Proceedings of the Out of Eurasia Hawai'i Conference, March 02-03, 2023

Trekking Shores, Crossing Water Gaps, and Beyond: Maritime Aspects in the Dynamics of "Out of Eurasia" Civilizations

Edited by **Akira GOTO and Naoko MATSUMOTO**

Pukapuka, a remote atoll in the northern Cook Islands
Photo courtesy by Mr. Kolee TINGA

OUT OF EURASIA

Grant-in-Aid for Scientific Research on Innovative Areas (2019-2023)

Integrative Human Historical Science of "Out of Eurasia"
Exploring the Mechanisms of the Development of Civilization

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Editors: Akira GOTO (Nanzan University)
Naoko MATSUMOTO (Okayama University)

Publishing Office
Research Institute for the Dynamics of Civilizations
Okayama University
3-1-1 Tsushima-naka, Kita-ku, Okayama, 700-8530, JAPAN
Phone +81-(0)86-251-7442

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Searching for Submerged Late Pleistocene Archaeological Evidence Along the Northern Pacific Rim

Loren G. DAVIS

Department of Anthropology, Oregon State University,

Abstract

The Coastal Migration Theory posits that the earliest human migration to the Americas occurred during the late Pleistocene along the northern Pacific Rim and as such, the earliest sites in the Americas should be found in coastal settings. The unique archaeological challenges associated with identifying and analyzing submerged sites are addressed, as these locations are often hidden or degraded due to marine transgression and associated geomorphic actions. However, through targeted exploration of key archaeological zones—including protected embayments, submerged river valleys, and underwater caves—meaningful insights into early human migration routes and adaptations to varying environments can be uncovered. Central to this research strategy is the use of advanced methodologies, such as side-scan sonar, sub-bottom profiling, marine coring, and the analysis of cored sediments to find and study submerged archaeological sites. This approach to finding early coastal sites can be built upon by discovering and examining resource rich areas like late Pleistocene estuaries throughout the northern Pacific Rim region. This comprehensive approach has the potential to further illuminate the complexities of the CMT, significantly expanding our understanding of early human history, migration patterns, and environmental adaptations.

Introduction

The archaeological questions of how and when humans initially travelled to the Americas is significant and associated studies have primarily focused on an overland route through Beringia and southward past North American continental glacial ice via an "ice-free corridor" (IFC) (Haynes 1964, 1980; 1982; 1987; Haynes 2002; Potter et al. 2018) or instead around the western edge of the glaciers along the northern Pacific coastline (Figure 1; Heusser 1960; Macgowan and Hester 1962; Laughlin 1967; Bryan, 1978; Fladmark 1978, 1979; Easton 1992; Busch 1994; Dixon 1993, 1999; Gruhn 1994; Mandryk et al. 2001; Erlandson 2002; Erlandson et al. 2007; Braje et al. 2017, 2020; Davis and Madsen 2020). The overland model has been traditionally used to explain the appearance of the Clovis Paleoindian Tradition shortly before 13,000 cal BP (e.g., Haynes 2002; Potter et al. 2018), which for some signals the initial entry of humans into North America and, as such, is sometimes called the "Clovis-first hypothesis".In contrast, the Pacific coastal route of entry has

Figure 1. Map of the north Pacific region during the late Pleistocene, showing the extents of Beringia, North American ice sheets, and the hypothesized coastal migration route along the edge of the Cordilleran Ice Sheet (CIS) from east Asia to the Americas (orange dashed line) (map modified from Davis and Madsen 2020).Davis and Madsen 2020).

featured prominently in models that argue for human presence in the Americas before the appearance of the Clovis Paleoindian Tradition (e.g., Dillehay 1997; Dillehay et al. 2008, 2012; Waters et al. 2018; Williams et al. 2018; Davis et al. 2019, 2022). Recently, Davis and Madsen (2020) argued that the archaeological discovery of repeated instances of human occupation south of the North American continental ice sheets predating the appearance of the Clovis Paleoindian Tradition and before any possible opening of an IFC between the Laurentide and Cordilleran ice sheets has falsified the long held Clovis-first hypothesis. The authors note that an array of geological, paleoenvironmental, and archaeological data is now sufficiently large that it requires an organizational framework within which to consider the processes and chronology underlying the only reasonable alternative for the initial Pleistocene peopling of the Americas: A Pacific coastal migration along and ultimately south of North America's continental ice sheets.

Davis and Madsen (2020:2-4) articulate a Coastal Migration Theory in this way:

> 1. The progenitors of the First Americans were Early Upper Paleolithic (EUP) foragers who originated in interior northeast Asia and made their way by various land and sea routes, including a northern route, possibly down the Amur River valley (Izuho et al., 2020; Jeong et al., 2016) and through northern China, and a southern route, possibly through southern China and Taiwan (Gakuhari et al., 2019; Izuho et al., 2020), to coastal Pacific areas ranging from South Korea to the Japanese archipelago and to its extension in the convergent island area that emerged during late Pleistocene marine regression known as the Paleo-Sahkalin-Hokkaido-Kuril (PSHK) area.

These populations merged prior to LGM, giving rise to daughter populations in the PSHK area which eventually evolved into such diverse groups as the Jomon in more southerly Japan, northeastern Siberians such as the Itelmen and Chukchi, and ancient Native Americans (Jeong et al., 2016).

2. Between ~40-30 ka these foragers adopted mixed and variable terrestrial, near shore, and maritime subsistence adaptations along this northwestern Pacific coastal margin, with the degree of specialization differing from area to area.

3. Starting in the EUP period, they developed both a stone tool technology characterized by unifacially and bifacially-worked stemmed projectile points and sea-going vessels capable of reaching pelagic fishing grounds and obsidian source areas scores of kilometers from the coast. A number of these populations may have become isolated in the PSHK region, allowing for genetic bottlenecks to develop via genetic drift.

4. By about 20 ka, sea levels as much as 130 m lower than modern, and correspondingly shorter travel distances between islands and refugia, allowed ocean-going coastal foragers in the PSHK to begin to expand along the Kamchatka peninsula to the southern margin of the Bering Land Bridge and Aleutian Islands to the coastlines of southern Alaska and British Columbia.

5. Sometime between ~20-16 ka these gradually expanding Late Upper Paleolithic populations reached coastal margins south of the Cordilleran glaciation. Once there, they applied generalized coastal fishing/foraging adaptations to wetland, terrestrial, nearshore, and maritime resources, which allowed more specialized daughter populations to expand rapidly inland, along major waterways and onto lake-margin habitats, and down the coast to South America through a variety of differing coastal habitats. Over the course of the next 3000-5000 years these populations expanded inland from the coast, developing specialized terrestrial hunting and gather adaptations which eventually led to later Clovis and other Paleoindian complexes.

