







Research Article

Preceramic riverside hunter-gatherers and the arrival of Neolithic farmers in northern Luzon

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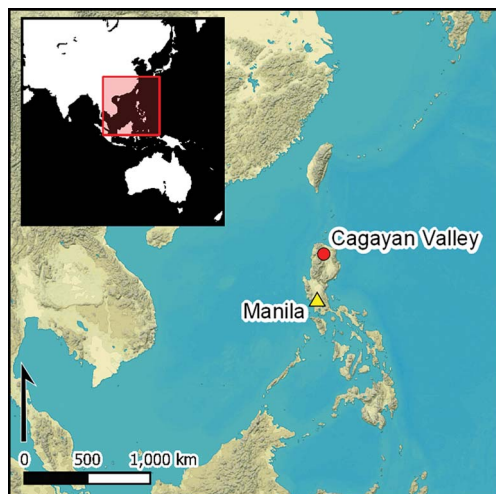
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The most westerly Pacific island chain, running from Taiwan southwards through the Philippines, has long been central in debates about the origins and early migrations of Austronesian-speaking peoples from the Asian mainland into the islands of Southeast Asia and Oceania. Focusing on the Cagayan Valley of northern Luzon in the Philippines, the authors combine new and published radiocarbon dates to underpin a revised culture-historical synthesis. The results speak to the initial contacts and long-term relationships between Indigenous hunter-gatherers and immigrant Neolithic farmers, and the question of how the early speakers of Malayo-Polynesian languages spread into and through the Philippines.

Keywords: Southeast Asia, Philippines, Neolithic, shell middens, radiocarbon dating, human migrations

Introduction

Located 125km off the south-eastern coast of China, the island of Taiwan was host to the earliest Neolithic cultures that existed offshore from the southern Chinese mainland. The Dabenkeng Culture, which marked their initial arrival, commenced *c.* 5500–5000 BP (Tsang *et al.* 2006; Hung & Carson 2014). Taiwan was also the most likely immediate

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archaeological source for the Neolithic settlement of the northern Philippines more than 4000 years ago (Hung 2005, 2008; Bellwood *et al.* 2011; Bellwood 2017; Carson & Hung 2018). Recent research on ancient DNA from northern Luzon, the Mariana Islands and the south-western Pacific suggests that the modern Austronesian-speaking populations of Island Southeast Asia and Oceania (beyond New Guinea and Island Melanesia) acquired much of their genetic heritage through ancient migration from southern China, via Taiwan, and through the Philippines (Skoglund *et al.* 2016; McColl *et al.* 2018; Pugach *et al.* 2021; Wang *et al.* 2021; for support from living DNA relationships, see Choin *et al.* 2021; Tätte *et al.* 2021; for a recent, thoughtful review, see Chambers & Edinur 2021).

These observations mean that Luzon, the first large landmass to be reached by Neolithic migrants heading south from Taiwan, must have played a significant role in the development of the ancestral languages and cultures of the Austronesian-speaking peoples of recent ethnographic times and through to the present. In terms of linguistics, for example, the Austronesian language family is divided into two major phylogenetic divisions: one includes the Indigenous (non-Sinitic) Formosan languages of Taiwan, while the other includes the Malayo-Polynesian languages of all other regions of the Austronesian world, from Madagascar to Rapanui (Easter Island), as well as the Philippines. Taiwan is also the source of Proto-Austronesian, the earliest proto-language that can be reconstructed through comparison of historically recorded and living Austronesian languages (e.g. Blust 1984/1985, 2019; Gray *et al.* 2009). The proto-language for the Malayo-Polynesian subgroup is thought to have developed somewhere within the northern Philippines, including Luzon and the Batanes Islands, or perhaps in eastern Taiwan (Ross 2005; Chen *et al.* 2022).

Sitting at the north-western limit of the Malayo-Polynesian linguistic distribution, northern Luzon would have been a strategic location for Neolithic migrants from Taiwan entering a world of ancestral Negrito hunter-gatherers in the Philippines. Based on the dating of several Neolithic assemblages in the Batanes Islands and northern Luzon, the first encounters between these Proto-Malayo-Polynesian-speaking migrants—carriers of a large agricultural vocabulary that included terms for rice cultivation and domesticated pigs and dogs—and the Indigenous hunter-gatherer populations of Island Southeast Asia occurred *c.* 4200–4000 years ago (e.g. Blust 1995; Hung 2005, 2008; Bellwood *et al.* 2011; Bellwood & Dizon 2013).

