Taking to the Boats

The prehistory of Indo-Pacific colonization

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When I was asked to give this lecture I thought that it would be a good opportunity to traverse some recent ideas about the prehistoric migrations through which the more remote islands in the Indo-Pacific region first became inhabited. The Indo-Pacific Prehistoric Colonization Project, which I convene, is studying those migrations as one of two major projects in Asian and Pacific archaeology which are currently in progress at the ANU. The other, called the Asian Fore-Arc Project, is a coalition of interests which is focussed on the fore-arc of islands lying along the western edge of the Pacific Basin from Japan to northern Australia. Down or through this island arc over a period of some 50,000 years came all the indigenous peoples of the Pacific and Australia. At present, there is a team working in East Timor and the Aru islands, and another on the northern Phillipines and Taiwan.

The Colonization Project has a much larger area, embracing the Pacific and Indian Oceans, but most of the islands are small, and the project is focussed on the relatively brief period of the Austronesian migrations. These occurred between about 1500 BC and 1500 AD, when maritime migrants, originating in island Southeast Asia and New Guinea, and generally speaking related tongues of the Austronesian language family, spread east and west to colonize previously uninhabited islands scattered across 26,000 km of the southern oceans - about two-thirds of the earth's circumference. It was one of the two most extensive phases of rapid migration in human history prior to the modern era; the other being the initial colonization of the Americas, also by Asian migrants, between about 13000 and 9000 BC.

The Indo-Pacific colonization project combines archaeological investigation of chronology, material culture and settlement patterns with palaeoenvironmental study of the ways in which landscapes and faunal diversity changed with the arrival of people. During the last six years we have worked from Christmas Island in the Indian Ocean right across the Pacific from the south China Sea to the Chilean Islands, and from the equator to the subantarctic. Amongst our various interests, we have tested the boundaries of prehistoric colonization in Lord Howe Island, the Juan Fernandez group and the Subantarctic islands and found that there was Polynesian occupation of the last of these some 700 years ago. We have investigated some of the so-called mystery islands, islands settled prehistorically, but abandoned before European discovery, and gained some understanding of the social and subsistence difficulties, under which communities on Kiritimati (Line Islands) and Norfolk Island had laboured prior to abandonment some 500 years ago. We have excavated numerous colonization sites in the Batanes Islands (Luzon Strait), Fiji, Niue, and French Polynesia and seen how quickly the bonds of a common material culture were eroded and how, with equal rapidity, the resources of forest and reef became diminished. Coring for information on landscape change, and palaeontological research have been regular adjuncts to our archaeological programme, the one showing a close chronological correspondence to the archaeological record, contrary to some earlier research in the Pacific, and the other continuing to unearth remains of a remarkable faunal diversity that crashed upon the advent of people, including the discovery of a diverse extinct megafauna in Fiji.

The data obtained in these projects become the essential nuts and bolts in constructing the prehistory of Indo-Pacific colonization, but they also provide a point of entry into larger questions about how the cultural landscape of the island world came into being. We are seeking to investigate the mechanisms, processes and consequences of island colonization, with the intention of understanding Austronesian expansion within the worldwide context of maritime migration.

Episodic Migration

Today I want to discuss one of those broader issues. It is one that has been a lightning rod of debate in Pacific archaeology, but now that data and opinions are stabilizing we can see the Pacific evidence coming into line with a worldwide trend in island archaeology, indeed the Pacific data might help us to a better understanding of how or why many islands first came to be colonized. I refer to the characteristic pattern of island colonization which is multi-phased or episodic within each region. Similar patterns can occur in initial terrestrial migration but less commonly and episodes are seldom so widely spread in time. The colonization of the Americas, for example, which crossed almost every type of environment on earth seems to have occurred rapidly and more or less continuously from Alaska to Patagonia.

But colonization of previously uninhabited islands proceeds typically through rapid bursts of dispersal separated by long periods of inactivity. In the north Atlantic, islands as far offshore as the Shetlands, were colonized between 5000 and 8000 years ago, but the next phase of discovery, involving the Faeroes, Iceland, Greenland and indeed the shores of North America, did not occur until the 8th to 10th centuries AD. In the Mediterranean most of the large offshore islands, such as Cyprus, Crete and probably Sardinia and Corsica were colonised at 8000-9000 year ago, but Mallorca and the Balearics in general not until 5000 years ago. In the Caribbean, too, initial colonization occurred progressively in three widely-separated dispersals at 6000, 4500 and 1200 years ago.

