irregular Southerly winds. We generally made between one and three knots, calculated by throwing a chip over the side and timing itâs travel between two notches cut in the beam logs. Skies were generally overcast, and navigation by stars was very infrequently possible at night. Dead-reckoning, however, was sufficient and proven accurate with the GPS unit in later weeks. The crew did well, as did the vessel, both responding to a dangerous situation in which we sailed too close to Isla de la Plata: this is described below in Sailing Characteristics. Seasickness struck all men at one time or another, including Ecuadorean fisherman Dowar Medina. The best remedy was to get out on deck, in the open air, and to suck on small slices of ginger. The vessel held together well, although the mainsail yard did break several times; the method for preventing this is mentioned in 4.8 Lateen Sails and Yards. There was no question that the numerous crossbeams were holding the hull-logs in an unbreakable grip. When the masts leaned from vertical, stays were tightened with tourniquets or a modified prussik method.

In the second week, we were in roughly 2degN 79deg45minW and began to consider our turn N for the Azuero peninsula. We re-evaluated this plan and decided against it, considering Haslettâs entrapment, in the doldrums found between our position and the peninsula, in 1995. Rather than drift aimlessly, we decided to carry on generally NNE towards Southern Panama, near Punto Marzo (roughly 6deg50minN 77deg30minW) before making a more direct crossing to the peninsula. We carried on at this heading, making 40-60 nautical miles per day (a DR plot is still with Haslett in the field at this writing, but will be added to this report at a later date).

On day 12, in roughly 6deg10minN 78degW, Siekierski and Smith went overboard for a routine check to see whether the hull logs were infected with Teredo navilis, the shipworm which devoured Haslettâs 1995 *Illa Tiki*. We discovered that there were in fact colonies of shipworm in many places on the hull. The rotenone had failed to deter the shipworms from the beam logs, and the antifoliant paint had flaked away from large areas of the other logs, allowing the shipworms to take hold. It was imperative to get the vessel out of the water immediately in order to dry the logs, deprive the worms of water, and exterminate their colonies.

We were obviously disappionted by the necessity to pause the voyage at this point. Haslett decided to sail immediately for the Azuero peninsula of Panama, to make repairs as soon as possible. At exactly this time our previous good luck with wind and current abandoned us entirely. The generally southerly wind, which we calculated would allow us to beam reach quickly across the Gulf of Panama to Azuero, now changed to come from due West; this would necessitate laborious tacking which would keep the vessel in the water longer. At the same time, the current seemed to increase in intensity, and with the inconsistent, gusty winds from the W, tacking in that direction was found to be impossible. The wind, often dying completely for some time here, was no use to us as we drifted with the current NE towards the jungle shores of the Darien Gap.

We spent several days fighting to keep from being shipwrecked on that desolate coastline; the story, in technical detail, is described below in 6.1 Sailing Characteristics. It is sufficient to say here that we managed to take advantage of the gusty winds in order to (a) turn SW, (b) work out from shore to a safe position to the SW and (c) sail against the swift current to safely arrive at anchorage in Bahia Octavia, near Punto Marzo. This test conclusively demonstrated the sailing ability of our replica of the the Manteño raft. We finally beached the vessel at Bahia de Solano, Colombia, on 4 November 1998, after 21 days at sea.

6
DISCUSSION

The initial, 21-day, 700-mile voyage of *La Manteña-Huancavillca* from Ecuador to Colombia was an excellent test of this vesselâs capacities and limitations. With analysis of labor-requirements ongoing, here we focus on reporting the sailing characteristics of the vessel. It will be seen that we found the vessel to sail perfectly well, and that this type of raft, with some minor adjustments to design features, is well-suited to the task of sailing 2,400+ miles to West Mexico, and returning from that destination.

6.1 Sailing Characteristics

The vessel handled very well consindering its experimental nature and the uncertainties inherent in the reconstruction of a vessel not seen for some centuries, and known only by fragmentary and occasionally unreliable reportage. The principal distinction between the Manteño Expedition and all previous reconstructions of aboriginal rafts of Ecuador is that our expedition used triangular, fore-and-aft sails, rather than going square-rigged, for reasons mentioned above (2.3 Use of the Relacion Samaano-Xeres in Building *La Manteña-Huancavillca*). The raft sailed well with these sails, as will be indicated below.

6.2 Running With the Wind

The raft sails nicely with the wind from the stern, making two knots with both sails opened in a moderate breeze. It is somewhat difficult to steer the vessel in this configuration, however: when the double-keel of guares arranged on the port and starboard of the casita 'grab' the water and bend the vessel to a particular heading, it can be difficult to overcome the keels to change course. This is best done by lowering the mizzen to reduce speed so that the keel guares' direction-stabilising effect can be reduced.

Note that the mizzen is opened to the port, and the main to the starboard, to run 'wing and wing', with a following wind. It is possible that in aboriginal times a rudder of some design would have been used when running with the wind; we suspect that the rudder principle would have been familiar to the Manteño, given their understanding of the change in sailing balance achieved with the use of guares.

6.3 The Beam Reach

The raft is most comfortable while running at right angles to the wind. With the wind from the port, for example, the main and mizzen are raised on the starboard side of the mast (preventing the sail from folding around the mast); forward guares are used to bring the vessel to the proper heading, using the well-known and documented method of lowering them to bring the bow into the wind and raising them to allow the bow to fall off. Four steering guares (two on the port, and two starboard) near the main mast were sufficient to fine-tune for any desired course from 90-270 degrees from the direction of the wind. Fine tuning was accomplished by adjusting the clew sheet of the main sail (the mizzen was normally left alone once generally tuned).

The last word in fine-tuning, however, was accomplished with a single guare, normally (for convenience) placed just port of the binnacle, in easy reach of the helmsman. This steering guare has three holes (for the guare pin) to allow fine adjustment of the surface area provided below the log hull (even finer tuning was possible by tipping the guare back from vertical, further reducing surface area beneath the raft). If the vessel begins to fall away from the wind, the guare is dropped half-way, or fully, and the bow swings back around towards the wind, using the steering guare as a pivot point. If the vessel begins to luff, the guare is raised as needed and the bow falls away. Course error was as much as 20 degrees (in gusty winds and with confused swells) and as little as 5 degrees in good conditions. In general, the vessel sailed exceedingly well on the beam reach, generally making between 2 and 3 knots. The vessel normally gave up roughly 5-10 degrees of leeway on the beam reach, though we were able to compensate adequately for this by adjustment of our course. Note that the mizzen provided a great deal of power, both by itself and by funneling wind into the mainsail.

6.4 Sailing Into The Wind

This of course is the real Ítestâ of any sailing vessel which intends to be self-sufficient. Modern yachts and sailboats can manage to sail up to 45 degrees into the wind. *La Manteña-Huancavillca* managed to sail within 60 degrees of the wind, which is comparable to the caravels used by early Spanish and Portugese explorers in the 16th Century (Morrison 1974).

While we managed to maintain the 60-degree heading, we were initially frustrated by giving up so much leeway that our COG (course over ground, the course actually made when leeway and other factors are considered) was actually 75-80 degrees. We later determined that this was due to two main problems which were addressed in the reconstruction of the raft in Colombia.

First, on diving beneath the raft we found that nine of the lower portions of our 24 deployed guares had broken away. This substantially reduced our guare surface area, thereby reducing the raft's resistance to lateral movement; we were being blown across the surface of the water, with insufficient resistance beneath us. Further, we found that with time many of the remaining guares had 'scissored', pivoting on their wooden pins at the deck; the result was that in many cases, one guare was overlapped with another, and therefore only the surface area of one guare was in effect.

