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# Crown Jewel of the Fleet: Design, Construction, and Use of the Seagoing *Balsa* of the Pre-Columbian Andean Coast

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*The seaworthiness of the balsa sailing raft, and the seafaring aptitude of those who built and sailed it, has been the subject of critically biased, often conflicting accounts over the nearly five centuries since contact. This paper objectively marshals historical evidence to recover the pre-Columbian design and construction of this 'Crown Jewel' of the coastal Andean fleet. Sailing balsas were constructed of balsa tree (ochroma spp.) trunks lashed together with henequen, covered with one or more decks of cane or reed, and fitted with crescent-rigged sails and guaras, or centreboards. The balsa trunks used for the deck, which maintained excellent long-term buoyancy after an initial period of water absorption, kept the raft afloat on rolling seas and allowed seawater to wash through the structure, preventing the craft from capsizing. The upper decks allowed for sensitive cargo to be kept dry during ocean voyages, and the straw huts and cooking pits on many balsas allowed seafarers access to subsistence and comfort while afloat. Finally, the sail-and-centreboard combination made the balsa a highly manoeuvrable craft that may have been capable of efficiently sailing in any direction with respect to wind. Through this evidentiary reconstruction, it will be shown that, though these rafts appeared primitive to many of the Europeans who saw and wrote about them, the aboriginal balsas of the Andean coast were both well-designed and extraordinarily capable of performing their assigned tasks, which included fishing and coastal trade, and may also have included lengthy voyages of commerce and exploration.*

Keywords: Andes; seafaring; economy and subsistence; indigenous people

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## The Sea and the Andean World

The portion of the Pacific coast of South America extending from Ecuador to northern Chile spans twenty degrees latitude and presents a diverse landscape, with tropical forests and navigable coastal rivers in the northern (Ecuadorian) area, and dry, infertile coastal desert on the coast of southern Peru and northern Chile. Though the barren nature of the Peruvian and northern Chilean coastal region, and its resistance to effective irrigation, made land-based subsistence in this southern extreme of the Andean world exceedingly difficult, the eastern Pacific Ocean presented the opposite scenario in pre-Columbian times, providing within its frigid waters "a source of inexhaustible subsistence for the inhabitants of its shores" (Rostworowski 1977:167; Coker 1918; D'Altroy 2002; Shimada 1994). As a result of this dichotomy, the sea was, to use Rostworowski's word, "everything" to the ancient coastal peoples of western South America (1977:167).

In order to take advantage of the opportunities and resources provided by the Pacific, coastal inhabitants developed and adopted different types of watercraft, each specifically suited to its respective geographic region and purpose. From north to south, these watercraft included dugout canoes, used for coastal and river navigation in Colombia and Ecuador; reed rafts; seal-hide floats; and balsa log rafts. The latter of these, often equipped with mast and sail, "served as the principal vehicle for ocean navigation off the coast of Peru" and northern Chile (Lothrop 1932:238). This sailing balsa raft was the crown jewel of prehistoric Andean seafaring, and it is the purpose of this paper to utilize historic accounts and modern analyses of these balsa log rafts of the pre-Columbian Andean world to determine their true aboriginal design and construction.

### *Subsistence, Exchange, and Exploration*

By means of the *balsa* (the broad Spanish term for "raft," which is used herein to refer to Andean log sailing vessels), the aboriginal peoples of coastal South America were able to take full advantage of the extraordinary fecundity of the eastern Pacific ocean, catching edible fish and sea-birds (D'Altroy 2002; Murphy 1923) and importing nutrient-rich *guano* from offshore islands to use for agricultural fertilization (Kubler 1948). However, aboriginal seafarers did not limit their activities to those solely related to subsistence. Sailing rafts were instrumental in the development and maintenance of vast trading networks (*inter alia*, Dampier 1968 [1703]; Dewan and Hosler 2008; Friederici 1907; Heyerdahl and Skjölsvold 1990; Hornell 1945; McClelland 1990; Quilter 1997; Sandweiss 1992; Shimada 1991; Stevenson 1825; Wallace 1991) extending from northern Chile at least to Colombia (Paulsen 1974; West 1961), and perhaps as far as Mexico (Coe 1960; Dewan and Hosler 2008; Hosler 1988, 1994).

These networks were used for importing and exporting technology, luxury goods, and items of ritual significance like *Spondylus* and *Strombus* shells, which were ferried from the warm waters off Ecuador and Colombia all the way to Lake Titicaca and other

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southerly locations (Currie 1995; Marcos 1978; Pillsbury 1996; Rostworowski 1970, 1977) at least as early as Chavín culture, and perhaps before. *Balsa*s may also have been used in original procurement of these valuable shells; see, for example, the *Los Buceadores* ("The Divers") relief from twelfth century Chan Chan, which appears to showing *Spondylus* divers beneath what might be the "hut" of a balsa raft used to bring the divers from shore and to take them, and their valuable cargo, back to land, as well as a Sican bowl which appears to show the same thing (Pillsbury 1996:317; Figure 1). It is quite probable that the first Andean *balsa* ever reported by a European – that intercepted by Francisco Pizarro's pilot, Bartolomé Ruiz, in 1527 (using Murphy's [1941] chronology) off the coast of Ecuador – was sailing north on one such voyage of exchange, and that its cargo of textiles and luxury goods was to be traded for these ritually significant shells (Dewan and Hosler 2008; Hosler 1994; Saámano 1844 [1527]).[1]

The *balsa* may not have been employed solely for coastal trade and fishing excursions, but may have included far-flung expeditions for the purposes of trade, ritual, and exploration (Doran 1971; Edwards 1960; Emory 1933, 1942; Heyerdahl 1963; Hornell 1945, 1946; Langdon 1993, 2001; West 1961). Heyerdahl and Skjölsvold (1990) have reported finding ceramic deposits on the Galápagos archipelago dating to as far back the Middle Horizon culture of Coast Tihuanaco, suggesting regular voyages of some distance in pre-Columbian times[2] (though Heyerdahl's knowledge of ceramic typology and Andean chronology has been called into question by at least one anthropologist – Suggs 1960). Further, both Sarmiento de Gamboa (1907 [1572]) and Fr. Miguel Cabello de Balboa (1586; 1920 [1586]) tell in their chronicles of a voyage by Thupa Inka Yupanki, made during the reign of his father Pachakuti, in which the former constructed a fleet of *balsa*s and sailed west in search of a pair of islands which traders had told him contained great riches. Thupa was reportedly gone for nearly a year before returning with a strange cargo of gold, brass, dark-skinned prisoners, and the jaw-bone of a horse, leading some to hypothesize that he may have reached the Galápagos (Markham 1907, 1910) before possibly turning to the northeast and plundering mainland central or North America and sailing back home (Hornell 1945, 1946; Lothrop 1932).[3]

