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THE SUBTLETIES OF THE SEAS: THOUGHTS ON MEDITERRANEAN ISLAND BIOGEOGRAPHY

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ABSTRACT

Mathematical principles developed for the analyses of Pacific island biogeography have been used to explain insular exploration and colonization in the Mediterranean. This paper contends that one mathematical tool, the Target-Distance Ratio, is not adequately suited for the Mediterranean. Its archipelagos are unique due to the surrounding nearby coasts, and the Target-Distance Ratio does not sufficiently explain the human perception of the initial colonization. A cognitive approach is adopted to assess how potential colonizers perceived the water barriers. I examine maps made prior to sextant mea-surements and the Mercator Projection to understand how would-be colonizers may have visualized and anticipated the voyage. The analysis suggests that mariners probably did not envision the dangers of sailing in terms of distances, implying Target-Distance Ratios are inade-quate to explain the Neolithic colonization of the Mediterranean islands. Instead, this essay focuses on developments in stone tool technology that probably advanced sea-faring capabilities and in turn allowed early farmers to move to islands.

KEYWORDS: Island biogeography, Neolithic, dugout boats, stone axes, early farming.

INTRODUCTION

In recent decades island biogeography has grown as a research paradigm in the Mediterranean (Evans 1977; Cherry 1981; Patton 1996; Broodbank 1999; Broodbank 2000). It uses mathematical tools developed for the analyses of animal ecology and human colonization of the Pacific islands. This paper contends that one of those tools, the Target-Distance Ratio, is not adequately suited for human island biogeography in the Mediterranean. These archipelagoes differ from the Pacific primarily because they are

closely surrounded by coasts. It is shown that this purely mathe-matical model does not sufficiently explain the perceptions and thought pro-cesses involved in colonizing the Mediterranean islands. The Neolithic colonizations (ca. 6500 BC) were not passive, stochastic or random because the targeted islands were already known (Cherry 1981), and the ships carried cargo prepared for landfall (Broodbank and Strasser 1991). In this essay a cognitive approach is adopted by asking how potential colonizers perceived the water barriers. Maps that did not use the Mercator Projection (1554 A.D.), or sextant measurements (1739 A.D.), are analyzed because they represent a visualization of perceived distances for sea-travel without accurate measuring devices. This comparison shows that maps without those innovations often underestimated spans of water and exaggerated land distances. They suggest that mapmakers, and probably mariners, did not envision the dangers of sailing the Mediterranean in terms of distances. Consequently, mathematical models may overestimate the difficulties involved in island colonization during the early Holocene. Instead, this essay focuses on a possible link between a technical development in stone tool technology and boat construction. Specifically, celts (polished stone axes) are woodworking tools novel to the Neolithic (Runnels and Murray 2001, 41-43) that were used to build sea-craft, which could, in turn, transport a sufficient amount of domesticates to ensure survival on an island.

TARGET-DISTANCE RATIOS IN MEDITERRANEAN ISLAND BIOGEOGRAPHY

To create a Target-Distance Ratios a base line is established parallel to the targeted island, and intersecting the closest point of embarkation (Figure 1). That point forms the apex of two lines that extend to the edges of

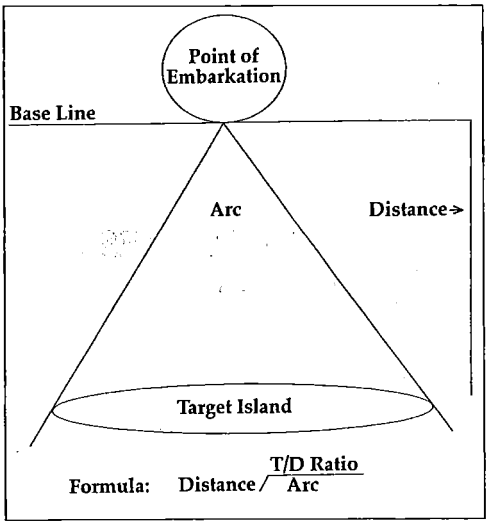

Fig. 1: Target-Distance Ratio.

the targeted island. The enclosed angle forms an arc of less than 180°. The Target-Distance Ratio is the quotient of the degrees in the arc divided by the shortest route between the point of departure and the island to be colonized, and thereby quantifies the general likelihood of randomly chancing upon the island. The lower the quotient, the less accessible the island is. Lower sea levels during the late Pleistocene and early Holocene would have in-creased the area of the islands and, consequently, their accessibility (Lambert 1996).

