
SHORTER COMMUNICATIONS

A RECONSTRUCTION OF A TAHITIAN STAR COMPASS BASED ON TUPAIA'S "CHART FOR THE SOCIETY ISLANDS WITH OTAHEITE IN THE CENTER"

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When Europeans first ventured into the Pacific they had to grapple with three almost inconceivable notions: (i) that Pacific Islanders could guide their canoes successfully over long distances without instruments, while they, the Europeans, had spent centuries developing the compass, the sextant and the chronometer for navigation; (ii) that the islanders could hold mental maps, while they, the Europeans, had spent centuries developing ways of representing a curved world on a flat map; and (iii) that Pacific islanders could memorise and transmit knowledge of numerous star paths, as well as “wind” or “island compasses” orally, in contrast to the almanacs and various mathematical tables created over centuries in Europe. This encounter of two schools of navigation, one technically sophisticated and based largely on written knowledge, the other an oral system, has led to considerable “*méconnaissance*” (Turnbull 1998)—not the least concerns methods of way finding and mental cartography. It is perhaps no surprise that Tupaia, the high priest and navigator encountered by Cook in Tahiti in 1769, had some difficulty convincing the Captain of the accuracy of the “situation of the islands” he knew of since hidden behind the Chart he drew was a body of local knowledge encompassing indigenous geography, astronomy and navigation. All of these domains were confounded into one “art of navigation” by Europeans.

In Oceania, the “... art of navigation includes a sizable body of knowledge developed to meet the needs of ocean voyaging... local navigators have had to commit to memory their knowledge of the stars, sailing directions, seamarks...” (Goodenough and Thomas 1987: 3). From all across the Pacific comes evidence of long-distance voyaging achieved by a combination of techniques involving detailed knowledge of wave patterns, cloud formations and bird movements, and dead reckoning following stars at night and swells by day (Akerblom 1968; Best 1922; Daiber 1986; Da Silva & Johnson 1982; Dodd 1972; Gladwin 1970; Goodenough 1953; Halpern 1986; Lewis 1964,

1972, 1978; Thomas 1982). Although the sun serves as a direction indicator, the rising and setting points of stars are the critical signposts for voyages across the open sea.

Sir Joseph Banks was perhaps the most perceptive early observer of the Tahitian use of astronomy for navigation.

The Polynesians' knowledge of the stars was very detailed. They know a very large part by their names, and the clever ones among them will tell in what part of the heavens they are to be seen in any months when they are above the horizons. They know also the time of their annual appearing and disappearing to a great nicety, far greater than would be easily believed by a European astronomer. (Banks 1962: 368)

The best documented records we have about star navigation come from Micronesia, although master navigators were also mentioned from time to time in other parts of the Oceania. In the 1950s, Goodenough (1953) established much of the framework upon which ethnographers have based discussions of indigenous astronomy and even today the Caroline Islands are still home to navigators schooled in the use of stars as guides on open-ocean voyages. They also use the concept of "star" and "island compasses" to organise their body of knowledge (Thomas 1982, 1987; Goodenough and Thomas 1987). To what extent Polynesians used similar concepts for storing and retrieving information is unknown, but star path navigation is well attested.

I propose in this article to develop a plausible reconstruction of some of these Tahitian star paths based on Tupaia's "Chart for the Society Islands with Otaheite in the center". For some of these stars, I was able to draw on their significance as navigational markers by comparing them with the Carolinian star compass and on their mythical associations with astronomical concepts by comparing them with the known Tahitian "pillars of the sky". I conclude by discussing the star compass as a mnemonic device employed by navigators to organise a large body of data, similar to the "method of loci", known to ancient Greeks.

STAR PATHS

There can be little doubt that Austronesian navigators steered their canoes with respect to rising or setting stars on the horizon. In any particular latitude, stars rise and set at the same point on the horizon throughout the year. Beyond the tropics, stars rise and set obliquely, describing a circle around the celestial pole. Close to the equator, their motion is nearly vertical. Stars that have set in the west or risen too high in the east to be good directional indicators are replaced by new ones on the same bearing. This succession of

stars is called a “star path” or “star lane” (Akimichi 1996, Alkire 1970: 47, Brower 1983, Daiber 1986, Dodd 1972, Frake 1995, Gladwin 1970: 131). As Gell (1985: 284) recalled, a star path is not a “set of sailing-directions for getting from island A to island B, but an abstract representation of where these islands are in relation to each other, expressed in terms of the bearings followed by an ‘ideal’ canoe”.

A refinement of star paths is the construction and conceptualisation of a sidereal or star compass, where standardised or conventionalised directions or azimuths are marked by the rising and setting points of stars on the horizon. Akerblom (1968: 108), in comparing between the use of a star compass and that of a magnetic compass, explained that

... the task of a sidereal compass is not to give true bearings but to indicate courses to be steered in relation to known geographical points. Consequently, it consists partly of a fixed number of points on the horizon where stars rise and set, and partly of the positions of the known islands and atolls in relation to those points.

