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Sailing virtual canoes across Oceania: revisiting island accessibility

Anne Di Piazza [a,*], Philippe Di Piazza [b], Erik Pearthree [c]

[a] CNRS-CREDO, Université de Provence, 3 Place Victor Hugo, 13331 Marseille, Bouches du Rhone, France
[b] Philippe Di Piazza, PTC, Vitrolles, France
[c] Erik Pearthree, CREDO, Université de Provence, 3 Place Victor Hugo, Marseille, France

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Abstract

Understanding sailing conditions is a basic requirement for understanding the two periods of settlement of the distant islands of Oceania, initially from the Bismarck Islands off New Guinea as far as Samoa and later from Samoa throughout East Polynesia. The question of a ‘‘navigational threshold’’ between these two worlds is the focus of this paper. A computer simulation is presented that quantifies the difficulty of sailing virtual canoes in the differing wind conditions in both areas. The model demonstrates substantial differences in ease of voyaging up to and beyond Samoa. That this measure is so markedly different between these two worlds gives support for the hypothesised pause between the discovery and settlement of islands West and East of Samoa.

Keywords: Oceania; Settlement; Navigation; Computer simulation; Island accessibility

1. Introduction

Discussions of ancient Pacific voyaging in the last 40 years have transformed an a priori ‘‘foreign’’ environment into a familiar ‘‘seascape’’, thanks to experimental sailing, revival of ancient voyaging traditions and ethnographies of oceanic navigators. An outgrowth of these navigational issues, namely computer based models, has contributed to envisioning the settlers of Oceania as strategic navigators, deliberately and systematically exploring the South Seas. Building upon these earlier simulations, a new voyaging computer model incorporating more precise wind data and realistic canoe behaviour is briefly introduced here. This paper focuses on one aspect of the model: to quantify the difficulty of sailing a canoe between various islands through actual wind patterns and in particular between islands settled by the ‘‘Lapita peoples’’ (from the Bismarck archipelago off New Guinea to Samoa) and the vast area settled by the ancestors of the East Polynesians (from Samoa to Hawai’i, New Zealand and Easter Island). Beyond Samoa islands become smaller and more scattered, thus more difficult to find. A wind chart shows that they are also more difficult to sail to since eastward from Samoa is directly against the prevailing trade winds. However, only a computer model incorporating seasonal wind patterns and simulating canoe courses can effectively ‘‘measure’’ just how difficult it is to sail up to or beyond Samoa. The fact that this measure is so markedly different between these two worlds allows a better understanding of the maritime conditions wherein the pause between the discovery and settlement of Samoa some 3500 years ago and that of East Polynesia, some 1000–2500 years later took place.

2. Seafaring and computer simulations

Computer simulations of sailing courses have provided comprehensive models for the prehistoric exploration and colonisation of the Pacific. The earliest of these was designed by Levison, Ward and Webb to test Sharp’s thesis that unintentional drift voyages could account for the settlement of

* Corresponding author. Tel.:+33 4 90 76 10 72.
E-mail address: dipiazza@wanadoo.fr (A. Di Piazza).

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Polynesia (Levison et al., 1973; Sharp, 1956). After simulating over 100,000 drift voyages, they rejected Sharp's hypothesis. They went a step further and tested one way intentional courses following selected headings and concluded that the settlement of Polynesia required systematic exploration. Two similar models have been used to investigate voyaging in the Caribbean. One tried to determine on which island in the Bahamas Columbus made his first landfall (Fuson, 1987). Another examined whether the settlement of the Antilles from mainland South America by the Saladoid peoples was through unintentional drift or directed voyages (Callaghan, 2001).

The most comprehensive of these simulations is that of Irwin and colleagues (Irwin, 1989, 1990, 1992, 1998; Irwin et al., 1990). They developed different voyaging strategies and compared their rate of success (percentage of canoes that found new land, returned home empty handed or whose crews died at sea) against the archaeological dates for settlement. The feasibility and relative ease of various selected passages undertaken beyond the Solomon Islands were examined in detail to differentiate prehistoric patterns of discovery, settlement and abandonment. More recently, Evans provided a refined computer simulation using new figures on sailing performance based on the experimental Hawaiian double-hulled canoes Nalehia and Hōkūle′a, as well as accurate remotely sensed weather data (Evans, 1999). Evans successfully tested virtual courses against modern experimental voyages, but didn't make comparisons with prehistoric voyages.