By using Target-Distance Ratios scholars have attempted to establish how discoverable an island is from a given point. For example, Cherry (1981) applied them to demonstrate that large Mediterranean islands were colonized before smaller ones, and that this pattern was dependent on subsistence strategies. He argued that Palaeolithic and Mesolithic hunter-gathers only visited the islands, while Neolithic subsistent farmers colonized the large islands (e.g., Crete, Cyprus etc...). During the Late Neolithic/Early Bronze Age smaller isles were colonized despite their limited carrying capacity because

trade networks allowed for the importation of subsistence items. An increasing amount of data, however, cast doubt on this hypothesis for the east Mediterranean (Katsarou-Tzeveleki 2001). Mesolithic remains found at Akrotiri-*Aetokremnos* on Cyprus (Simmons 1999), the Cyclop's Cave (Youra) in the Sporades (Sampson 1998), and Maroulas (Kythnos) in the Cyclades (Sampson et al. 2002) make untenable the patterns of island colonizations posited by Cherry (1981; 1990). Indeed, Maroulas on Kythnos had been discovered almost three decades ago by Honea (1975), well before Cherry's model for island colonization in the Mediterranean. Cherry had rejected the Mesolithic date for the site based on problems with the obsidian hydration dates, and his own (i.e., Cherry's) surface collection of lithics[1]. Now that carbon-14 dates and the Mesolithic stone tools from recent excavations have been published, Cherry's dismissal of Maroulas is invalid, and Honea's initial assessment has been confirmed. Cherry saw no quartz tools that Honea had reported, but only natural cobbles; and the obsidian tools the former analyzed were "not necessarily incompatible with a Neolithic or Early Bronze Age date" (Cherry 1979, 30). The primary mistake in the analysis was that Cherry studied his own surface collection, found no quartz tools, and then surmised that Honea misunderstood the quartzite objects in the original assemblage found a few years before. Recent excavations, however, have broadly confirmed the nature and composition of the lithic assemblage as described by Honea[2].

Either Cherry's surface collection was so highly biased that it had no inferential utility for interpreting subterranean remains, or the lithic analysis was seriously flawed. Not only was there a Mesolithic Age in the Cyclades, but also the suite of artifacts found at Maroulas may equal Franchthi Cave in significance for that period.

Despite these data for Mesolithic remains on Aegean islands, it is still reasonable to presume that a Neolithic colonization of Crete occurred based on the earliest evidence from Stratum X at Knossos (Evans 1964; 1968). The introduction of domesticated animals and plants indicate a demic colonization (Broodbank and Strasser 1991), even if future research should discover a yet known pre-Neolithic culture on Crete (see below).

Held (1989) moved beyond the Mediterranean by comparing Cyprus, Madagascar and the islands of Melanesia to make several counter-intuitive inferences. He noted that during the Pleistocene the islands of Melanesia were less remote than those of the land-locked Mediterranean at the same time (Held 1989, 14). This principle, however, is not absolute. Beyond a certain point distance becomes the only geometric property to have bearing on the success of the colonization (Held 1989, 13). Conversely, the length of the voyage becomes somewhat meaningless below a certain distance. Crete is a much larger target from the aspect of Santorini than from Kasos (Fig. 2 and Table 1) (Held 1989, 12. See also Patton 1996, 37-58). This comparison is meaningless because Kasos and

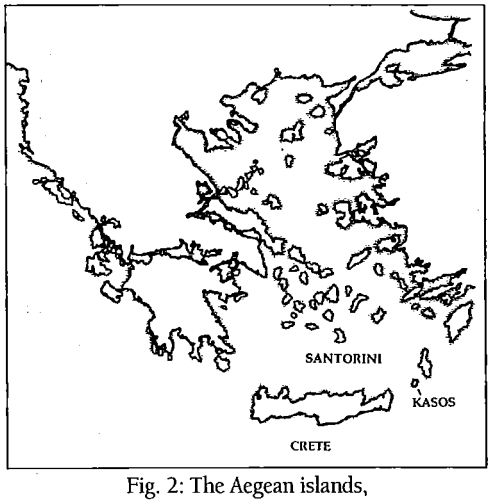

Fig. 2: The Aegean islands, with Crete, Kasos and Santorini.