Determining whether this Coastal Migration Theory is viable requires, as with any theory, explicit tests of its various implications. In the case of the Coastal Migration Theory, most of the testable hypotheses involve the discovery and exploration of geological deposits and archaeological sites around the northern Pacific Rim dating to the last glacial period from ~23-16 ka. Simply put, if the First Americans initially migrated from northeast Asia into the Americas along the northern Pacific Rim during this time, then we should find the earliest archaeological sites in preserved paleolandscape features that predate ~16,000 cal BP. However, if this hypothesis is false, then no such evidence will be found in last glacial period deposits along the coastlines of southern Alaska and British Columbia. Finding archaeological evidence of an initial coastal migration is challenging because postglacial marine transgression and glacioisostatic adjustments worked in tandem to submerge, erode, and otherwise obscure such sites, if they indeed exist. How then should archaeologists search for archaeological evidence along the theorized Pacific coastal migration route?

The U.S. Bureau of Ocean Energy Management (BOEM) and the U.S. National Oceanic and Atmospheric Administration (NOAA) have provided funding in recent years to conduct offshore investigations to evaluate whether late Pleistocene terrestrial landscape features and any archaeological sites they may contain exist along the Washington, Oregon, and California coastlines (ICF International et al. 2013; Braje et al. 2019; Klotsko et al. 2020). These projects have led to the development of a methodological approach that focuses on modeling submerged coastal landscapes, deploying marine geophysical survey techniques to find submerged and buried paleolandforms, coring potential submerged paleolandforms, and seeking to recover associated archaeological evidence from intact submerged contexts. In the sections that follow, I provide a summary of the methods and results of our recent work and offer suggestions for how the search for submerged landscapes and associated archaeological sites could be expanded to evaluate the Coastal Migration Theory more fully.

One Approach to Finding Submerged Pleistocene Coastal Sites

The discovery of submerged late Pleistocene coastal sites can be facilitated through a systematic, multifaceted approach that combines advanced technology and geological knowledge. The first step involves constructing a digital model of the ancient coastal paleolandscape. In the BOEM and NOAA-funded projects mentioned above, we employed the following steps. First, we combined bathymetric information and relative sea level history data to build a coastal paleolandscape model of the terrestrial landscape that existed on the now-submerged continental shelf. Once this model is created, the next step is to develop a site location potential model for the submerged paleolandscape (Figure 2).

Here, high probability areas for archaeological occupation are identified, hinting at regions where traces of ancient human activities might be found. The third step focuses on collecting marine geophysical data (Figure 3).

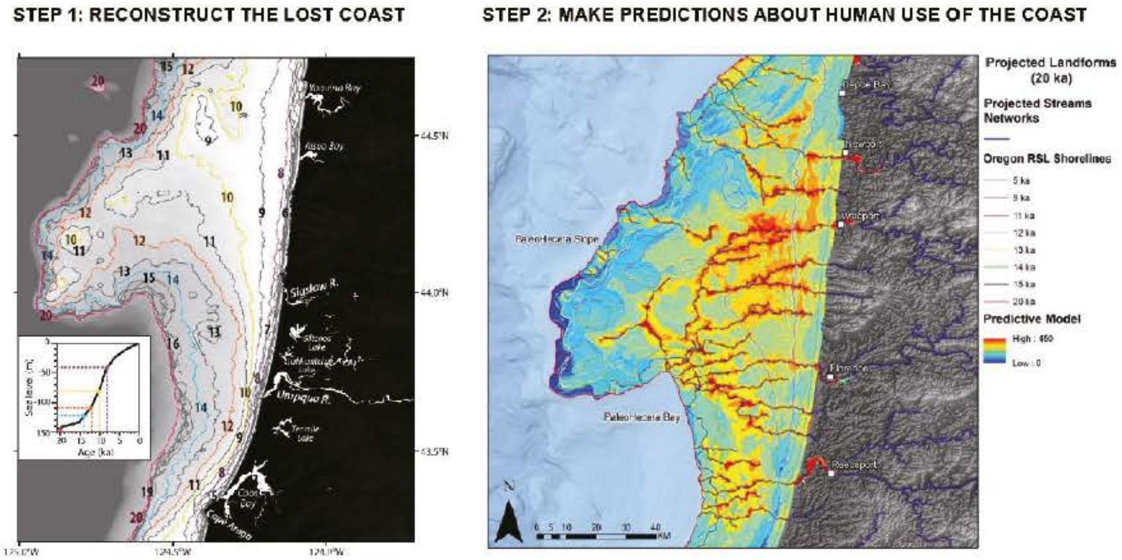

Figure 2. Maps showing reconstructions of relative sea level (at left) and site location potential (at right) along Oregon's central coast.

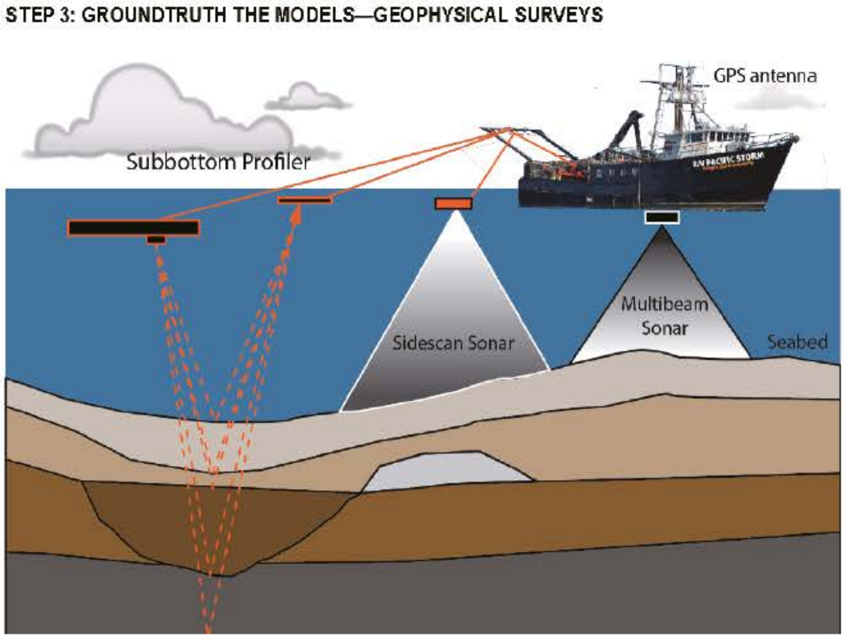

Figure 3. Diagram showing the marine geophysical technologies used to map the seafloor and see into its deposits.