Thupa's yearlong voyage in search of Pacific islands was not the only lengthy raft expedition to enter Andean legend. Balboa (1586, 1920 [1586]) also tells of a man named Naylamp, who arrived in the Lambayeque Valley on a fleet of rafts and established a dynasty which ruled the on the north coast of Peru before the emergence of Chimor. Whether Naylamp came from the far north (Bandelier 1905; Means 1942) or the far south (Balboa 1920 [1586]; Donnan 1990; Davies 1997) is a matter of debate,[4] as is the historical nature (or lack thereof) of this immigrant and his pre-Chimor dynasty is also a matter of debate (Moseley and Cordy-Collins 1990). The overwhelming presence of balsa wood on the coast of Ecuador is an effective argument for the Naylamp having arrived from the north. However, as mentioned above, the term

*balsa* was used by the Spanish to refer to rafts of any type; that, combined with the fact that a great deal of iconography featuring Naylamp shows him riding alone on a *totora* reed raft, would not rule out a southerly point of origin, as Balboa (1920 [1586]) said.

Certainly the presence of an idol among Naylamp's belongings which "gave its name to the valley of Lambayeque" (Balboa 1920 [1586]; translation by Donnan 1990:244) suggests that etiology, rather than a historical recounting of actual events, may be a key part of this story's purpose. However, the claim that a legendary figure came from a distant place on a fleet of *balsa*s at some distant point in prehistory, bringing court officials and a number of other men and women with him, certainly speaks to the antiquity and importance of raft-borne sea travel in the minds of coastal Andeans.

***A Checkered Past: Previous Descriptions and Studies***

Reports of Andean *balsa* rafts, and European observations on their construction an apparent seaworthiness, have been set to account since Ruiz first spotted a foreign sail on the horizon in 1527 (Saámano 1844 [1527]; Murphy 1941). In the second half of the sixteenth century and in the seventeenth – almost immediately after the conquest – Spanish and Mestizo chroniclers like Sarmiento de Gamboa (1907 [1572]), Garcilaso de la Vega (1869 [1609]), and Fr. Bernabe Cobo (1979 [1653]) recorded stories about, and their own observations of, these rafts, as did sailors, travelers, and clergy like Gonzalo Fernando de Oviedo (1959 [1535]), Pascual Andagoya (1865 [1540]), Pedro de Cieza de León (1864 [1553]), Girolamo Benzoni (1970 [1565]), Fr. Miguel Cabello de Balboa (1586, 1920 [1586]), Pedro Gutiérrez de Santa Clara (1905 [1603]), Joris van Spilbergen (1619), and the pirate and naturalist duo William Dampier (1968 [1703]) and Lionel Wafer (1934 [1699]). In the eighteenth century, sailors George Juan and Antonio Ulloa (1801 [1760]) visited Peru, describing the rafts they saw in great detail and publishing an excellent sketch of a sizable *balsa* (Figure 2).

In the nineteenth century, numerous sailors and travelers visited the Andean coast, offering their own observations of the balsa log rafts still being sailed by Indians who were now in their third century of Spanish rule. These included, *inter alia*, Alexander von Humboldt (1989 [1816]), whose name is borne by the Peruvian Coastal Current to this day, Basil Hall (1833), William Ruschenberger (1834), Benjamin Morrell (1841), François Edmond Paris (1843), William Prescott (1847), George Byam (1850), George Coggleshall (1858), Thomas Hutchinson (1873), and Daniel Kidder (1876).

In the twentieth century, research of a more scientific and experiential nature began to be carried out on these aboriginal watercraft, including the observations at Sechura by Clinton R. Edwards (1960), an engineering analysis of seafaring rafts' seaworthiness by Leslie Dewan and Dorothy Hosler (2008), and Thor Heyerdahl's (1950a, 1950b, 1952) famous 1947 voyage from Peru to the South Pacific on a

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reconstructed aboriginal balsa in an attempt to prove his theory that Polynesians may have been of Peruvian origin.

Even within these sources, the seafaring tradition of the aboriginal inhabitants of western South America has, until the twentieth century, often received short shrift, coming in a distant second in Europeans' minds to the wonders of the Andes themselves and the riches surely accumulated by the mountains' inhabitants and their ruler at the time of contact, the Inka. In other words, the Spanish invaders, and subsequent European visitors, "acquired the highland vision of the Andean world, with its ruling sons of the Sun, its strange customs, and its social and economic structures, and they left to us only limited accounts of that coastal world" (Rostworowski 1977:168).

Further, European influence on aboriginal seafarers resulted, over time, in alterations to raft sailing and construction; as a result, the greater the temporal distance from first contact, the greater the likelihood that the picture painted by the aforementioned observers did not reflect the aboriginal *balsa* as it appeared in prehistoric times. Add to this the fact that the time immediately preceding the conquest is poorly accounted for in the earliest diaries and chronicles, which are "few, sketchy, and filled with disagreements," having been "set down…chiefly from memory" by individuals who were "far more keenly concerned with affairs subsequent to the capture of Tumbes in January, 1532" (Murphy 1941:4), and the result is a schizophrenic picture, riddled with inaccuracy, mistaken perception, and inconsistency, of the maritime aptitude of Indian seafarers and the capabilities of their prime craft, the sailing *balsa*.

However, as no physical remains of prehistoric *balsa*s have yet been discovered (Dewan and Hosler 2008), the modern scholar of pre-Columbian seafaring in the Andean world is at the mercy of these accounts, and the sketches which accompany some of the earliest among them, as they constitute the entirety of the available source material on the construction, performance, and use of these aboriginal seafaring vessels.