The star compass was first described by Sanchez y Zayas (1866: 263-64) and came to be well known after Goodenough’s study in central Micronesia (Goodenough 1953). There is, however, evidence of star compasses having been used elsewhere in the Pacific. Kaho, a Tongan navigator, gave Lewis a list of eight stars “... that indicated directions rather than the positions of islands. The star paths, or succession of steering stars, for these horizon compass points he termed *kaveinga*, the same word that is used for the guiding stars for islands” in other places in Polynesia (Lewis 1972: 77). On Huahine, Ellis wrote, “When setting out on a voyage, some particular star or constellation was selected as their guide in the night. This they called their *aveia*, and by this name they now designate the compass because it answers the same purposes” (Ellis 1831 v. 1: 168 cited by Lewis 1972: 77). Malo reported that in Hawai‘i the stars were also used as a compass (Haddon and Hornell 1936-38: 25). These three references may be too fragmentary to ascertain that the star compass as such was in fact used in Polynesia, but I agree with Lewis in finding it “difficult to imagine what, other than some form of star compass, any system of directions round the horizon indicated by stars could be” (Lewis 1972: 77). Historical linguistics also points toward the importance of star paths, if not the star compass. “The term ‘*kaveinga*, the star path’ has a well-supported PPn [Proto-Polynesian] antecedent and etymology. PPn **kaweiŋa* ‘that which is steered for (usually a star)’ (From PPn **kawe* ‘to carry’ + *-i* ‘verbal suffix from POc [Proto-Oceanic] transitive marker **i*’ + *-ŋa* ‘nominaliser’)” (Osmond 2007: 180).

Analogous compass systems, the so-called “wind compass”, have been recorded in the Caroline Islands, the Solomons, Fiji, the southern Cooks, Pukapuka, Tokelau and Tahiti (Montmignon 1826 v. 8: 289, Neyret 1950: 11, 1974 v. I: 64, Gill 1876: 319-21, Beaglehole E. and P. 1938: 22, Burrows 1923: 147, Corney 1913-19 v. II: 284-85 cited by Lewis 1972: 73-76). In 1774, Andia y Varela learned from Puhoru that: “They [the Tahitians] have no mariner’s compass, but divide the horizon into sixteen parts, taking for the cardinal points those at which the sun rises and sets.” Corney added in a note to this text that these parts are named after the winds, “according to the direction from which they blow”. This is the first complete description of a Tahitian wind compass. Andia y Varela continued, asserting that

When the night is a clear one they steer by the stars; and this is the easiest navigation for them because, there being many stars not only do they note by them the bearings on which the several islands with which they are in touch lie, but also the harbours in them, so that they make straight for the entrance by following the rhumb of the particular star that rises or sets over it; and they hit it off with as much precision as the most expert navigator of civilized nations could achieve. (Corney 1913-19 v. 2: 284-87)

While this is a clear description of star paths and the wind compass, it gives no support to a star compass.

The Micronesian star compass and the more widespread wind compass share similarities. Both are based on a mental partition of the horizon. The Carolinian star compass is typically divided in 32 points indicated by 12 stars, 2 asterisms (Orion’s belt, the Pleiades) and a single constellation (the Southern Cross). Twenty-six points are marked by the rising and setting of 13 of these bodies; Polaris occupies one position, whereas the Southern Cross provides five. While this compass is symmetrical east to west, the points are not evenly spaced since they represent the actual rising and setting of stars. In Tahiti, Puhoru’s wind compass was partitioned into sixteen sectors, generally in combination with cardinal points based on the sun (Corney 1913-19, v.2: 284-87, Lewis 1972: 75-77). To be practical guides, bearings from a particular island to another must be known and incorporated into either star or wind compasses. Resemblance stops here insofar as winds “at best can be but impermanent secondary indicators of approximate reliable phenomena”, when compared with stars (Lewis 1972: 78). Wind compasses may well have been restricted to travel within sight of land. Star compasses require prolonged study of astronomy. Each compass point is associated with a list of stars that rise or set along the same bearing, a body of knowledge that encompasses hundreds of names. This knowledge was probably restricted to professional navigators but was sometimes shared with those few missionaries and

ethnographers, such as Ellis, Gladwin, Lewis and Thomas, who accompanied them on long distance canoe voyages. Wind compass were probably part of common knowledge. They do not seem to have been surrounded by secrecy, nor require practice to learn them.¹

How similar the Polynesian and Micronesian navigational systems and conceptual compasses were remains in question, but there is no doubt that sailors of both regions used sophisticated mental cartography as mnemonic devices to arrange their knowledge of celestial (star courses) and terrestrial geography (island bearings) into organised bodies of data.

A RECONSTRUCTION OF TAHITIAN STAR PATHS

Tupaia, the Raiatean high priest and navigator who embarked on the *Endeavour* in 1769, sparked the admiration of Cook's officers when it came to piloting the vessel around Tahiti or to pointing towards his home island wherever they went across the Pacific waters (Beaglehole 1955: 293, 294). But Tupaia is especially famous for his "Chart for the Society Islands with Otaheite in the center...", now in the British Library, London. Numerous authors have struggled with the location and identification of its 74 islands, turning and flipping quadrants of the Chart, trying to read it like a conventional map. In an earlier study, my colleague Erik Pearthree and I concluded that Tupaia's Chart, while having the appearance of a map, is actually a mosaic of island compasses drawn on paper and re-assembled, presumably with input from Cook (Di Piazza and Pearthree 2007, 2008). An island compass is a version of a star compass where the bearings point to islands lying under particular stars.