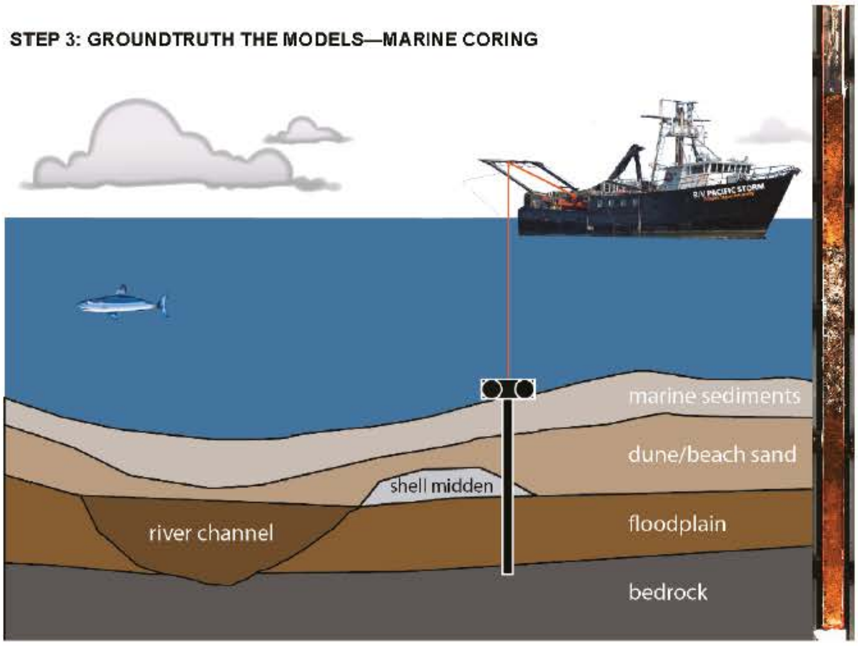

Figure 4. Diagram showing the use of a vibracore to sample submerged and buried landform deposits. The core at right is an example of the kind of terrestrial stratigraphic sequence that might be expected to come from a cultural shell midden buried by aeolian dune sands and soil development (cf. Kirkpatrick 2019).

This process is integral to improving our understanding of the seafloor's surface, as well as assessing the buried stratigraphic record for signs of preserved paleolandscape features and potential archaeological sites. Following the geophysical data collection, marine cores from selected targets are gathered and their contents are studied (Figure 4).

Analysis of the core samples provide an opportunity to characterize the physical sedimentary properties of observed geophysical signatures, establish a chronostratigraphic sequence for landscape change from subaerial coastal to submerged marine environments, and hold the potential for discovering archaeological evidence of late Pleistocene human occupation along the North Pacific coastline.

Thinking about site formation in submerged settings

With the warming climate and melting ice at the end of the Pleistocene leading to rising sea levels, coastal landscapes were gradually submerged, first flooding low-lying areas and then higher elevations, causing a direct loss of human habitation, and forcing human migration to higher ground or areas more inland. Archaeological sites on these now-submerged landscapes faced various fates: some were washed away, some buried under sediment layers, while others were preserved in place. The underwater conditions, while sometimes causing disturbance and degradation of artifacts, can, in some instances, preserve organic materials not usually conserved in terrestrial sites. Today, these submerged Pleistocene-era archaeological sites, found globally in diverse underwater contexts, provide rich historical insights. They can be found on the continental shelves, exposed during the last glacial period and offering vast habitation spaces; in submerged river valleys, which were crucial human migration paths and settlement areas during the Pleistocene; and in underwater caves, which sometimes safeguard well-preserved traces of human occupation, such as artifacts, cultural features, and human skeletal remains.

The survival of archaeological sites positioned in island archipelago areas amidst marine transgressions hinges on a variety of factors that protect these sites from erosion or complete destruction. A primary factor is rapid burial - if a site is swiftly buried by sediment instead of being subjected to erosion during the initial stages of transgression, it can effectively be shielded from any subsequent erosive forces of waves and sea action. This blanket of sediment preserves both the archaeological context and materials. Geomorphic features also play a critical role in protecting and preserving sites. Archaeological sites located within caves, rockshelters, or dunes are provided with a natural shield against marine transgression and a stable preservation environment. Human intervention can sometimes protect sites as well. The construction of buildings, walls, landscape modifications, or even the intentional burial of sites could offer some defense against rising sea levels. However, such defenses are not expected to have been created by late Pleistocene coastal forager societies. In certain regions, the process of isostatic rebound, wherein the Earth's crust rises in elevation due to the melting of ice sheets, could counteract sea-level rise, preventing specific areas from submersion and thereby protecting archaeological sites. Finally, natural ecosystems like mangroves and coral reefs can serve as barriers against wave action and erosion, assisting in the preservation of nearby archaeological sites. Even with these protective factors, marine transgression can still lead to the loss of numerous coastal and island archaeological sites. Therefore, urgent efforts are needed to identify, document, and if feasible, excavate these threatened sites.

Archaeological sites perched on elevated landforms were most likely subjected to erosion due to transgressive wave action, potentially resulting in the obliteration of the archaeological record in large areas. Conversely, archaeological materials that collected in lower landscape areas such as stream valleys or bays might have been preserved as alluvial and estuarine sediment aggraded in conjunction with marine transgression (Figure 5).

This process could subsequently lead to the burial of any archaeological evidence situated close to sites found on neighboring shorelines or riverbanks, thereby protecting it from the erosive forces of marine transgression. Concentrating our efforts on uncovering submerged and buried alluvial and embayment deposits from where estuaries would form provides a promising avenue for unearthing artifacts, features, and even sedimentary ancient DNA (sedaDNA) related to late Pleistocene coastal peoples.