After 30 years of virtual voyaging, the obvious question is do we need another simulation? The answer is yes, for several reasons:

- the unavailability in the 1970s and 1980s of good weather data, obliging both Levison et al. and Irwin et al. to use monthly summaries of wind direction and force recorded from British vessels sailing the Pacific between 1855 and 1938 for squares of 5° latitude by 5° longitude. Many squares had few or no observations requiring interpolation;
- the winds experienced by their canoes are randomly selected (from the direction-force probability matrices); this procedure may be questionable on the grounds that real wind sequences are auto correlated and follow predictable patterns;
- the methods employed to compute the distance sailed by the canoes are irrespective of their heading relative to the wind. Levison et al.'s canoes vary their speed only in relation to wind force (Levison et al., 1973). Irwin et al.'s canoes sail at constant speed (Green et al., 1997).

Building on these previous simulations, we use weekly observations of wind speed and direction for the years 1991 to 1999 with a precision of 1° of latitude and longitude. Distance sailed varies with wind speed and direction.

3. Land indicator zones and arcs of landfall

Navigators in Oceania are known to have developed techniques for "expanding" the size of their targets. This art of identification of distant land beyond sight range relies upon the fact that islands are surrounded by zones of land indicating signs such as homing birds, land clouds, swell patterns and phosphorescence (Lewis, 1975). An early and now widely accepted estimate for an average radius of these zones is 30 nautical miles from a low island such as an atoll (Frankel, 1962; Lewis, 1975). Groups of islands may have overlapping land indicator zones bridging the gaps between them, thus forming a "screen" or "island block". The angle between two tangents from the island of departure to the 30 nm land indicator zone(s) is the arc of landfall (Fig. 1). Arc of landfall $= 2(\text{Arc tg})\,(r/d)$ (where r is the radius of the indicator zone and d the distance between the two islands).

Arcs of landfall allowed Lewis to analyze actual voyages made by traditional canoes to deduce "which arcs of [expanded] landfall would be relatively safe, risky or too small for safety" (Lewis, 1975). He noted that most recorded inter-island voyages had target angles from 11° to 18°, and that the 7.5° angle (from Pulusuk to Kapingamarangi) might represent the limit of the navigational accuracy of Pacific islanders (Lewis, 1975). Similarly, Irwin plotted expanded target angle against the distance between islands to measure the "relative accessibility of island groups" (Irwin, 1992). He noted for example that from central Vanuatu to Fiji, a distance of 500 nm, the target angle is 21°, while from Samoa to the southern Cooks, a distance of 630 nm, the target angle is 15° and concluded that "…no navigational thresholds are apparent" (Irwin, 1992). These voyages will be re-examined below since the former represents the longest and most difficult voyage in the area of Lapita settlement, while the latter represents the presumed first settlement of East Polynesia.

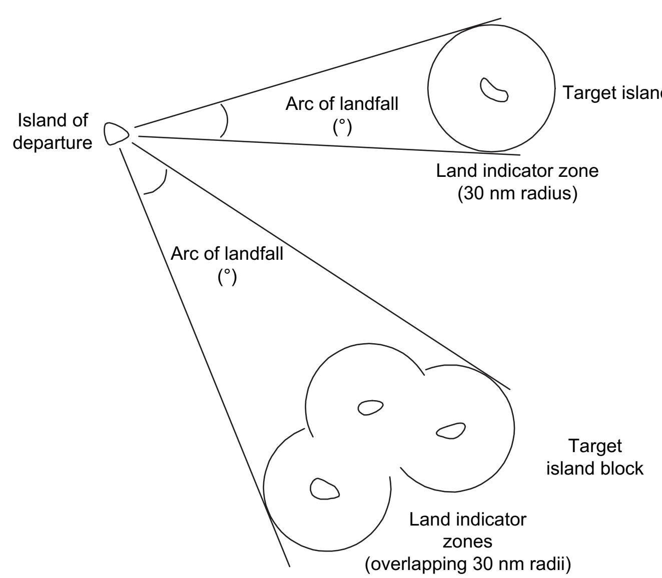

Fig. 1. The arc of landfall is the angle between 2 tangents of a circle (with a 30 nautical mile radius drawn around the target island(s)) and the point of departure.