Until quite recently it was thought that Austronesian colonization began about 3500 years ago in the western Pacific and expanded continuously to reach eastern Polynesia about 2000 years ago, with perhaps only New Zealand rather later as a result of the different weather and sea conditions involved. This idea has been modelled in various ways, and is commonly shown as expanding concentric rings of successively younger colonization. Ten years ago, that pattern seemed to be supported by the distribution of radiocarbon dates on early settlement sites or on evidence of landscape disturbance associated with human habitation. Subsequently, the simple pattern has begun to break up. Many more recent radiocarbon dates, and critical review of the older results, and some other

evidence, including the rates of change in Oceanic languages, suggest that the pattern was not continuous at all. Indeed, it was quite strongly episodic or punctuated.

About 4500 years, there was an expansion of people from mainland Asia into Taiwan and the southeast Asian islands, a movement distinguished archaeologically by various kinds of red-slipped pottery together with ground stone adzes and in some sites by remains of domestic animals and evidence of cereal cultivation, especially of rice. They came into an island world already inhabited by people who had quite sophisticated economic systems which included the management of tree and root crops and who had some maritime capability. By about 3300 years ago, a local red-slipped pottery tradition, known as Lapita, had developed in the islands to the north of mainland New Guinea. Both this and other red-slipped pottery traditions then began to expand, about 3000 years ago, into the uninhabited Pacific, to western Micronesia, and past the Solomons into Santa Cruz, Vanuatu, New Caledonia, Fiji and west Polynesia.

There, it seems, there was a long pause in dispersal. This has been one of the most contested propositions in Oceanic archaeology but, in my view at least, the recent data are compelling. Here is a case in point. The argument for substantial continuity in colonization from west to east Polynesia depended in part on the radiocarbon dating of a series of archaeological sites in French Polynesia which appeared to suggest that habitation was already quite well-developed there by more than 2000 years ago. Recent research on those sites, especially in the Indo-Pacific colonization project, shows that without exception they are much younger. All of them were first occupied about 1000 years ago.

So, the pattern of colonization now looks like this:

(i) a very rapid Lapita dispersal, about 2800-3000 years ago, which was more or less contemporary with similar dispersal of initial colonisation in western Micronesia

(ii) late or post-Lapita expansion into central Micronesia, about 2000 years ago, probably from or through the Santa Cruz region, and contemporary colonisation of some islands marginal to the eastern Lapita expansion (Niue, Pukapuka and Rotuma)

(iii) rapid, aceramic, dispersal, beginning in the late first millennium AD, from West into and through East Polynesia, and

(iv) colonisation about 700-800 years ago of South Polynesia, involving virtually simultaneous occupation of all groups from the subtropics to the subantarctic.

Why is there a similarity of pattern in initial island colonization worldwide? One possibility is that it had to do with the development of maritime technology. Early Atlantic and Mediterranean migrations are approximately coincident with the first archaeological evidence of dugouts which could have reached islands 15-45 km offshore. The later colonizations, on passages of 100 km or more occurred after the advent of sailing technology, approximately 4000 years later. This is especially clear in the north Atlantic where an excellent archaeological record of preserved boats shows a rapid transformation of hull shapes to reduce leeway, and then the actual existence of sailing technology, immediately prior to the Norse expansion. Even so, the north Atlantic case occurred more than a thousand years after sailing had reached western Europe, and sailing technology was unknown in the Caribbean, where there was no extension of range to distant islands, such as Bermuda, yet the colonization pattern was still highly episodic. Sailing was clearly an important factor in maritime migration, but its relationship to episodic expansion was not a simple one. I shall return to this matter in more detail soon.

A similar case can be made for the relevance of agriculture. It was almost certainly a major factor in the long-term survival of colonization on many islands, and its absence or failure may have been crucial in the abandonment of some 40 ‘mystery’ islands in the Pacific. However, the early Atlantic and Mediterranean colonizations preceded agriculture, so too did the two main colonizations in the Caribbean. Recent evaluations of central Pacific evidence suggest that agriculture may have been largely absent in the earliest dispersal. Equally, its undoubted presence for 1500-2000 years in west Polynesia, prior to the settlement of east Polynesia, and probably for several thousand years in the west Pacific prior to the Lapita expansion, indicates that it was not a critical factor in initiating renewed colonization.