The exploration for sedaDNA in submerged estuaries on the Pacific continental shelf presents a compelling opportunity for archaeologists studying Pleistocene human occupation of the northern Pacific Rim. Estuaries, with their confluence of salt and freshwater and frequently anoxic conditions, can be ideal environments for DNA preservation. Historically, such areas have seen intensive human

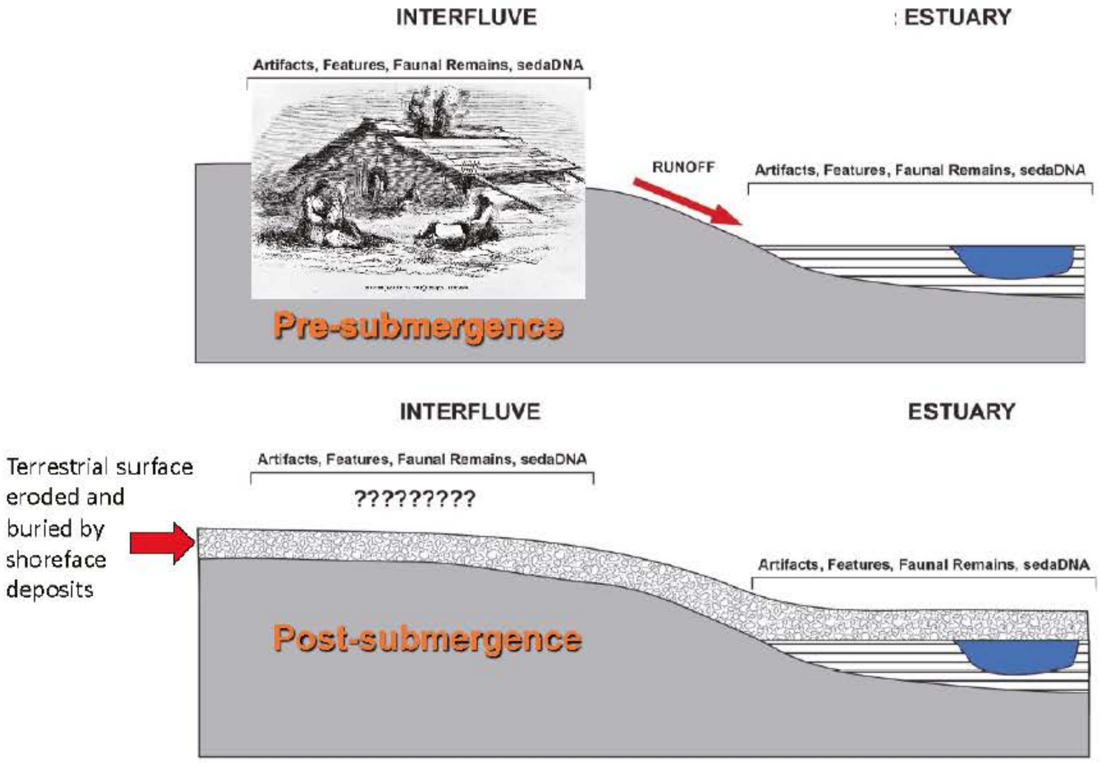

Figure 5. Diagram showing a hypothetical active cultural state of coastal occupation that contributes archaeological materials to estuary deposits and adjacent interfluve shoreline areas. Following marine transgression and submergence, the interfluve area may have experienced significant erosion and degradation of its associated archaeological record, while deposits in the adjacent estuary zone may have buried by aggrading alluvial sediments prior to marine transgression.

activity and settlement due to the rich availability of resources such as fish, shellfish, and waterfowl, suggesting the likelihood of Pleistocene human presence. Analysis of sedaDNA offers an invaluable lens into this past human presence and their dietary habits, as DNA from plant and animal species utilized for food or other activities, or even ancient human DNA introduced into estuary environments via surficial runoff from nearby settlements, could be uncovered. Beyond this, sedaDNA can help in reconstructing past environments, indicating the presence of specific plant and animal species, and tracking changes over time, thereby illuminating the environmental contexts and adaptations of Pleistocene humans. Importantly, with the end of the Pleistocene marking significant sea-level rises, many human habitation sites were submerged, transforming the continental shelf and submerged estuaries into an underexplored archaeological frontier. The study of sedaDNA in these locations could unlock access to these elusive submerged sites. Lastly, considering the northern Pacific Rim's speculated significance in human migration routes during the Pleistocene, sedaDNA evidence could provide critical insights into these migration patterns. Despite the inherent challenges, these factors make a strong case for archaeologists to delve into the study of sedaDNA in submerged estuaries on the Pacific continental shelf.

Conclusion

While intact archaeological sites containing late Pleistocene-aged artifacts, features, and other cultural evidence may yet be found in submerged landscapes along the northern Pacific Rim, having escaped the destructive power of rising post-glacial sea levels, searching for this evidence is arguably a specialized field of study that will require the development of methods for narrowing down and identifying submerged and buried site evidence in areas where taphonomic processes favored site formation and preservation. Because much of the late Pleistocene coastal landscape of the northern Pacific Rim is submerged at depths below which traditional underwater archaeology methods may be used with ease, we must imagine other ways of conducting research. An alternative approach to finding archaeological evidence of early cultural occupation along the Pleistocene northern Pacific coastline would be to search for, identify, and sample through marine coring estuarine deposits that may retain artifacts, features, and sedaDNA (Figure 6).