Corfu	27.2
Corsica	1.5
Crete	72.5
Cyprus	1.7
Euboia	360.0
Kasos	1.0
Lefkas	210.0
Mallorca	0.2
Melos	20.0
Samos	26.0
Santorini	1.2
Sardinia	1.5
Sicily	56.3

TABLE 1: Examples of Target-Distance Ratios for selected Mediterranean islands (Based on Patton 1996, Table 3:2).

Crete are inter-visible, and configuration is an important variable only when islands are out of sight. Moreover, this notional distance may have to be increased when considering that cloud coverage and birds can indicate an island below the horizon. Another point of interest Held noted was that Madagascar was colonized from distant Indonesia rather than nearby East Africa. This is contrary to one of the biogeographical precepts, the "distance effect", which posits that islands are usually colonized by the nearest culture. Held states that "accessibility and remoteness are in the eye of the beholder, or, in this case, dependent on dispersal abili-ties of would-be colonists, whether humans or animals" (1989, 11). Though islands may not appear similar in size and configuration, they may nevertheless have other significant elements in common. Because of this Held uses Target-Distance Ratios to calculate an island's accessibility and remoteness[3]. The Target-Distance Ratios allow Held to draw general conclusions concerning the global history of island colonization, three of which are presented here.

i) Most islands without Pleistocene land bridges that were colonized earlier than the late Pleistocene have very high Target-Distance Ratios (i.e., are very accessible).

ii) Due to lower sea levels, the islands in the Mediterranean were much more accessible during the late Pleistocene and early Holocene than at any time since. Consequently the lack of colonization in those periods is unlikely to be due to stochastic (i.e., involving chance or probability) variables alone.

iii) Three general episodes exist in the history of global island colonization by humans: 1) 40,000-32,000 BP when the islands near the continent in Southeast Asia were colonized. 2) The Pleistocene/Holocene boundary when Cyprus and the Philippines were colonized. 3) A few millennia later a drastic increase in island colonization occurred globally, with many of the Mediterranean islands acquiring early farming cultures.

Though Cherry and Held's researches are helpful in recognizing the quantifiable variables to examine the Mediterranean islands, several shortcomings remain. Both a geographical anomaly and a chronological disparity prevent the Mediterranean from being analogous to the Pacific scenario. The Mediterranean basin is a land-locked sea; and the discovery and colonization episodes in the east Mediterranean did not coincide (Broodbank 2000, 116-117), as they may have in the Pacific (Bellwood 1996; Terrell 1999, 243). Cherry and Held have observed both points, but there remain un-addressed implications. Before turning to them, however, it is germane to recognize two alternative approaches recently proposed.

Broodbank (1999; 2000) adopted the idea

of *autocatalysis* to postulate mechanisms of island colonization. Autocatalysis posits that certain configurations of islands and nearby coasts stimulate sea-faring activities and island colonization. For the Cyclades Broodbank suggests two specific areas where the coasts and nearby islands are so intervisible that there is almost a continuity of landscape: 1) Attica, Euboia, Kea and Andros in the northwest Cyclades; and 2) Samos, Kos, Rhodes and associated nearby islands in the west and southwest Aegean. These two regions have coastlines that jut to and between islands, making both highly intervisible, and therefore capable of promoting sea faring. Autocatalysis is an attractive concept because it takes us beyond the quantification of Target-Distance Ratios, and uses configuration of archipelagoes to explain island colonization. Moreover, it could illustrate why, say, a central Cycladic island was occupied prior to those closer to the mainland. Judgment, however, must be reserved for this model because of the fluid nature of the data, especially the emerging Mesolithic evidence, and because an enormous amount of survey data will be necessary to test the hypothesis.

Also of interest is Rainbird's (1999) recent argument that island biogeography was developed by westerners who perceive islands as dangerous and inhospitable. Though his essay is primarily an historical account that provides the intellectual context for the formulation of island biogeography, it does touch on a question asked here. Namely, does the quantification of insular sizes, shapes and configurations truly bring us closer to how early Aegean seafarers perceived islands? Does a low Target-Distance Ratio (i.e., very remote) for a given island, measured from modern aerial view maps, accurately reflect early Holocene perceptions of islands in a three-dimensional world?