Tupaia's achievements were not limited to island compasses. He must have known at least one steering star for each island, if not the entire star path. To list all the potential steering stars Tupaia may have used, the method entailed recording all the bearings from the nine island compasses (so far recognised) on Tupaia's Chart (Di Piazza *in prep.*). When reassembled, the 53 bearings² gave a "composite island compass" with 34 points; 19 of the bearings were identical on two to five island compasses (Fig. 1). These bearings are concentrated in the north-east and north-west sectors. Not surprisingly, this reflects South Pacific geography where most island groups extend along an east-west axis. According to Akerblom (1968: 104), in the Caroline Islands, the total number of points on a star compass varies between 28 and 36, a figure that strongly resembles mine and which would be sufficient to indicate the direction to a great number of islands.

The 19 cases of identical bearings on our "composite compass" is probably our best support for demonstrating the existence of a mental construct of a partitioned horizon linked to particular steering stars, hence a reconstructed star compass. The four major bearings—those which were identical on at least

Table 1. Star paths from Ra'atea on bearings from Tupaia's Chart. Astronomers commonly designate stars using letters of the Greek alphabet together with Latin constellation names. For example, alpha Scorpii is the brightest star in the constellation Scorpius. Stars in bold are guiding stars found on Goodenough's Carolinian compass. Stars in italics are "star pillars" from Rua-Nui's chant.

Rising star bearing	Setting star bearing	Reconstructed star paths
0°		Pherkad; χ Draconis (very low on the horizon)
13.5°	348°	Giausar; Altais; κ , ω , ζ , ϵ Draconis; Alfrk; ι Cephei; α , γ Camelopardalis
25°	335°	\omicron Draconis; Alderamin; η , ζ , ν Cephei; Caph; Ruchbach; γ Cassiopeiae; HIP 16228 A; HIP 18488 A; β Camelopardalis; 2, 15 Lyncis; Mscida; Dubhe ; Megrez; Alioth; υ Ursae Majoris; Edasich; Grumium; θ , η Draconis
28°		Grumium; θ Draconis; 33 Cygni; HIP 102431; ϵ Cephei; HIP 111795; Shedir ; ρ , η , ϕ Cassiopeiae; η Persei; 15 Lyncis; υ , β , δ Ursae Majoris
35°	323°	Etamin; Azelfafage; θ 1, \omicron 2 Cygni; β , 4, α , g Lacertae; Shedir ; ζ Cassiopeiae; 3 Andromedae; Mirphak; δ , τ , γ , λ Persei; 9, \omicron , ψ 1 Aurigae; 21 Lyncis; Talitha; Alkaid; κ , θ , χ Ursae Majoris; θ , ι Bootis; τ , ι Herculis
		ι Herculis; 16 Lyrae; 30, α 2, Deneb, fl, ϵ 2, ρ Cygni; 5 Lacertae; λ , ψ , 22 Andromedae; n Cassiopeiae; ϕ , 49, c Andromedae; HIP 13965; HIP 15004; δ , c, d Persei; Capella, n Aurigae; κ , χ Ursae Majoris; τ , ι Herculis
47°		B, ϵ Persei; 31 Lyncis; μ , λ Ursae Majoris; β Canum venaticorum; β Bootis; χ Herculis; δ , α Cygni; Capella
51°	310	H, n, ϵ , ρ , θ Herculis; Vega ; ζ 1, ζ 2, θ Lyrae; Sadr; 1 Lacertae; μ , v, β Andromedae; 16, ρ , ϵ Persei; ζ , v, θ Aurigae; 38 Lyncis; 10, 21, β Leonis Minoris; Cor Caroli; 25 Canum venaticorum; HIP 66257; Segimus; Alkalurops; υ Bootis
64°	294°	α , 13, 25, 30 Vulpeculae; Sadalbari; κ , λ , ι , u, τ , ψ Pegasi; ζ , η Andromedae; ϕ Piscium; Hamal; λ Arietis; HIP 13121; Taygeta; Electra; Merope; Pleiades ; Atlas; 36, u, τ , ζ Tauri; Propus; Tejat; Mebsuta; Mekbuda; Wasat; υ , κ Geminorum; Asellus Borealis Cancri; Adhafera; Zosma; ϵ Leonis; Arcturus ; d Bootis; Kornephoros; Maasym; Δ Herculis