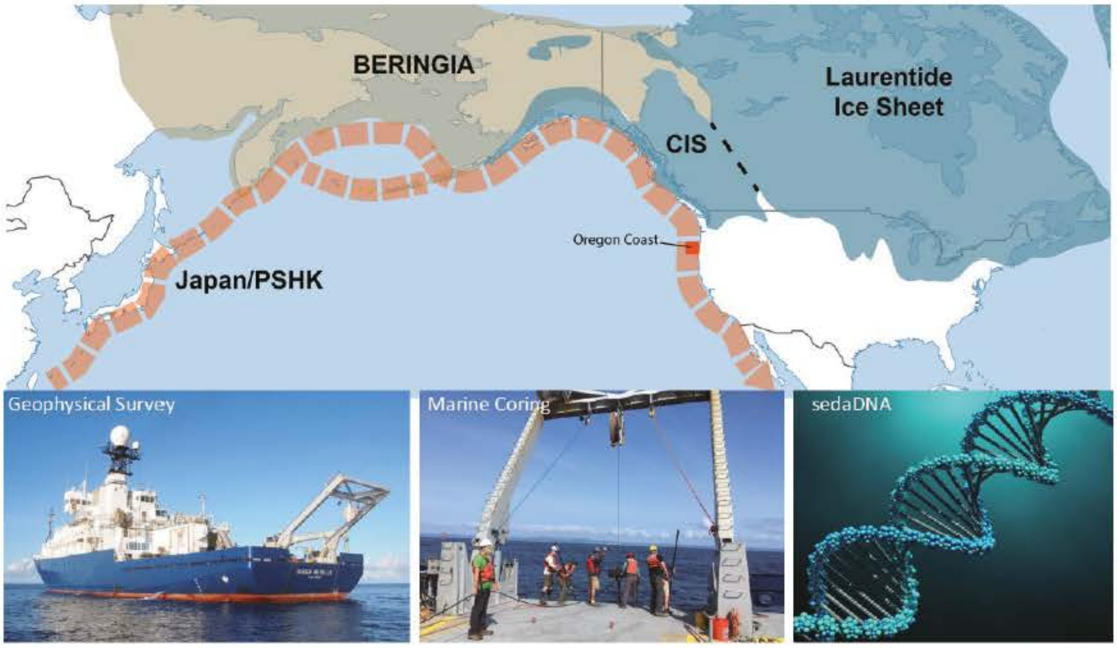

Figure 6. A coordinated research program involving geophysical surveys, marine coring, and study of cored sediments (for artifacts and sedaDNA) in estuarine environments around the northern Pacific Rim may lead to the discovery of late Pleistocene human presence in now-submerged landscape contexts.

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Form, Function, and Design of Terminal Pleistocene Shell Fishhooks of the Pacific Rim: Coincidental Convergence or Shared Knowledge?

Matthew R. DES LAURIERS[1], Loren G. DAVIS[2] and Antonio PORCAYO MICHELINI[3]

[1]Department of Anthropology, California State University, San Bernardino
[2]Department of Anthropology, Oregon State University
[3]Instituto Nacional de Antropologia e Historia, Baja California, México

The Terminal Pleistocene was a period of remarkable change for humanity, within a relatively short span of a few millennia, events would unfold that would lay the human ecological foundations for the historical processes that continue to shape our present day lives. Both people and the world they lived in were at a tipping point of irreversible change and movement. Widespread extinctions, migrations, displacements, floods of legendary scale, and the second and last genuine "discovery" of continental scale landmasses by behaviorally modern humans all happened between 16,000 and 13,000 years ago (e.g. Clark et al. 1996; Smith et al. 2022; Neri et al. 2015). The cultural traditions of hunting and gathering people all around the western Pacific Rim – accumulating for tens of thousands of years – were tested, transformed (e.g. Nakazawa et al. 2011), and displaced (see Norman et al. 2024), but not destroyed. Along the shore of the Western Pacific, there were communities of skilled boatwrights and fishermen that lived along the beaches and islands strewn along an immense East-facing coastline that looked out over deep, blue ocean that seemed to have no end. These populations had been expanding for thousands of years, as evidenced by occupation of even relatively smaller offshore island archipelagos like the Ryukyus (see Kaifu et al. 2020).

Their movements along the Pacific Rim – both clockwise and counterclockwise – clearly began before the Terminal Pleistocene climate crises became acute (e.g. O'Connor 2007; Kuzmin and Glascock 2007; Buvit et al. 2016). but what began as a trickle of population movement, became a flow once the collapse of Beringia's ecological systems began (Faith 2011; Murchie et al. 2021), and populations would have been not only driven, but drawn along in their migration routes and later dispersal, metaphorically resembling a gravity driven siphon.

Early sites in the Americas like Cooper's Ferry in Idaho, dating to just shy of 16,000 years ago (Davis et al. 2019) indicate that occupation of the Western Hemisphere began before the drowning of Beringia, but the number of sites seems to explode in the Americas after 14,500 BP (the date most commonly cited for the meltwater pulse 1A event, Clark et al. 1996). This may indicate that early "pioneering" populations reached the Americas slightly earlier (Gruhn 2023), only to be followed by subsequent waves of migrants fleeing the inundation of coasts and islands of the North Pacific (Buvit et al. 2016; Dobson et al. 2021; Cassidy et al. 2022). This complex, multi-staged process would fit more closely with most documented and/or archaeologically identified migrations in human history.

