Technological and Social Interactions between Hunter-gatherers and New Migrants in the Prehistoric (Neolithic) Islands of Southeast Asia and Oceania

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Technological and Social Interactions between Hunter-gatherers and New Migrants in the Prehistoric (Neolithic) Islands of Southeast Asia and Oceania

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ABSTRACT

This paper explores possible technological and social interactions between aboriginal human groups, mainly fishing/hunter-gatherers, and new Neolithic migrants who had farming, animal husbandry, and fishing/hunter-gathering skills in the islands of Southeast Asia and Near Oceania during Neolithic times. Based on current major hypothesis and archaeological/anthropological data, newer Neolithic migrants or linguistically Austronesian groups originating somewhere along the southern Chinese coast as far as Taiwan migrated to islands in Southeast Asia and Oceania during Neolithic times after 2000 BC. During their migration process, they may have encountered aboriginal human groups who originally migrated to these islands during the late Pleistocene and middle Holocene eras with a lifestyle based on hunting, fishing, and gathering. Their social and technological interactions are not yet clear from current archaeological findings. However, the material culture of the Lapita migrants, who first migrated from Taiwan to Island Southeast Asia as well as Near and Remote Oceania islands, indicates possible technological interactions with the aboriginal Melanesian people during the initial waves of migration. Their material culture has been identified as the 'Lapita Cultural Complex' in Oceania archaeology. Here, the potential prehistoric social and technological interactions between newer migrants (farmers/Neolithic peoples) and aboriginal hunter-gathers in the islands of Southeast Asia and Oceania are discussed, particularly in Oceania, by focusing on their maritime technology.

INTRODUCTION

From the viewpoint of human history, it is generally understood that the emergence of agriculture was in the early Holocene period, about 10,000 to 12,000 years ago, when temperatures rose in Mesopotamia and China, where early archaeological evidence of farming has been found. In Southwest Asia, for example, there is evidence to indicate that the domestication and use of cultivated cereals and beans, as well as livestock animals, spread rapidly during the warm period of 11,000 to

9,300 years ago. Tropical farming, mainly with slash and burn or swamp irrigation, to domesticate crops in Southeast Asia and Oceania is thought to have spread after the Neolithic period around 4,000 years ago (e.g., Bellwood 2005). This means that the major subsistence activities in these regions were hunting, fishing, and gathering for a long time.

The excavation of the Kuk swamp site in the Wahgi Valley of the New Guinea Highlands (Figure 1) from the 1970s onwards found some crop plants such as taro (*Colocasoa esculenta*), pandanus, Australian *musa* bananas, yams, and sugar cane, which were possibly domesticated through the use of irrigation with drainage channels around 10,000 years ago (e.g., Golson 1977; Denham et al. 2003). Some traces of systematic banana cultivation on the wetland banks from 6,500 years ago have been found, and irrigated tropical farming has been confirmed as having been established for a long time in the New Guinea Highlands (Denham et al. 2003). The Kuk results signal that the New Guinea Highlands may be one of the world's first centres of agriculture; the prehistoric Highland people could have been the first farmers in this area, well before the later Austronesian farmers who migrated into the islands of Southeast Asia and Oceania 4,000 years ago (e.g., Bellwood 2005; Ono 2018).

Such irrigated farming seems to have been quite localised in the canyon 1,300 to 2,300 m above sea level in the New Guinea Highlands. Bellwood (2005: 142−143) mentioned that this altitude is consistent with the growing limits of many crops, and could hence have been affected by long-term drought and other crises during the early Holocene. In fact, there is no evidence of early farming in lowlands and coastal areas below 1,300 m above sea level in New Guinea, and

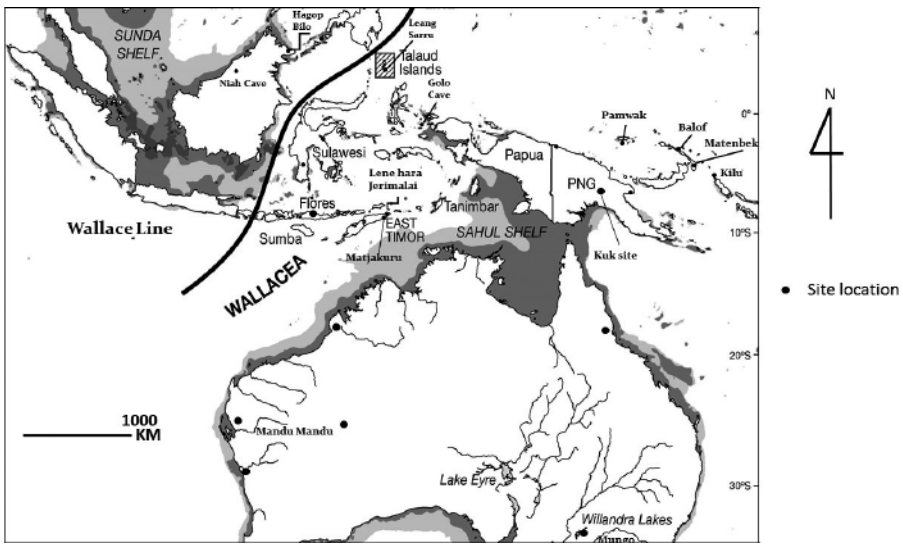

Figure 1 Major late Pleistocene to early Holocene sites in Sahul and Wallacea (Original map created by CartoGIS Services, College of Asia and the Pacific, Australian National University)

hunting and gathering continued to be the basis of activity until the later migration of Austronesian farmers after Neolithic times. Apart from the New Guinea case, other archaeological traces of crop plant use from the late Pleistocene were also found at Niah Cave on Borneo in Southeast Asia, as well as at the Kilu site on the island of Buka in Melanesia (Figure 1), though it is still unclear whether these crops were actually cultivated or collected. Judging by the location of these sites and other materials found, it is possible that these crops were collected by hunter-gatherers. Thus, except for the New Guinea Highlands, all the islands in Southeast Asia and Oceania were occupied by hunter-gatherers by at least the middle Holocene.

