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Debate

Upper Palaeolithic mariners? Evaluating experimental evidence for intentional early seafaring

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Brought to popular consciousness by Thor Heyerdahl in the 1940s, the role of seafaring in human migration has been intensely debated. Aiming to stimulate discussion around the ways in which experimental archaeology is used to support such grand narratives, the authors of this debate critically assess a recent claim for Upper Palaeolithic seafaring in the Japanese archipelago. Here, they argue that creating a boat for which there is no archaeological evidence with generic tools that were not widely available in the region risks a confounding circularity of logic.

Keywords: Ryukyu Islands, Jōmon, experimental archaeology, seafaring, human migration, groundstone axes

Introduction

Seafaring was an essential adaptation that enabled modern humans to expand across their current global range. Though other hominins also crossed water, extensive colonisation of the world's continents and island chains was facilitated by an unambiguous and habitual use of watercraft by *Homo sapiens* through much of the Holocene (Cherry & Leppard 2025). Sea travel allowed diverse cultures to emerge and thrive, making a living from the oceans and maintaining social networks across vast distances. If other species—from coconuts and iguanas to *Homo floresiensis*—accidentally dispersed over water, drifting with currents after being washed out to sea, one of the differentiating elements of late *Homo sapiens* is a behavioural repertoire that came to incorporate intentional and purposeful long-distance maritime travel.

A recent paper by Kaifu and colleagues (2025) asserts that such intentional crossings occurred approximately 35 000 BP through the Ryukyu Islands that stretch between Taiwan and Japan, pushing claims for seafaring back thousands of years deeper into human prehistory. Using a Palaeolithic tool kit to produce dugout canoes, the authors rely on an experimental voyage between Taiwan and the island of Yonaguni to support their conclusions, which they then use as the basis for computer modelling (Chang *et al.* 2025). Beyond just this regional island chain, the validity of the experiments underpinning this case study has significant implications for how we explain broader histories of

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human migrations around the world. With ramifications for how we understand the timeline for intentional sea travel, this debate article levels a critical gaze at the use of archaeological experimentation by Kaifu and colleagues, prompting broader discussions on the role of experimental archaeology in support of grand claims. We suggest that, given the reported evidence—which hinges upon the production of boat types for which there is no archaeological evidence, partially constructed using tool types that do not exist across the region in question and that are typologically ascribed to watercraft production—an intentional sea crossing remains unsupportable.

Background

Intentional seafaring facilitates the exploitation of marine resources, travel to new environments and maintenance of extended social networks for exchange. Aside from bipedalism, intentional seafaring is arguably the most essential human adaptation that facilitated our species' broad global expansion. Being washed out to sea and drifting to another landmass involves a measure of bad luck and chance—it happens to various species of lizards, mammals and plants that find themselves on natural rafts (Thiel & Gutow 2005; Scarpetta *et al.* 2025). Conversely, long-distance seafaring implies a level of behavioural complexity and intentionality. It assumes an ability not only to build a suitable watercraft, but to navigate to places potentially unseen, thinking ahead for vessel repair and food provisioning during extended trips.

To elucidate when and where intentional seafaring occurred represents a contentious debate in anthropological archaeology (see for instance Bednarik 2003; Botha 2025; Cherry & Leppard 2025). The conversation reaches tens to hundreds of thousands of years ago into the Palaeolithic, to other species including *Homo floresiensis*, *Homo erectus* and *Homo neanderthalensis.* Across these diverse cases, it has been crucial to understand sea levels and ocean currents as they intersect with archaeological, behavioural and technological contexts. While hominin dispersals to island ranges that would have required travel over oceans are not necessarily uncommon before the Holocene (*c.* 11 700 BP), research into how these dispersals took place—whether through accidental rafting or intentional navigation—has been subject to critical inquiry.

For example, *Homo floresiensis*, the diminutive island-dwelling species in Indonesia, is often associated with rafting from nearby Southeast Asian landmasses (Dennell *et al.* 2014). On the other hand, with its large brain and complex behavioural repertoire, *Homo neanderthalensis* has been considered an early candidate for intentional sea travel (e.g. Ferentinos *et al.* 2012; see also Runnels 2014; Runnels & Holcomb 2025). The presence of early stone-tool industries on islands that could not have been reached by now-submerged land bridges represent subjects for hypothesis testing related to early seafaring (see again Cherry & Leppard 2025). Yet, no direct archaeological evidence supports the construction of watercraft in any of these Palaeolithic island dispersals. That hominins occupied islands might be suggestive, but not conclusive.