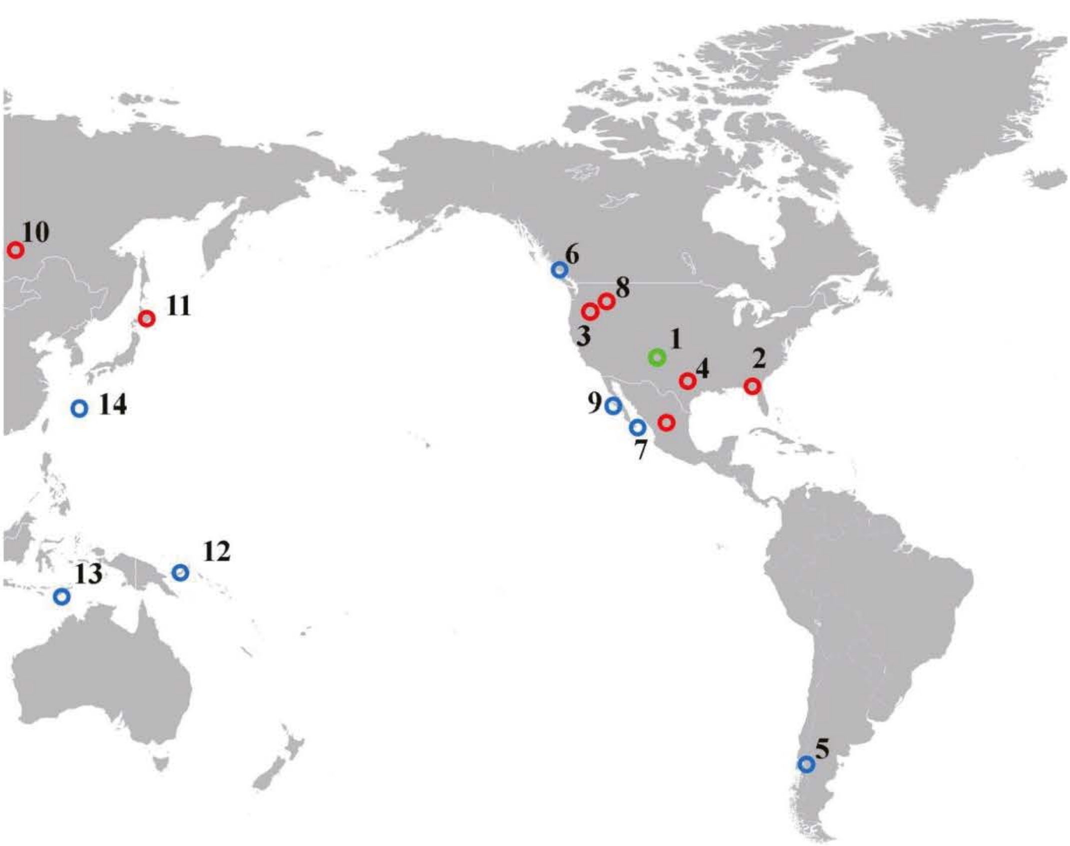

Figure 1. Map of the Pacific Rim and adjacent regions. 1. Folsom archaeological type site, New Mexico; 2. Page-Ladson Archaeological Site, Florida; 3. Paisley Caves, Oregon; 4. Gault/Friedkin Clovis Site; 5. Monte Verde, Chile; 6. Triquet Island, British Columbia, Canada; 7. Espiritu Santo Island, Baja California Sur, México; 8. Cooper's Ferry, Idaho; 9. Isla Cedros, Baja California, México; 10. Lake Baikal, Russia; 11. Hokkaido, Japan; 12. New Ireland and New Britain, Papua New Guinea; 13) Isla Alor, Indonesia and East Timor; 14. Sakitari Cave, Okinawa, Japan.

The post-Pleistocene history of Ireland (see Woodman 2011; McLaughlin et al. 2016) provides one such example, where over time, multiple groups sequentially contributed to initial settlement, technological developments and genetic diversity of later populations. It may be that the old model of 100 people showing up at the south end of the Ice Free Corridor and being the sole ancestors of all later First Nations is no longer very tenable, for reasons other than the route itself (e.g. Fix 2005; Moore 2001; Waters 2019) .

So, if this is the story that we developed, how shall we test its veracity? The sample size of ancient DNA data points is increasing (Bisso-Machado and Fagundes 2021), but still very small (see Raff 2022). Far too small, in my estimation, for them to be used as sole arbiters of hypotheses. Additionally, the time resolution of those genetic data are still inadequate to provide more than very general connections between populations (e.g. da Silva Coelho et al. 2021), especially when you have samples separated by gaps of thousands of years with no corroborating evidence to fill in that empty data space. Radiocarbon dates provide simple presence-absence data but tell us little about whether our model of how-and-why is close to the mark.

If we want to know about our hypothesized boatwrights and fishermen, what better archaeological marker for them than their fishing tackle? We can identify some of the earliest fishhooks in the world along the Western Pacific Rim (Fujita et al. 2016; Langley et al. 2023), and shortly after the earliest people arrive in the Americas, we see the earliest unequivocal fishhooks in the Americas along the Eastern Pacific Rim margin of the continents (Des Lauriers et al. 2017; Fujita 2014; also Alcalde and Flores 2020, though somewhat later in time). We here describe some of these early hooks from Isla Cedros, Baja California, México (Figure 1) and compare them to other Pleistocene fishhook assemblages from the Pacific. We propose that this technological tradition was either brought as part of the early migrants' conceptual toolkit, or that the knowledge of and design for these objects was transmitted during the 'settlement' phase (see Rockman and Steele 2003) following initial entry of earlier pioneering populations into the Americas.

The populations of the Western Pacific Rim must have been expanding in the Late Pleistocene, especially since permanent occupation of small offshore island groups (see Ihara et al. 2020) does not typically occur if populations are contracting, nor during periods when island size itself was decreasing – as would have been the case *during* eustatic sea level rise (Cherry and Leppard 2018). Populations across this region, from Okinawa to Indonesia were making and using shell hooks by the beginning of the Terminal Pleistocene (e.g. Kealy et al. 2020). We do not presume that the hooks in Indonesia and Okinawa had separate origins, why should we assume that the Eastern Pacific examples are independent, especially given the demonstrable direction of population movement from west to east along the Pacific Rim (see Davis and Madsen 2020)? Early hooks are present over at least 1000 kilometers of coastline in Baja California, as evidenced by their presence On Espiritu Santo island (Fujita 2014), on the mainland between Playa Tecolote and La Paz (Fujita and Ainis 2018:297), and the robust assemblage recovered from Isla Cedros (Des Lauriers et al 2020). This was not an isolated idiosyncratic development of a single community, but a tradition shared across a wide area. Although dates firmly placing this technology in the Terminal Pleistocene are currently unavailable from South America, the technology is very much present there during the Early Holocene (Llagostera 1992; Scheinsohn 2003) and may simply require further research to push the antiquity back to the range identified on the Baja California Peninsula. If so, this technological tradition would have been shared from Northern Chile to Central Baja California *at the very least*.

This is particularly interesting if we think about the cultural implications of such a widely shared tradition. Obviously, different styles of hook have advantages for catching different kinds of fish and for different fishing techniques (see Stewart 1977 for a unparalleled compendium of this notion for the Northwest Coast of North America). This is not necessarily true for terrestrial weaponry, as a spear tipped with almost any style of point can be used to kill a giant ground sloth or a Pleistocene kangaroo or a camel. There is a specificity to maritime technologies that is not fully replicated in most terrestrially deployed weaponry. Even specifically aquatic projectile weaponry has unique design

Figure 2. Single-piece, shell fishhooks from Isla Cedros, Baja California, México (top), and Okinawa Japan (bottom). Bottom image from Fujita et al. 2016.

characteristics (e.g. leisters vs. toggling harpoon heads, see Ballester 2018:70). The fact that the early Pacific Rim hook assemblages are so remarkably similar in design (Figure 2) means that the people using them were likely using the same kinds of techniques to catch similar kinds of fish, so the similarity is not just in the technology, but in the application. This would strongly argue against the independent development of this tradition on Isla Cedros, around La Paz, and in Coastal Peru and Chile. Just as it makes sense to imagine that the Okinawan and Indonesian hooks share a common cultural tradition, it makes sense that the early hook traditions of the *Pacific* coast of the Americas are likewise related to one another.