## Balsa Wood

### *Species* Ochroma

Apropos of their name, the main decks of Andean sailing *balsa*s were composed of logs from the balsa tree (*Ochroma lagopus*; Fletcher 1951). Indigenous to central America and Ecuador (Fletcher 1949), where in prehistoric times balsa forests dotted the Pacific coast (Heyerdahl 1952), balsa trees grow quickly, reaching 50 to 60 feet in height and two to two and a half feet in diameter in less than a decade (Fletcher 1949). A "light, porous wood" (Hutchinson 1875:454) with a density just over 1/10 that of oak (McGrail 2001; Trechsel 1994), the timber provided by the balsa tree is "whitish [and] soft…, and so very light that a boy can easily carry a log of three or four yards in length and a foot in diameter" (Juan and Ulloa 1801:189 [1760]; translation by Lothrop 1932:235). Cobo went out of his way to praise the unique nature of this "featherweight

wood" (Fletcher 1949), saying, "Even if some woods are esteemed for being hard and heavy, one does not therefore depreciate those which are soft and light, since different qualities are required for different purposes; and such is what in these lands is called a *balsa* timber, because one makes of them good… balsa rafts to navigate on the ocean and on the rivers" (1979:122 [1653]).

*Buoyancy and Absorption of Balsa Wood*

Cobo was correct when he credited the lightness of balsa logs for the aboriginal rafts' "very swift" performance (1979:122 [1653]), though the property of these logs responsible for this performance was technically *buoyancy* rather than a lack of weight. That *Ochroma* spp.'s abnormally low density (Trechsel 1994) gives it excellent buoyancy is not in dispute; however, questions of the wood's absorbent nature have dogged discussion of aboriginal rafts' performance, and capacity for long-distance travel, since Europeans first took note of them almost five centuries ago. The account which may have had the greatest influence on twentieth century opinion of the seaworthiness of balsa log rafts is that of George Byam, who visited the Americas in the mid-nineteenth century (Heyerdahl 1951). When visiting Guayaquil, Byam was impressed by an aboriginal *balsa* he saw maneuvering through the gulf. Upon asking his ship's captain about this native watercraft, he was told that after each voyage, the seafarers must "unlash their rafts and leave the wood on the shore to dry, as it is so porous that in a few weeks it absorbs so much water as to lose most of its buoyancy" (1850:202).

This account influenced Lothrop (1932:238) to conclude, in his seminal work on aboriginal seafaring in the Andean world, that the absorbent nature of balsa logs made these rafts unable to remain at sea long enough to complete voyages of any length. It also convinced Harvard anthropologist E. D. Merrill (1954) against the rafts' seaworthiness, which in turn led James Hornell to conclude that no voyage of any distance could have been undertaken on a *balsa* unless its logs had been "treated…with some kind of waterproofing composition [such as] gum, resin, or wax" (1946:53). Though he does not question their long-term seaworthiness, Andagoya's account (1865 [1540]) does corroborate Hornell's hypothesis that balsa logs were sometimes coated with resin before rafts were set afloat; however, this does not appear to have been the case on all *balsa*s.

It is accurate that dried balsa wood, of the type that is commercially available, is absorbent in nature (Fletcher 1941, 1951; Heyerdahl 1968), reacting to initial exposure to water with "significant swelling,…absorption, and deterioration of compression properties" (Sadler et al. 2009:330). However, after this initial reaction, *Ochroma*'s rate of absorption slows greatly. Botanist Merna Fletcher (*inter alia*, 1941; 1951) tells of logs which, after laying in the Guayas River for over a dozen years, were still only 65 percent submerged, and of balsa log rafts which have been "held in backwaters for years at Iquitos and along the upper Amazon [yet] are still buoyant" (1951:117).

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Heyerdahl (1968) argues for the use of green balsa wood, rather than white, or sun-dried, wood in the construction of *balsa*s, saying that green wood, with its organic moisture still intact, has more long-term buoyancy than its dried commercial counterpart. Writing of his 1947 voyage on *Kon-Tiki*, the deck of which was constructed of green balsa logs which had been floated down the coast from their Ecuadorian point of origin to his Peruvian point of departure, Heyerdahl says:

> We found that the sea-water quickly penetrated the outer surface of the logs to the depth of an inch or more, after which the absorption of water proceeded very slowly until a certain limit was reached, after which hardly any change could be noticed. After less than a fortnight at sea chips and splinters of the soggy outer section of the balsa logs sank when dropped beside the raft, and yet the general condition of the timber was such that the raft could still carry tons of burden upon its arrival in Polynesia [Heyerdahl 1952:604]

Green balsa wood is "highly perishable and may spoil quickly simply by exposure to the sun" (Fletcher 1951:116); however, as Heyerdahl found, submerging freshly cut logs before they can be exposed to terrestrial and solar elements preserves both the wood and its buoyant nature (Fletcher 1951; Heyerdahl 1952, 1968). As Heyerdahl's voyage "amply demonstrated" (Edwards 1965:100), balsa log rafts, though absorbent, are capable of remaining afloat long enough for voyages of impressive distance to be completed.

## Deck Construction

### *Lower Deck*

The main, or lower, deck was constructed by laying an odd number of logs side by side, with the longest – the middle – protruding from the stern to provide a perch for the rudder-wielding steersman (Benzoni 1970 [1565]; Cobo 1979 [1653]; Dampier 1968 [1703]; Edwards 1965; Hornell 1970; Johnstone 1980; Juan and Ulloa 1801 [1760]), as can be seen in Italian traveler Girolamo Benzoni's sketch (1970 [1565]; Figure 3). To this main deck was attached the mast, or sprits (see below), which held the main sail or sails (Edwards 1960; Morrell 1832). The upcurved bow in Benzoni's drawing is likely an "imperfect" (Means 1942:113) representation of the bow-to-stern taper some rafts featured, as a deck taper would have improved the crafts' hydrodynamic nature (McGrail 2001), but would have been counteracted by such an upcurve. Like Benzoni, Paris (1843; Figure 4) portrays an elongated center log, but the remainder of his deck representation follows Cobo's description (1979:221 [1653]) that "one by one [the logs] are shorter the closer they are placed to the sides, in such a way that, at the bow, they get the same form and proportions as seen on the fingers of an extended hand."