Despite their extensive range, it is not until long after modern humans expanded out of Africa that the practice of intentional seafaring becomes unequivocally apparent in the archaeological record. The first direct archaeological evidence of any boat comes from

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approximately 10 000 years ago in the Netherlands, long after modern humans colonised Australia, the Americas and Southeast Asia (Cherry & Leppard 2015). It is not implausible that oceangoing vessels played a role in the peopling of many regions prior to the Holocene, but rewriting archaeological consensus will require crossing a high threshold of evidence.

Experimental archaeology

In dialogue with direct archaeological evidence examining intentional seafaring, experimental archaeology has emerged as an essential avenue to evaluate human migration patterns over water. Though it has earlier precursors, experimental archaeology as we know it today emerged in earnest alongside scientific archaeology through the mid-twentieth century. By the 1960s and through the expansion of a New Archaeology, systematic approaches to decoding the material record covered a vast range of subjects, from stone-tool and pottery production to zooarchaeology (for an early treatment of the term, see Ascher 1961). Faced with just a partial record, archaeologists seek to disentangle production strategies, allowing for the inference of cultural practices and meaning where only physical artefacts are left behind.

The production of watercraft has enjoyed significant attention from experimental archaeologists. Popularised by Thor Heyerdahl's Kon-Tiki expedition in the late 1940s, but with antecedents that reach earlier into the century (Heyerdahl 1948), the construction and use of vessels to explore early migration routes through maritime technologies took off. Heyerdahl's initial projects sought to demonstrate that simple balsa vessels could drift long routes on open water. Later expeditions tested the feasibility of additional vessel types, including reed boats, and their construction techniques (Heyerdahl 1971). Through the 1960s and 1970s, experimental vessels and rafts were used to test migration hypotheses, often in the Pacific, yet could be criticised based on their inability to comprehensively support bold hypotheses on migration (see Duncan 1982 for early critical assessments of experimental vessels in the Pacific).

If early experiments conducted by archaeologists mirrored the haphazard excavation styles of the nineteenth and early twentieth centuries, today the subfield of experimental archaeology is characterised by more systematic and hypothesis-driven practice (see for instance Magnani *et al.* 2014; Eren *et al.* 2016). Conclusions are tempered by principles of equifinality, asserting that many different technological, taphonomic and social avenues can yield similar physical traits in artefacts (e.g. Conrad *et al.* 2023; see also Eren & Meltzer 2024 for a detailed review of the limitations of inference). Contemporary approaches in maritime archaeology have also cautiously posited about early seafaring based on the limitations of experimentation. Scholars such as Bednarik (2003) who firmly support hypotheses related to Pleistocene seafaring are usually cautious about generalising too far from their unique experimental context. Bednarik makes use of sailed rafts as heuristic devices to understand what is possible rather than to make conclusive statements about Pleistocene watercraft. In line with Eren and Meltzer (2024), Cherry and Leppard (2015) suggest that the use of specific boats in contemporary experimental contexts does not inherently lend support to claims about prehistoric behaviour and

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migration paths. Even scholars who have tested hypotheses related to watercraft depicted in more recent Bronze Age rock art are reserved about using experimental archaeology to affirm their hunches on the antiquity of sails (Bengtsson & Bengtsson 2011).

Experimental protocol and typology

At its core, Kaifu and colleagues' claim of early seafaring hinges on an over-reach of experimental logic. They affirm specific tools, neither present across the entire study region nor employed for the duration of the project, were used to make a specific type of boat for which there is no archaeological evidence. Below, we unpack the central tenets of their argument, highlighting the logical flaws and internal inconsistencies in their case. The ability to produce something with a tool today in no way indicates that it was done that way prehistorically—rather, we contend that anthropological archaeology is meant to reveal not what was possible given a particular tool kit, but how people used tool kits to adapt to the social and physical environments of the past.