The new guares and their configuration seem to have eliminated these problems, although lack of good winds and other factors (see below) prevented suitable testing of *La Manteña-Huancavillca II*. The new guares were designed to be stronger and none were to have have 'middle' holes (most of the broken guares were broken at the middle adjustment hole, a weakness in the plank). Additionally, the keel guares were be secured against Îscissoringâ to ensure that all surface area of the guare array was utilized. Finally, the 'keel guares' flanking the casita were secured such that there are no gaps between them, thereby presenting two large Îfinsâ to resist leeway rather than 24 separate Îteethâ hanging from the bottom of the raft. These modificaitons should allow us to sail to within 55-60 degrees of the wind, while giving up only an acceptable amount of leeway; tests, at this writing, are forthcoming.

6.5 Four Examples Illustrating Our Handling of La Manteña-Huancavillca

Aside from the generally good nature of *La Manteña-Huancavillca* under sail, three incidents stand out to indicate our ability to control the vessel. These examples show that she is responsive (and importantly, responsive in appropriate measure) and that we are sailing, rather than drifting, to a far higher degree than on any previous reconstruction of a balsa raft, including those of Heyerdahl (1947), Willis (1953), Alsar (1988) and Haslett's 1995 (square-rigged) expedition. Our expedition is qualitatively different from those in that we have demonstrated the raftâs ability to sail out of danger; drifting vessels would not fare well at all in the coastal waters between West Mexico and Ecuador. It is a further testament to the raftâs merit that most of these maneuvers were carried out in consistently (and frustratingly) irregular winds with regard to direction and velocity.

1. Sea Trial at the Bay of Salango

On our first sea trial, on 10 October 1998, we were towed 3 miles NW from our anchorage towards the lee side of Isla Salango. With the raft free of the tow, we anchored and prepared the raft to sail back to anchorage. Subsequently we raised anchor and after a short wait were able to catch a gust which brought us out from the lee of the island. We now entered a 2-knot current with a roughly NNW set. Wind was from the south and was at a relatively good breeze of 8-10mph.

We first headed due N, running with the wind and using guares to keep the bow pointed somewhat NNE, such that we were crabbing to fight the current. Control of the vessel was easy and we did not need to use the large, oar-like rudders we had made in case of emergency. Approaching our moorage, we dropped fore guares further to bring the bow more into the wind, and once at 90 degrees to the wind, trimmed the sails and guares to beam-reach due E. This we did easily, giving up very little leeway. With guares and adjustment of the main clewsheet, we piloted the vessel to within 10m of the same anchorage spot we had left a few hours earlier. This was a successful sea trial which showed us that we had built a vessel that, at least, could sail at 90 degrees to the wind without giving up too much leeway.

2. Isla De La Plata

Two days after launch we approached ÎIsla de la Plataâ (roughly 1deg15minS 81deg05minW) (ÎSilver Islandâ or ÎCash Islandâ), sailing N past it's E side. In the evening we attempted to turn west to navigate past the north tip of the island and go further out to sea. On turning NNW, howver, we were suddenly caught in a strong current which drove us WNW at an estimated 2 knots. This was bringing us dangerously close to the rocky northeastern cliffs. We decided to turn south, against the wind, and tack away, and then sail S past the S tip of the island before heading N. As the gyre pulled us closer to the island, we dropped the sails and lowered the fore guares to bring the bow to the generally southerly wind. When the bow was properly positioned, we raised the mainsail (leaving the mizzen down) and sailed E for a short time to get some distance from the island. We then turned SSW and managed to sail past the S tip of the island, where we turned W and then headed N to resume our course.

3. Clawing Off From Darien

On day 15 we spotted land some miles to the East. This was the Darien, the mountainous jungle of Northern Colombia and the Southern reaches of Panama. Our plan was to turn W here for the 120-mile crossing of the Gulf of Panama, towards the Azuero Peninsula where we could beach the vessel and assess shipworm damage. The wind, previously SW, now changed to due W. Additionally, a strong current was taking us NE at more than 2 knots. This sudden change of conditions quickly put us into the alarming situation of approaching a desolate shore which would be extremely difficult to escape given the prevailing wind and currents. We decided to try to sail into the wind to get SWW, and then S, to wait for the wind to change and allow us to move W across to Azuero.

We dropped sail and lowered fore guares to bring the bow into the generally westerly wind. Once situated, we raised sail and began to sail at roughly 60 degrees into the wind on a course of roughly SW; however our leeway problem (see above, ÎSailing Into The Windâ) combined with the weak and gusty wind, and the speedy current, gave us a COG (acutal course) of S or even ENE when there was only a breath of wind; we were losing ground and drifting towards Darien, coming as close as a mile to the shore.

We spent the next 48 hours Îclawing offâ the shore, sometimes just maintaining our position and heading and often drifting ENE towards the shore when the wind died entirely for short (and worrying!) periods. The wind remained weak and gusty, but using guares and adjusting clewsheets, we were able to keep *La Manteña-Huancavillca* from giving up entirely and being swept to shore. We finally managed to get 15 miles out, beam-reaching with a very poor wind and confused seas the whole way; at this point the the wind died entirely and we were becalmed for many hours. The main point to consider here is that a drift-type raft would have had no hope of escaping the wind and current we encountered. The exploration and continued use of a maritime route on the Pacific coast of Central America would have to be carried out by nothing less than fully-capable sailing craft. Those who assume that the northward-flowing Humboldt current in this region affords a simple drift route to the North do not appreciate the complexities of sailing these vessels on this coastline.

4.   Piloting Into Bahia Octavia

When the decision was made to land in Colombia to replace our worm-eaten hull logs, we decided to anchor at Bahia Octavia. This on our charts was a small harbor, just beyond Cabo Marzo, approximately 30 miles N of Bahia de Solano (at roughly 7degN 77degW; variously mapped as Francisco Solano, Bahia de Solano or Cabo Solano).

The charts also indicated shallow rocks and islands guarding the entrance to the bay. Shallow rocks, actually, were no real threat, as our draft (vessel below the waterline) is miniscule for a vessel of our size; with guares up (easily accomplished if we were to approach rocks) we have a draft of about a foot. It is interesting to note that this is one of the great qualtites of the raft as a vessel of exploration; it can handle shallow water better than any vessel short of a canoe.

Our main threat was the rocky islands off both beams. We could see the white spray of waves smashing into the dark rocks, less than a mile off, and we knew we could not make any errors in entering the harbor. Again navigating using only guares and the clewsheets, we slipped perfectly through a one-mile wide gap between the rocks. We then spotted a Colombian Armada vessel at anchor in the bay and decided to anchor next to it. This vessel was 3 miles away when we first spotted it. The writer personally piloted the vessel into the harbor and to the exact spot we had planned on; 50 meters to the starboard side of the Armada gunship. An hour of very delicate maneuvering of the clewsheet, with the wind at our back, brought us directly to our intended position. Again, a drift vessel would be hard-pressed to respond so nicely to direction.

6.6 The Shipworm Problem

Clearly, while the vessel sails well and may be considered a candidate for making the voyage to Mexico and back, the shipworm presents a major barrier to wooden vessel navigation in these waters. While it has been suggested that the shipworm was introduced to the Pacific Ocean by European explorers, this has yet to be proven (though it is being investigated). If the shipworm was in place in pre-Columbian times (which is most likely, as the first ships built on the West Coast of Central America by the Spanish were continually damaged by shipworm), the Manteño would have had to deal with them.