A third possibility, often suggested, is that the pattern reflects periodic increases in population pressure on resources. For example, once initial settlement had occurred in Fiji and West Polynesia, nearly 3000 years ago, it then took some time before population growth reached the point that renewed migration eastward was seen as a preferable option to increased resource competition at home. The first millennium AD development of monumental architecture, and evidence of increasing warfare, are held as potential evidence of the looming crisis. This is a very plausible hypothesis but it lacks any quantitative basis. My intuition in the matter is that given the rates of population growth known historically, and inferred elsewhere in the Pacific, the demographic crunch would have arisen very much sooner, and at different times between archipelagos of very different land area and resource array. Population growth, however, is unquestionably one of the prime movers of culture change of many kinds, and it provided both a general impetus to migration and a limitation on the extent of migration mobility, so it must be brought explicitly into play in thinking about colonization processes. We need urgently some large scale simulation modelling in this area.

Beyond those three factors, each potentially influential in shaping colonization histories, there exists another, which I want to explore today, and that is the relationship of maritime technology to climatic change. My particular take on this is that the episodic chronology of initial habitation in remote Oceania reflects the periodic lifting of limitations on maritime technology by climatic change at the millennial level. Let us look first at maritime technology.

Maritime Technology

The early history of seafaring in island southeast Asia and the western Pacific remains very uncertain, and I have some difficulty with common suggestions about it. For example, it is proposed that seafaring progressed from sailing within sight of land to sailing out of sight of land, sometimes with proposed interstages concerning whether land remained in view in one direction or both. This developmental hypothesis contains, however, an unwritten assumption, which is that seafaring was controllable; that mariners who wanted to stay within certain visibility limits, or escape them, had the means to

ensure that their vessels could do so. For open sea voyaging, the usual means would be use of a sail and steering oar, or less usefully an ocean-going paddled canoe, but that technology seems to have arisen nowhere any earlier than the mid-Holocene, about 5000 years ago. Had it existed much earlier in the western Pacific, we might have expected a great deal more evidence of Pleistocene inter-island voyaging than exists, and almost certainly some considerable extension of voyaging range. But as it stands, the current data indicate no extension of a voyaging range that stood at around 200 km for some 40,000 years. As to the nature of early watercraft, it is a reasonable conjecture that the prevalence of giant bamboos in island southeast Asia, and the frequency with which they form natural rafts after storms, provided the first pattern for boats. On the other hand, I don't think that anything like the recent experimental craft, such as the *Nale Tasih 2* raft, powered by a square sail on a passage from Timor to Australia, are at all plausible, for reasons I have just alluded to: if they had existed so early then we would expect a great deal more evidence of their use than currently exists, not to mention very much earlier long-distance voyaging in the Pacific and Indian oceans. The problem I see in this sort of experimentation is that it attempts to minimize seafaring dangers and ensure voyaging success, as if the matter at issue was how Australia, or some other distant landmass, could have been reached successfully at the first attempt. A more realistic perspective, in my view, is to acknowledge the immense period involved and thus the operation of chance. It is this which accounts for the colonization of quite distant islands by small mammals; of the Galapagos, 800 km offshore, by rodents on natural rafts in three separate events over several million years, and of Christmas Island, 250 km offshore, also probably in three separate events over about one million years. Somewhere closer to such seeming improbabilities, overcome by the operation of chance in geological time, than to the ethnographic perspective of some current thinking, lies, I suspect, the reality of early seafaring in our region. As yet, however, it remains hidden to us.

What is clear, though, is that when change came, it was abrupt and substantial. In the mid-Holocene the range of seafaring increased sixfold, quite suddenly, and this is most plausibly associated with the arrival of the sail. The critical question here is the nature of the early sailing technology.

The earlier view of continuous colonization had as its necessary corollary the prior existence of a quite sophisticated maritime technology; one which was not easily baulked by contrary winds, increasing distances or smaller island targets. It was assumed that the essential vessel type of Oceanic migration was a large double-hulled sailing canoe that was capable of long passages which included upwind sailing and navigation out of sight of land. It is argued that the process followed a long-term voyaging strategy that involved sailing first into the direction of the prevailing wind, because that offered the best chance of a safe return if anything went wrong, and later in cross-wind or downwind directions. The origins of this theory are complex, and go back into the long history of controversy about Oceanic voyaging, but as I think that in some important respects it is flawed, it is worth taking a little time to review the issues.

I think we have to reject the strategic proposition. Since the prevailing wind runs east along the main band of islands, and therefore opposite to the main direction of migration, from the west, the early colonising voyages must have been upwind irrespective of any voyaging strategy, or none, since uninhabited islands lay successively to the east. Besides, much the same pattern of colonisation is evident in reconstructing the pre-human dispersal of animals and plants across the Pacific. Pattern does not imply purpose and much of it was inherent in the shape of Pacific geography.