Upper Palaeolithic axes

Kaifu and colleagues sought to demonstrate that an Upper Palaeolithic tool kit from the period and general region in question could be used to manufacture a dugout canoe capable of long-distance sea travel. In particular, they focused on a thin-tipped groundstone axe associated with just part of the Ryukyus. Archaeologically, groundstone is widely associated with technologies like mortars and pestles, for breaking down plant foods or pigments, and adzes and axes for working wood and other organic materials. A host of archaeological and ethnographic case studies chart the emergence of its use in the Palaeolithic to its continued broad function in contemporary societies (such as Iran Jaya or Kenya; Shoemaker *et al.* 2017; Pétrequin & Pétrequin 2020).

Without supporting archaeological evidence (e.g. boat-production sites associated with groundstone and cautiously interpreted use-wear), it is problematic to associate specific Palaeolithic typologies with specific activities. Extrapolating boat production from the general shape of a stone tool alone is fraught, because groundstone, like flaked stone, is multifunctional. Further, a broad range of stone implements could hypothetically be used to hollow out a log to make a watercraft. One could easily ask the same question about Lower and Middle Palaeolithic hominin tool kits: could a flaked stone tool industry yield a suitable oceangoing vessel? Were scholars to successfully hollow out a log with an Acheulean or Mousterian handaxe, after breaking dozens of such tools, the experiments would not form a reasonable basis to suggest early hominins dispersed using dugout canoes earlier in the Pleistocene (*c.* 2.6 million years ago to 11 700 BP). Specific stone-tool morphologies require archaeological context to be convincingly associated with the production of secondary, complex technologies.

Were we to take at face value an association between groundstone axes and the production of watercraft, we still run into issues based on the parameters of the experiment. As Kaifu and colleagues (2025: 2) point out themselves, the axes are not widely distributed across the study region. This begs the question, where are all the broken axes?

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Their experiments demonstrate a high level of failure across the production of a single boat. Axes used through the study were knocked out of commission in as little as 11 seconds, with others lasting more than two hours. This type of production and failure would lead to substantial archaeological traces related to the creation and maintenance of axes, in addition to use-wear that might at least suggest chopping activities (in this vein, see Iwase *et al.* 2024, where the same authors handle experimental axe production and use in more detail).

Finally, the authors attempt to demonstrate that a specific tool type could be used to create an oceangoing dugout canoe. To test the hypothesis as set forth by the authors' own parameters, it would be prudent to use the tool type for the duration of the experimentation. Yet, this was not the case; the authors reverted to 'thicker-bladed' groundstone axes partway through the work (Kaifu *et al.* 2025: 4). If the purpose of the experiment were to demonstrate that a specific type of boat could be constructed with a specific type of groundstone axe, the internal logic of the experimentation necessitates the use of that specific implement to produce the boat in question. The study thus demonstrates only that groundstone axes, in general, can fell trees and be used to make dugout canoes. This is already a well-established ethnographic and archaeological fact.

Vessel type

Like groundstone tools, dugout canoes are widespread in the archaeological and ethnographic record (e.g. Jefford 1962; Adewumi 2014; Biar 2017). Evidence spanning all continents, from Africa to Eurasia and the Americas, attests to how many societies use and used a combination of axes, adzes and, occasionally, controlled burning to hollow out and spread logs—in some cases tens of metres long—to move across inland waterways and oceans. Boat production requires substantial time investments and may leave significant material or symbolic representations where few archaeological remains are preserved (see for instance Lape *et al.* 2007).

While widespread globally and in the region in question tens of thousands of years later, dugout canoes are anachronisms in the Palaeolithic. The authors justify their selection of a dugout canoe, suggesting for instance that sails were unlikely to be present on Palaeolithic watercraft because they did not come into existence until thousands of years later. Other reed and bamboo vessels were dismissed as infeasible because of the difficulties controlling them encountered during other sea trials (Kaifu *et al.* 2019, 2022). If dugout canoes reflected a deeper and shared adaptation around the world, we would expect their use to be more widespread iconographically or archaeologically with greater time depth. Yet, it is simultaneously equally plausible and equally impossible to assess whether people were using other materials to make other types of boats for which there is no archaeological evidence.