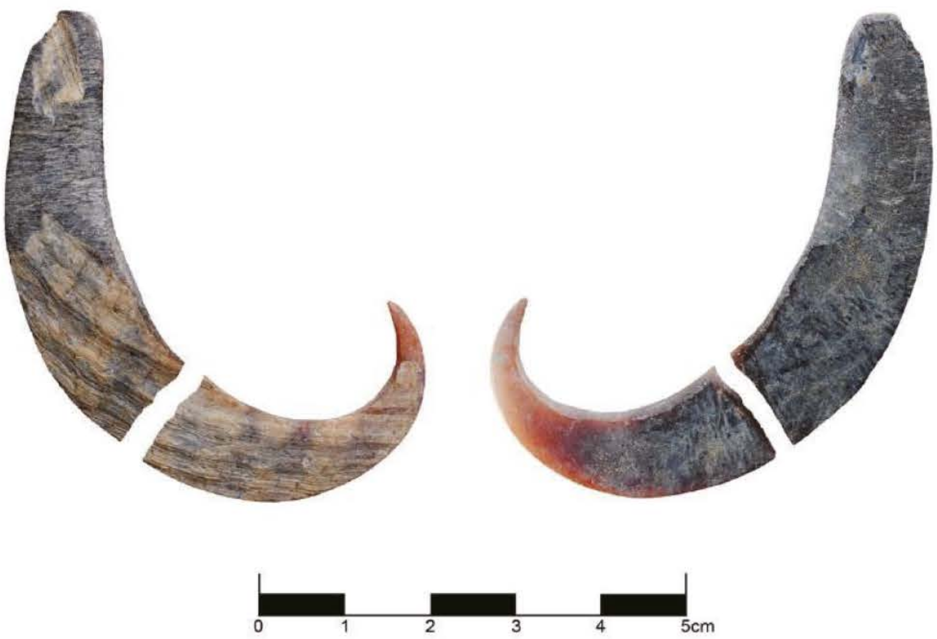

Figure 3. Single-piece mussel (*Mytilus sp.*) shell fishhook from the Cerro Pedregoso site (PAIC-44) Isla Cedros, Baja California. Note the well-preserved evidence of manufacturing techniques and the "waist" below the top of the shank created by grinding.

Unlike later Polynesian (e.g. Allen 1996) and Alta California (e.g. Vance 2000) examples, no knob or notch was carved into the shaft for hafting of the Baja Californian or South American examples, indicating that the line attachment was of a fully lashed variety, and would have had an axis of tension obliquely transverse to the shank of the hook, rather than parallel. This is supported by well preserved examples (Figure 3) displaying a "waist" below the end of the shank, especially in the mussel-shell variety. Abalone examples are almost always of green abalone (*Haliotis fulgens*) and occasionally of pink abalone (*H. corrugata*) *the epidermis of which species* are rough and ribbed, creating friction and purchase for the lashing, in addition to the creation of the 'waist' as a hafting zone. One effect of this on the function of these hooks would have been to create increased resistance to the downward pull on the tip of the hook as more tension is applied, as well as maintaining the force more parallel to the laminae of the nacreous shells used. This would have contributed to less force being applied perpendicular to the laminae, focusing downward force along the strongest axis of the hook base material.

The hooks within this assemblage vary in size more than in overall design, though two variants can be proposed, some approach a J-shape, while others are closer to circular or C-shaped (Figure 4). The largest examples indicate that quite large fish were targeted by these hooks, while smaller hooks would have been for commensurately smaller fish. The J-shape is more commonly manufactured from mussel shell, while the circular examples are more frequently made from Abalone. They lack barbs or major degrees of recurve, meaning that once a fish was hooked, constant pressure would have had

Figure 4. Single-piece abalone (*Haliotis* sp.) shell hook from the Richard's Ridge (PAIC-49) site on Isla Cedros, Baja California. This example shows the 'C' shaped configuration more common at Espiritu Santo Island in contrast to the 'J' shape of many other examples in the Isla Cedros assemblage.

to be maintained on the line, suggesting that they might have been more difficult to use in water zones with heavy swash or surge like sandy surf or rocky intertidal.

We have a fair idea of the manufacturing *chaîne operatoire*, based upon numerous unfinished examples found broken or abandoned partway through the process. The makers appear to have selected the flattest portion of the shell in both mussel and abalone raw material sets. For the mussel, this meant that they were selecting a portion nearest the newest part of the shell. Additionally, their oriented their mental template of the finished product so that the bottom curve of the hook would parallel the natural growth bands of the shell. For the abalone, the orientation seems to have focused on locating the natural ripples and valleys of the epidermis of the shell perpendicular to the long axis of the shank of the hook. This was almost certainly to facilitate more secure line attachment. Once the raw material had been selected and a blank obtained by breaking away the more curved or irregular portions of the shell, the general form of the hook was achieved by chipping rather than cutting, drilling, or sawing.

This is interesting, since later Holocene examples from Alta California utilize drills and reamers to create the central perforation, and this may emphasize their more circular form. It is even possible that the manufacturing method influenced the final form as much as any intentional design did. Think about the difference between wheel thrown pots vs. coiled or otherwise hand-built. Given that these

Figure 5. Small grooved-pebble line weight from Cerro Pedregoso, Baja California, México.

hooks appear to have been individually crafted, it means that the makers were free to create them to whatever dimensions or shapes they desired, making them each the product of intentional crafting rather than dependent upon a mold or die.

Following chipping them to their general form, great care was taken to grind them down to a fine point at the hook and very smooth margins for the shank and curve. Faceting is present in this grinding, indicating that it is not simply the 2 dimensional outline that matters, but the smoothing and evening out of the curve. As with other examples of technologies finished through grinding, having a smooth, even surface even increases the strength, by grinding down any small cracks or divots produced during the roughing-out phase.

These hooks were also used in conjunction with stone line weights, the most common form being carefully grooved pebbles (Figure 5). This type of weight would have been located at the terminal end of the fishing line, indicating that the hooks would have either been integrated into the main line or attached via leaders, since the “end” of the line was occupied by the weight. While sufficient for allowing the line to be cast and travel to the bottom, these weights are not so heavy that they would have allowed a hook to maintain position in the surf zone, providing another argument against their use in that microenvironment. It also suggests that the targets of these hooks included fish that were not exclusively surface feeders.

Experimental replication *and use* of Late Holocene Alta California shell fishhooks (McKenzie 2007) has strongly indicated that these hooks are excellent at catching fish with particular mouth anatomy, and ineffective at catching fish with different configurations. Fish with protrusible jaws are the most likely target for these hooks, while cartilaginous fish and fish with thick tissue surrounding the mouth are less easily caught – if at all – by these hooks. Seabass, perch, halibut, and even small grouper can be caught with shell hooks, while cartilaginous sharks and rays, as well as fish with more

Figure 6. Well-made stone ring from Cerro Pedregoso. These items – of varying thicknesses and weights – have been recovered from three separate early sites on Isla Cedros, thought their function remains enigmatic.

distinctive mouths like moray eels and triggerfish would not be appropriate targets for shell fishhooks (McKenzie 2007).

Additionally, fish with heavy jaws and teeth capable of crushing shell would not have been caught by these hooks. California sheephead (*Semicossyphus pulcher*), which preys upon shellfish and crustaceans, would have made short work of these hooks. The highly consistent presence of these fish in the assemblages from all time periods on Isla Cedros indicates that these hooks were only one of the methods used by the early Islanders to catch a remarkably diverse set of icthyofauna. Harpoons and nets were almost certainly used as well.