We can also put aside the longstanding debate about Oceanic navigation. There is no evidence from archaeology, and very little direct evidence from traditional or historical records, concerning actual pre-European methods of long-distance navigation, but experimental sailing shows that simple means of astral navigation were potentially available to prehistoric Indo-Pacific seafarers. Combined with dead-reckoning, and careful observation of land-proximity indications, such as changes in swell directions, they could have enabled long-distance way-finding of reasonable accuracy.

The issue, then, is mainly about the technology of boats. It was recognized as fundamental almost from the beginning of European enquiry. Jacob Roggeveen, the

Dutch explorer who found and named Easter Island in 1722, asked how island colonization was possible given the primitive sailing technology he observed. It was, he wrote, a question which so exceeded understanding that it could only be stated and then answered with silence. Well he could hardly have been more wrong about the silence - academic discussion has resembled at times the debate of seagulls over discarded fish and chips. But he was right about the difficulty of explanation. In Europe, where there are thousands of prehistoric boats preserved, with examples going back 10,000 years, the history of seafaring is quite visible, but very few prehistoric boats have been found in the Oceanic islands and all of them are late. Nevertheless, we do have an unusually comprehensive ethnographic record from the age of European exploration which provides an opportunity, within limits, to use historical data in reconstructing the nature of prehistoric seafaring.

While early European observers, such as Roggeveen, had not been impressed by the form or performance of Oceanic canoes, by the late 18th century the philosophical context of ethnographic enquiry had changed, and a different consensus began to emerge. George Forster, on Cook's 3rd voyage suggested that seafaring must once have been more accomplished than was evident from contemporary observation, thus foreshadowing what Greg Dening described as the principle of degeneration in Pacific historiography; the idea that what had been observed ethnographically was merely the degraded remnant of a more glorious past. This idea lent credibility to traditions about remarkable feats of voyaging in prehistory and even when those so-called 'traditionalist' accounts of the past were abandoned under persistent questioning of their historical credentials, the same principle was retained into modern 'neotraditionalist' theories and experimentation.

It has been used most influentially in designing experimental voyaging canoes such as the *Hokule'a*. This, and others of its kind, are often described as replica vessels, as if they reproduce historical designs, but that is not the case at all. In fact, they are modern designs which appeal explicitly to the principle of degeneration in combining favourable features from different Oceanic boatbuilding traditions to create vessels of superior sailing and seakeeping qualities. *Hokule'a* has a Hawai'ian hull plan but Tahitian hulls

and two masts, not recorded from Hawaii, while her masts and rigging are of a Tongan design unrecorded in East Polynesia. She has watertight compartments, glass-over-ply construction, nylon rope rigging and terylene sails of massive area. East Polynesian vessels observed at contact set either one large sail as in Hawaii, or two small sails as in Tahiti. The sails used on *Hokule'a* and other such vessels are about twice the area, relative to waterline length, of those recorded on historical canoes.

As a result, experimental vessels such as *Hokule'a* have sailing capabilities that match those of modern cruising yachts. These include average sailing speeds on long passages of about 4 knots, providing daily runs of around 100 sea miles or 180 km, and an ability to sail quite competently to within 70 degrees of the wind. It is those data which have been used as variables in recent computer-simulated sailing experiments. Those show, predictably, that such capable, seaworthy and well-found double canoes would have had no difficulty in sailing throughout Oceania and could soon have found all but the most isolated islands; a conclusion which was, of course, consistent with the idea of continuous discovery.

There are several problems concerning boat technology in this hypothesis. First, the double canoe has an historical distribution and linguistic history which suggest that it was relatively late in the colonization sequence and developed in Fiji-West Polynesia after the Lapita expansion, not before it. Second, the historical accounts of Oceanic sailing vessels from the 16th to 18th centuries do not show a degeneration of technology, indeed quite the reverse, they show it developing. The early tongiaki type had a relatively primitive lateen rig which made it difficult to sail well, and even dangerous, on one tack. This has been doubted by some commentators, even by that great seafarer, the late David Lewis, but its deficiencies were clearly-recorded by the artists with the 17th century Dutch explorers. By the late 18th century, the tongiaki arrangement was largely replaced by a more efficient lateen rig.