In the case of tropical farming, it is not easy to recognise whether the subject was a farmer or a hunter-gatherer from archaeological remains alone. Another important factor to recognise in farmer society is the use of domesticated animals. Regarding this aspect, no evidence has so far been discovered for the use of domesticated animals by the first farmers in the New Guinea Highlands. On the other hand, the later Austronesian farmers who succeeded in migrating to the entire region of Southeast Asia to the Oceanic islands 4,000 years ago used domesticated animals, including pigs, dogs, and chickens from the stages of their initial migration. In addition to developing taro cultivation with irrigation systems, these new migrants also had advanced navigation and fishing techniques. Such knowledge and new techniques enabled them to migrate to many islands and vast areas of both Southeast Asia and Oceania.

Of the areas to which they newly migrated in Micronesia, Polynesia and some Melanesian islands east of the Solomon Islands are known as ‘Remote Oceania’. The islands in this vast region were previously uninhabited by humans before the Neolithic human migration. Thus, there should have been no hunter-gatherer societies on these islands in Remote Oceania. However, in ‘Near Oceania’ or the Melanesian islands west of the Solomons, aboriginal hunter-gatherers and their societies did exist when the new Austronesian migrants arrived. Although the current archaeological data showing what happened between these groups during the initial migration periods in early Neolithic times in Near Oceania are limited, this paper focuses on the Lapita people, who are thought to have been the first Austronesian migrants in both Near and Remote Oceania, to discuss the possible social and technological interactions between aboriginal hunter-gatherers and newer migrants or farmers in prehistoric times.

THE SUBSISTENCE AND TECHNOLOGY OF HUNTER-GATHERER GROUPS IN THE EARLY HOLOCENE

Here, before describing the Lapita technology and their cultural complex, we need to review the previous subsistence activities and technology of hunter-gatherer groups in both Southeast Asia and Oceania. All the evidence discussed here refers to cases of hunter-gatherers living in an island environment. Hence, their maritime/

island adaptation and use of marine resources can be one of the key aspects. Archaeologically, stone artefacts, bone tools, and the remains of terrestrial animals have also been found or excavated from many prehistoric sites in the region, though temporal changes, particularly for the production and use of stone tools, are not very clear during the Holocene. Terrestrial animals and the variety exploited seem to have been affected more by the local environment; it is therefore not easy to connect this directly with debates on the technological aspects of each hunter-gatherer group in the early Holocene. For these reasons, this paper primarily centres on their marine usage and technology.

After the Holocene, the world climate rapidly warmed, and the sea level rose progressively until about 6,500 years ago. In both Southeast Asia and Oceania, the number of archaeological sites dramatically increased, which may indicate the increasing human population during warm periods. In the Wallacea Islands, including the East Indonesian islands and Timor (Figure 1), the number of archaeological sites in the early Holocene also rose dramatically. In Timor, for example, human habitation of Matja Kuru 1 Cave (e.g., Veth et al. 2005) and Uai Bobo 2 Cave (Glover 1986) began around 13,000 years ago, and there is evidence of increased human presence and activity from 8,000 to 5,000 years ago. During this latter period, human habitation in Bui Ceri Uato Cave in East Timor also commenced (Glover 1986). Matja Kuru 1 and Bui Ceri Uato caves, which are close to the coast, produced a variety of marine shellfish, while Uai Bobo 2, located in the inland hill country, has no marine shells.

In northern Borneo, Hagop Bilo Cave was abandoned about 10,000 years ago, while human activity at the Madai caves is evident from 11,000 to 7,000 years ago (Bellwood 1997). The Madai caves produced a variety of fresh and brackish water shellfish, but no marine shellfish. The distance of these caves from the coast during the early Holocene was over 15 km, which, as for Uai Bobo 2 in East Timor, would explain why marine shellfish are absent. Other sites such as Niah, Lang Rogrien, and Leang Burung 2 were continually inhabited during the early Holocene, but no marine exploitation occurred there either.

On the other hand, the total number and volumes of marine fish and shellfish remains substantially increased at the Jerimalai (or Asitau Kuru) site in East Timor (Figure 1) during the early to middle Holocene, dated around 6,500 to 5,500 years ago. For marine fish, the numbers and percentages of inshore coral-dwelling fish species—including Scarids (parrotfish), Balistids (triggerfish), and Serranids (grouper)—increased (O'Connor, Ono, and Clarkson 2011; Ono 2016). The heavy reliance on marine resources, especially shellfish, is evident in Lene Hara (O'Connor and Veth 2005) and Bui Ceri Uato (Glover 1986) in East Timor.