Using the abovementioned stone tools, the authors felled and hollowed out their vessel from a Japanese cedar. They emphasise their boat's similarity to Jōmon-style dugouts and modelled their vessel on an example found at a beach that was likely used at sea *c.* 5300–5400 BP (Kaifu *et al.* 2019: 1429). The boat was decorated using burn patterns typically associated with Jōmon canoes but was fitted with seats. The Jōmon were

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distributed across the study region and were prodigious boat builders; well-preserved vessels and tool kits associated with Jōmon boat production, and the remains of dozens of dugout canoes have been discovered around locations like Lake Biwa (Seguchi *et al.* 2014).

Using a Jōmon canoe as a model, a vessel that post-dates the experimental context by more than 25 000 years, from a period when regular boat construction took place, fails to meaningfully further conversations about Palaeolithic seafaring. The vessel the authors selected to reproduce was found in an archaeological context that suggested it was likely used at sea. Projecting an anachronistic seagoing vessel into deeper time risks a circularity of logic, using canoes we already know to be ocean-capable from later time periods to evaluate hypotheses about the antiquity of seafaring. The design of the reported experimental work is better suited to address research questions related to Jōmon-period seafaring.

Discussion and conclusion

As a cornerstone of *Homo sapiens*' global distribution, significant archaeological interest has been vested in the exploration of early, intentional sea travel. Seafaring attests to extensive technological abilities, not only to build seagoing watercraft and maintain supplies, but also to be able to effectively navigate using celestial and other environmental markers. To understand when and where seafaring emerged is to differentiate us from iguanas, anoles and coconuts, not to mention members of our own genus, including *H. erectus, H. floresiensis* and *H. neanderthalensis*. Intentional ocean navigation places ancient mariners and their contemporary descendants among the great technological innovators of the human lineage. For grand claims shifting these narratives to gain acceptance, watertight experimental argumentation must foreground hypothesis testing.

Experimental archaeology has emerged as a crutch to support narratives that would restructure generations of archaeological research. For instance, experimental work has been used to try and push back the peopling of the Americas by more than 100 000 years (Magnani *et al.* 2019a & b). Yet, to be accepted, these claims must integrate robust archaeological evidence, not lines of suggestive experimentation. While experimental archaeology can be used to evaluate hypotheses and reveal new ways of looking at the past, it cannot authoritatively speak in the absence of archaeological evidence. Even under the best and most stringent conditions, most experimental archaeologists should take issue with the claim that "experimentation is an effective, if not conclusive, way to test possible hypotheses" (Kaifu *et al.* 2025: 1).

For contemporary anthropologists, evidence that a particular tool kit could be used to make a specific boat does not hold water. With appropriate time investment and practice, and given enough elbow grease, a Lower Palaeolithic tool kit could likely achieve feats of complex woodworking. Tools available to Upper Palaeolithic cave painters could be used to produce impressionist paintings. Yet, it would be misleading to use these implements to create any of these anachronistic technologies or representations. What is possible in and of itself does not constitute a plausible line of argumentation; tools are less limiting than a community's cultural practices. Anthropologists maintain interest in

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technology, insofar as it tells us about the broader sociality of human societies. There is no doubt that people in the Palaeolithic were capable of creating seagoing watercraft. The question is whether these people were embedded in sociocultural networks where this was called for and done. Acknowledging that many things could be made by modern humans using Palaeolithic tool kits, we must then rely on archaeological evidence to differentiate speculative from scientific approaches.

In this vein, there is a high experimental threshold to affirm intentionality behind Upper Palaeolithic sea travel. Currently, the experimental archaeological evidence that has been furnished does not support these grand claims. We do not contest that intentional sea travel may have been taking place during the Upper Palaeolithic at the time depth reported by the authors. Modern humans, we know well, are capable of making boats. However, it is imperative that these claims be backed up by experimental logic that adequately supports, not undermines, archaeological evidence. As executed, the authors provide more suggestive evidence about the seaworthiness of Jōmon canoes, derived from a time thousands of years after the period under scrutiny.

Despite our critique and contention that their experimental evidence does not support claims of intentional seafaring, we commend the authors for undertaking attention-grabbing research. To their credit, Kaifu and colleagues managed to pull off a modern Heyerdahl-type undertaking: they executed a physically demanding project that required a significant investment in time, resources and perseverance. Logical flaws in their research do not undermine the accomplishment of taking a dugout canoe with a small team across perilous straits. Such projects hold immense value, inspiring interest and fostering a new generation of popular engagement with the field.

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