If we work back from the tongiaki, then, some components of it can be seen in the 18th century Tahitian rig, but these got no further into east Polynesia and are possibly

indicative of the 2nd millennium AD expansion of the Tongan empire. Similarly, the fixed mast got to Hawaii, possibly late in prehistory, but Hawaiians at 1788 had lightweight standing rigging and seem mainly to have used the sail in a downwind mode and assisted by paddling. In New Zealand and probably the Marquesas, there was a two-boomed oceanic spritsail held up only by running stays forward and sheets aft held against wind pressure. I suspect that this, or something like it, was the rig used in Oceanic colonization. I do not say it was the oldest type because it occurs in the most marginal areas – the simple age-area proposition – rather that, as I have just indicated, historical evidence suggests that the more complex rigs were only reaching the Central Pacific in the later second millennium AD.

A linguistic argument is also possible. The term for yard or boom goes back to Proto-Oceanic, but the terms for mast are non-specific or of questionable antiquity. Similarly, while there is a Central Pacific term for running stays, there seems to be none for standing rigging, and the word for tacking is the same as the older term for paddling. Taken together, these various data suggest that the fixed mast rig and lateen sail were relatively late introductions to the central Pacific, and post-dated by some centuries the initial colonisation of east and south Polynesia. If so, all the Austronesian migrations in Oceania probably used a mastless version of the oceanic spritsail, such as the New Zealand rig, if I can call it that.

The advantages of the New Zealand rig as a dispersal mechanism were that it was very simple and readily repaired at sea; it was flexible in use and could be set in high or low aspect shapes, it avoided the massive stresses on gear associated with windward sailing – these can be up to nine times those of downwind sailing for the same windspeed - and it was the safest of all Pacific rigs because it could be instantly demounted in high winds or squalls. However, it would almost never take a vessel on any direction forward of the beam. It had either to be used when there were fair winds towards a particular destination or, on longer passages by lying ahull in headwinds, with the rig stowed.

If it can be taken from this discussion of what is admittedly quite inadequate evidence that initial dispersal occurred without either the double canoe or the lateen sail, and that east and south Polynesian dispersal had the double canoe but probably only Oceanic spritsails and no fixed mast, then performance characteristics quite different to those envisaged in the neotraditional hypothesis must have prevailed. With relatively small sail areas and the New Zealand, dispersal must have been slow, difficult and often impossible against the prevailing winds.

The problem with this kind of conclusion has been seen as the upwind location of the marginal archipelagos. But here, experimental sailing has shown that the more important issue is point of origin. To go far to the east, south or north in East Polynesia the trick is to begin as far as possible to the east. An origin far to the southeast in French Polynesia provides a fair chance of a downwind passage on subtropical summer easterlies to New Zealand, on winter westerlies to Easter Island, or on prevailing southeasterlies to within range of Hawaii.

Even so, the proposition that Remote Oceanic colonization occurred opportunistically in vessels largely restricted to sailing downwind still does not explain why the pattern of colonization was episodic, but it does contain the seed of an explanation and I turn now to the matter of climatic change.

Climatic change

Within the tropical Pacific, sailing from the west was into the prevailing winds and it was the existence of anomalous westerlies, in seasonal or El Nino conditions, which provided a potential means to go east. These blow for a week or so at a time in the central Pacific and occur frequently, in some cases annually, so they cannot explain the long pauses in the colonising sequence. However it is now becoming apparent that there was also long-term variation in the frequency of westerly winds of El Nino origin.

Proxy measures of the frequency and intensity of El Nino conditions include variation in sediment deposition in South American lakes, reduced oceanic circulation and upwelling

marked by variations in atmospheric radiocarbon, and long-term records of loess production in China. Together, these show substantial El Nino variation occurred on a millennial scale. There were periods of high frequency about 6000-4500 BP, 3300-2300BP, 1400-1100BP and 600-modern. It should be emphasized here that these proxy data are quantitatively relative rather than absolute, that the climatic concepts involved in using them may be overly simplistic and that for various reasons inherent in radiocarbon dating, including reservoir effects, the ages might be subject to a general error of plus or minus 250 years. So this is an hypothesis, and no more than that.

Nevertheless, taking it on at that preliminary level, the dispersals out of Southeast Asia, in the Lapita expansion to the west Polynesian margins, and into East Polynesia approximate the pattern of high El Nino frequency. That is, the eastward movements occurred at times when the trade winds were suppressed and westerly winds prevailed. They were all largely west to east movements. Conversely, the mainly east to west movements, into Central Micronesia and to South Polynesia, occurred at intervening periods during the 'normal' pattern of tradewind dominance.