Rafts were naturally of different sizes according to their function (Juan and Ulloa 1801 [1760]; Lothrop 1932). Those used for fishing consisted of "three, five, seven, nine, or even eleven timbers" (Benzoni 1970:242 [1565]), while the largest of these *balsa*s –

those carrying large quantities of goods up the coast, such as that encountered by Ruiz in 1527, or those described by Zárate (1824 [1555]) as being capable of carrying 50 men and three horses – could be "made of 20 or 30 great Trees of about 20, 30, or 40 foot long" (Dampier 1968:141 [1703]). On the largest rafts, a second layer of logs was laid crosswise over the first to provide better support for the deck (Cobo 1979 [1653]; Dampier 1968 [1703]; Edwards 1965; McGrail 2001; Stevenson 1825) and for the mast, which, according to an engineering study by Dewan and Hosler (2008), could reach up to 23 feet in height and six inches in diameter.

The log construction of the main deck, which was constantly in contact with the water, deserves the greatest share of credit for the *balsa*'s exceptional seaworthiness. Since water was allowed to pass freely between the bottom-most logs, which maintained their high position relative to the ocean surface due to their high buoyancy, a raft could not be swamped as a traditional boat or ship, which depended on an air-filled hull for buoyancy, could be (Doran 1978; Heyerdahl 1951, 1968). Additionally, *contra* Captain David Porter's declaration that "There can be no stronger proof of the mildness of this ocean, so justly, in this part, deserving of the name of the Pacific, than the fact that the loss of these vessels…is very uncommon" (1815:134), the buoyancy of the logs which formed its main deck gave the *balsa* a "unique ability to rise with any threatening sea, thus riding over the dangerous water-masses which would have broken aboard most other small craft" (Heyerdahl 1968:108). Dampier reported that, during doldrums or storms, "all [sailors'] care then is only to keep off from Shoar; for [*balsa*s] are so made that they cannot sink at Sea" (1968:142 [1703]). Further, on the off chance that the craft did end up being capsized by an aggressive wave, it "could be righted and reoccupied with minimal effort and danger" (Doran 1978:22).

***Lashings***

The logs that made up the main deck – whether one level or two – were lashed "very tightly together with a kind of hemp rope" (Estete 1968:66 [1535]; translation by Dewan and Hosler 2008:25), or *hennequen* (Cobo 1979:221 [1653]; Heyerdahl 1950b, 1952, 1955, 1957; Hornell 1970; Johnstone 1980; Juan and Ulloa 1801 [1760]; Morrell 1832; Saámano 1844 [1527]). According to Heyerdahl, this method of connecting logs "permitted independent movement between the separate pieces of wood and bamboo, and gave the craft an amazing toughness and resiliency" (1950a:30). These lashings were the linchpin of *balsa* construction; if they did not hold for any reason, the base of the raft would quickly come apart, followed by the rest of the structure.

Cobo (1979 [1653]) claims that this happened on occasion due to carelessness on the part of the aboriginal raft builders, but he maintains that the most common reason for raft dissolution was treachery. He writes, "[*Balsa*s] are very suitable for the planning by the Indians of some treason, because they could execute it unexpectedly by cunningly untying the logs and dissolving the composition of the raft" (1979:221 [1653]).

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Garcilaso tells of similar happenings in the waters off Puná after the Inka conquest of that island. Ordered to ferry Inka troops from Puná to mainland Ecuador, the skilled island mariners cut the lashings holding the logs together, causing the Inka soldiers to fall into the sea – then they returned to the island, picked up another load of Inka troops, and "killed them in the same place and in the same way as they had killed their companions" (Vega 1869:432 [1609]).

Alone among the historical sources, Dampier (1968 [1703]) and Wafer (1934 [1699]), who were in Guayaquil in 1684 (Preston and Preston 2004), report that pins were used on some rafts to hold the logs together, and to serve as anchors for the lashings; however, with no accounts available that corroborate this pair of travelers, it must be assumed that pinning logs was a rare or localized phenomenon, and that lashing alone was standard practice (Estrada 1955).

*Upper Deck(s)*

Due to balsa wood's rapid initial absorption of water, the lowest deck rode low in the water, sometimes being greater than 75 percent submerged (Dewan and Hosler 2008; Heyerdahl 1950a, 1952). For this reason, a platform (or multiple platforms) of canes was placed above this bottom deck (Hornell 1945; Saámano 1844 [1527]). On those *balsa*s with multiple platforms, the heaviest, least perishable cargo (such as ballast stones and water jars) was kept on the lowest deck, while dry cargo was carried on the topmost platform (Cobo 1979 [1653]; Dampier 1968 [1703]; Edwards 1960). Also atop this upper platform was a place for cooking fish caught while at sea, and some *balsa*s – particularly those sailing inland – featured a thatched hut for sailors or important passengers (Hornell 1970; McGrail 2001; Figures 2, 4-5). According to Prescott, entire families voyaged in hut-equipped *balsa*s, which provided "the most commodious means for the transportation of passengers and luggage on the streams and along the shores of this part of the South American continent" (1931:223 [1847]).

***Guaras***

The "greatest peculiarity" of Andean sailing *balsa*s (Juan and Ulloa 1801:192 [1760]; translation by Lothrop 1932:237) were the *guaras* (originally *guares* – Edwards 1960:369n.1), or "centerboards," which served in tandem with the sail to provide steering for the raft. Multiple *guaras* were inserted both at the bow and at the stern of the *balsa*, with a third bank (or more) being added on larger craft (Edwards 1960, 1965; Heyerdahl 1978; Juan and Ulloa 1801 [1760]; McGrail 2001). These flat boards, several feet long and approximately two feet across (Baleato 1820; Stevenson 1825), were placed in the water between the logs of the main deck, and were raised and lowered to create or reduce subsurface resistance, thus steering the craft. For example, if *guaras* near the bow were thrust deeper into the water, or were moved closer to the bow – or *guaras* near the stern were raised or removed – the raft would turn towards the wind (McGrail 2001:401-402).

