– NOTE –

East Polynesian Sailing Rigs: The *Anuta Iti* Experiment

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INTRODUCTION

The sailing capability of East Polynesian canoes in prehistory is a subject of manifest difficulty reflected in a long-continuing debate invoking ethnographic description, computer simulation and experimental voyaging (e.g. Anderson 2008; Finney 2006; Irwin 2010). If robust solutions are to be found this research must continue, including on rigs ignored hitherto. We describe here the first, informal, trial of a small double canoe carrying a sailing rig based upon observations in AD 1769 of a large double canoe in the Bay of Plenty, the first encountered in New Zealand. The trial occurred on the north coast of Makira Island (Solomon Islands), during a brief layover of our double-hulled voyaging canoes on 'The Lapita Voyage' (http//:www.lapita-voyage.org) in 2009.

An anonymous account of the Bay of Plenty rig, generally ascribed to the *Endeavour* midshipman James Magra (Beaglehole 1955: cclviii), refers to a triangular sail attached on one side to a mast and on the other to a spar that, according to the wind, was moved from side to side (Beaglehole 1955: 190). This could refer to a fixed mast and trailing spar (Irwin 2006). However, the Swedish supernumerary, Hermann Spöring, also on the *Endeavour*, drew the vessel as it sailed alongside in a following wind (Figure 1) and he depicts a less conventional arrangement that would actually preclude a trailing spar from being shifted side to side.

The rig appears to have no fixed mast. Instead, two spars, one each side of the sail, are angled forward and hold the sail transversely against windflow from astern.

Stays run from each spar to the bow of the corresponding hull (possibly running stays), and sheets are being hauled by crew in the sternsheets. From the origin of both spars between the crews in each hull, the rig was probably attached to a platform, mentioned by Joseph

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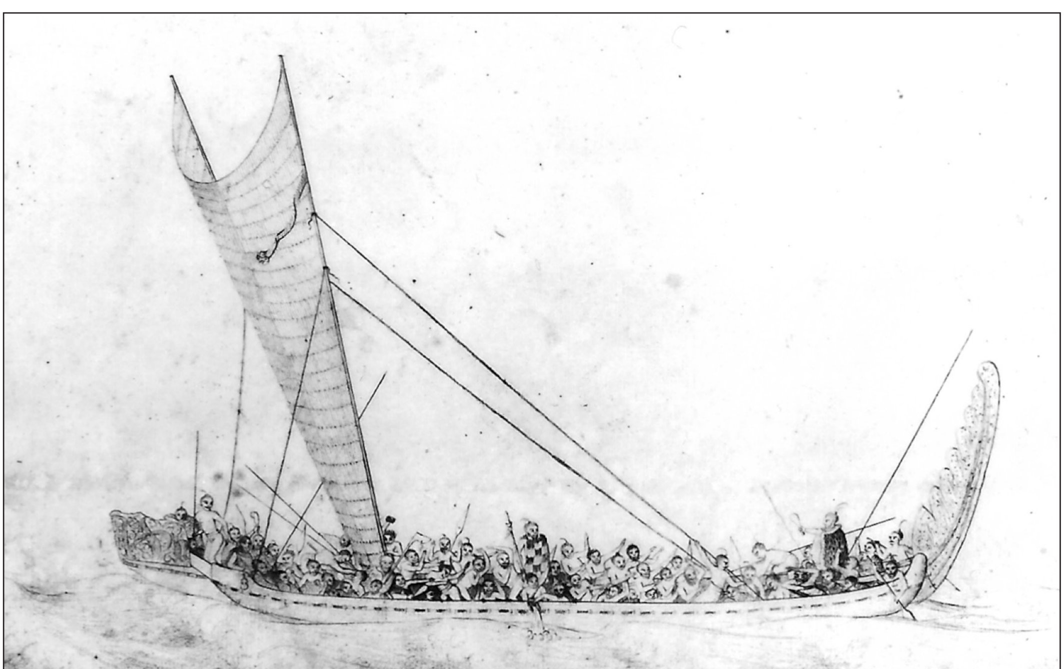

Figure 1. New Zealand double canoe in the Bay of Plenty drawn in AD 1769 by Hermann Spöring (published with permission from the British Library, ref: 23920/48).