PROBLEMS WITH ISLAND BIOGEOGRAPHY IN THE MEDITERRANEAN

The obvious fact that the Mediterranean is a land-locked sea should not be minimized. If the late Pleistocene/early Holocene seafarers were aware of this, exploratory forays would have been much less fearsome endeavors. The difference between the Mediterranean and the Pacific can be clarified by examining the choices the initial explorers (not colonizers) had. Presuming the loss of life was an unsatisfactory outcome, if the early Pacific explorers did not discover an island, they had to return home. In the Mediterranean, assuming a near straight line was maintained, if the island was by-passed, the opposite mainland would offer a not-too-distant landfall. In comparison to the Pacific, the scale in the Mediterranean is so small that the navigational hazards can hardly be equated. In terms of discovery, a far greater element of chance is involved in the Pacific scenario. This is not to make light of the formidable difficulties presented to the early Mediterranean seafarers, but if broadly equal navigational abilities are given, the distances in the Pacific made death a more likely outcome. If this possibility was in the minds of the early sailors, then their conception of, and reasons for, island travel should be weighed and mea-sured in these terms.

Held maintains that global comparisons show that technical capability in sea-faring is not a reliable indicator of how early or what island were colonized (1989,14-15), and is a secondary factor. Since Cherry (1981, 45-48) notes that the colonization of the Mediterranean islands occurred several millennia after their discovery (based on Melian obsidian found at Franchthi Cave [Perlès 1987]), the application of some geometric properties of island biogeography for the colonization (versus discovery) of the eastern Mediterranean islands is not relevant

(Patton 1996, 41-42). Quantification of island configuration and distance to measure accessibility are inappropriate factors since they were presumably known prior to the colonizing group's departure. Scholars should not measure the likelihood of discovering islands, but analyze both the way islands were perceived, and the problems in colonizing them in terms of transportation logistics (Broodbank and Strasser 1991). When those difficulties are reviewed it is then seen that Mediterranean islands were purposively colonized.

AN ALTERNATIVE APPROACH TO THE NEOLITHIC COLONIZATION OF THE MEDITERRANEAN ISLANDS

To understand better the navigational difficulties presented to the island colonizers, it is useful to ask how they abstracted and conceptualized the islands' configurations. In contrast to quantitative studies, a qualitative approach is adopted as a better line of inquiry to address their mental templates. Following the cognitive model of Renfrew and Zubrow (1994) this essay attempts to construct how mariners perceived their upcoming island colonization. Whether they actually drew maps or orally transmitted this information is unimportant. Since the islands were already discovered, the real distance versus the perceived distance is the salient distinction. Because the colonizers knew their destination and anticipated the event (Broodbank and Strasser 1991), the seafarers would have visualized the colonization, and perhaps constructed some sort of cartographic device, in order to exchange information about the trip. Based on the artifacts of the early Neolithic cul-tures in the eastern Mediterranean, it is fair to assume that cartographic abilities were no more sophisticated than those of Medieval and Renaissance Europe before the advent of the Mercator Projection and sextant measurements[4]. Though technological and material resources were certainly different between the two periods, the analogy probably shows the best possible replication of the Mediterranean insular configurations as perceived by the Neolithic migrant farmers. Inaccuracies in maps made prior to the inventions of the Mercator Projection and the sextant, or had yet to adopt the benefits of those innovations, may indi-cate similar problems in conceptualizing islands during the early Holocene Aegean. A review of such maps for the Aegean illustrates an interesting error (Zacharakis 1982). A frequent mistake was the exaggeration of land distances and the diminution of sea expanses (fig. 3). Figure 2 is a map based on a seventeenth century example that does not use the Mercator Projection, and seems to follow Ptolemaic versions. These errors may result from an inability to measure accurately sea distances and the idea that land travel was considered more difficult, or consumed more time. Such difficulties affected measurements that, in turn, were translated into distances on maps.