Since they are laterally static agents of resistance, rather than mobile water-displacing implements like oars, *guaras* cannot function effectively unless they are paired with sails (Estrada 1955; Heyerdahl 1957). By adjusting these boards in concert with sail adjustments, though, aboriginal seafarers could cause the *balsa* to "sail to windward, tack [sail within 90 degrees of upwind, to starboard], jibe [sail within 90 degrees of upwind, to port], or run [sail with the wind]" (Baleato 1820, translated by Estrada 1955:145; Edwards 1960), thereby performing "all the maneuvers of a regularly built and well-rigged vessel" (Stevenson 1825:223), and in any wind conditions. Estrada goes further than this, suggesting that this method of steering was "more efficient than the conventional [ship's] rudder since there is no drag in any position – to windward, reaching [traveling perpendicular to the wind], or running" (1955:144). The reason for this efficiency is that maneuvers are not reliant on resistance on one side or the other of a rear-mounted surface, as with a rudder, but instead is effected by shifting the craft's center of resistance itself.

Spilbergen's 1619 sketch of a *balsa* in Guayaquil harbor (Figure 6) shows three crew members adjusting *guaras*, and Paris's drawing shows multiple banks of *guaras* protruding through the raft's main deck. Though *guaras* have been in use in the Asian world for some time, including off Taiwan, Japan, and parts of Polynesia (McGrail 2001; Nelson 1961; Nishmura 1925; Nordenskiöld 1931; Suggs 1960), this method of steering was unknown to Europeans before contact with Andean seafaring culture (a key point when discussing the antiquity of aboriginal sailing vessels; see below). Both Juan and Ulloa (1801 [1760]) and Stevenson (1825) saw the value of this steering technology, and suggested that *guaras* be adopted by European builders of life rafts for the purpose of allowing them to steer toward land, rather than floating listlessly while their shipwrecked passengers awaited rescue.

The antiquity of *guaras* is not definitely known. The earliest evidence for these implements is a series of grave assemblages containing wood slabs that appear to be highly decorated centerboards (Edwards 1965; Heyerdahl 1978; McGrail 2001). The oldest of these, found in Ica on the south coast of Peru, dates to approximately 300 BC (McGrail 2001), with more recent examples coming from Middle Horizon Coast Tihuanaco sites (see images in Bennett 1954:80-81). Some controversy does exist regarding the actual function of these objects, though; Max Uhle (1914), who initially excavated the Ica graves, described them as agricultural implements rather than sailing centerboards, and John Howland Rowe adopted and expanded that interpretation to include possible canoe paddles found in similar graves, as well (Edwards 1965).

## Mast and Sail

### *Antiquity*

The equipping of ocean-going *balsa*s with cotton sails is well-attested (*inter alia*, Cobo 1979 [1653]; Garcilaso 1869 [1609]; Lothrop 1932; Saámano 1844 [1527]; Santa Clara

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1905 [1603]). However, the timing of the sail's arrival in the Andean world – specifically, whether it was a pre-Columbian invention or a Spanish introduction – has long been a controversial issue (Edwards 1965). Drawing on the fact that the earliest reports of *balsa*s traveling under sail were made in the northern regions of the Andean coast – the portion closest to the North American territories which were already in contact with Europeans – Swedish ethnographer Stig Rydén (1956) has suggested that knowledge of this European technology came from the Spanish, but preceded their physical arrival in South America.[5] Suggs (1960) offers no such support for his concurring opinion; he simply declares that the sail was absent from the Andean coast in pre-Columbian times, and that *balsa*s floated before the conquest were invariably propelled and steered by paddles alone.

Those who see the sail and centerboard package as a pre-Columbian invention cite as evidence of their antiquity the fact that the raft intercepted by Ruiz in 1527 carried a sail (Lothrop 1932). Ruiz was reportedly surprised to see this (Murphy 1941), as no aboriginal sailing craft had yet been encountered in the New World (Prescott 1931 [1847]); however, Saámano's report of Ruiz's encounter (1844 [1527]) makes clear the fact that sails were, in fact, present on this first Andean watercraft ever encountered by Europeans. Pedro Gutiérrez de Santa Clara, a chronicler writing shortly after the conquest, claimed that sails had been used on aboriginal *balsa*s "from time immemorial" (1905:527 [1603]; translation by Edwards 1960:381).

However, as there are no confirmed examples of sailing vessels in Andean art (Edwards 1960; Lothrop 1932),[6] the evidence for sails in the pre-Columbian Andean world is limited to the grave assemblages purportedly containing *guaras*, mentioned above. Given the fact that centerboards must be paired with sails to be of any use in marine navigation (Edwards 1960; Heyerdahl 1957), if these artifacts are in fact centerboards, they would seem to confirm the pre-Columbian status of aboriginal sailing vessels. However, with no consensus on these artifacts' status as such, those attempting to determine the antiquity of sails on Andean *balsa*s are largely restricted to assessing aboriginal and European sail typology and development in an attempt to evaluate whether the latter simply served over time as an influence on the former, or if it was the likely source of sail technology in the first place.

### *Type*

The type of sail carried by aboriginal sailing craft has often been a matter of controversy, for two very good reasons. First, as sail shape and design is crucial to the function of a raft (Dewan and Hosler 2008), determining the rigging used by aboriginal Andean seafarers is vital to determining the capabilities of their craft. Second, if aboriginal sails can be shown to have been variations of European design and rigging, the likelihood of their having been a purely European introduction is greatly increased – and vice versa.

The disagreement on sail design comes down to two main shapes and riggings: square and "lateen," or triangular. Both are present in early sketches of *balsa* craft; the earliest, by Benzoni (1970 [1565]), features a square-cut sail supported by bow-mounted shears crossed like an "X," while perhaps the most detailed, that by Spilbergen (1619), shows a raft with a pair of crescent-rigged triangular sails.