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Rising star bearing	Setting star bearing	Reconstructed star paths
69°		Mekbuda; v Geminorum; Asellus Australis; Algieba; Zosma; Chertan; η Leonis; α Comae Berenices; Muphrid; <i>Arcturus</i> ; κ Serpentis; γ Herculis; Sham; γ Sagittarii; ξ Pegasi; Sheratan; Mesarthim; Ain; ζ Tauri
75°		B, γ Serpentis; γ Herculis; Rasalhague; ε, ζ Aquilae; Sualocin; γ2, δ Delphini; Markab; Algenib; η Piscium; <i>Aldebaran</i> ; λ, γ Tauri; v, ξ Orionis; ξ, λ Geminorum; 29 Cancrī; Regulus; Chertan; Denebola; η Leonis; Vindeliatrix; υ, ζ Bootis
84°		Tarazed ; Alshain ; Altair ; δ Aquilae; HIP 100541; 13 Delphini; Kitalpha; ε Equulei; Bitham; 7, 35 Pegasi; θ, ι, w, 62, ε, μ, v Piscium; Menkar; v Ceti; HIP 14925; HIP 16358; u, v Tauri; Bellatrix; <i>Betelgeuse</i> ; n3, n4, 63, 66 Orionis; ε, 18 Monocerotis; HIP 34987; <i>Procyon</i> ; σ, η Hydrae; v, δ, T, 19 Virginis; ε Serpentis; Cebalrai; Alya
90°		58, θ, ι, d, 68 Aquilae; Sadalmeli; Sadachbia; ζ1, η Aquarii; 20, 38, 60, 61, 70, δ Ceti; 10 Tri; HIP 17805; 24 Eridani; HIP 18859; 45 Eridani; <i>Mintaka</i> ; <i>Alnilam</i> ; <i>Alnitak</i> ; 60 Orionis; HIP 30717; 21 Monocerotis; τ2 Hydrae; α, β Sextantis; 13, ζ Virginis; HIP 74901; HIP 80693; HIP 85667A
94°		Sadalsuud; Sadalmelik; Sadachbia; ζ1, μ Aquarii; K Piscium; 66, δ Ceti; Cursa; v, μ, ω Eridani; τ, ι Orionis; γ, ζ Monocerotis; τ1 Hydrae; Syrma; μ Virginis; μ Serpentis; Yed posterior; η Serpentis; β Scuti; λ, θ Aquilae
97°		Sadalsuud; Ancha; λ Aquarii; 33, 30 Piscium; 66 Ceti; Cursa; v, ω Eridani; Rigel; Saiph; τ Orionis; γ, β, α Monocerotis; α Hydrae; Syrma; κ, μ Virginis; Zubeneschamali; Yed Posterior; α, β Scuti; λ, θ Aquilae
102°		Albali; μ Aquarii; c Capricorni; σ, ψ1, ψ2, ψ3 Aquarii; Baten; ι, η Ceti; HIP 12444; Azha; ε, δ, 39 Eridani; Rigel; Saiph; 3 Monocerotis; θ Canis Majoris; <i>Alphard</i> ; ε, θ Crateris; <i>Spica</i> ; κ Virginis; Zubeneschamali; ζ Ophiuchi; v Serpentis; HIP 90804A; HIP 91105; Algedi
107°	255°	α1, α2, v Capricorni; HIP 102891; 18, ι, τ Aquarii; Diphda; 42, μ, τ, σ, n Ceti; ι, 42, 51, τ Aquarii; HIP 115125; ω1, ω2 Aquarii; p, ε, n Ceti; HIP 16263; Zaurak; HIP 20922; ι Eridani; μ, κ, λ, ι, ζ, η, θ Leporis; HIP 31827; Mirzam; Sirius; Muliphein; 11, μ, ι Canis Majoris; α Monocerotis; <i>Alphard</i> ; κ, v1, λ, μ Hydrae; δ, η Crateris; Gienah ; Algorab; η Corvi; <i>Spica</i> ; 53, κ, λ Virginis; Zubenelgenubi; γ, θ Librae; Sabik; ζ Ophiuchi; ε, ο, v, ξ, σ Serpentis; λ, γ Scuti; HIP 92814; Dabih; Nashira; Deneb Algebi; θ, ι Capricorni