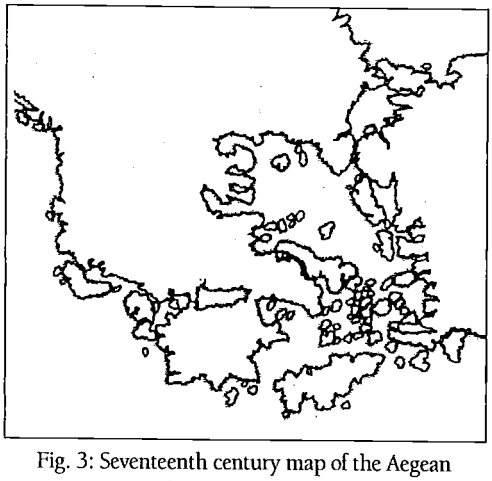

Fig. 3: Seventeenth century map of the Aegean islands by H. Le Roy
(Based on Zacharakis 1982, 110, pl. 228).

Contemporary cartographers regarded the islands' areas as much larger than the equivalent expanses of the surrounding sea (for further examples see Zacharakis 1982, passim).

This point has implications that affect the rules of island biogeography. It indicates that actual parameters in colonizing (versus discovering) Mediterranean islands depend less on quantifiably random chances than on anticipated difficulties; and they most likely reflect sea-faring capabilities. This may explain odd anomalies such as Madagascar's colonization by Malagasy peoples of southeast Asia rather than the closer Bantu tribes in east Africa (Keegan and Diamond 1987, 57), where configuration and distance played no role in determining the first colonizers. The important factors for establishing how and why islands are colonized may be culturally specific (Terrell 1999).

Survivability, rather than the chance for discovery, is apparently the main criterion for the 'who', 'what' and 'where' of a colonizing process (MacArthur and Wilson 1967, 68-93). Since the population's survivability is limited by the carrying capacity of the island, it is important to consider the "expected time" of survivability of the colonizers rather than simply their "inevitable time." Since it had been thought that the Aegean islands were only explored during the Late Palaeolithic and Mesolithic, but not extensively colonized until the Neolithic, a change in subsistence patterns that demanded more land offered a plausible reason for the Neolithic wave of colonization (Cherry 1981; Amermann and Cavalli-Sforza 1984; van Adel and Runnels 1995). Though it is now clear that at least some of the small Aegean islands (e.g., Kythnos) were occupied during the Mesolithic, a subsequent Neolithic colonization event (e.g., Crete) still can be safely argued based on the importation of domesticated fauna and flora. The difficulties in transporting founding populations of domesticated animals to Crete, as a novel subsistence strategy, almost certainly implies human colonizers as well, even if future research should find pre-Neolithic remains there. The whole Neolithic subsistence "package" occurs contemporaneously with the advent of humans on Crete. This suggests that the colonizers were trying to replicate *in toto* their mainland subsistence base. The combination of fauna found in Knossos Stratum X are very similar to those found at other Aceramic and Early Neolithic sites in Greece (Broodbank and Strasser 1991, 237 table 1) and the Near East (Payne 1972; Mellaart 1975, 98; Clutton-Brock 1981, 46-51; Runnels and Murray 2001, 46-49).

A scenario involving cultural diffusion to introduce farming to hunter-gatherers has implications that are difficult to accept. The concept of agriculture, by itself, could not have been exchanged, but would have involved the domesticates themselves. It seems highly unlikely that farmers would have met a group of hunter-gatherers, explained the concepts of selection and husbandry, convinced the hunter-gatherers to engage in a new symbiotic relationship with the local animals, and then conduct potentially thousands of years of selection to cause the local evolution of domesticates (Harlan 1986, 31; contra Barker 1985). The carbon-14 dates do not allow for a slow process. The hunter-gatherers would have had to trade for domesticates in order for a cultural diffusion hypothesis to suffice.

The exchange of domesticates themselves has other implications. Farming consumes much more time than hunting and gathering (Lee 1968, 36-37). Harlan (1986, 31-32) lists several ethnographic examples where hunter-gatherers lived near or beside farmers but never selected agriculture as a subsistence strategy. The adoption of farming may require the partial, if not total, abandonment of previous food procurement strategies that they were well acquainted with, and had sufficed to that

point. Scholars now accept that the Neolithic way of life in Greece and the Aegean is exogenous (van Andel and Runnels 1995; Runnels and Murray 2001, 46-49). Consequently, a significant variable for measuring colonizing success is the ability to survive immediately after landfall, and to establish a viable community. In turn, the transportation constraints imposed on the seafarers by their cargo is one of the primary factors to consider for Mediterranean colonization events (Broodbank and Strasser 1991).