Similarly, some marine shellfish species increased in Leang Sarru on Talaud Island during the early Holocene (Ono et al. 2010). This is especially the case for Tridacnidae and Fasciolariidae, which are subtidal or coral rubble–dwelling species. As noted above, the increase in coral rubble-dwelling species such as Tridacnidae possibly relates to the rise in sea temperature and the growth of coral

reefs. Similarly at the Golo Cave in Maluku, the Holocene sediment prior to 3,000 years ago contains a high density of shells (Szabó et al. 2007: 704). In Buang Merabak on New Ireland, subtidal species such as *Trochus* spp.and limpets suddenly increased after 10,000 years, while coral rubble-dwelling species, such as *Cypraea* spp. and *Strombus* spp., increased around 5,000 years ago (Swadling 1994; Rosenfeld 1997). All this indicates that the change in target species possibly corresponds to the changes in the early Holocene coastal environments.

In another aspect of maritime exploitation during this age, the archaeological evidence in both Wallacea and the islands of Oceania show a new tradition of shell use for tools and ornaments. In Wallacea, Jerimalai, and Lene Hara on East Timor provided some *Trochus* single-piece fish hooks from around 10,000 years ago; the one from Lene Hara (O'Connor and Veth 2005) is especially notable, almost complete and of a rather larger size, possibly for capturing larger fish. Although Jerimalai has one (possibly) much older *Trochus* fish hook, maybe even as old as 23,000 to 16,000 years ago (O'Connor, Ono, and Clarkson 2011), clear evidence of such hooks are from 11,000 to 10,000 years ago during the terminal Pleistocene to early Holocene. Jerimalai also produced quantities of shell beads and ornaments after the late Pleistocene, but mainly in the Holocene ages around 8,000 to 5,500 years ago (Langley and O'Connor 2016).

In Northern Maluku, Golo Cave and Wetef rockshelter on Gebe Island produced a number of Tridacna shell adzes which are directly dated between 38,000 to 6,700 BP but concluded C. 7,000 BP for its manufacture and use (Bellwood 2019) while Cassis shell adzes are also directly dated to 10,000 BP but considered as much younger products, after around middle Holocene of Neolithic as most of them are from the upper layers (Bellwood 1997; 2019), while the site also yielded possible Turbo shell operculum scrapers from the late Pleistocene dating back to 35,000 years (Szabó et al. 2007). The Tridacna and Cassis shell adzes from Golo are so far some of the oldest shell adzes in the world. Since early modern humans in Africa and Arabia already produced and used marine shell ornaments and tools dated to 130 to 70 ka (or possibly even *Homo erectus* after 500 to 400 ka), it is not so surprising that the modern humans who migrated into Wallacea also used such shell tools from the initial stage during the late Pleistocene. Clearer evidence of shell use for tools and ornaments after the Holocene in the region might indicate that such use was more actively practised during the Holocene.

In Oceania, on the Pamwak site on Manus Island (Figure 1), stone and Tridacna shell edge-ground tools appeared from around 10,000 years ago, while a single edge-ground axe fragments, shark teeth, and cut *Trochus* shells were also found in Balof, another Manus site, from 10,000 years ago. Matenbek (Figure 1) on New Island produced a decorated shell bead, while Kilu on Buka Island (Figure 1) revealed drilled shark teeth (Allen 2000). All of this archaeological evidence from Wallacea and Oceania clearly shows that human (hunter-gatherer) maritime adaptation, as well as more elaborate techniques for both fishing and tool making, had been developed by this time.

Further, there is some archaeological evidence of the possible use of food plant resources in the Pacific islands during the terminal Pleistocene to early Holocene. For instance, the Kilu site produced botanical remains of tubers and corms, comprising taro and *Alocasia* sp., from 28,000 years BP (Loy et al. 1992). The analysis of plant residue on stone tools and shell scrapers from Balof on Manus Island shows that these tools were used for processing starchy plants, including taro (*Cyrtosperma*) and yam (*Dioscorea* sp.), which are regarded as plants introduced from New Guinea 14,000 years ago (Barton and White 1993). For other evidence, *Canarium* nutshells, also judged to be plants introduced by humans from Wallacea or New Guinea, occurred in Pamwak 11,000 years ago, and on the Kilu site 10,000 years ago (Spriggs 1997). The fruit of such introduced trees has also been archaeologically recorded on the northern coast of New Guinea, where wild forms were endemic (Yen 1995).

The possible evolution of plant use and its technologies could correspond with the development process of maritime adaptation and seafaring skills by these hunter-gatherer groups during the Holocene times. Then, more skilled new migrants, known as Austronesian farmers with their highly developed maritime and agricultural skills, appeared around 4,000 to 3,500 years ago or 2,000 to 1,500 BC in both Southeast Asia and Oceania.

NEOLITHIC MIGRATION AND POSSIBLE TECHNOLOGICAL INTERACTIONS IN OCEANIA

During the Neolithic age 4,000 years ago, various kinds of technology appeared, including farming, animal husbandry, fishing, and seafaring technology in Southeast Asia and Oceania. These new technologies were mainly introduced by new migrants who spoke Austronesian languages. Current linguistic studies indicate that they originating somewhere along the southern Chinese coast as far as Taiwan, then dispersed into Southeast Asia and to islands in Oceania (e.g., Bellwood 1997). This linguistic hypothesis of Austronesian dispersal overlaps with archaeological findings of Neolithic materials, including pottery, polished stone adzes, and the remains of domesticated animals and plants, with a variety of more sophisticated ornaments and tools in the region. Based on this understanding, many archaeologists support the idea that the Neolithic age in Southeast Asia and Oceania was started by an Austronesian farming population comprising newer Neolithic migrants.