It can be proposed, then, that Remote Oceanic sailing during dispersal was technically restricted to downwind activity and probably at slow overall sailing speeds on long passages. Successful voyaging would have been significantly more difficult, with much lower rates of success, than is envisaged in the traditionalist and neotraditionalist theories. It was, perhaps, undertaken uncommonly at times when winds were predominantly adverse. However, long-term episodes of wind reversals, on millennial scales, may have provided conditions that encouraged renewed voyaging and enhanced the probability of colonising success toward the east.

While this climatic forcing hypothesis seems a plausible explanation of episodic migration in Oceania, it might not be the only one, nor might it apply equally to other cases of episodic maritime migration in world prehistory. So let us look briefly at those. First, it is important to observe that throughout the oceanic world a rough coherence of climatic change during the Holocene is beginning to emerge. There are still far too few

data to say anything useful about the last 10,000 years in the Indian Ocean, except that there is a mechanism of periodic wind reversals, called the Indian Ocean dipole, for which there is yet very little continuous history. Between the Atlantic and the Pacific, however, the connections are becoming better understood. At the risk of considerable over-simplification they correlate something like this: when there are long cold periods in the North Atlantic, as during the Little Ice Age, 1300-1850 AD, sea-surface temperatures also fall significantly in the tropical Atlantic. The fall is abrupt and substantial (3.0 to 8.0 degrees Celcius). It pushes the Inter-Tropical Convergence Zone southward to lie across northern South America and brings relatively dry conditions in the Caribbean with enhanced NE trade wind activity. These phases are correlated with periods of vigorous El Nino activity in the Pacific, where relative warming of the south-eastern waters also brings the ITCZ southward and produces heavy precipitation, contrasted in the western Pacific with frequent drought: the conditions that obtain today, in fact.

Now, the interesting thing about this trans-Oceanic connectivity, is that it is patterned in much the same way as in the Pacific. There is a millennial scale pacing or recurrence of climatic trends at 1000-1500 year intervals, in which high El Nino frequency is broadly correlated with periods of tropical Atlantic cooling, north Atlantic cold periods, and mountain glacier advances. Furthermore, there is some correspondence between the cooling and El Nino phases and periods of maritime migration generally.

This broader hypothesis needs to be regarded even more cautiously than the Pacific case. I must emphasize again the preliminary and rather generalised nature of the climatic data, their somewhat slippery chronology and similar difficulties in some of the archaeological data – the age of the Indian Ocean colonizations is particularly problematical. Further, while it is possible that the North Atlantic expansion was facilitated by a late first millennium decline in the strength and persistence of westerly winds at the beginning of the Medieval Warm Period, 900-1250 AD, in the Caribbean there was no sail and periods of expansion had enhanced trade wind activity - headwinds to prospective migrants - so that while these were also times of substantially reduced hurricane frequency, which

might have been important, it is more likely that the climatic impetus operated in other ways.

In fact, if there is one common factor through the low latitude oceans, at least, it is that the correspondence of periodic cooling and high El Nino frequency resulted in significant periods of drought on mainland regions adjacent to islands open to colonization (southeast Africa and southern Madagascar; southwest India adjacent to the Maldives), and on already colonized archipelagos in western oceanic situations (island Southeast Asia and the western Pacific, northern South America, parts of Central Americana dthe southern Caribbean). A climatic forcing model of island colonization, at least across the tropical oceans, might envisage, therefore, a primary impact operating through environmental stress, with a secondary impact of meteorology upon seafaring.

These conjectures suggest, at any rate, an agenda for future research in two particular directions. First regionally, in the Indian Ocean where despite the Austronesian origins and common seafaring traditions of at least some of the colonists, the geographical pattern of colonization is almost the inverse of that in the Pacific and bears no similarity chronologically; secondly, in modelling the impact of periodic environmental stress, at the millennial scale, upon the demography and economics of key island groups in the colonization sequence, such as west Polynesia.

It would be idle to speculate about the results of such research, but suffice to say that the nexus of climatic change and demography, regarded by some commentators as the great issue of the 21st century, and at one level a longstanding staple of archaeological explanation, might prove particularly enlightening in our understanding of island colonization.

Further Reading:

Anderson, A.J. (2000) Slow Boats from China: issues in the prehistory of Indo-Pacific seafaring. In O'Connor, S. and Veth, P. (eds) East of Wallace's Line: Studies of past

and present maritime cultures of the Indo-Pacific region. *Modern Quaternary Research in South East Asia* 16: 13-50. Balkema, Rotterdam.