Banks (Beaglehole 1962: 423), and as the angle of the spars indicates that they cannot have met above the waterline it is very probable that the sail had a flat base (tack) as in the only possible pre-European specimen of such a sail, in the British Museum (Asset NZ 147). We constructed a sailing rig based on this interpretation of the Spöring drawing.

METHODS AND RESULTS

We used two 5 m long × 0.5 m wide canoe hulls (the hulls of our outrigger-canoe tenders) built from plywood, fibreglassed in and out, with built-in buoyancy in the bilges. Each had a shallow V bottom (20 degrees) and weighed about 25 kg. We set the hulls with their centre lines 1.55 m apart and lashed three rough-sawn crossbeams plus a cylindrical wooden pole forward of them, tying the whole superstructure together with a beam lashed along the mid-line; the craft, called *Anuta Iti*, weighed 60–70 kg (Figure 2).

The sail was of 'Canvacon', a plasticized, coarse-woven cloth, with bolt-ropes sewn intermittently along each side, to which bamboo spars were attached. Except for the tack, taped-up to make a flat base, 0.3 m wide, we had a triangular sail, apex down, measuring 2.7 m along the starboard spar, 2.5 m along the port spar (the original sail was slightly asymmetrical), and 2.4 m across the top (Figure 3). The lower ends of each spar were attached to the forward beam, using a rolling hitch to prevent slippage, and square lashing, tied loosely, to allow each spar to be pulled fore and aft (Figure 2). Running stays from each spar were led through the carrying handles at each stem and back to the sternsheets. Sheets were attached to each spar above the stays.

One or other, or both, spars could be moved forward using the stays, and the sheets likewise to move them back. This enabled the sail to be set transversely across the hull for a wind from directly aft (flat run); with one spar angled slightly back for a wind from the quarter (broad reach), or further back for a wind on the beam (beam reach). With the spars held as far apart as possible fore-and-aft the sail was in position to beat to windward (close hauled).

The rig, tested on shore in winds of 5–7 kts, worked well, especially with one person controlling the lines in each hull. The utility of a flat base to the sail was demonstrated by the necessity of separating the spars sufficiently at the base so that they could move independently without catching on each other below the beam. However, this had the disadvantage that as one spar was pulled back a fold developed diagonally across the sail, spoiling the shape of the foil. The fold turned the sail into two approximate planes more or less at a right angle to each other; one angled transversely, one aligned fore-and aft (Figure 2).

The canoe was then taken into the lagoon, in a dying breeze of 0–5 kts with a short sea up to 0.7 m high. The rig worked well on a flat run and broad reach, coming up to a beam reach. Through a beam reach the sail began to luff continuously at about 75 degrees off the wind. It was a few degrees better than that when the trailing spar carried the shorter side of the sail, and a few degrees worse when it carried the longer side. The canoe could be pushed up to 65–70 degrees off the wind but with rapidly decreasing boat speed and increasing leeway. It was difficult to measure leeway but it seemed to be about 10 degrees on a beam reach of 90 degrees and several degrees more at 80–85 degrees off the wind. Therefore, the drawing capability of this rig appeared to be relatively unimpaired, except by the sail fold, up to about 90 degrees, beyond which it had a slight but inefficient windward ability.

DISCUSSION AND CONCLUSIONS

Our results confirm that the rig was easy to use and safe; it could be dropped almost instantly. Using a sail with a double tack (flat base) on spars attached to the leading edge of a platform between the hulls in a double canoe is shown to be a plausible and practical interpretation of the historical evidence.

The sail worked better than Anderson (2001) guessed, but a slight windward ability in *Anuta Iti* may have depended upon the hull shape and a wide angle of attachment for the stays. When a canoe rigged in this way is reaching, its absence of side stays means that the windward spar, acting as a mast, is held upright mainly by the outward angle and tension of the running stay attached to it. The greater the angle of the stay, measured from a line running fore-and-aft through the point of attachment of the stay to the windward spar, the more secure is the mast-spar. The minimum angle is about 11–13 degrees and in *Anuta Iti* the angle was about 30 degrees (Figure 3). We found that if the windward stay was held tight and moved toward the centerline of the canoe about 0.35 m, thus closing the angle down to around 15 degrees, the whole rig slumped to leeward, and moved further in that direction the rig collapsed.