Stevenson, who visited Peru in the nineteenth century – almost two hundred years after contact – describes the sail carried by aboriginal *balsa*s as "a large square lugsail…on two poles or sheers" (1825:223), a statement largely corroborated by Porter (1815), Humboldt (1989 [1816]), Morrell (1841), and Hutchinson (1875), and reflected in Juan and Ulloa's sketch (1801 [1760]), though in the latter case with a single mast in place of shears. Lothrop (1932) and Heyerdahl (1952) viewed this design as correct. The latter believed that "the original square sail of the balsa rafts survived in both Ecuador and Peru until the craft itself went out of use at the opening of the [20th] century" (1952:530), and he elected to employ this type of sail when constructing *Kon-Tiki*. Heyerdahl explains away Spilbergen's representation of crescent-rigged sails by suggesting they are an outlier or a "late acquisition," and hypothesizing that the portrayal was brought on by "a lapse of memory if the artist made his drawing upon return to Europe" (1952:530).

Though Heyerdahl believes that the sail as used on *balsa*s was an indigenous invention, and that its original design was square, "the rigging of the square sail shown in Juan and Ulloa's drawing exhibits features which are unmistakably European…the square sail, of unquestionable Old World ancestry, was most probably not invented independently by South American Indians, and thus must have been introduced by the Spaniards" (Edwards 1960:379). The features alluded to by Edwards include bowsprit and bowline rigging of the type known to have been used in Europe by the 14th century. This means that, if square-rigged sails were in fact the type first used on aboriginal *balsa*s, then the sail was almost certainly a post-Columbian introduction.

However, an immediately apparent problem with this line of reasoning is the fact that, aside from Benzoni, who was present in Peru in 1565, the earliest visit by any of the travelers who observed square sails on *balsa*s was Juan and Ulloa's 1760 voyage. Though they made detailed observations of aboriginal sailing rafts, the two centuries that passed between European contact and their arrival in South America provided ample opportunity for Spanish sail design and rigging to influence aboriginal raft builders. Further, Benzoni's drawing, which shows a square sail slung across two bow-mounted shears, fails to show *guaras* or any other means of steering and propulsion besides square sail and paddles, suggesting that it was his sketch, rather than Spilbergen's, that showed something other than the most widely-used type of aboriginal seafaring *balsa*.

The Spanish chronicler Gonzalo Fernando de Oviedo y Valdés (1969 [1535]) describes aboriginal sails differently than do the aforementioned travelers who

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followed him to the New World centuries later. Rather than square rigging, the sails Oviedo describes – including that first seen by Ruiz in 1527 – "resembl[e] a lateen [triangular] sail" (1969:121 [1535]; translation by Edwards 1960:381). This is supported by Saámano's statement that the sail on that 1527 raft was "of the same form as our [Spanish] ships," if it is considered that Ruiz would have been sailing a small caravel on this voyage, rather than a large galleon, and that caravels at this time were commonly fitted with lateen-rigged triangular sails (Edwards 1960). Santa Clara (1905 [1603]) also described aboriginal sails as being triangular, or rigged in lateen fashion.

However, Spilbergen's illustration shows that the lateen-style rigging of these sails was significantly different than European lateen style (McGrail 2001). Spilbergen's sails were rigged in crescent fashion (Dewan and Hosler 2008; Edwards 1965) which most resembles not a European style of rigging, but a style known as the "Oceanic spritsail" (Bowen 1953), which is common, as its name suggests, in Oceania. This style of rigging is similar to a European lateen, but with curved "sprits" in place of rigid masts, which combine with triangular sails to create a supremely aerodynamic shape (Curry 1930; Van Dam 1987). To this unique sail rigging can be added the presence of the aforementioned *guaras*, which had never before been seen by Europeans before their arrival in the sixteenth century – and which, therefore, were certainly not introduced by the Spanish. The use of these centerboards, which can only be effectively employed in tandem with sails, combined with the Oceanic crescent style of rigging seems to confirm not only that the sail was present in the Andean world in pre-Columbian times, but that the sails depicted by the earliest chroniclers and artists, who described and portrayed them as lateen-type sails, were triangular in shape.

As later visitors to South America observed, the square sail was eventually adopted by Andean seafarers. Bowen rightly points out that it "is difficult to see…why the more efficient Oceanic spritsail would be abandoned for the less efficient square sail" (1953:91). However, based on the development of the sail-and-centerboard package, and the Oceanic rigging style described and portrayed by almost all of the earliest visitors to the Andean coast, it seems most likely that, as Doran says, Spilbergen's illustration featuring crescent-rigged triangular sails is "the best approximation of the aboriginal form of Ecuadorian rafts" (Doran 1971:130).

## Perception and Reality

Bartolomé Ruiz, the first European ever to see an aboriginal South American *balsa* afloat, was "astonished" (Murphy 1941:17) to see such a sizable vessel plying the waters of coastal Ecuador, under sail, laden with cargo, and bound for a distant port. Benzoni observed that the Indians of the Pacific coast were "great fishermen" (1970:242 [1565]), while the Spanish accountant Agustín de Zárate declared the aborigines to be "*grandes marineros*," or "great mariners" (1824 [1555]; translation by Heyerdahl 1950b:24). However, not all observers were as impressed as Ruiz by the seafaring aptitude of the

Indians, or the seaworthiness of their log sailing rafts . "All the peoples who dwelt along the two-thousand-mile Andean coast, from what is now northern Ecuador down into north-central Chile…were, in fact, utter landlubbers," wrote P. A. Means (1942:108), whose *balsa*s were "obviously a type of boat that would awake nothing but scorn in the breasts of shipbuilders of almost any other maritime people in the world" (1942:121).[7] Conversely, Dampier reserved his criticism for those who thought so little of the aboriginal seafarers, calling the former "grossly ignorant…of Sea-affairs," and pointing out the conquering Spaniards' reliance on Indians to conduct their coastal trade and other maritime endeavors. "[The Spanish] build indeed good Ships," Dampier wrote, "but this is a small matter...The Native Spaniards are too proud to be Seamen, but use the Indians for all those Offices" (1968:190-191 [1703]).