Today, the broad alluvial plain of the Cagayan Valley in northern Luzon, created by tectonic fault lines and the longest and widest river valley in the Philippines, is occupied by Filipino rice farmers. The hills beyond, especially to the east (Sierra Madre), still contain small populations of Negrito foragers, whose genetic ancestors were present within the region when Austronesian speakers arrived (Arenas *et al.* 2020). There is evidence, however, that many cultural aspects deemed characteristic of Negrito populations today are of relatively recent origin, reflecting the impacts upon them of the immigrant farmers who occupied their former lands. These characteristics include restriction to remote forested regions of little value to farmers and the adoption of Malayo-Polynesian languages (Reid 2013; Bellwood 2017). Clearly, research into the initial contacts and long-term relationships between Indigenous hunter-gatherers and immigrant Neolithic farmers in the Cagayan Valley has the potential to illuminate the question of how the early speakers of Malayo-Polynesian languages managed their expansion into and through the Philippines.

During the past 20 years, new archaeological data from the lower Cagayan Valley and neighbouring regions have become available. These data span much of the Holocene era, encompassing the replacement of an entirely foraging-based economy by a system of food production with some ancillary foraging, as we report here. This study provides new radiocarbon dates from seven shell middens in the Cagayan Valley, including four excavated by the authors, as well as related dates from other sites in the region. The total corpus of 47 radiocarbon dates is calibrated in a Bayesian model. The resulting chronology, which includes four directly dated samples of domesticated rice, provides a solid foundation for the revised culture-historical synthesis presented here.

We discuss the evidence in terms of three cultural periods, which we term Preceramic (no pottery, no metal), Neolithic (pottery, no metal), and Metal Age (pottery and metal). While some might regard this terminology as rather traditional within the intellectual history of archaeology, we regard it as useful, relatively unambiguous and difficult to replace with any other more suitable scheme. This terminology allows us to discuss broader issues that span the past 7000 years since the formation of the Cagayan alluvial plain following postglacial sea-level rise. Coastal and valley-bottom sites more than 7000 years old are now located below sea level or are buried under many metres of in-washed sediment.

Geography and research background

The Cagayan River is the longest river in the Philippines (Figure 1: 1). From its headwaters in the Caraballo Mountains in central Luzon, it flows northward for 446km to enter the Babuyan Channel. Its basin contains deep alluvial deposits, accumulated from the main river and its various tributaries, totalling approximately 3125km² of Tertiary and Quaternary alluvial fill (Wernstedt & Spencer 1967: 17 & 314).

Luzon does not lie on a continental shelf, and therefore its coastlines rise steeply from great offshore depths. During the Last Glacial Maximum (*c.* 24–18 kya), the rivers of Luzon incised canyons into their lower courses and flowed to meet a sea level that was nearly 120m below its present position. With postglacial sea-level rise, the narrow and steep-sided canyons were flooded, and the Cagayan Valley, in particular, included a sprawling estuary, which extending inland for perhaps 100km from the palaeo-coastline. By 7000 years ago, the rising sea had stabilised to around its current level, and in-washed sediments thereafter created the present-day Cagayan alluvial plain, burying under considerable depths the remains of any previous human settlements, as has been documented previously (Carson & Hung 2018).

Archaeological explorations in the lower Cagayan Valley commenced in May 1971, when Israel Cabanilla and Yoji Aoyagi discovered the Magapit shell midden, located atop a section of the steep eastern bank cut back by the Cagayan River (Cabanilla 1972). So far, over 30 shell middens have been reported in the lower Cagayan Valley, making it perhaps the densest landscape of prehistoric settlement in Island Southeast Asia. The large number of middens reflects the unusually rich shellfish resources of the mid-Holocene estuary.

Most of these shell middens are distributed over a distance of 20–30km between the modern towns of Gattaran and Lal-lo. Downstream, to the north of Lal-lo, the alluvium is too recent to contain sites of Neolithic date. All Neolithic sites were previously identified as



Figure 1. 1) The Cagayan River in the Lal-Lo area; 2) part of the Magapit shell midden; 3) archaeological excavation of square P15 at Nagsabaran; 4) the Nagsabaran site, viewed from a distance (photographs by H.C. Hung).

exposures in the banks of the river, or as mounds with loose shell near to the river. The shell middens comprise thick deposits of *kabibe* bivalve shell (*Batissa childreni*), with small quantities of other estuarine gastropod and bivalve species, including *Thiara rudis*, *Thiara winteri*, *Melanoides tuberculata*, *Melanoides granifera*, *Melanoides maculata*, *Corbicula fluminea* and *Nitidotellina minuta*. Some of the shell middens are more than 5m deep (Figure 1: 2–3), and many overlie basal layers of alluvium containing pottery and other artefacts (Aoyagi et al. 1993; Ogawa 2005; Hung 2008).