In Wallacea and adjacent islands in Southeast Asia (Figure 2), several major sites dating back to this age are known, such as the Leang Two Manae site on the Talaud Islands (e.g., Bellwood 1997; Tanudirjo 2001), the Uattamdi site on the island of *Kayoa,* Northern Maluku (e.g., Bellwood 2019; Bellwood et al. 1993, 1998), the Bukit Tengkorak site on the eastern coast of Borneo/Kalimantan Island (e.g., Bellwood 1989; Chia 2001; Ono 2003, 2004, 2010), the Kalumpang site on the island of Sulawesi (e.g., Bellwood 1997; Anggraeni et al. 2014), and Duyong

Figure 2 Major Neolithic sites in and around the Wallacea region (Created by Ono).

cave on the island of Palawan (e.g., Fox 1970).

Of these, only two sites produced quantities of marine fish and shellfish remains—Uattamdi on Kayoa (Bellwood 2019; Bellwood et al. 1998; Ono et al. in press) and Bukit Tengkorak on Borneo/Kalimantan (Ono 2003; 2004; 2010)—that show traces of possible Austronesian maritime exploitation and adaptation in the Neolithic times. Both sites were mainly used between 3,500 and 1,800 years ago, though Bukit Tengkorak was used more heavily during Neolithic times around 3,400 to 2,800 years ago (Ono 2003), while Uattamdi was employed as a habitation or camping site during the Neolithic dating between 3,500 and 2,800 years ago, and secondly as a burial site during the early Metal age around 2,200 to 1,800 years ago (Bellwood et al. 1998; Ono et al. in press). The locations of Bukit Tengkorak and Uattamdi also indicate that these Neolithic people, possibly new in the region, had developed maritime skills and knowledge, and strategically selected coastal environments with large coral reefs for their initial settlement. Such migration strategies and preferences for coastal settlement can be seen clearly in the case of Lapita sites in Oceania.

The Lapita people are usually identified as the first Austronesian language-speaking people who migrated to the Melanesian islands around 3,300 years ago. They are thought to be originally from the Asian region (somewhere between Taiwan and Southeast Asia), with a Neolithic culture including a tradition of

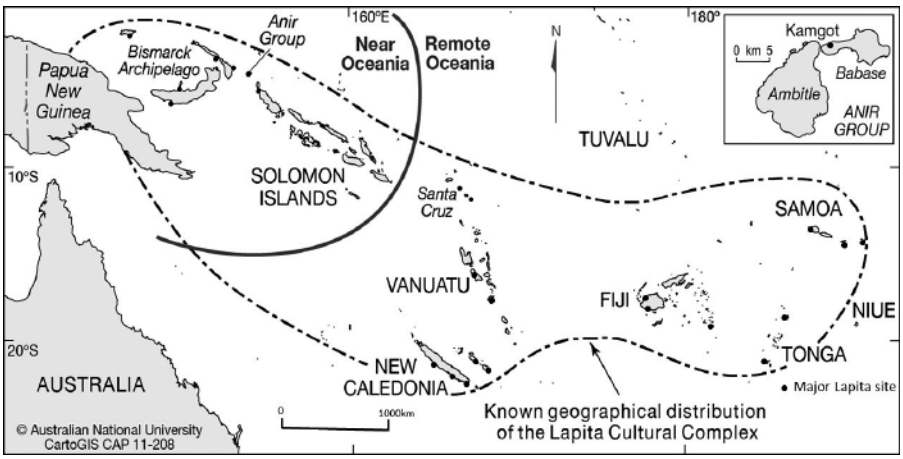

Figure 3 Distribution area of Lapita sites in Near and Remote Oceania (Original map created by CartoGIS Services, College of Asia and the Pacific, Australian National University)

pottery use, systematic agriculture, and animal husbandry. They migrated to many remote islands in Melanesia to Western Polynesia, which had been mostly uninhabited before their migration (Figure 3). The Lapita people are believed to be the first *Homo sapiens* who managed to migrate to these islands in Remote Oceania, including Polynesia. Thus, they are also believed to be the direct ancestors of Polynesian people who migrated to most of the other Polynesian islands, including Hawaii, Rapanui (Easter Island), and New Zealand, in later times.

The Lapita culture seems to not have originated solely from the Asian region. One of the most specific materials belonging to the Lapita are their pottery assemblages, which include diagnostic motifs of human faces and geometric patterns made by dentate-stamping techniques on the pottery surface, some of them impressed using a white-lime material. The techniques of making pottery, dentate-stamping, and lime impressing could originate from Southeast Asia or from Taiwan to southern China, since much older pottery made by such techniques was found in these regions. However, when reducing pottery to a single element, there are 30 Lapita elements, of which 17 (57%) were recovered from pre-Lapita Melanesian sites, 21 (70%) from Neolithic Southeast Asian sites, and only 8 (27%) from pre-Neolithic Southeast Asian sites (Spriggs 1996; Allen 2000).

As for the pottery itself, the diagnostic motif of a dentate-stamped human face, and the mixture of various patterns in a single piece, are very specific characteristics of Lapita pottery (Figure 4) never seen in other regions, including Southeast Asia. Thus, even if Lapita pottery production technology were originally from Southeast Asia and Taiwan, elements in their pottery decoration could have originated somewhere in the Melanesian islands, possibly as a result of cultural and social interactions between newer Neolithic migrants and aboriginal hunter-gathers.