115°	247°	49, c1, c2, b1 Aquarii; κ Fornacis; τ 1, τ3, τ4, τ 5, τ 6, τ 9 Eridani; HIP 21743; Nihal; ε, δ, γ Leporis; ζ1, ζ2, o1, o2, 145 Canis Majoris; HIP 36431; HIP 36795; HIP 36817A; ξ, j, ρ Puppis; G, I Hydrae; HIP 47592; η Crateris; Alchiba; ε, β Corvi; ψ, γ Hydrae; σ Librae; Dschubba; <i>Antares</i> ; v Scorpii; ω, 58 Ophiuchi; Kaus Borealis; Nunki; φ, η, ε2, c Sagittarii; ψ, ω, η, φ, 33 Capricorni; 8, ε Piscis Austrini; HIP 109737; δ Sculptoris
121°	239°	c Sagittarii; ω Capricorni; HIP 103902A; HIP 104750; η Piscis Austrini; HIP 108975; Fomalhaut; ε Piscis Austrini; HIP 115312; α, δ Sculptoris; ω, γ2, ε, α Fornacis; <i>Phaet</i> ; v2 Columbae; Furud; Adhara; Aludra; σ Canis Majoris; ι Puppis; HIP 38901; γ Pyxidis; α Antliae; ξ, ε Hydrae; τ Librae; ρ, τ Scorpii; Kaus Media; Alnasi; Ascella; 3, φ, τ Sagittarii
177°		ε Pavonis; ζ Volantis; HIP 44599; HIP 50954
	223°	v, n2 Columbae; v, σ Puppis; Regor; Suhail; q Velorum; β, v1 Centauri; τ2, I, α, λ, v, ε Lupi; Girtab; ζ2, v Scorpii; α Telescopii; ζ Corona Borealis; Arkab; Rukbat; I Sagittarii; v Microscopii; δ1, θ Gruis; Ankaa; κ, γ Phoenicis; s, e Eridani; α Horologii; δ Caeli
	227°	Naos; α, η Puppis; ψ Velorum; ι, η, δ, v Centauri; δ, γ Lupi; Shaula ; ζ 1, κ, ι1 Scorpii; λ, α Coronae Australis; ι Sagittarii; γ Gru Gruis; β Sculptoris; ι Eridani; HIP 17797 A; β Caeli
	234°	κ Canis Majoris; α Pyxidis; η Antliae; ξ, β Hydrae; Menkent; ι, 2, 3, h, c1 Centauri; φ1, ψ1, χ Lupi; HIP 80911; ε Scorpii; HIP 87261; Ascella; ε, η Sagittarii; α, γ, ε Microscopii; Fomalhaut; θ, τ, β, δ Piscis Austrini; γ, α Sculptoris; β Fornacis; g, v 4, v 3 Eridani; Wazn; ε, κ, δ Columbae
	280°	Tarazed ; Altair ; ε Delphini; γ, δ Equulei; Enif; Homan; μ Ceti; τ Tauri; <i>Beteigeuse</i> ; Meissa; n1, μ Orionis; Gomeisa; β Cancri; n Leonis; ω, ε, 4, o, d2 Virginis; HIP 70327; 31 Bootis; K, 72 Ophiuchi
	300°	Alpheratz; δ Andromedae; Mothallah; Alnath; Pollux; ι Geminorum; ι, χ Cancri; λ, 16, 14, 31, β Comae Berenices; Izar; ψ Bootis; Alphekka; ε Coronae Borealis; μ, ε, o Herculis; Albireo; φ, 41, ζ, μ1 Cygni; Matar
	328°	Shedar; η Draconis; Alderamin; Kurhah; θ, η, ι Cephei; ε Cassiopeiae; o Ursae Majoris

When comparing these reconstructed star paths to the guiding stars on Goodenough's compass, it appears that setting Altair, setting Tarazed, setting Pleiades, rising and setting Vega, rising Orion's belt, rising Alshain, setting Shedir, as well as rising Gienah fall within 1° of Tupaia's bearings, rising Aldebaran, rising Antares and setting Shaula within 2°, rising and setting Dubhe as well as Crux upright within 3° (Fig. 2). Although the bearings of Polaris and Kochab are on our composite compass, these two stars, invisible from Ra'iatea, could not have served as steering stars at the latitude of the Society Islands. They are below the northern horizon. In summary, 17 bearings on our composite compass are within 3° of one of the 32 points of the Micronesian compass. But perhaps more telling is that all 15 stars, asterisms and the constellation in the Carolinian compass are marked by bearings in our composite compass.

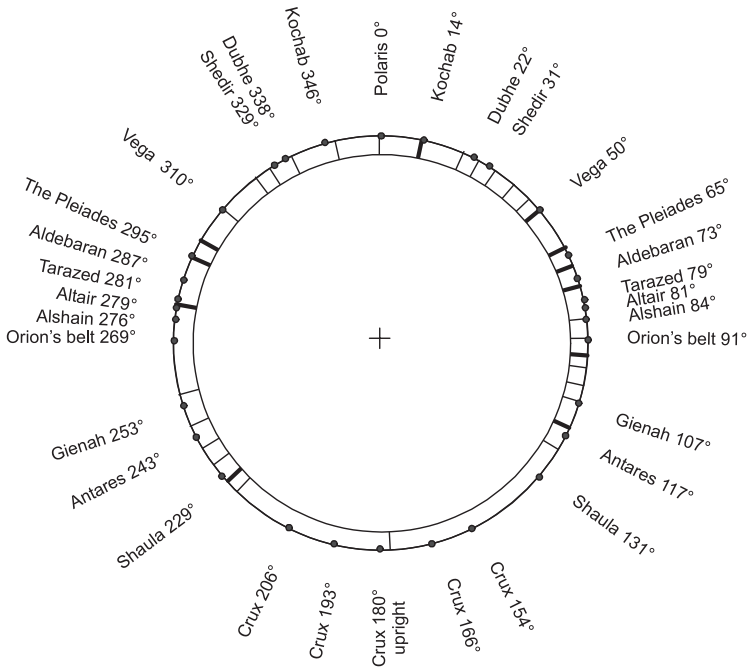


Figure 2. Bearings from Tupaia's Chart with associated Carolinian guiding stars (after Goodenough 1953) at the latitude of Ra'iatea. Polaris and Kochab are invisible from Ra'iatea.