Research on how the Manteño would have dealt with this major obstacle is currently underway; possibilities include charring the hull logs to Îhideâ the wood from the senses of the shipworm larvae, the systematic replacement of balsa logs at predetermined ports on the West Coast of Central America, and treating the hull logs with natural substances such as sulfur, brea (tar), rubber or wax. APPENDIX C details some of the findings of this research.

6.7 Conclusions

While the other reconstructions have relied on drift to take them on trans-Pacific voyages, the Manteño Expedition has examined (and continues to examine) the feasibility of the Manteño to navigate on the West Coast of Central America. I feel that, even in our interrupted, 700-mile, 21-day voyage from Ecuador to Colombia, we have dramatically illustrated that the Manteño must have been able to sail: coastal navigation is too tricky to be left up to drifting. Sailing is best accomplished with a 'fore-and-aft' sail, such as the lateen sail. We feel this is further support for Clinton

Further reports will supplement this publication, addressing topics such as:

* Labor and material costs involved in the production of these vessels
* Regional geographic barriers and resource opportunities for pre-Columbian mariners
* Possibilities for discovery of archaeological balsa ports on the West coast of Central America
* Methods of dealing with the shipworm, Teredo navilis

SPONSORSHIP

Expedition support or endorsement was not sought from the Royal Geographical Society, this being a largely American/South American venture; planned follow-up expeditions, however, may seek RGS endorsement providing that a 1/3 British involvement is established, according to 1999 RGS regulations. Financial support was raised almost entirely by expedition leader John F. Haslett, who secured deposits or pledges of approximately £10,000 over several years of planning; a further cash infusion (value undisclosed) was provided by American Adventure Productions, a Colorado-based adventure-film documentary production company.

In return, AAP was given production and transmission rights to the film of the expedition. The script for the narration of the first installment of the film, an hour-long documentary covering the construction of the vessel and the voyage from Ecuador to Colombia, has just been completed by expedition archaeologist Cameron M. Smith in conjunction with Amy Clemens, an AAP documentary film producer. The video is to be broadcast as part of the ÎAdventure Questâ series, on the Outdoor Life Network, in late 1999 or early 2000 under the title Î*The Voyage of La Manteña*â, and will be advertised as Part I of a trilogy of films documenting Haslettâs expeditions.

Further financial support came from pledges by individual crewmembers, who variously donated from £500 to £1000 each. Dr. Don Wilhelmus provided supplies of contact lenses and solutions, and made cash donations; Dr. Robert Schmeider donated cash as well as assisted in the field, installing our radio equipment in Salango, Ecuador. Much support was provided by sponsors such as Hehr Power Systems, who donated batteries and the battery-generator bicycle.

Other valuable support came from the following sponsors, each of whom receive reports and genuine feedback and thanks for their efforts from the crew:

Corporate Sponsors Include: *American Adventure Productions, Alpina Water, American Medical Response, American Radio Relay League, Baltech Industries, Bryant-Haymes Music, Challenge Air Cargo, CineFilm, Cordell Expeditions, Corporacion Naboa de Ecuador, Cruising Equipment, Eastman Kodak, East Penn Manufacturing, The Explorers Club, Foreign Trade Export, Hehr Power Systems, Igo Films, Lockhart Industries, Mazda Motors of Ecuador, Museo Salango, Northern California DX Foundation, Process Project Inc., Rescue 3 International, Secosa Corporation of Ecuador, Shade Tree Studios, Standard Fruit Corporation, Survival Products, Yaesu Radios, NewTronics Antenna Corporation, Whole Earth Provision Company and Zee Medical.*

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TABLES

Table 1.
Summary of Early Historical Descriptions and Illustrations of Native Vessels of NW South America.

Historian or Chronicler	Date and Location of Documentation	Context of Encounter and Documentation	Note on Historian or Chronicler	Vessel Described	Sails and Rigging Described	Secondary Source (s) and/or Comment
Relacion Samaano-Xeres	Describing Ruiz encounter with balsa raft in 1526, off Northern Ecuador (near Punta Galera).	Eyewitness account of native raft and cargo, captured by B. Ruiz; the description was to be read to the King of Spain.	Author currently unknown, but certainly the document derives from an eyewitness; possibly G. F. de Oviedo, from an interview with B. Ruiz.	Seagoing log raft with two masts and two sails; a crew of up to 20; a large and varied cargo; a size of up to 30 tomoles, comparable with the Ruiz vessel of probably 60 feet keel.	Sails descrived as being Î...of the same appearance as our ships...â. Also, the use of the word antenas, to describe the raftâs yards, refers normally to a lateen yard, whereas verga normally refers to the yard of a square sail.	Edwards 1965:67-68, also Szaszdi 1978: 524-525, and Parry and Keith 1984, Volume IV: 16.
Gonzalo Fernando de Oviedo y Valdes	Piblished in 1535, but describing the events of the Ruiz encounter (above) as well as the other rafts encountered by the Pizarro Expedition at Isla Puna, nar Guayaquil.	Historical description of F. Pizarroâs expeditions to find and conquer the Inka.	Oviedo was a chronicler who probably interviewed many eyewitnesses while in Panama, including Bartholome Ruiz.	As above.	As above. Note that Oviedo says that the Spanish, on first seeing the raftâs sails at a distance, Î...thought it was a caravel..â. He then states that the sails looked like lateen sails, thereby to a	Edwards 1965: 68. See also Parry and Keith 1984 Volume IV.

					degree equating caravels with lateen-rigged vessels.	
Pedro de Cieza de Leon	Written in the 1540âs, but describing the 1526 Ruiz encounter.	As above; another chronicle of Pizarroâs adventures.	Cieza de Leon was a soldier-turned-chronicler; he was not an eyewitness on the Ruiz vessel, but probably interviewed eyewitnesses.	As above.	As above: He also, specifically, says of the Ruiz crew, that Î...they saw a lateen sail of great size...â on first spotting the distant balsa raft.	Parry and Keith 1984: IV: 29.
Pedro Guttierez de Santa Clara	Written between 1540 and 1560, describing Indians and customs of NW South America.	Describing vessels seen on the NW coast of South America.	Guttierez was a mestizo soldier and a chronicler. He wrote both fiersthand descriptions and from eyewitness reports, and may have seen these vessels, if at a distance.	Guttierez describes a variety of large and small vessels, used for fishing.	Guttierez specifically mentions Î...triangular lateen sails...â.	Edwards 1965: 68.
Augustin de Zarate	Written between 1540 and 1565.	Describing peoples of Isla Puna, near Guayaquil, Southern Ecuador.	Written between 1540 and 1565.	Describes bow and stern with longer center logs and tapering towards the beams.	Zarate mentions that one sail is used on some craft, but does not mention whether it is square or lateen, or otherwise.	Edwards 1965:70, and Heyerdahl 1955: 254.
Gorolamo Benzoni	Written between 1540 and 1565. (see illustration, Figure 12)	Describes watercraft of coast North of Punta Santa Elena, therefore in the region of the Manteno chiefdom.	Benzoni was an Italian traveller and writer.	As above.	Benzoni mentions the use of sails Î...according to [the size of the vessel]...â. In a crude illustration he shows a sheer mast with a square sail.	Edwards 1965:71, and Heyerdahl 1955: 254.
Richard Madox	Madox made a drawing of a raft of some type during a Pacific voyage in 1582-1583. (see illustration, Figure 11)	The illustration is from Madoxsâ sea diary; whether it was intended for publication is unknown.	Madox was a shipâs chaplain; he spoke with other travellers, but according to Edwards (1965:69) Î...[Madox] never saw the rafts [or] .....Peru.â. The illustration is therefore suspect in accuracy.	The illustration shows an apparent log raft with several crew paddling, and an unusual sail.	The sail shown appears to be fore-and-aft rigged, but it is if dubious accuracy.	Edwards 1965:7069.
Joris van Spillbergen	Spillbergen illustrates a raft seen at Paita, Peru, around 1618 or 1619. (see illustration, Figure 13)	Spillbergenâs illustration was intended to show the native vessels encountered during his raid on the Spanish port at Paita.	Spillbergen was a Dutch sea captain who published his account of a voyage around the world; this voyage included an occasional raid or piracy, such as the attack on Paita.	The illustration shows a log raft with many intersting details, such as two fore-and-aft rigged sails, probable stone anchors, guares in use by some crew, and so on.	The illustration depicts two fore-and-aft rigged sails, with seams and curious two-part masts, which may or may not be accurate.	Edwards 1965:69, and Heyerdahl 1955: 256.