Figure 4 Lapita pottery (A) with various patterns of diagnostic dentate-stamped motifs including a bird (B), a zig-zag pattern (C), and a human face (D), all excavated from the Teouma site in Vanuatu by Australian National University (Photos taken by Ono in 2009)

If so, Lapita culture is more like a complex synergy involving both Austronesian immigrants and the Melanesian descendants of the Pleistocene and early Holocene hunter-gathers of New Guinea and the Bismarck Islands (e.g., Green 1991; Kirch 1997; Allen 2000). This also suggests that the Lapita people were created from a mixture of new migrants (farmers) from Asia and indigenous Melanesian islanders (hunter-gatherers).

In terms of the Lapita people's maritime exploitation and adaptation, they seem to have more developed maritime skills, for both fishing and seafaring. Regarding their fishing practices and marine exploitation, most of the Lapita sites produced more inshore fish remains, as with Bukit Tengkorak, including parrotfish, wrasses, snappers, triggerfish, groupers, emperors, unicorn fish, and porcupine fish. Although the number and volume are smaller, pelagic fish remains have also been found, including tuna and barracuda (e.g., Kirch and Dye 1979; Green 1986; Kirch 1997, 2000; Ono 2003, 2010, 2011; Ono, Hawkins, and Bedford 2019)

Further, several Lapita sites produced large to small-sized shellfish hooks and *Trochus*-made lure shanks (e.g., Kirch 1997, 2000; Szabó 2010; Ono, Hawkins, and Bedford 2019). Such lure shanks clearly show the possible employment of offshore trolling to catch skipjack tuna or other fast-swimming fish species; the Lapita *Trochus* lure shanks are possibly the oldest evidence for this type of hook so far (Figure 5). Various sizes and styles of shellfish hooks provide other evidence of

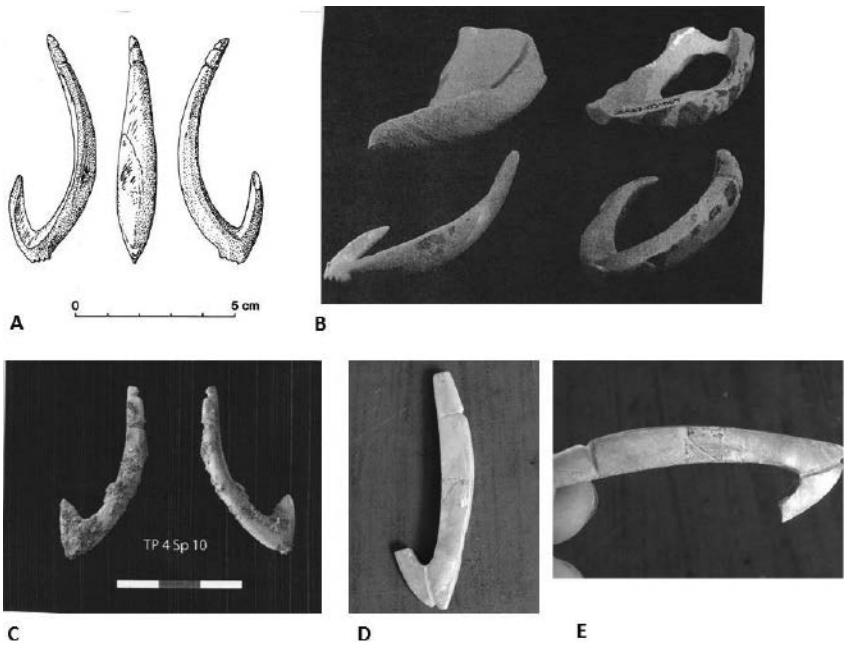

Figure 5 One-piece *Trochus*-made trolling lure-hooks from Western Lapita sites. (A-B) complete and worked lure-hooks from the Talepalemarai site on Musau Island, (C) a complete lure-hook from Kamgot site, (D-E) a broken lure-hook from Vao Island in Vanuatu (Ono et al. 2019).
(Source: A: Kirch 1997, p. 201, Figure 7.1; B: Kirch 1997, p. 200, Plate 7.2 and photo taken by Therese Babineau; C: Summerheys et al. 2010, p. 71, Figure 10; D: photo taken by Ono in 2009; E: photo taken by Ono in 2009).

active line fishing. Most of these hooks are made from *Trochus* sp. or *Turbo* sp. Shell; the former could originally be from the *Trochus* fish hook tradition, which dates back to the late Pleistocene to early Holocene in Wallacea and Melanesia (Figure 6). If the Lapita *Trochus* fish hooks belong to the old traditions of aboriginal hunter-gatherers in the region, this would imply possible technological interactions between the newer Neolithic migrants and the aboriginal population.

The area and islands to which the Lapita people migrated are mostly remote islands with limited land area, and can be recognised as places of marginal agricultural production during their initial migration stages. Possibly because of such factors, recent archaeological finds from the Lapita sites show heavy hunting pressure on local land animal resources, which made many of the larger terrestrial species (such as land tortoises, land crocodilians and large flightless birds) go extinct during the initial colonisation periods (e.g., White et al. 2010; Hawkins et al. 2016). Such rapid extinction of large land animals may have forced the early Lapita migrants to depend much more on marine resources for protein.