This essay posits that a technological advance in stone tool production allowed for greater wood working skills, and which, in turn, increased the efficiency of boat construction and sea-faring capabilities. Specifically, the development of the polished stone axe (or 'celt') industry dovetails with the Neolithic colonization event. The Neolithic period saw the advent of the lithic technology of grinding and polishing that requires stones that are far less fragile than their flaked counterparts primarily used during the Palaeolithic. With this new stone industry dugout boats could easily be made. Recent archaeological evidence supports this idea, and experimental archaeology has demonstrated the efficacy of dugouts.

In the last decade Tichy (2000; 2001, 185-214) has been leading the *Monoxylon Project* that, among other things, conducts experiments with traditional tools to make boats, and test their abilities. He recently used a new craft design based on an Early Neolithic dugout found at Lake Bracciano, Italy (Fugazzola-Delpino and Mineo 1995). The efficiency of this craft exceeded expectations, met the transportation needs of early farmers and was more successful than earlier experiments with reed boats called *papyrella* (Tzalas 1989). The dugout based on the Bracciano example was a little over nine meters long, over one wide and carried nine to eleven paddlers (Tichy 2001, 207)[5]. It covered distances of fifty-seven kilometers paddled in fourteen hours when conditions were favorable. Thirty-two kilometers over eleven hours was the daily average. On a trip from Sicily to Portiragnes (west French Riviera), the cargo was one hundred kilograms of obsidian and two linen bags of wheat. The wheat was planted in Portiragnes, and all of it germinated. Tichy adds that there was much additional space and the obsidian worked well for ballast. In light of excess space, Tichy's experiments met the transportation needs of Neolithic farmers to import domesticates.

The dugout was partially shaped with stone axes (Tichy 2001, 206), and Tichy estimates that a boat the size of the Bracciano example would take three hundred hours to construct. As Tichy points out, that is one month for an individual, or at least ten days for three men. Though dugout construction by celts seems an arduous project when compared to manufacturing with metal tools, it sheds light on how difficult large-scale woodworking must have been prior to the Neolithic when only flaked stone tools were available. If Tichy's experiments are broadly correct, the counterintuitive point is that the three hundred hours must have been a quantum leap in efficiency and quickness of construction in comparison to imaginable Palaeolithic attempts to hollow tree trunks with only flaked stone tools. A dugout can be produced by other means such as controlled burning, but polished stone axes are obviously more efficient. Celts allowed for the expanded production of dugout boats that in turn accelerated sea-faring capabilities. The advance in lithic tools enabled the transport of domesticates that increased the chances of long-term survival after landfall. This factor should be considered along with the desire for arable land to explain how and why farming spread from the Near East into the Aegean basin.

Rather than seeing islands as inhospitable for survival to the Palaeolithic and Mesolithic cultures, a more fruitful line of inquiry would be to focus on the difficulties in replicating mainland Neolithic subsistence strategies on islands. The Neolithic way of life required the transport of founding populations of animals and plants, which necessitated the appropriate boats. As the Lake Bracciano example indicates, celts permitted the Neolithic people to harvest and shape large tree trunks in a relatively short time. Before the ground and polished axe industry, islands were not fundamentally hard to visit, but difficult to transport domesticates to. The new woodworking tool of polished axes may have been the technological trigger that alleviated transportation constraints, and opened the Mediterranean islands to farming colonists.

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END NOTES

1 Cherry and Torrence conducted the surface collection and lithic analysis, but the former published the results.

2 Cherry also argues that the absence of pottery does not necessarily indicate a pre-ceramic phase. Though true, the absence of ceramics is rather unusual for Neolithic or Early Bronze Age interments.

3 Held measures "configuration" differently than Cherry (1991, 48-58). Rather than computing the area of an island from a bird's-eye view, Held uses the size of the island as a target from the vantage point of embarkation. He uses the vertical and horizontal area of an island as seen from the horizon rather than as seen from directly above. This has a direct effect on their measurements of accessibility and remoteness.

4 The Mercator Projection is the grid of parallels and meridians that allow navigators to plot a course over a long distance and produce an accurate ratio of longitude and latitude at any point. The sextant measures the angle of heavenly bodies over the horizon to determine longitude and latitude.

5 The original was longer by over a meter, but the Monoxylon project had to use a single log, and only had access to one a bit shorter than the original.