Table 2.
Notes on Most Natural and Indigenous Materials Used in Building the Raft.

Common	Latin Name	Specific	Use and Comments	Reference

the Quevedo river, South of the city of Quevedo in Central Ecuador. This survey was conducted to identify possible barriers to the construction of the raft near where the logs were to be cut, just SW of Quevedo in the governmental INIAP experimental forest, located at roughly 1deg03minS 79deg 30minW. We name this stretch of the river ÎQuevedoâ, though maps of the region are variable, and some name this the Vinces River.

Roughly 65km of this very slow-flowing river were navigated, using a large inflatable dinghy for the six men and towing a smaller dinghy loaded with supplies. I (C.M. Smith) took depth measurements roughly each 50 feet (or less in some areas, and more in others) using a long bamboo pole marked in 1-foot increments. Depth soundings will be reported later with a detailed map; here it is sufficient to state that the river was found to normally range from 1 to 15 feet in depth. The river bottom was normally muddy or silty; much alluvium is washed in from the surrounding lowlands, which were heavily employed in banana agriculture. Stratigraphy in the visible riverbanks was characterized by undifferentiated alluvium, though this occasionally contained distinct strata of rounded cobbles (15cm in maximum dimension). Such strata were generally 1-5 feet in vertical thickness.

In the first three days of survey we noted several areas of the river which were too shallow to allow the logs to pass as a wholly-constructed raft; it was proposed to simply float the logs past these obstacles and build downstream, but there were other obstacles which precluded that plan. Although some good, level, rocky building sites were found, the river seemed to be too low for our plans. We did not want to gamble on the river rising during our counstruction activities, and we therefore opted to activate Plan B, to find a building site on the coast. We terminated the survey at the village of La Libertad, roughly at 1deg30minS 79deg 45minW, taking a bus back to Guayaquil.

During the survey we experienced intense tropical heat, but an absence of insects. The river water was often fouled with raw sewage (near villages). Agricultural chemicals, drained into the river from the surrounding fields, contributed to the riverâs generally unpleasant condition. We camped on riverbanks and on the higher ground of small islands.

APPENDIX B
THE *ILLA TIKI* EXPEDITION, 1995

In 1995, J.F. Haslett built his first balsa raft in Ecuador. The vessel was constructed in Salango for an expedition to boyage across the Pacific to Hawaii. At that time, Haslettâs interest was more in the trans-Pacific voyage than in the history of the Manteño chiefdom; since that expedition, however, his interest has changed to include experimental archaeology and the Manteño-Huancavillca.

The Illa Tiki was launched in late March 1995, after three months of construction. On that exedition, all construction was by hand, with no bulldozers or other mechanical advantages to move the logs. This resulted in the long construction period, but also generated useful labor-cost data (which have yet to be analyzed). The vessel was crewed by Haslett, his brother Brock Haslett, cinematographer Chris Humphries, Ecuadorean Dowar Medina and Swedish ethnologist Jurgen Morgensen. After sailing somewhat NW from Salango, the square-rigged raft was turned N to work in that direction before heading WNW for Hawaii. Luck was not with the expedition; the wind died, and 30 days were spent in the doldurums, drifting NW and N. With the return of wind, Haslett decided to head for the Azuero Peninsula of Panama, having noted that his vessel was heavily infested by the shipworm, Teredo navilis. On the 38th day of the voyage the vessel landed at Panama. After some period attempting to restart the voyage, Haslett returned to the USA and began planning the 1998 expedition.

The great distinction of Illa Tikiâs voyage is that she was devoured by shipworms, a fate completely without precedent in balsa raft reconstructions; for this reason, in planning the 1998 expedition, Haslett spoke with all experts on the Teredo and formulated a series of plans to prevent the disaster occuring again; as the reader is aware, however, this is precisely the problem encountered on the Manteño Voyage. We are currently investigating this obstacle; see Appendix C.

APPENDIX C
THE SHIPWORM, *Teredo navilis*

The shipworm has devoured three of John Haslettâs vessels: *Illa Tiki* (1995), *La Manteña-Huancavillca* (1998) *La Manteña-Huancavillca II* (1999). The voyages of Alsar, Heyerdahl and Willis each were free from the problem of the shipworm. Several questions naturally arise: What is the shipworm? Of the many balsa raft expeditions, why have only the Illa Tiki and Manteño Voyage expeditionsâ vessels succumb to the shipworm? What can be done about it? How did the ancient Manteño defeat the shipworm? We are currently investigating all of these questions, but some general comments may introduce the topics below.

The Shipworm

Because of the wide distribution of shipworm, and its damaging effect on wooden ships, pilings, wharves and piers, it has been studied by many researchers, mainly in efforts to find means of deterrent. To date, no lasting method has been found aside from sheathing wooden elements with tar, metal or plastic, injecting them with creosote or simply replacing them with metal or concrete. All pre-industrial methods were simply delaying the inevitable, and it has been noted that virtually every wooden ship ever to enter the sea, if not sunk or destoyed by fire, has been eaten by the shipworm. Here I will not exhaustively treat the subject, but simply introduce the reader to the shipworm and indicate some of our current lines of investigation.

Teredo navilis is one of the many species of the Teredinidae, or shipworms; it is not actually a worm, but a marine mullosc which is extremely well adapted to boring into wood, which it consumes as food. In the larval stage, the creature attaches to any bit of wood in itâs saltwater habitat, and begins to eat, boring a hole into the wood. This boring both (a) creates a Îpassagewayâ which fills with water, reducing bouyancy, and (b) degrades structural integrity, weakening the wooden elements of a ship or pier. Many millions of eggs are produced at a high rate; colonies grow rapidly, with devastating effects. Shipworms can grow to be up to 10cm in length, and 1cm in diameter, and they can (and often did) very quickly devour the unprotected planks of vessels such as the thin-hulled caravels and other vessels of the 16th Century. Explorersâ journals of those days are full of comments on the scourge of the wooden boat, the shipworm, which mariners wryly called Îla bromaâ or Îthe jokeâ. A grim joke.

At first, the Spanish simply lived (and died) with this problem; later they began to fix copper sheathing to their ships, and to paint them with tar. These methods worked to a degree, but the broma always had the last laugh, as they slipped between copper plates, or infiltrated non-tarred areas of a vessel; only the worldwide adoption of metal hulls has prevented more disasters attributable to the shipworm.

Natural Methods of Deterrent

If the Manteño were sailing the long route from Ecuador to West Mexico, and back, they must have been dealing with the shipworm. There are many ways in which this could be accomplished; the objective of current research is to search the archaeological and historical records to identify the methods most likey to have been used, and then to test these methods in an effort to learn more about their costs and effectiveness; eventually, of course, the point is to arrive at the logical conclusion and state with certainty what method(s) were used.