The similarities between these two compasses leads to the following questions: could the Carolinian sailors share a star compass with the Raiateans? Do the same stars have the same azimuth at 8° N (the Carolines) and 17° S (the Societies)? When comparing the azimuths of the Carolinian guiding stars from the islands of Satawal and Ra'iatea respectively with the aid of Stellarium, the variation remained under 1°, except for Dubhe, which changed 6°. Carolinian and Raiatean navigators could well have partitioned their horizon similarly and used analogous star compasses, indeed the same stars, although evidence for prolonged interaction and shared navigational knowledge between Micronesia and Polynesia is meager. Only two constellations have reflexes in both Polynesia and Micronesia. These are **manuk* 'bird' and **tolu* 'three' (Osmond 2007: 168, 188). **manuk* refers to stars in the western constellations of Orion and Canis Majoris, including Betelgeuse, Sirius, Canopus, Rigel and Procyon. **tolu* refers to the group of three bright stars in a row making up Orion's belt. No cognates for star compass, wind compass or star paths were found, leading Osmond to conclude:

So although we can recognize the same navigational techniques such as the use of star paths and swells in places as far apart as the Papuan Gulf, the Admiralties, the Solomons, Micronesia and Polynesia, and techniques involving a wind compass and deep luminescence in Micronesia and Polynesia, comparative linguistics provides no proof that these shared techniques evolved from a common knowledge base at the POc stage. (Osmond 2007: 191)

In 1818, Orsmond recorded an old Tahitian chant, the "Birth of the heavenly bodies" recited by an old woman called Rua-Nui and published by his granddaughter Teuira Henry. The sky "is said to have been low down formerly, and propped up from the earth with [star] pillars" (Henry 1907: note1). These 10 pillars (all prefixed with *'Ana* meaning star) are Antares, Aldebaran, Spica, Dubhe, Alphard, Arcturus, Procyon, Betelgeuse, Phaet and Polaris. We do not know if these stars are referred to in the myth as rising, setting or both. Comparing these stars to our composite compass, we find that rising Arcturus, rising Procyon, rising Orion's belt and setting Phaet fall within 1° of Tupaia's bearings; rising Aldebaran, rising and setting Betelgeuse, rising Spica and rising Antares fall within 2°, rising and setting Dubhe within 3° (Fig. 3). That Polaris, invisible from Ra'iatea, could have served as a guiding star or even been known to the Raiateans suggests that they were accustomed to long voyages to the northward, to the latitude of the equator. Thirteen of the star pillars' bearings (0°, 22°/338°, 73°/287°, 82°/278°, 85°/275°, 91°/269°, 117°/243°) also appear on Goodenough's

compass, although two of them are named after different guiding stars: Betelgeuse and Procyon in Tahiti, Altair and Alshain in Micronesia. These “pillars of the sky” not only point towards important bearings, here again mostly clustered in the east and west, but underline the importance of chant as a means of memorising navigational knowledge.

THE ART OF MEMORY

Navigation demanded rigorous and prolonged training, involving instruction ashore and at sea, as well as the memorisation of voluminous information on land signs, seaway conditions, and not least, precise lists of star courses to all potential islands (Riesenberg 1972).

Sustaining the total body of navigational knowledge in the absence of writing is accomplished first by organizing it, making it systematic and schematic. It is taught and learned in this organized form. Indeed, it is over-learned with the use of standardized drills and exercises that build in redundancy and that are continually rehearsed. (Goodenough and Thomas 1987:12-13)

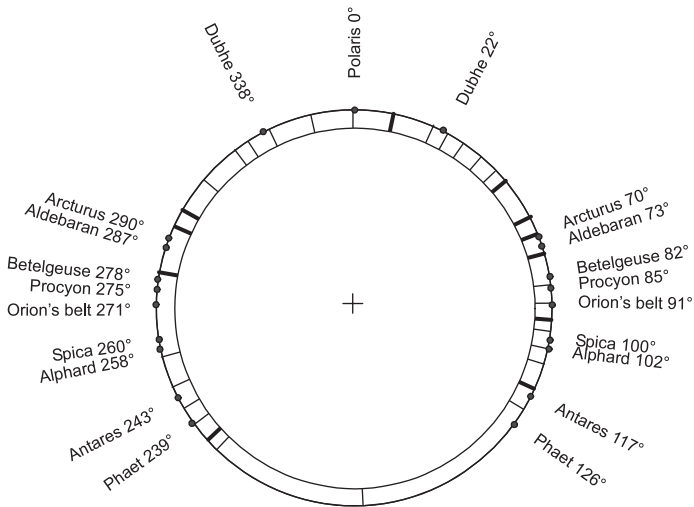


Figure 3. Bearings from Tupaia’s Chart associated with the Tahitian “star pillars” (after Henry 1907) at the latitude of Ra’iatea. Polaris is invisible from Ra’iatea.