The stay attachment angle on *Anuta Iti* was achieved by a relatively generous beam/waterline length ratio of about 1:2. This is typical of modern catamarans and experimental Polynesian canoes – the ratio of *Hokule'a* is around 1:3 – but pre-European vessels, with material constraints, seem to have been much narrower. The hulls of the Bay of Plenty double canoe were only about 0.3 m apart (Banks in Beaglehole 1962: 423). If its hulls were each about 1.0 m wide at the waterline, and the waterline length was approximately 15.4–15.8 m (Anderson 2008: 246) then the ratio would have been 1:6 to 1:7.

On such relatively narrow vessels it must have been difficult to obtain a running stay attachment angle sufficient to hold up the rig; either the stays had to be attached lower down the spars, inviting further rig instability, or the sail had to be narrowed. The latter option may be reflected in the narrowness of the Maori sail in the British Museum (4.4 m long but only 1.91 m wide, excluding the pennant).

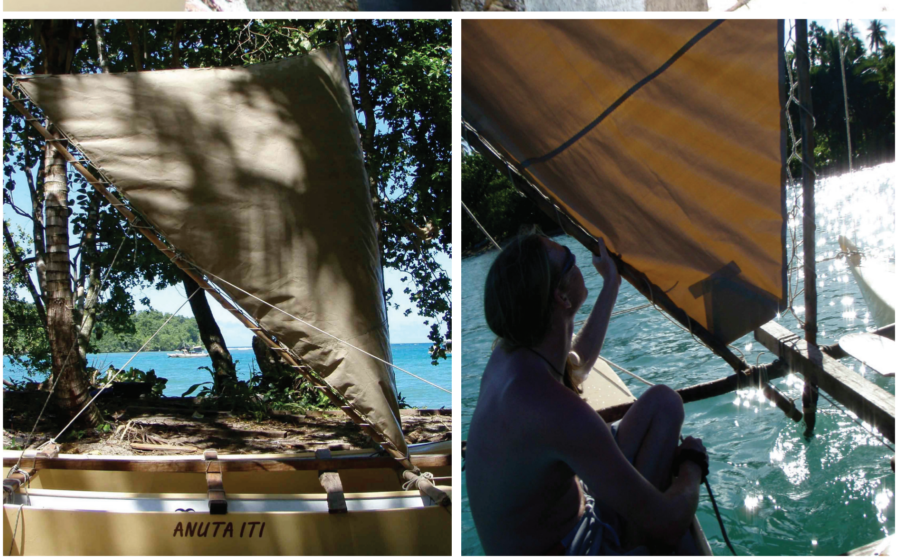

Figure 2. *Top left*, the double canoe with superstructure and sail (Tulano Toloa at stern); *top right*, the sail from astern in downwind position; *middle*, the sail attachment area with upper hitches holding down the tacks, square lashings connecting each spar to the forward beam and lower hitches preventing the spars from slipping down when the sail was raised; *bottom left*, the sail in beam wind position showing the right-angled fold from the base of the near spar toward the top corner of the sail on the far spar; *bottom right*, the lower spars, Jamie Wharram helping the sail to come about during a lull.