1. Barbasco

When the 1998 expedition arrived in Salango, and we asked the local fishermen how we could possibly prevent the loss of the ship to Îla bromaâ, they told us to paint our vessel; good advice, but modern antifoliant paint would not have been used by the Manteño. We asked about indigenous methods, and were told by all that the best method would be to apply the juice of the barbasco fruit to the logs; the results of the experiment which ensued are reported above in 4.11 Anti-Shipworm Experiment and Log Treatment; notes on barbasco species are provided in Table 2. As noted, barbasco is a fruit which grows naturally in Western Ecuador (and many other regions of South and Central America); it is crushed and the pulp used as a cleanser as well as a fish poison, utilizing the properties of rotenone, a substance occuring in the plant. Today barbasco is widely used in shrimp farms of Southern Ecuador, where the barbasco is used to kill shrimp-eating fish which intrude on the large shrimp-growing ponds.

Twenty-kilo sacks of barbasco fruits cost, in Machalla, in 1998, approximately $30.00 US; we estimated that 50 such bags would be necessary to derive enough juice to coat the entire vessel; this was beyond our budget, so we opted to use a rotenone-based solution in place of the barbasco juice.

At this point, it is sufficient to say that the rotenone treatment was not effective; the shipworms infested the rotenone-treated logs. It may be that our rotenone solution was too weak, or too strong; or improperly applied. It may be that the separation of the rotenone from other chemicals in the barbasco fruit precludes some necessary reaction; all these options are being researched at present and experiments are being designed to test this possibility more thoroughly. The important point is that we are here investigating a realistic possibility, based in traditional knowledge, to overcome the shipworm problem.

2. Tar

Another possibility being researched is that of the application of tar. Seeps and springs of natural tar, or brea are, very interestingly, mentioned by several early explorers of what are today Ecuador and Northern Peru. Proceeding chronologically, we find four passages of particular interest.

The historian Zarate, writing in the 1550âs about events witnessed from as early as the 1540âs, tells us, in a passage titled ÎOf the Vaynes of Pitch, Which are at the Cape called Destahelena, and of the Gyants which in the Past Inhabited Thereâ:

ã... [there] are found certayne springs of Pitche, or Tarre, and it serueth for the same purpose, for Ships; Nort far from the said Cape, the Indians of that Countrye doth affirme, that sometime dwellt certain Gyantes, who were of maruaillous great stature..."

Zarate 1555 [1700]

Writing in the 1570âs, about events witnessed in New Spain in the 1560âs, Joseph de Acosta tells us:

"...At the point of Cape S. Helen there is a spring or fountaine of pitch, which at Peru they call Copey. This should be like to that which the Scripture speakes of the wild valley, where they did find wells of pitch. The Mariners use these fountaines or wells of Copey to pitch their ropes and tackling, for that it serves them as pitch and tarre in Spaine. When I sailed into New Spaine by the coast of Peru the Pilot showed mean Iland, which they call the Ile of Wolves, where there is another fountaine or well of Copey or pitch, with the which they annoint their tackling. There is another fountaine of pitch, which the Pilot (an excellent man in his charge) tolde me he had seene, and that sometimes sailing that waies, being so farre into the sea as he had lost the sight of land, yet he did know by the smell of the Copey where he was, as well as if he had known the land, such is the savour that issues continually from that fountaine. "

Trans. and ed. by Markham, 1880

Pascal de Andagoya, writing in the early 1600âs, tells us the following:

"From San Miguel towards Puerto Viejo and the north the climate changes; for it rains in certain seasons, and the heat is greater. The people too are very different. They go to sea to fish, and navigate along the coast in balsas made of light poles, which are so strong that the sea has much ado to break them. They carry horses and many people, and are navigated with sails, like ships. In these provinces are found the rich emeralds which are met throughout the land. On the coast there is a fountain of rosin, whence they take a rosin like tar, and it forms a little lake in front of the fountain which gives it birth, and there it thickens under the sun. The ships which pass by, take quantities on board, and with it they tar the ropes and the ship's sides."

Trans. and ed. by Markham, 1865
(authorâs emphasis)

Somewhat later, Reginaldo de Lizaraga, speaking of the Santa Elena Peninsula, mentionss the use of tar once again:

"There is, not far from here [Punta Santa Elena] a spring, from which flows a liquid-like brea, and not in small quantities, which is utilized by vessels instead of pitch, as we did with ours, because when it began leaking we put into the bay of Caraquez, rounding Cape Pasao 8 leagues beyond Manta, from where we sent the long boat with some sailors to this point for the brea, which is called Îcopeyâ and when it arrived the vessel was dischared and careened and painted and caulked with the brea that had been boiled down to thicken it, so that sailing from there we navigated without so much danger."

Lizaraga in Bosworth 1922:340

In each passage, the author mentions the presence of natural tar seeps, as well as their use to treat ships. The treatments focus on the vesselsâ sides (strongly implying a desire to deter the shipworm, or, possibly, in conjunction with caulking) and the tackle (ropes &c.) in which we may assume they were trying to preserve cordage and prevent the shrinkage and expansion that occur with natural cordage when wet and dried. The tar was also used in caulking between planks.

Acosta identifies ÎCape St. Helenâ, now Punta Santa Elena, at roughly 20S 810â W, just 50 miles South of Salango, Ecuador; this same geographical point is mentioned by Zarate, calling it ÎDestahelenaâ. Zarate also mentions the legends of giants in this area; interestingly this is the result of the tar seeps of the area preserving the bones of large Pleistocene fauna in the manner of the bones preserved at the famous La Brea Tar Pits of Los Angeles, California. Native inhabitants considered these bones to be the remnants of giant humans. Palaeontologists have surveyed these areas in search of the bones; Edmund identifies specific fauna-bearing tar seeps on the Southern coast of the Santa Elena Peninsula at 20 18â S 800 49â W; more tar seeps are mentioned as existing Îbetween Salinas and Santa Elenaâ, in a region known as the Îtierra breaâ (land of tar) (Edmund 1965). Earlier work by Sheppard (1937) identified hand-excavated tar pits on the Santa Elena Peninsula, used by the early Spanish, and certainly known to the pre-Spanish natives (Sheppard 1937:251-252, and Figure 191). The wide distribution and potential availability of natural tars in this region are indicated by Campbell (1979), who notes further tar seeps to the South, as far as Talara in Northern Peru.

It is clear, then, that natural tar seeps were available to the Manteño. The brief historical notes presented identify the use of this tar by 16th and early 17th Century mariners. Although we do not learn, from the above, whether these mariners are European, Spanish, or both, I suspect that the Spanish learned the whereabouts of tar seeps from the native Manteño, as they learned the location of many other resources. It is difficult to imagine that the Manteño were unaware of these resources, and in fact the Whatever the case, tar was used to protect ships, very likely from shipworm.

The evidence is good; however, it is somewhat distressing that the seven coats of tar applied to *La Manteña-Huancavillca II*, before her launch in January 1999, did not prevent more woodworms from attacking and destroying the vesselâs bouyancy. The shipworms ate through the seven coats of tar painted onto all surfaces of the balsa hull logs. Analysis of this infestation is currently underway.

3. Other Methods: Rubber, Wax, Sulfur, Charring

Although none of these methods were suggested to us, or are mentioned in the historical texts, it is entirely possible that the Îsecretâ used by the Manteño has not been preserved, and that only by exhaustive experimentation can we ever approach the truth. The application of natural substances such as wax, rubber, sulfur (all readily available within Manteño territory) to the logs, or the treatment of the logs by methods such as charring, are all being researched.