This “organized form” takes the figure of a compass and recalls the “method of *loci*” used in Europe to memorise items in a precise order that dates back to the ancient Greeks⁴ (Yates 1975). These mnemonic techniques rely on spatial relationships. The subject memorises the layout of a building or structure which may be imaginary (a compass in our case) composed of a number of discrete *loci* (bearings and compass points). When one wishes to remember a set of items, the subject “walks” through these *loci* (or sails along these bearings) and commits an item to each locus by associating or forming an image (or a verse in a chant) between the item and that locus. As Goodenough and Thomas stated: “[F]or memory storage much of the lore is also embedded in chants. The metric and tonal structures of Carolinian chant forms provide aids to recall” (1987: 13).

It is all too easy to underestimate Polynesian navigational methods, since the era of ancient Polynesian voyaging is now closed, increasing the misunderstanding of concepts such as compasses, chants to islands or “pillars of the sky”. It is thus risky, though not impossible, to reconstruct part of the knowledge embedded in Tupaia’s Chart. Doubtless, the islands referred to by Tupaia are associated with bearings and star paths. That these bearings make up a star compass is supported by a few references in the literature, but is supported because identical bearings, making a pattern, centred on different island compasses, have been found. Some of these bearings point toward stars (such as Dubhe, Shedir, the Pleiades, Arcturus, Aldebaran, Tarazed, Betelgeuse, Procyon, Orion’s belt, Spica, Alphard, Gienah, Antares, Shaula, Phaet, Crux) which serve as guiding stars in the Carolinian archipelago or are found in Tahitian astronomical chant. Such association is unlikely to be fortuitous, and suggests the use of similar star compasses across Micronesia and Polynesia. The architecture and ordering of such a compass may well be a very efficient mnemonic device to help sustain the knowledge embodied in navigation.

NOTES

1. Father Cantova was based on Guam and was forbidden by his superior to embark with the Carolinian castaways returning to their home island (Montmignon 1826 Vol VIII: 289). Father Neyret, a Marist missionary sent to Fiji in the 1930s, confessed that his experiences at sea “always happened, thanks to god, close to the reef” (Neyret 1950: 27). Andia y Varela “was able to find out the method by which Tahitians navigate on the high seas” while in Lima when Puhoru, a master navigator came to Peru (Corney 1913-1919 Vol.II: 284).
2. I only used bearings to islands identified with some certainty (Di Piazza *in prep.*). For the island compass centred on *Mehetia*, I retained the islands of Mataiva, Nuku Hiva/UaHuka, Hiva Oa, Fatu Hiva, Vahitahi, Pukapuka, Mauke

- and Rotuma. For the one centred on *Ra'iatea*: Mataiva, Ahe, Kaukura, Tahanea, Hereheretue and Takapoto. For the one centred on *Tahiti*: Savaii, Mataiva, Tikehau, Rangiroa, Takaroa, Fakarava and Hao. For the one centred on *Pukapuka*: Savai'i, Upolu, Tutuila, Manua/Vavau and Uiha. For the one centred on *Savai'i*: Rotuma/Uvea, Manu'a, 'Upolu/Tutuila, Mangaia (and its backsight). For the one centred on *Mauke*: Rarotonga, Atiu, Takutea, Aitutaki/Manuae and Mitiaro. For the one centred on *Hao*: Eiao/Motu Iti, Fatuhuku/Tahuata and Vahitahi. For the one centred on *Rapa*: Vahitahi, Tahiti, Pukapuka, Savai'i, Rotuma/ Rarotonga. For the second compass centred on *Ra'iatea*: Rurutu, Mauke, Rotuma, Pukapuka, Rangiroa, Apataki, Raroia/Fakarava, Hao/Vahitahi, Borabora/Tupai, Taha'a.
3. This software can be downloaded at <http://sourceforge.net/projects/stellarium/files/Stellarium-win32/0.10.5/stellarium-0.10.5.exe/download>.
 4. The Art of memory was still in use until the first half of the 19th century in works on Rhetoric, Logic and Philosophy (Yates 1975).

REFERENCES

- Akerblom, Kjell, 1968. *Astronomy and Navigation in Polynesia and Micronesia*. Stockholm: Ethnografiska Museet.
- Akimichi, Tomoya, 1996. Image and reality at sea: Fish and cognitive mapping in Carolinean navigational knowledge. In R. Ellen and K. Fukui (eds), *Redefining Nature. Ecology, Culture and Domestication*. Oxford: Berg Publishers, pp. 493-514.
- Alkire, William H., 1970. Systems of measurement on Woleai Atoll, Caroline Islands. *Anthropos*, 65: 1-73.
- Banks, Joseph, 1962. *The Endeavour Journal of Joseph Banks, 1768-1771*. 2 vols. Edited by J.C. Beaglehole. Sydney: Angus and Roberston.
- Beaglehole, Ernest and Pearl Beaglehole, 1938. *Ethnology of Pukapuka*. Bernice P. Bishop Museum Bulletin 150. Honolulu.
- Best, Elsdon, 1922. *The Astronomical Knowledge of the Maori*. Dominion Museum Monograph 3. Wellington.
- Brower, Kenneth, 1983. *A Song for Satawal*. New York: Harper and Row.
- Burrows, William, 1923. Some notes and legends of a South Sea island. Faka'ofu of the Tokelau Group or Union Group. *Journal of the Polynesian Society*, 32: 143-73.
- Corney, Bolton G. (ed.), 1913-1919. *The Quest and Occupation of Tahiti by Emissaries of Spain during the Years 1772-6*. 3 vols. London: Hakluyt Society, pp. [II]: 284-87.
- Da Silva, Armando M. and Rubellite K. Johnson, 1982. Ahu A 'Umi Heiau: A native Hawaiian astronomical and directional register. In A.F. Aveni and G. Urton (eds), *Ethnoastronomy and Archaeoastronomy in the American Tropics*. New York: Annals of the New York Academy of Sciences, pp. 313-31.