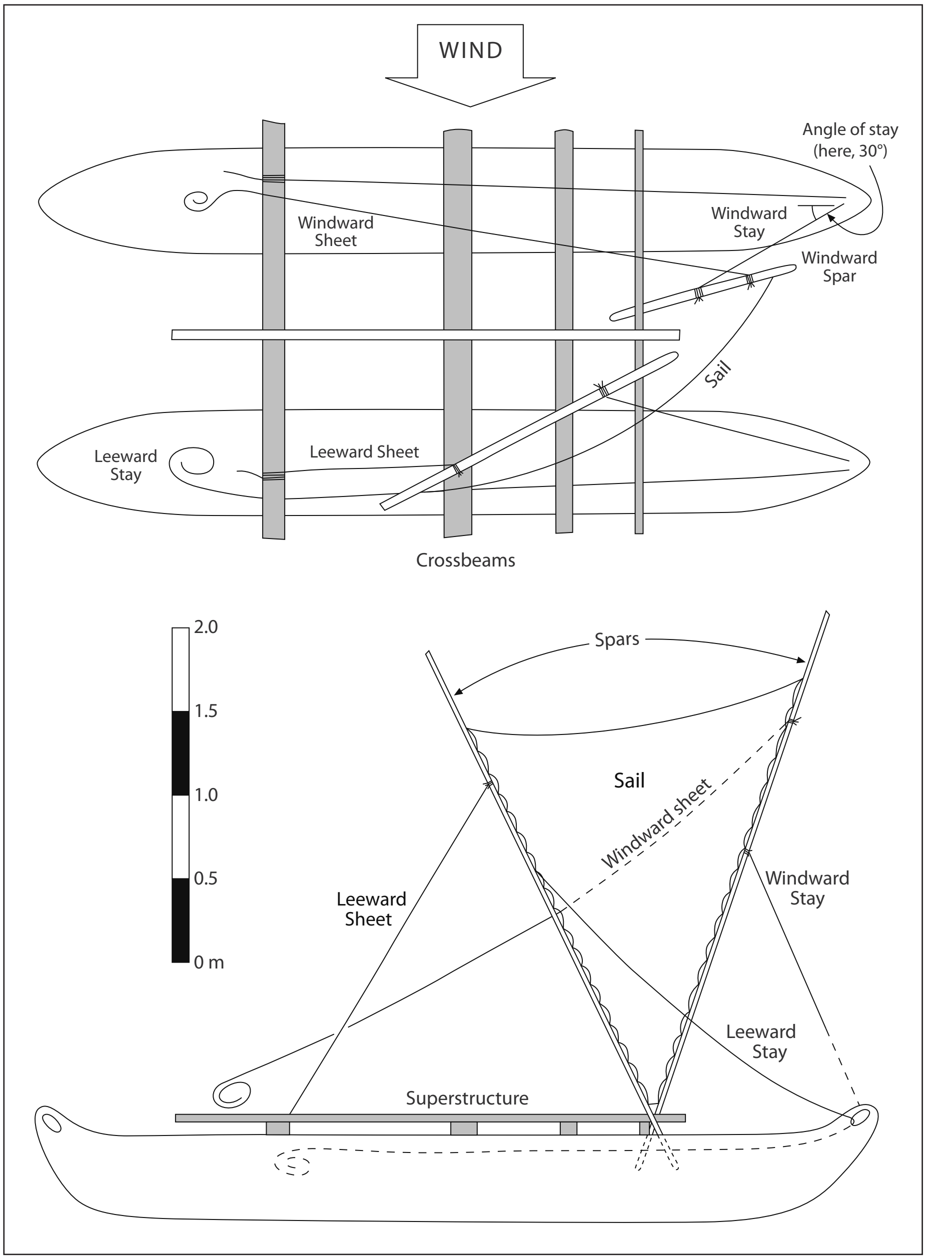

Figure 3: Sketch-plans of *Anuta Iti* with the rig on port tack for beam reaching.

An alternative was to sail exclusively in the downwind sector, where the stay attachment angle hardly mattered, and to use paddles for going to windward. When the Bay of Plenty canoe broke off contact with *Endeavour* and stood back into the wind, it 'doused the sail' (Parkinson 1984: 102), indicating that the rig was not used upwind.

In summary, this first test of an 18th century Maori rig type shows that it may have been effective up to a beam reach, which could have given voyaging canoes sufficient capability to reach the remote islands in East Polynesia, although not necessarily easily nor often with the prospect of return. Variations of construction or rig, such as a narrower hull configuration, a narrower sail, or placement of the spars in different positions fore-and-aft require further experiment, and accurate measurement, preferably in the controlled conditions of a wind tunnel (Irwin 2010) and in the varying conditions of the open sea.

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