4. Other Factors: Water Temperature, Habitat, Vessel Speed

It is possible that other expeditions did not suffer from the shipworm because the waters in which they operated were too cold; similarly, habitat differences may be involved, or even habitat and species change through time. All of these possibilities are being investigated. Note also that vessel speed may be critical; vessels travelling at over 1.5kts are too fast for larvae to attach themselves to; it is possible that while anchored at the bay of Salango, generally immobilized in our 12-day provisioning and sea-trial period, the worms may have infested our vessel.

5. Fresh-Water Treatments, Drying and Refitting

Given the fact that moving vessels are not vulnerable at sea, it is also possible that Manteño vessels were allowed to stop only in fresh water, as this (a) would prevent shipworms on a clean hull (Teredo lives in salt water only) and (b) kills any shipworms entrenched (though this may take several days). If so, possible ancient balsa ports may not have been directly on the seaside, but some distance up rivers. Drying an infected log also kills Teredo, though the logâs bouyancy and structural integrity have already been degraded.

One futher possibility is that the rafts, once infected, were simply rebuilt, using the balsa trees which are found all up the Pacific Coast from Ecuador to Panama, as well as into Costa Rica and yet further North. If so, we may be alble to estimate the number of stops necessary for rafts of given sizes, again helping to determine labor costs, and possibly helping to identify archaeological sites. As in all cases, this possibility is being investigated.

Interestingly, Haslett has theorized that the log-hull philosophy of the balsa raft may have been developed precisely to deal with the shipworm; if it is known that the shipworm is a potentially deadly menace, it makes sense to build vessels from solid logs, which take longer to sink, than with mere planks. This hypothesis is being refined and tests of its implications are being designed for systematic examination.

Our goal is to identify the method or methods used by the Manteño to deal with the obstacle presented by the shipworm. Archaeological experimentation and archaeoloogical/historical research are being combined to search for the answer.

APPENDIX D
16th CENTURY EUROPEAN SHIPS OF EXPLORATION

My interest in this topic stems from my obsession with the following question: Î*What was Bartholome Ruiz sailing, and how was his ship rigged, in 1526, when he encountered the native balsa raft off the coast of Northern Ecuador*?â. Since the Spaniard on the Ruiz vessel commented that the nativeâs balsa raft sails Îwere of the same form as our ownâ, if we can identify whether Ruiz was lateen-rigged or square-rigged we can identify how the native balsa was rigged.

Considering the importance of the maritime affairs to the Spaniards in the exploration and conquest of the New World, it has been pointed out that their attention was in fact more directed towards the land, and the gold and silver it contained, than to the sea. Rather than a clear delineation of ship types and functions, what we find in the Spanish Chronicles are a variety of terms referring vaguely to a constellation of different types of ships (see note 5 in Romero 1943:4).

Although a number of authors have discussed the early ships of the Spanish exploration in the New World (e.g. Smith 1991, 1993), most focus on the later explorations and the treasure fleets; the early activities of Pizarroâs three expeditions, beginning in 1524, on the Pacific Coast of South America, are lacking documentation. Three important treatments of Pizarroâs early expeditions are discussed further below.

The Nao, the Caravel and the Bergantin

Some of the best research on the subject, to date, is that of Romoli, who, in an under-appreciated masterpiece of historical research (1951), notes that in the early 16th Century AD, the Spanish were basically operating types of ships in the New World. The largest was the nao (a contraction of navio, meaning Îshipâ in Spanish, according to Vigneras 1976:37), which was a ponderous, deep-hulled, square-rigged vessel used to transport cargo. This vessel would be similar to the common conception of the galleon, and was in fact its ancestor. Somewhat smaller was the caravel, more nimble, narrower of beam, shallower of draft and often lateen-rigged in the Portugese fleets. The Spanish, according to Romoli, preferred the caravel square-rigged, but for some work, such as coastal exploration, lateen caravels were favored due to their maneuverability and shallow draft; King Ferdinand in fact mandated that each fleet contain at least a few Îlateen caravelsâ. The last general term to be applied to these 16th Century Spanish vessels was bergantin, referring to an open boat, often to 8m or so in length (Vigneras 1976:38); bergantines were favored for coastal exploration, and could be propelled with oars, or with the use of a sail; this sail was, in almost all cases, lateen in form, allowing windward sailing. The word bergantine (or vergantin, or bergantina, or brigantine; depending on translator, nationality and linguistic affinity) should here be noted to apply only to the small, normally open vessel of the 16th Century, and not the larger, fully rigged vessels, called brigantines or brigs, of more recent times.

Variability in Bergantine Function and Rigging

Returning for the moment to the original question, we can, I feel, rule out the nao as being used on the Pizarro voyages; such a large vessel would not be used for aims of exploration and conquest which were driving Pizarro. We are left, then, with the bergantin and the caravel. Both were, as noted, often lateen-rigged. Although one would like to leave the situation Îclarifiedâ in this way, further research shows that caravels and bergantines did vary in regards to the use of square or lateen sails. Because the caravel is quite well documented (basically being either caravela latina (carrying three lateen sails) or caravela redonda (carrying a lateen mizzen and main, with a square foresail), I here concentrate on the lesser-known bergantin.

Haring (1918:264) characterizes the Spanish berganitne as a Îsmallâ boat, both rowed and sailed, used for coastal and river navigation; he points out the variability in the use of the term Îsmallâ by indicating that bergantines could reach up to 200 toneladas, the size of the largest caravels. Haring also recognizes the great variety in ships of the 16th century, naming the frigata, barco, zabra, tartenas (a lateen-rigged fishing boat similar to the bergantine) and the avisos.

In 1508, we know that Sebastian de Ocampo was comissioned to explore the coastline of Cuba: this was to be done with two bergantines (Anderson 1941:150), though we do not know whether they were square or lateen-rigged. Gardiner (among others, including R.C. Smith, 1998, personal communication to the author) notes that the bergantines used by Cortez in the conquest of Tenochtitlan were square-rigged (Gardiner 1956). Duthurubu illustrates a square-rigged bergantine; he also shows other, interesting, and lateen-rigged vessels he believes were used in the exploration of Pacific South America (1972: 175-218). Anderson indicates that in Pedrariasâ fleet, leaving Spain in 1514, there were among the 25 vessels six bergantines, four undecked and two decked (1941); although they were Îfully riggedâ, we do not know whether this is lateen or square.

In the third letter from New Spain, Cortez, talking about exploring what is now the Gulf of Cortez, states that he planned to build two medium-sized caravels and two bergantines; tellingly, he says that the caravels are to be for voyages of discovery, and the bergantines for charting the coast (Pagden 1975:277). In his 1513 letter to the King of Spain, Balboa spefically mentions bergantines and caravels operating at Darien; one bergantine is noted to be en route to Spain and we may expect this was at least not of the smallest size (Blacker and Rosen 1961:44). Balboa also specifically notes the the necessity of building bergantines for his further explorations of the New World, particularly the Pacific Coast of South America (Blacker and Rosen 1961:52). Indeed, Balboa later was employed by Pedrarias to build just these bergantines, the first European ships built on the Pacific side of the Isthmus of Panama (Parry and Keith 1984:49-50)

We see, then, a great variety in descriptions and uses of these vessels, though some general themes resound. I will return to these themes after a brief diversion to examine one more line of potential evidence; illustrations.

Direct evidence of vessel form may be found in illustrations of the period. I perfert to examine the vessels shown on maps, as the cartographers were often pilots themselves (Lockhart 1968) (as was Ruiz; see below) and they would be most familiar with the form of their vessels. Two maps stand out here, of the many available for review. First, the famous Juan de la Cosa map of 1501 (or 1500), currently in the New York Public Library; this map, illustrating the New World as known for the first time, drawn by the experienced pilot and explorer Juan de la Cosa himself, shows 12 vessels; of these, seven are lateen caravels. Figure 14 illustrates a typical lateen caravel of the 16th Century; this, I feel, is very close to what Ruiz would have been sailing.