As we have seen, despite some Europeans' negative opinions toward it, the aboriginal *balsa* of the Andean world was not a "flimsy, unworthy craft which constituted proof of the primitive, "unenlightened" (Porter 1815:134), and "singularly unmarine-minded" (Means 1942:125) nature of the South American Indians. Instead, with its sturdy deck of balsa logs, its crescent-rigged sails, and its *guaras*, the *balsa* was a craft well suited to its purpose: it was buoyant and stable in all sea conditions, able to steer as well as any ship with rudder and keel, aerodynamic enough to sail in any direction respective to wind, seaworthy enough to remain afloat for long periods of time, and capable of the long-distance travel necessary to carry on trading relationships with peoples as far away as Central America or Mexico.

As Heyerdahl described it, the Andean *balsa* was "a craft of great carrying capacity and buoyancy; and one safer for crew and cargo, both in coastal surf and in deep sea navigation, than any other open craft ever constructed by an aboriginal seafaring nation" (1951:71). Though these craft have become scarce along the Pacific coast of South America, they still ply the waters off Sechura, where Edwards (1960) has observed them carrying out their daily voyages into the Humboldt current, the sailors upon them taking advantage of the fertile waters off the Andean coast just as their ancestors did before the arrival of the Spanish nearly five centuries ago.

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## Figures

Figure 1. Sican bowl from the Museo Nacional de Arqueologia, Antropologia e Historia in Lima. In the center is an image of *Spondylus* divers beneath what might be the "hut" of a balsa raft, which may have been present to bring the divers from shore and to take them, and their valuable cargo, back to land (Pillsbury 1996:329).

Figure 2. Sailing raft of Guayaquil, with square sail, hut, fire pit, and centerboards (Juan & Ulloa 1801:190 [1760]).

Figure 3. In the foreground, a Peruvian log balsa, being propelled by a square, shear-mounted sail and paddles (Benzoni 1970:243 [1565]).

Figure 4. Balsa Log raft from Guyaquil. *a*: Raft; *b*: Cross Beams; *c*: Deck; *d*: Cabin; *e*: Center Boards, or *guaras*; *g*: Mast Shears. (Paris 1843:148)

Figure 5. Sailing *balsa* raft on the Guayas River (Humboldt 1989:LXIII [1816]).

Figure 6. Drawing of balsa raft in Payta harbor by Joris Van Spilbergen, showing a sailor manipulating a crescent-shaped sail and sailors manipulating centerboards, as well as several water jars and millstones (for anchorage) on deck. Original caption: "One of the savages' vessels, called *Balsem*. Here they have fish aboard, and they can sail swiftly with these vessels in the wind" (Spilbergen 1906:82).

## Notes

[1] Saámano describes in intricate detail the cargo being carried by the Indians – "many pieces of silver and gold for personal adornment…among which were crowns and diadems and belts and gauntlets and greaves and breastplates," finely worked textiles "with figures of birds and animals and fish and trees," beads inlaid with precious gems, and "some small scales for weighing gold." All these, Saámano writes, "they bring to exchange for some seashells" (1844:11 [1527]; translation by Pillsbury 1996:319-320). Though he does not specifically mention *mullu*, it is still highly likely that the vessel was embarked on a mission to trade for these ritually significant shells which are found almost exclusively in the tropical waters of Ecuador and Colombia (Currie 1995; Paulsen 1974; Rostworowski 1977). Thomas Hutchinson, an emissary of Queen Victoria to the Peruvian port of Callao, scoffed at the "farcical" idea that such valuable items as those recounted by de Saámano would have been transported on a "floating bundle of corkwood" like the Peruvian *balsa*, and compared them to other unproven riches of the Inka empire, writing, "Ruiz must have found in this floating bundle of corkwood a rather aristocratic crew and passengers, for we are told: 'On board of it Ruiz saw ornaments, displaying great skill, wrought in silver and gold, vases and mirrors (?) of burnished silver, curious fabrics, both cotton and woollen, and a pair of balances made to weigh the precious metal.' The idea of balances to weigh gold on board of a little craft, in such a rough sea as is generally in the northern Pacific, borders somewhat on the farcical. Atahualca, too, had a lot of gold with him, at the baths of Caxamalpa, when he was ordered to be executed; and ten thousand llamas were on their way down from Cuzco to stop this barbarity, each llama carrying one hundred pounds weight of gold on its back. Ten hundred thousand pounds in weight of gold! It had only reached half-way when news arrived to the llama drivers of its being too late, as Atahualpa had been strangled. So, presto! the Indians and llamas skedaddled, and the gold evaporated, for nothing has ever been known of it to this day!" (1875:454-455). However, as the evidence demonstrates, Hutchinson's skepticism aside, seaborne trade was a very common undertaking by the aboriginal Andeans, who both gave items of great value to, and received them from, those at the far ends of their trading networks.

[2] Heyerdahl and Skjölsvold cite a 1947 horticultural study by J. B. Hutchinson, R. A. Silow, and S. B. Stephens as further support of their claim that Peruvian sailors made prehistoric visits to the Galápagos. Hutchinson, Silow, and Stephens found that the *Gossypium darwinii* strain of cotton, once thought to be endemic to the archipelago, was actually a variety of *Gossypium barbadense*, which is cultivated on the north coast of Peru. Referencing personal communication with one of the study's authors, Heyerdahl and Skjölsvold say, "Silow and his coworkers regarded it entirely possible that the prehistoric Galápagos cotton was transported by early man from the American continent" (1990:20-21). They continue, "The domesticated New World cotton of which the wild Galápagos species is a mere variety belonged to the same cultures of the Tomaval and La Plata periods on the North Coast of Peru that had carried their pottery types to the islands…It is perfectly reasonable to assume that cotton seeds spread to the islands at the same time and through the same means as the numerous aboriginal sherds

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which were discarded on the local campsites" (1990:68). Heyerdahl and Skjölsvold also cite personal communication in quoting Junius Bird as saying "the cotton seeds may well have found their way there in the materials brought by weavers, who plied their trade after reaching the Galápagos, and who would have been picking out and throwing aside seeds as they worked" (1990:68). This explanation is plausible (Carrie Brezine, personal communication 2010); however, determining whether it is historically accurate requires more evidence, if in fact it can be determined at all.