Figure 7. A sample of the finished bifaces/projectile points from Terminal Pleistocene contexts on Isla Cedros.

Evidence for nets is strongly suggested by the abundance of very small fish vertebrae identified the smelt family in most of the Terminal Plesitocene midden deposits, and further confirmed by the presence of larger notched stone weights. Enigmatic stone rings (Figure 6) have also been recovered at multiple Terminal Pleistocene sites, including PAIC-44 and -88. These are of unclear function, but several of the hypotheses include their use as ring weights for bottom nets for crab and lobster (both identified in some frequency in early faunal assesmblages), or involved in the manufacture of cordage, line, and rope. These nets could have been deployed along sandy beach stretches whose presence is indicated by the frequent occurrence of Pismo clams (*Tivela stultorum*) or possibly from boats. According to local fishermen, their use in rocky open stretches of shoreline would not have been productive, and would have certainly led to significant damage to the "costly" and time consuming nets.

The use of harpoons or spears for some fishing is inferred by several lines of evidence other than the obvious presence of bifacial projectile points (Figure 7). 1) sheephead would not have been caught by single piece shell hooks due to their aforementioned crushing jaws; 2) They are ambush predators of the kelp forests and thus not very susceptible to being caught in nets – in fact, in repeated trips with modern net fishermen on Isla Cedros, I have never seen a sheephead caught in a weighted set net. 3) The presence of both Red (*H.* rufrescens) and Pink (*H.* corrugate) abalone in early molluscan assemblages indicates that early islanders were diving to obtain these species which are always found below low tide water levels. In many areas where traditional diving techniques were documented or continue to be practiced, the use of the natural environment to aid divers is well documented (e.g. Martinez 2004; Lim et al. 2012). Whether it be the coral reefs, vertical walls, or as is likely in the case of Isla Cedros, long, vertical kelp (*Macrocystis pyrifera*) stalks, traditional divers will make use of these features to be able to dive deeper or longer to better exploit submarine resources. So the presence of the habitually 'deeper' species of Abalone, combined with these other factors, lead us to propose that at least some of the fish in the Isla Cedros assemblages were being hunted by diving spear fishermen (e.g. Mesquita and Issac-Nahum 2015).

One additional point is worth highlighting. From multiple lines of evidence, including the design of the hooks and their use in a non-terminal location on the line along with the presence of fish species such as Ocean whitefish (*Caulolatilus princeps*) which are not known, - not by traditional fishermen on Isla Cedros nor Departments of Fish and Game management in Baja or Alta California – to be caught from shore (Bellquist et al. 2008), we can confidently infer the presence of open-water capable watercraft on Isla Cedros during the Terminal Pleistocene. Ocean Whitefish also are not known to occupy the kelp understory nor the space between the kelp and the shore. This means that to catch them, early Cedros Islanders were travelling in their boats as much as 2km offshore *just to fish.* This does not suggest a limit to the watercraft's capabilities, but merely a "floor" of seaworthiness. Additionally, many of the fish species recovered – Ocean whitefish included (Esgro et al. 2020) – are not found in shallow water where they could be seen like trout or salmon in a river, but in deeper water up to 80-90 meters. To ability to consistently know where to fish in deep water seems magical to the uninitiated, as anyone who has even spent time with knowledgeable fishermen can attest. Such seemingly intuitive understandings are almost always the product of multigenerational wisdom (*sensu* Ingold 2021).

The fact that they were fishing deepwater species means that the early islanders had to produce large lengths of cordage, since tying and splicing short sections is cobbled together and ineffective, particularly for longer lengths of cordage. The nets would have required immense amounts of cordage, since they were catching very small fish with some of them, implying relatively small gauges for these nets. The production of masses of processed fiber and its use in the spinning of large quantities of string, twine, rope, and fishing line would have been a ubiquitous sight in the settlements of the Terminal Pleistocene on Isla Cedros. An addendum to this is that they early Islanders had access to a species of *Agave* for their principal fiber source (see Hulle et al. 2015). This was fortunate, since *Agave* plants produce one of the plant fibers with high tensile strength, display excellent lashing properties, and display resistance to deterioration in saltwater (Bakar et al. 2020).

The fact that hook and line fishing was daily practice for early Cedros Islanders, who were also deploying large nets from boats, coupled with their diving from these substantial craft (possibly similar to those described by Des Lauriers 2005) to access the understory of the kelp forest where the abalone thrive speaks of a rich and truly maritime tradition of subsistence. These are not people who just arrived from the plains of West Texas, nor likely to have been the descendants of hunters of the frozen conifer forests of Siberia. These were people of the Sea. Even to those who love her, the ocean can be fickle, and is always slow to give up her secrets. The knowledge of how to exploit the full panoply of the sea's resources, from the shore to the depths, and from the humblest periwinkle to powerful cetaceans and pinnipeds *takes time.* The breadth of experience evidenced by the full faunal assemblage from the early Isla Cedros sites is staggering, and in an odd twist of history, eclipses even Late Holocene sites for the range of maritime environments and species exploited (Des Lauriers 2010).

This is part of what is meant when we say that to gain further insight into the processes that led to the peopling of the Americas, we must apply an historically contextualized, anthropologically relevant and environmentally situated model for the migration and settlement of the Americas. We must go beyond simply noting the presence of people on an island, because identifying and undertstanding their capabilities vs. their challenges and opportunities will allow us to better understand both the decision-making process and the lived experience of these ancestors of the First Nations of the Americas.

By focusing on their technological systems and implied concomitant knowledge systems (see Ingold 2013), we can demonstrate their intention and ability to actually explore and settle coastlines and islands. The mere presence of people can occur in any number of ways, from the purposeful to the unintentional, and even non-human colonization of islands by mammoth occurred on the paleoisland of Santa Rosae off of Alta California (e.g. Muhs et al. 2015).

However, the ability to distinguish between the "good places" from the not-so-good is something borne of experience, and trial and error probably does not result in expansive, successful colonization from British Columbia to Tierra del Fuego in under 2,000 years. We are actually at a very good position from a research perspective, since we are left with only two reasonable hypotheses to explain this data; 1) people were here *much* longer that currently understood, or 2) they brought a huge amount of knowledge with them, and at least in the case of the inhabitants of the Pacific Coast, important pieces of that knowledge may have travelled from as far away as the Ryukyu Islands.

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