The second map of great interest is one made in 1527 by Ruiz himself, with the assistance of another pilot, a certain Peñate who was a pilot for Pizarroâs first expedition in 1524 (Parry and Keith 1984:19). This map shows the lands Ruiz discovered in 1526. I recently found this map (see Romero 1943: 9) after much research on the subject, and one may imagine my excitement, as I opened the appropriate volume, at the prospect of finding Ruizâs sketch of his own vessel; surely that would seal the investigation. One may also imagine the exhasperated disappointment which swept over me as I scanned the old explorerâs map in vain, and found no trace of a depiction of the vessel. Hope still exists: if I can find the original map, I will have it examined under a variety of lighting conditions, well-known and often used by historians, to search for possible erasures; perhaps Ruiz sketched his vessel, and then decided against it, and scratched it out. If so, I may solve the mystery once and for all. Until that time, we must use the textual descriptions, as summarized below.

We see that bergantines were normally relatively small, maneuverable vessels which could be rowed or sailed; they were often towed behind larger vessels, and were handily used for a variety of tasks, including, prominently, coastal and riverine exploration, although Romoli (1941) reminds us that some bergantines were even used to cross the Atlantic. Given their characteristics (maneuverability and speed) and origin (in the lateen-rigged fishing craft of the Mediterranean), I think a useful, and reasonable summary of current knowledge regarding bergantines is found in the 1995 Oxford Companion to Ships and the Sea, which identifies bergantines as lateen-rigged vessels, deriving from the Mediterranean region, reaching 40 feet in length; they can carry one or two masts, and have eight to 16 rows of benches for the oarsmen. Bergantines, the Companion notes, often had a raised stern for officers, and may have been carried Îknocked downâ in the holds of larger vessels for longer voyages. In a similar distillation of knowledge, Parry and Keith, who have reviewed and edited a massive body of data on the early exploration of the New World, note in their glossary that the bergantin is a small sailing vessel or a launch (Parry and Keith 1984: Volume III: Glossary: ix).

With regard to caravels (on which there is a large literature: for an introduction see Smith 1993), Duthurubu notes that while both lateen and square caravels were used in the early exploration of Pacific South America, we cannot be sure which types were used by Pizarro, or even whether they were true caravels (1972:194). Rather small caravels were, however, the vessel of choice for rather long-range exploration; in a 1503 letter to don Alvardo de Portugal, explorer Cristobal Guerra wrote that Î...for exploration the most appropriate vessels are the small caravels, not exceeding 50 tons...â (Vigneras 1976:37). Duthurubu makes this point because all ships in these early years were being built on the Pacific side of the Isthmus of Panama, by often inexpert shipwrights (see Balboaâs complaints in this regard in the letter of 1513: Blacker and Irwin 1962:50), and with a hoge-podge of material carried across the isthmus, there must have been a great deal of variation and improvisation at this time. On the other hand, I suspect that the Spanish carried notions of what a certain ship Îshouldâ look like, and that some guides, or perhaps even stereotyping, was employed in the building of these vessels. Unfortunately, one can only speculate on this matter.

Ships of the First Two Pizarro Expeditions from Panama

Romero states that the vessels on Pizarroâs first voyage, in 1524, were the Santiago and the San Cristobal (1943:3), estimating their tonnage of 25 and 45 toneladas, respectively. These names are corroborated in Duthurubu (1972), Parry and Keith (1984) and Szaszdi (1978). A bergantine was also taken for various task (Romero 1943:4), the vessels in sum composing a typical 16th Century Spanish armada of exploration and conquest. Some clues to the rigging of the named vessels may be available; one was a vessel built for Vasco Nunez de Balboa (who had been executed by this time), the other purchased from one Pedo Gregorio. Although a Îpaper trailâ may exist here somewhere with regard to Gregorio, I suspect that there is no such evidence remaining for Balboa, as all paperwork regarding that explorer mysteriously vanished just after his sham trial and execution by Pedrarias (Romoli 1951). The historian Oviedo is said to have read all of these documents, and been shocked at their scandalous contents. They were then confiscated by Pedrarias and, before the crownâs investigation of this old villanâs activities, the papers vanished. Personally, I feel they all ended up in Pedrariasâ fireplace some time in 1520. We do find that the Balboa vessel had to be reassembled, being at this time taken apart on the beach (Shay 1932), but there is, alas, no mention of Îantenasâ or Îvergasâ or any other clue here. In any case, although the topic is fascinating, we are most concerned with the second voyage, on which Ruiz encountered the native raft.

The second expedition has been treated comprehensively by Szaszdi (1978), and here I will simply state the few known facts. First, there were three vessels, again making a Îtypicalâ armada of the time; two Înaviosâ (according to Guerreira 1979:3) -- not to be confused with the Înaoâ mentioned above -- of 40 and 60 tonoles (contrasting with the 25 and 45 ton Santiago and San Cristobal of the first voyage). How these vessels were obtained, either through custom building or the purchase of finished vessels, is at unclear at present. There was also third vessel: according to Guerreira, a bergantine (Guerreira op cit), according to Murphy, a canoe (Murphy 1941:23); canoes were used for much coastal navigation. Sailing from Panama, the expedition came to Rio San Juan, at roughly 4degN 77deg30min W. There they halted; Pizarro waited as Ruiz moved South and Almagro went North. No further clues appear as to Ruizâs rigging at present.

Summary and Conclusions

Considering all the information presented, I feel we may reconstruct the Ruiz vessel with a reasonable degree of certainty, partly through identifying what it was he was comissioned to do. Bartholome Ruiz was on a mission of exploration (ÎRuiz...vaya explorar...Surâ Romero 1943:12); he was concerned not with the movement of troops or supply, but with exploring unknown territory. Almagro, in contrast, at this point headed North, towards Panama, in order to fetch reinforcements and supplies (Romero 1943:12); he would have taken whichever vessel was most suitable for transport. The third vessel, either a bergantine or a canoe, was left with Pizarro for whatever purpose he may need.

It is clearly stated that in this instance, Ruiz took the smaller of the two vessels; the one estimated at 40 tons (Szaszdi 1978). I would suggest that this vessel was very likely to have been lateen-rigged, for the purpose of coastal exploration. Whether it was a caravel or a bergantine is currently unknown; Szaszdi states that it was a caravel (1978), Edwards is unsure (1965 and 1998, personal communication with the author) and the Peruvian historian Ortiz-Sotelo thinks it was a bergantine (1998 personal communication with the author). Other prominent scholars of Spanish maritime history, professors C. Archer (Calgary), R. Smith (Florida) and P. Hoffman (Louisiana), have indicated that they also cannot be sure on this point (Archer, Smith and Hoffman all 1998, personal communication with the author).

Whatever the case, we may learn from the facts that Ruiz was an experienced explorer, and the chart reconstructing his voyages indicates much coastal work (see Szaszdi 1978). I feel he would have predicted the importance of having a lateen-rigged, windward-capable ship, and, given current evidence, I believe that is what he sailed in the year 1526. I am also strongly of the opinion that the balsa encountered on 1 October of that year was, in fact, lateen-rigged.