[3] Whatever the truth may be regarding Thupa's legendary voyage to the west, the maritime reputation of this Inka far surpasses those of his predecessors and successors alike. Garcilaso (1869 [1609]), for example, tells of Thupa effectively and innovatively waging war against island peoples and riverside jungle dwellers alike by means of *balsa*-borne marines and in a style reminiscent of Roman soldiers using their superior land warfare skills in naval combat with Carthaginian sailors (Polybius 1979), while Sarmiento (1979 [1572]) credits this Inka with discovering (or rediscovering) the Ocean altogether! As for the *balsa* expedition itself, Heyerdahl (1952), as may be expected, points to this voyage as an example of Andean seafarers journeying across the Pacific, perhaps as far as Polynesia. Interestingly (and in all likelihood coincidentally), a tradition exists among the natives of Mangareva, one of the Gambier Islands of French Polynesia, that "a chief called Tupa, a red man,… came from the east with a fleet of canoes of non-Polynesian model, more like rafts" (Christian 1924:525). Local history states that in the 14th century, Tupa "came to [the island of] Temoe and built a marae but, finding no food, he sailed on. Another myth states that Temoe was formed from a headdress of ripe pandanus fruit that Tupa cast into the sea. Tupa sailed to Mangareva through the southeast passage subsequently named Te Ave-nui-o-Tupa (Great Channel of Tupa). ...Tupa is credited with introducing the *kouneriki*, breadfruit, coconut, and other trees, He also commenced the building of maraes in Mangareva" (Buck 1938:22). Heyerdahl (1952) suggests that this legend, on an archipelago 4,000 miles from Peru, refers to Thupa Inka Yupanqui and his westward voyage from Guayaquil in search of the islands of Hahua Chumpi and Nina Chumpi, saying, "There is only one truly important Tupac (or Topa) in Peruvian history, and similarly only one Tupa in Polynesia. Without other evidence the similarity of their names would not have suggested any connection. But none of them are remembered as stationary. The Peruvian Tupac is memorized as a specific king who sailed west into the Pacific and returned to Peru after visiting two distant inhabited islands, and on two of the very nearest inhabited islands in that ocean Tupa is memorized as a foreign king who came from the east and stayed only for a short while, afloat in the south-east passage, before he left the islands to return to a vast land with a large population and powerful kings. The probability that both references are to the same Tupa(c) seems large" (1952:566). In reality, the likelihood that these accounts refer to the same person is certainly far smaller than Heyerdahl suggests; however, the similarity in time (approximately one century apart), in name, and in direction of travel are very interesting.

[4] The overwhelming presence of balsa wood on the coast of Ecuador is an effective argument for the Naylamp having arrived from the north. However, as mentioned

above, the term *balsa* was used by the Spanish to refer to rafts of any type; that, combined with the fact that a great deal of iconography featuring Naylamp shows him riding alone on a *totora* reed raft, would not rule out a southerly point of origin, as Balboa (1920 [1586]) said.

[5] Rydén (1956) attempts to support this hypothesis by citing Nordenskiöld's assertion (1979 [1922]) that domestic fowl were introduced to the Americas by the Spanish, and diffused into South America before the European invaders themselves arrived. However, the fact that aboriginal sails were first sighted by the invading Spaniards in the north, and then progressively southward down the coast, which Rydén uses as the linchpin of his argument for post-Columbian introduction, seems to be explainable by the simple fact that the Spanish invasion of South America was carried out from north to south.

[6] Uhle excavated what may have been a small model of a boat, complete with matted reed sail, containing a mummified fetus. He gave the artifact a *terminus ante quem* of 300-400 AD, and published the find with the caption, "Model of a boat, stitched of two little mats of totora-reeds in the middle and provided with another little mat of totora which served as a sail...the sail covered the mummy in the form of a roof, about 30 cm long" (192:49, IV; translation by Heyerdahl 1978:199). However, Rydén, who disputes the pre-Columbian presence of sails in the Andean region, naturally disagrees with Uhle's explanation of this item. He writes, "Rather, when the Indians were making the cover for the fetus to be buried, "they simply took two small totora mats, sewed them together and folded them along the seam, and then sewed them together at both ends. In this way a cover was made which looked like a boat- a boat, however, of European type with planking as well as stem at both ends. It should be unnecessary to point out that sailing-vessels of this type were not used in South America in pre-Columbian times. Uhle was struck by the likeness of the cover to European boats, and, unmindful of the fact that boats of this type were not used by the Indians, inadvertently interpreted the cover as the model of a boat and the covering totora mat as a sail belonging to it" (1956:155).

[7] Means latched onto John Howland Rowe's research as further proof of the primitive and "un-marine-minded" nature of the Andean peoples, saying, "the two general languages of the Andean natives, namely, Quechua and Colla (or Aymará), have between them only one word for boat. It is the word *huampu*, and all terms relating to boats and to parts of boats and to kinds of boats are build up on this one word to which are added, at need, elements indicative of parts of the boat or of use of the boat, etc. Thus, the word for oar or paddle is, literally, 'of-a-boat-paddle.' And so on. This conspicuous lexical poverty, in Quechua and Colla, of terms referring to ships, boats, rafts, etc., etc., is a reflection of the general ineptitude of the people for seamanship as a whole" (Means 1942:125). However, the fact that coastal Andeans' watercraft, while diverse and suited admirably to their respective tasks and conditions, were all some version of a canoe or raft speaks to the lack of need for more titles to give different types of craft. Further, the fact that Quechua and Aymará are agglutinative languages would seem to explain what Means sees as "lexical poverty" without actually revealing any

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"general ineptitude of the people for seamanship as a whole." One wonders if Means would call speakers of Persian, Japanese, or Sumerian – the language represented in the world's oldest known script – primitive because of the nature of their tongues, which are, like Quechua and Aymará, agglutinative. In all, Means' argument that the Indians' languages prove they had no aptitude for seafaring is a poor one – and, in when considered alongside his other arguments against *balsa*s as effective watercraft and their crews as effective seamen, it appears to reflect a desire to force all possible evidence to conform to a preconceived conclusion.