Lastly, regarding the Lapita's seafaring skills, we do not have any archaeological evidence of vessels used by the Lapita people, though it is thought that their colonisation could have been carried out via outrigger canoes using a

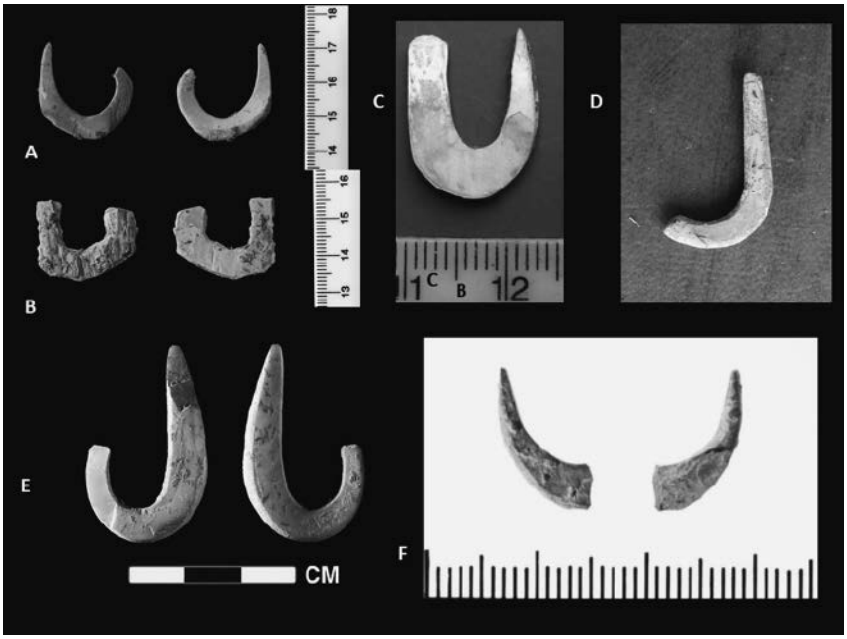

Figure 6 *Trochus*-made one-piece fishhook from Lapita sites (upper) and from late Pleistocene sites in Timor (lower). A and B: one-piece hooks from Kamgot (Szabo 2010); C and D: one-piece hooks from Vanuatu (Ono et al. 2019); (E) one-piece hook from the Lenehara site in East Timor, dated to 11,000 BP (O'Connor and Veth 2005); (F) broken fishhook from the Jerimalai site in East Timor, dated around 23,000 and 16,000 BP (O'Connor, Ono, Clarkson 2011).
(Source: A-B: photo provided by Summerhayes, p. 71, Figure 10; C: photo taken by Stuart Bedford in 2010; D: photo taken by Ono in 2009; E: O'Connor and Vath 2005, p. 254, Figure 5; F: O'Connor, Ono, and Clarkson 2011, p. 1120, Figure 3).

primitive Oceanic spritsail (Anderson 2000: 38). Outrigger canoes are a major canoe type in almost the entire area where the Austronesian language dispersed from Southeast Asia to the Pacific, and also in Madagascar in Africa, where later migrations by the Austronesian-speaking people occurred, possibly from the Indonesian islands 2,000 years ago. One exception is Taiwan, which is considered a potential place of origin for the Austronesian language group, and where no outrigger canoes have been used. It is unknown where the original outrigger canoes were invented, but they are certainly the major type of canoe in the Austronesian-speaking region.

The Lapita people's migration to islands in Remote Oceania also shows that these newer Neolithic migrants' ability to cross vast distances at sea may have been much greater than that of previous human voyagers during the late Pleistocene to middle Holocene. The Lapita people are the first human group able to successfully migrate beyond the sea gap in the Solomon Islands, or to travel between Near Oceania and Remote Oceania, then onward to many other remote islands including New Caledonia, Vanuatu, Fiji, Tonga, and Samoa. Such

migrations to remote islands sometimes required navigating over 800 km. Further, the corresponding Austronesian migration into the Mariana Islands in Micronesia from the Philippine Islands required navigating over 2,000 km (e.g., Bellwood 2013). These facts strongly suggest that the seafaring technology and skills of these newer Neolithic migrants were far more developed than those of the aboriginal Melanesian people, who were the descendants of Pleistocene and early Holocene hunter-gatherers in the region.

DISCUSSION

1) Possible Interactions between the Lapita and Aboriginal Melanesian People

Recent archaeological and genetic studies show the possible spread of aboriginal Melanesian people from New Guinea to surrounding remote islands, including the Maluku Islands west of New Guinea, during the post-Lapita period around 2,500 to 2,000 years ago (Ono et al. 2017, 2018a, 2018b; Bellwood 2019). In fact, many Melanesian islanders look physically similar to the people of New Guinea, with darker skin and curly hair, but not like Polynesian people, who are thought to be direct descendants of the Lapita. The current analysis of ancient DNA from the Vanuatu Lapita bones confirm that their DNA exhibits the highest similarity with the DNA of current aboriginal Taiwanese people, but not with Melanesian people (Skoglund et al. 2016). Although the number of Lapita individuals analysed is as yet limited, this outcome signals that the initial Lapita were composed of people originating in Asia.

On the other hand, most current Melanesian islanders are not like past Lapita people, and such physical changes might be due to later migration to the Melanesian islands by aboriginal Melanesians. If such post-Lapita migration happened in Melanesian areas, such events would also tentatively point to past social and technological interactions between newer groups and older/aboriginal people. With such interactions and information networking systems, the new migrants (farmers) could acquire knowledge about useful plant, animal, and marine resources in the islands, as well as hunting and fishing skills, while the older/aboriginal groups (mainly hunter-gatherers) could acquire new domesticated crop and animal species, long-distance navigation technology, and other forms of new material culture.