In addition to the shell middens, there are several caves and open sites in the limestone hills to the east of the Cagayan River, especially in the Peñablanca region. These sites contain cultural sequences from the Preceramic through to the Metal Age, and document continuing interaction between hinterland foragers and riverine agriculturalists, described ethnographically for this region by Jean Peterson (1978). Callao Cave is the largest and oldest of these sites; excavations here have recovered evidence of *Homo luzonensis*, a small-bodied hominin species of the Late Pleistocene (Détroit et al. 2019).

Several of the shell middens in the Cagayan Valley contain layers that span variously the Preceramic, Neolithic and Metal Age periods. The Gaerlan shell midden, located on the east bank of the river, 45km upstream from its mouth, for example, includes a lower Preceramic matrix and an upper Neolithic matrix with potsherds (Ogawa 2005). Other middens near Lal-lo, such as Catugan, Irigayen and Nagsabaran, contain Neolithic and Metal Age layers with no underlying Preceramic layer. At these three sites, the red-slipped, and sometimes incised and stamped Neolithic pottery extends downwards into the alluvium that pre-dates the shell midden. The Metal Age black wares tend to be concentrated in the shell middens themselves (Tanaka 1998; De la Torre 2000; Hung 2008).

So far, no shell midden has revealed a continuous chronological sequence covering the past 7000 years, but some caves may have preserved longer time spans. For example, investigations of Pintú rockshelter, located 250km south of Lal-lo on the Ngilinan tributary of the Cagayan River in Barrio Cabu'an, Nueva Vizcaya Province, have recovered core and flake stone tools throughout the sequence, with sparse pottery in the middle and upper layers. Two radiocarbon dates from Pintú calibrate to 4960–3683 BP for Preceramic occupation and 4150–2949 BP for the earliest appearance of pottery (Peterson 1974; see Table S1 in the online supplementary material (OSM)), although the error ranges are broad. The pottery at Pintú is described as a “reddish-orange ware” (Peterson 1974: 29), with some rims showing stamped circles on their interiors, resembling the Neolithic red-slipped sherds from the Cagayan Valley.

The Preceramic period (7000–4200/4000 BP)

The chronology and cultural content of the Preceramic shell middens is established based on four sites: Ulet, Leodivico Capiña, Miguel Supnet and Gaerlan. Their locations are shown in Figure 2 (1, 2, 6 & 7, respectively), with relevant radiocarbon dates listed in Table S1. These sites are located on islets of slightly raised alluvium or on promontories close to the mouth of a Cagayan estuary that, at 7000–4200/4000 BP, was much broader than it is now.

Of these four Preceramic shell middens, Ulet yielded stone flakes but no pottery during augering in 1986, with an associated date of 6745–6495 cal BP obtained from charcoal