APPENDIX E
ASCENT OF ISLA SALANGO

In early September, 1998, Scott Siekierski and I (Smith) made an ascent of Isla Salango, to itâs Eastern false summit at what I would estimate to be roughly 500m above sea level. We began the dayâs expedition by swimming from Punta Salango to the islandâs NE shore. The swim was not unduly difficult, although the strong southerly current made crabbing necessary; we had to swim SW to arrive on the NE point of the island, rather than simply swimming W. Swimmers are advised that there are rocks roughly in the middle of the channel which would be unwise to approach given the violent water action in that area. Wildlife encountered on the swim were unidentified species of large, gray fish, swimming at some depth (roughly 15m), possibly hammerhead sharks as seen in fishing boats in the vicinity.

I wore an ultralight, one-piece wetsuit, diving mask, scuba flippers and a rash-guard top. I also towed a dry-bag containing a camera, matches, a large knife, two pairs of shoes and some bits of chocolate. Scott wore a life preserver, swim fins, a t-shirt, trunks and a mask.

Landing on the island, we noted the basaltic composition of the bedrock. We moved around to the Northern shore of the island, finding a pleasant, sandy beach. We then began climbing a wall of friable, blocky basalt, at an angle of roughly 45-60 degrees. The ascent was made on the NE buttress of the island. The climbing was treacherous. I am a mountaineer with 13 yearsâ experience across the Americas and in Europe, including technical alpine climbing. I rate the ascent at 5.6âXâ. I feel that I was more concerned about the conditions than Scott, who was inexperienced and happily oblivious to our peril.

The dry and breakable nature of the heavy vegetation which clung to the wall at places made it unpredictable, thereby making the act of hauling on branches to move upward extremely risky. Two vertical steps, and a very dodgy, steep and crumbling traverse, led to an easing of the buttress angle. Here we ascended through heavy vegetation to the false summit plateau in mid-morning, after a 40-minute climb. I was relieved that weâd arrived without one of us falling off for a 300m drop to the rocks below. Technical climbing would be impossible here, with the blocky and crumbling basalt making anchors (nuts, bolts or pins) an impossibility.

Vegetation on the upper slopes of the island was thick and tangled, making bipedal progress extremely difficult. We gamely crashed onward and upwards for some time here, gaining roughly 200m towards the false summit, but we abruptly concluded that descent was the better option. The population of the island included nesting brown pelicans and an inestimable number of palm-sized, shiny, red-and-black spiders. The stringy webs of these spiders quickly formed a sort of gauze around our scratched and sunburnt bodies as we wrestled through the vines, WNW, on the false summmit ridge. We were looking to find a suitable gully in which to descend 500m to the beach.

We found a likely-looking gully dropping roughly N towards what we hoped was the sandy beach weâd seen earlier. Over the next hour and a half we descended through some of the most impenetrable vegetation I have encountered in more than 20 years outdoors. Security of footing was impossible to predict as it was composed of either a yielding mass of dried and cracking vegetation or a steep and crumbling basalt rock buttress. Thorns, cacti and apparently sentient vines alternately impeded progress or simply provided fresh injuries. Our best progress was made when we found thinner undergrowth in the narrow gully bottoms; here we crashed through rank upon rank of spiderwebs such that by the time we emerged from the bush to the beach, very suddenly, our hair was pressed down as with a net, and our eyes, ears, noses and mouths were dry and sticky with the tough cobwebs.

A quick swig of water on the beach was followed by our happily splashing into the ocean, where we swam for shore. We had a bit of work to avoid the rocks mentioned above, but once cleared we were pleased to find ourselves well on course, and soon enough we landed back on the mainland.

Although I have no scientific results to report, I am researching the vegetation and the spiders encountered, as well as the archaeological potential of the island (survey has apparently been conducted, and sites excavated, by Presley Norton). This small trip was simply a day off as we waited for the balsa logs to be delivered to Salango.

APPENDIX F
CREW BIOGRAPHIES

Summary notes on expedition core team members (at this writing) are given below.

John Franklin Haslett III (36) expedition leader, took a degree in history before serving for a period in the US Army. He is an avocational historian and has research interests in the US Civil War as well as the archaeology of South and Central America. Haslett is self-employed as a writer, lecturer and a stock market trader. Haslett has spent the 1990âs pursuing his dream of voyaging on the high seas on reconstructions of traditional balsa rafts. His many explorations in Central and South America have cultivated an important understanding of the land and itâs interface with the sea. Haslett has been sailing since he was a child, with voyages throughout the Gulf of Mexico, in the SW Atlantic, and the Pacific Coast of South and Central America.

Alejandro Martinez-Carvajal (28) is a former Colombian soldier, with degrees in anthropology and geology. Alejandroâs graduate thesis ("Solid Waste Disposal Management in Bahia Solano") will earn the Administration degree with emphasis on environmental management. He is also the Assistant Director of Conferences at the Astronomic Observatory of Pereira, a certified PADI rescue diver, a member of the Red Cross Voluntary Corps, and one of the best mountain guides at "Los Nevados" National Park, Colombia.

Cesar Alarcon (30) received his baccalaureate degree at Bolivariana Pontifical University, Medellín. He has spent fifteen years dedicated to the observation and study of Colombian snakes. Thriatlon, mountain bike and dive activities are his main hobbies. He has a wide geographical knowledge of the Costa Pacifica Colombiana Zone (Pacific coast of Colombia).

Annie (Biggs) Haslett met her now husband John in 1995, when she joined the first Illa Tiki Expedition as the director of filming operations. For the Manteño Voyage, Annie has acted on behalf of the expedition by negotiating the documentary film of the voyage to be produced by American Adventure Productions. Annie is also acting as Expedition Coordinator while the expedition is in the field by heading up the publicity efforts, acting as the US liaison, and coordinating HAM radio transmissions to schools, friends and families. Annie is a filmmaker in Dallas and a partner in The Process Project, a film/video and multimedia production company.

Cameron McPherson Smith (32) is an archaeologist with 15 field seasons in England, Scotland, Africa and the Western USA. He has worked in two archaeological expeditions to Africa, and one to Mexico. As a mountaineer, Smith has made expeditions and ascents in Alaska, Canada, Scotland, Austria and throughout the Western USA. Smith is currently completing his PhD at Simon Fraser University, Vancouver Canada, holding an MA from Portland State University (Oregon), a BA (Joint Honours) from Durham (U.K.) and an AA from United States International University (USA, England and Kenya). Smith is a Life Fellow of the Royal Geographical Society, London.

The following crew members left the expedition after landing in Colombia:

Dowar Medina (33) is a native of Salango, and a direct ancestor of the ancient Manteño. In 1995, Haslett, Medina, and three other team members built the balsa raft Illa Tiki, sailing it for 38 days in the Gulf of Panama and the Pacific Ocean. Señor Medina has an estimated 7,000 sea days. He returned to Salango, Ecuador, after landing in Colombia, in order to spend time with his family.

David Moorer (36) is an experienced emergency paramedic and search-and-rescue professional. His work as an Emergency Medical Technician has led to action in the Loma Prieta earthquake aftermath, the Oakland Hills Firestorm, and Joshua Tree National Monument. Moorer left the expedition in Colombia, citing an inability to adapt to the life at sea.

Scott Siekierski (23) was the youngest member of the Manteño Voyage. A recent college graduate from the University of Texas at Dallas, Scott's tenacity and willingness to face danger outweighed, to an extent, his lack of expedition experience. Although jokingly refering to his expedition role as ãshark-baitä, Scott's experience in both indoor and outdoor activity, as well as his excellent command of Spanish, are valuable assets to the expedition. Scott acted as quartermaster for the first phase of the expedition, very capably handling the massive challenge of expedition supply and provisioning. He, regrettably, was forced to leave the expedition in Colombia with medical problems of the lower back.

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