In the Indonesian region, the new archaeological findings of early metal-aged potteries with specific decorations in the Northern Maluku Islands, dating back to around 2200−2000 years BP, indicate the possibility that such decorations could have been introduced from the Melanesian islands, where such decorated pottery also appeared in post-Lapita times, dating back around 2500 to 2000 years BP (Ono et al. 2017; 2018a; 2018b).

Other archaeological evidence that the Melanesians sourced obsidian (possibly from the Fergusson Islands), excavated from the early Metal age burial site on Morotai Island in Northern Maluku (Peter Bellwood, personal com. 2017), implies

possible migration or interactions between the Melanesian region and the East Indonesian islands. The analyses of genome-wide data from the 56 populations in Island Southeast Asia by using new methods for tracing their ancestral gene flow by Lipson and others (Lipson et al. 2014) also confirms most of the Austronesian speaking groups in Island Southeast Asia contain Negrito or Papuan component as their ancestral components. All this evidence tentatively hints at active interactions between newer migrants and aboriginal hunter-gatherers during Neolithic times in Southeast Asia. With such social and technological interactions, a second wave of human migration by local and aboriginal Melanesian groups to remote islands both to the east and to the west could have happened.

In terms of intermarriage between these groups, the marriage of hunter-gatherer women to farmer men is commonly recorded in ethnographies (Bellwood 2005). However, the current DNA analysis of ancient Lapita remains in Vanuatu so far denies such a possibility in the initial stages and genetically identified three Lapita women as Asian, most closely related to contemporary indigenous Taiwanese groups (Skoglund et al. 2016). If such cases are common in the initial Lapita groups, intermarriage between these groups of Asian and Melanesian origin should have occurred sometime after the initial migration period or in early Lapita times. As mentioned above, other genetic studies on current populations in Remote and Near Oceania, as well as in East Indonesia, point to such a possibility. The archaeological study of later large-scale migrations and possible intermarriage between these groups is just beginning. Future research may reveal detailed migration and exchange network systems between these groups in the past, particularly during the post-Lapita phase between around 2500 to 2000 BP, in both Melanesia and the Maluku region in Indonesia.

2) New Perspectives on Possible Technological and Social Interactions in Prehistoric Times

The Austronesian people, as newer Neolithic migrants, extended into both Southeast Asia and Oceania during early Neolithic times between 4,000 and 3,000 years ago. Previous studies have corroborated that their subsistence was based on farming, animal husbandry, hunting, fishing, and gathering (e.g., Green 1986; Kirch 1997; Bellwood 2005; Ono 2010). Thus, they have been identified as farmer-based people, but not hunter-gatherers. Given the possible impact of such new migrants (who had an economy unlike that of the indigenous groups, whose economy was primarily grounded in the hunter-gatherer systems of Southeast Asia), previous linguistic, ethnological, and ethno-archaeological studies have established that the then-current hunter-gather groups—including the *Aeta* and *Negrito* peoples in the Philippines and the *Semang* people in Malaysia—may have been strongly affected over a long period by such farmer groups (e.g., Fox 1953; Headland 1986; Reid 1994; Bellwood 2005).

However, the exact time scale of such interactions is uncertain, and archaeological traces of contact between newly emigrated farmers and native

hunter-gatherers in Southeast Asia during prehistoric times remain unclear. For example, Ogawa (2009) conducted archaeological research to discern traces of resource exchanges between hunter-gatherers, possible ancestors of the *Aeta* people, and prehistoric farmers on northern Luzon in the Philippines. He selected both cave and rock shelter sites along hill and forest areas, and open sites in low lands and along river formations, for excavation. According to his hypothesis, the former sites could have been used by hunter-gatherers, while the latter sites could have been used by prehistoric farmers after Neolithic times. Following a comparative analysis of the two archaeological sites, he concluded that resource and tool exchange networks between the two groups may have existed in prehistoric times, though the archaeological data to indicate such exchange networks are currently very limited, and their details and historical processes are not well understood. Although the truth is still unverified, it seems clear that the migration of Austronesian groups had significant impacts on aboriginal hunter-gatherer societies in Southeast Asia.

The recent genetic study by Lipson and others confirms that all the studied *Aeta* people as one of the Negrito groups in the Philippines contain an average of 20 % Austronesian gene component (see Lipson et al. 2014, Figure 2). The *Aeta* have continued their hunting-gathering activities until recently, and have maintained their uniqueness to some extent, but their spoken languages belong to the Austronesian group (e.g., Fox 1953; Reid 1994). Thus, the aboriginal hunter-gatherer groups have also been strongly socially influenced by Austronesian farmers since Neolithic times.

The possible existence of Negrito gene component among the Austronesian farming groups mainly in the Philippines and wester Island Southeast Asia (Lipson et al. 2014) suggests that these newer migrants could have also been influenced by the indigenous hunter-gatherer groups and their subsistence activities. In Southeast Asia, there have been cases where a group that was historically a farming group became a hunter-gatherer group in a marginal environment. In Southeast Asia, the *Kubu* in Sumatra and *Punan* in Borneo are famous, and are likely to have biologically been Austronesian farmers in the past (Bellwood 2005), though they are reported in several European ethnographies to have been hunter-gatherers, at least after colonial times until recently. In the case of the *Punan* people on Borneo, also known as sago collectors, they seem to have originally been farmers in the river basin, then consciously shifted towards hunting and gathering in the tropical rain forest between the rivers (e.g., Sellato 1994, 2002; Koizumi et al. 2012).