- Daiber, Andrew J., 1986. Significance of constellations in Carolinian navigation. *Journal of the Polynesian Society*, 95: 371-78.
- Di Piazza, Anne and Erik Pearthree, 2007. A new reading of Tupaia's Chart. *Journal of the Polynesian Society*, 116: 321-40.
- 2008. Il cartografo Tupaia, James Cook e il confronto tra due saperi geografici. *Quaderni Storici* 129 (3): 575-92.
- Di Piazza, Anne (in prep.) Complément d'enquête sur la carte de Tupaia: des différents usages d'un même document, du 18^{ème} siècle à nos jours.
- Dodd, Edward, 1972. *Polynesian Seafaring*. New York: Dodd, Mead.
- Ellis, William, 1831. *Polynesian Researches during a Residence of Nearly Eight Years in the Society and Sandwich Islands*. 4 vols. 2nd edition. London: Henry G. Bohn.
- Frake, Charles O., 1995. A reinterpretation of the Micronesian "star compass". *Journal of the Polynesian Society*, 104: 147-58.
- Gell, Alfred, 1985. How to read a map: Remarks on the practical logic of navigation. *Man*, 20 (2): 271-86.
- Gill, William W., 1876. *Myths and Songs from the South Pacific*. London: Henry S. King.
- Gladwin, Thomas, 1970. *East Is a Big Bird*. Cambridge: Harvard University Press.
- Goodenough, Ward H., 1953. *Native Astronomy in the Central Carolines*. University of Pennsylvania Museum Monographs: Philadelphia.
- Goodenough, Ward H. and Stephen D. Thomas, 1987. Traditional navigation in the Western Pacific. A search for pattern. *Expedition*, 29 (3): 3-14.
- Haddon, Alfred C. and James Hornell, 1936-38. *Canoes of Oceania*. Vol. 2. Bernice P. Bishop Museum Special Publication 28. Honolulu.
- Halpern, Michael, 1986. Sidereal compasses: A case for Carolinian-Arab links. *Journal of the Polynesian Society*, 95: 441-59.
- Henry, Teuira, 1907. Tahitian astronomy. *Journal of the Polynesian Society*, 16: 101-4.
- Lewis, David, 1964. Polynesian navigational methods. *Journal of the Polynesian Society*, 73: 364-74.
- 1972. *We, the Navigators*. Honolulu: University Press of Hawaii.
- 1978. *The Voyaging Stars*. New York: W. W. Norton.
- Montmignon de, Jean Baptiste (ed.), 1826. *Choix des Lettres édifiantes, écrites des missions étrangères....* 2nd edition. In Vol. VIII: Lettre du Père Jean-Antoine Cantova au révérend Père d'Aubenton, Confesseur de sa Majesté Catholique. Paris: Grimbart.
- Neyret, Jean M., 1950. Notes sur la navigation indigène aux îles Fidji. *Journal de la Société des Océanistes*, 6: 5-31.
- Osmond, Meredith, 2007. Navigation and the heavens. In M. Ross, A. Pawley and M. Osmond (eds), *The Lexicon of Proto-Oceanic, Volume 2: The Physical Environment*. Canberra: Pacific Linguistics and ANU Press, pp. 155-91.
- Riesenberg, Saul H., 1972. The organization of navigational knowledge on Puluwat. *Journal of the Polynesian Society*, 81: 19-56.

- Sanchez y Zayas, E., 1866. The Marianas Islands. *Nautical Magazine*, 35: 253-66.
- Thomas, Stephen D., 1982. The puzzle of Micronesian navigation. *Pacific Discovery*, 35 (6): 1-12.
- 1987. *The Last Navigator*. New York: Henry Holt & Co.
- Turnbull, David, 1998. Cook and Tupaia, a tale of cartographic “Méconnaissance”. In M. Lincoln (ed.), *Science and Exploration in the Pacific. European Voyages to the Southern Oceans in the 18th Century*. Suffolk: The Boydell Press in association with the National Maritime Museum, pp. 117-31.
- Yates, Frances A., 1975. *L’Art de la mémoire*. Paris: Bibliothèque des Histoires, Gallimard.

ABSTRACT

In this paper I propose a reconstruction of a Tahitian star compass and associated star paths based on Tupaia’s famous Chart. I further argue for the existence of such a navigational device for Polynesia in general. I conclude by drawing inferences from the methods of ordering data embedded in a star compass and the “method of loci”, known to the ancient Greeks to memorise items in a precise order.

Keywords: Tupaia, Polynesian navigation, astronomy, star compass, method of *loci*.