Similar to the *Punan*, some coastal groups that originally practised both farming and fishing in Southeast Asia transformed into a maritime-oriented society with full-time fishermen groups. The *Sama-Bajau* and *Orang Laut* people have a reputation of being ‘sea people’ and ‘fishing and collecting people’ (e.g., Sather 1997; Ono 2010, 2011). Although they tended to move seasonally in search of marine products, such seasonal movement and fishing had a high commercial orientation, and market principles can be identified in the context of their

activities. The *Sama-Bajau* can be also divided into two main groups: one with a joint land- and sea-based economy known as *Sama dyak* (Land Sama), and another focused on sea-based fishing and gathering, known as *Sama di Laut* (Sea Sama). Historically, these two groups lived side by side with an exchange network system and market principles.

The ethnographic cases of the *Kubu*, *Punan*, and *Sama-Bajau* peoples, who can be linguistically and physically identified as Austronesian, indicate that some originally agriculturalist Austronesian groups could have shifted into fairly marginal agricultural and marine-based production economies in Southeast Asia. Although it is unclear when such a shift of subsistence and economy did occur among these ethnic groups, these cases could have resulted from long adaptation processes to environments by the newer migrant groups, and also the possible impact of any technological and social interactions with aboriginal hunter-gatherer groups, including the ancestral *Aeta* and *Negrito* peoples.

For Oceania, we have more and varied archaeological evidence of possible technological interactions between Lapita people, as the newly Austronesian migrants and the aboriginal Melanesian groups date back to Neolithic times. Previous studies have mainly focused on motifs in Lapita pottery as evidence for material culture (e.g., Kirch 1997), while we confirm here that possible technological interactions between these groups could have occurred in terms of maritime-based technology and material culture.

The use of *Trochus* shell hooks over a very long period of time by aboriginal hunter-gatherer groups in the Melanesian region and South Wallacea date back to the terminal Pleistocene; the intensive use of *Trochus*-made hooks (with more variety in Lapita culture) is one such piece of evidence. Importantly, such *Trochus*-made shell hooks have thus far not been found in Taiwan or the Philippines and North Wallacea regions, but can be recognised as a local trend from Melanesia to South Wallacea (such as the islands of Timor and Alor). Some variation in fish hooks has been known in Taiwan and the Mariana Islands in Micronesia, dating back to early Neolithic times. This evidence signals that the early Austronesian migrants did have fish hooks as part of their material culture, and engaged in line-fishing with hooks to target certain fish species, but their fishing technology and fish hook variety further developed when they reached Melanesia and South Wallacea.

The archaeological finds of Musa banana genus (mainly *Musa acuminata*) cultivation at some Lapita sites (Lentfer and Green 2004; Kennedy 2008; Horrocks et al. 2009) provide further evidence of technological interactions. However, recent ethno-botanical and genetic studies have revealed the strong possibility that the Musa genus banana came from New Guinea, as their phytoliths are also present in the Kuk Swamp site from about 10,000 years ago (Denham et al. 2003), while the major species—including *Musa acuminata* and *Musa balbisiana*—were distributed widely in New Guinea, Southeast Asia, and South Asia, possibly before 4000 years BP or pre-Austronesian times during the Holocene (Donohue and Denham 2009;

Xavier et al. 2011). If future, detailed micro-botanical and genetic studies of excavated Musa phytoliths can identify them at the species and genetic level, we will have a clearer view of past technological interactions and farming culture knowledge exchanges between newer Austronesian migrants and aboriginal Melanesian people in New Guinea.

In terms of the potential technological influence of Austronesian migrants on aboriginal Melanesian people, new aspects of material culture, such as pottery production and polished stone adzes, became popular after 3000 BP in both the coastal and highland regions of New Guinea (Summerhayes and Allen 2007; Gaffney et al. 2015). Although the agricultural economy had begun by at least 7000 BP in the New Guinea Highlands, as known from the famous Kuk Swamp site (e.g., Denham et al. 2003), there was no pottery production in New Guinea and the surrounding islands before the arrival of Lapita or Austronesian migrants. Thus, the broader spread of pottery production and its use is clear evidence of the technological and possible social interactions during Lapita times, as well as in post-Lapita times. The introduction of the pig as a domesticated animal into New Guinea probably commenced after the arrival of Austronesian groups. In previous studies, some pig remains were actually excavated and reported from some early Holocene sites in New Guinea and surrounding islands dating back to around 10,000 BP (e.g., Bulmer 1975; Allen 2000), though no securely dated pig bones have been found to before 3000 BP, and most excavated pig bones in New Guinea dated to less than 500 years old as much younger than the previous expectations (e.g., O'Connor, Barham, and Aplin et al. 2011).

Lastly, other vital technologies likely introduced by the Austronesian migrants were outrigger canoes or highly developed navigation technology. Although we have no clear and exact archaeological proof of early Austronesian boats in either Southeast Asia or Oceania, all evidence of early Austronesian migration to many remote islands located between 200 and 2000 km from the nearest location/island tentatively indicates highly developed navigation skills and technology. The later extensive movement or migration by Melanesian groups between the Maluku Islands and Remote Oceania during post-Lapita times (around 2000 BP) may have been triggered by the introduction of developed maritime technology and continued interactions. The current archaeological and genetic evidence is still too fragmented to reconstruct the details of such interactions between Austronesian migrants and aboriginal hunter-gatherer groups after Neolithic times, though we can state that the likelihood of such an interaction having taken place, both in Island Southeast Asia and in Oceania, in prehistoric times is quite possible.

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