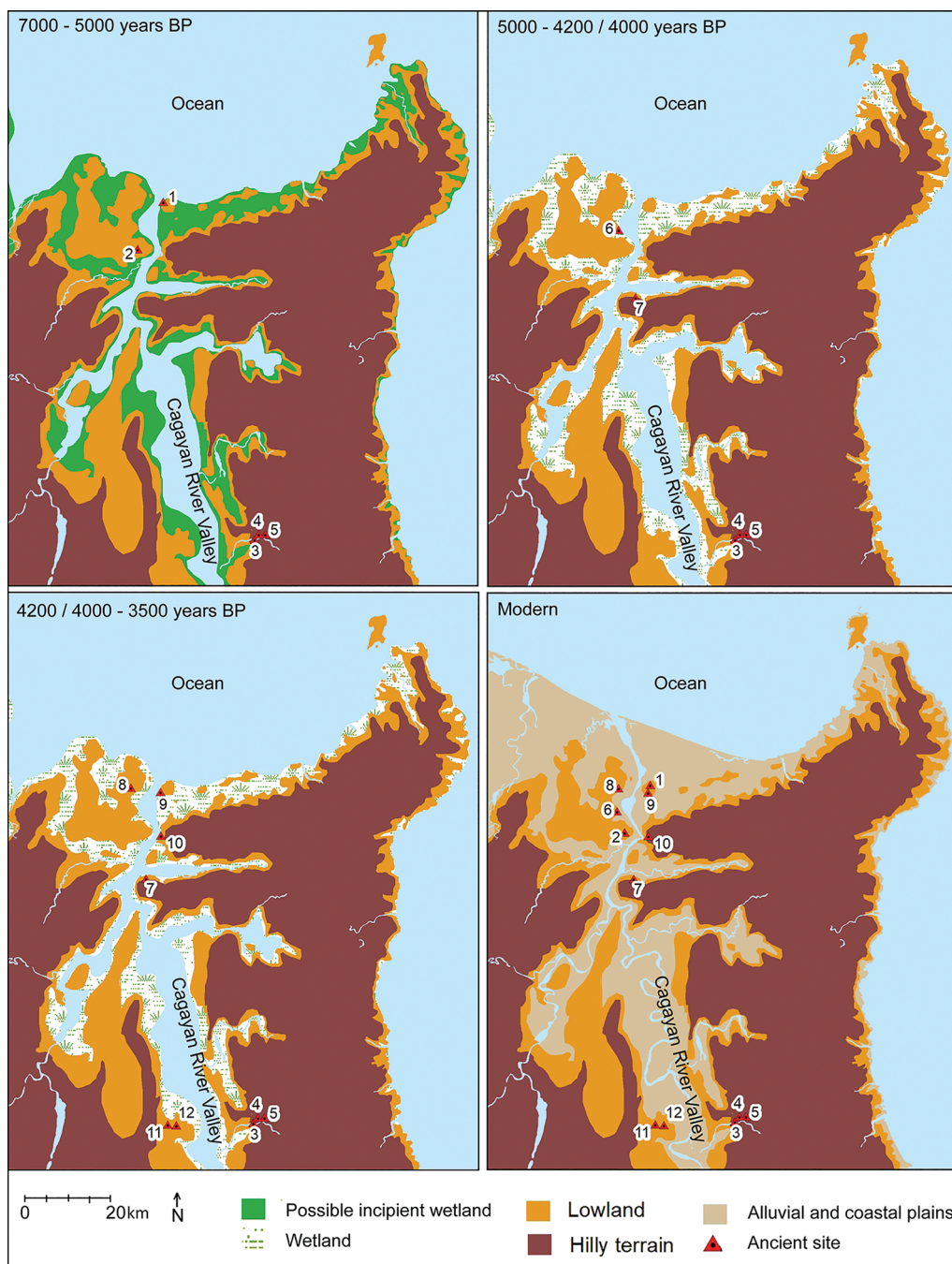


Figure 2. The major archaeological sites discussed in this study and landscape changes through time in the lower Cagayan Valley: 1) Ulet; 2) Leodivico Capiña; 3) Callao Cave; 4) Musang Cave; 5) Arku Cave; 6) Miguel Supnet; 7) Gaerlan; 8) Nagsabaran; 9) Irigayen; 10) Magapit; 11) Pamittan; 12) Andarayan. This figure uses an ancient landscape model refined by Carson and Hung (2018) (figure credit: M.T. Carson).

(Ogawa & Aguilera, Jr. 1992). Gaerlan has a lower Preceramic layer with chert and andesite flakes, dated to 4295–4090 cal BP from animal bone (Table S1: NUTA2-7941). The upper layer with red-slipped pottery at Gaerlan has three dates that range from 4092–3687 cal BP (Ogawa 2005).

The Leodivico Capiña and Miguel Supnet middens are located on the west bank of the river. Both comprise 1.5–3m of dense shell midden containing animal bones and flakes of chert. When excavated by Tsang, Santiago and Hung in 1998, these sites were regarded as Neolithic. Both middens, however, lack pottery below their topsoil, as well as the polished stone tools, baked clay spindle whorls and body ornaments that now are understood to be indicators of regional Neolithic assemblages (Tanaka 2002; Hung 2005, 2008; Ogawa 2005). Excavation square P1 at Leodivico Capiña, for example, yielded 39.5g of pottery from the upper 0.30m of a 4 × 4m trench that was 3.2m in overall depth; no pottery was found below this level. A similar situation was recorded at Miguel Supnet. In total, 20 radiocarbon dates are available for these two sites, based on charcoal, animal bone and riverine shell. The dates fall between 7074 and 4514 cal BP (Figures 3, 4 & 5; Table S1).

The faunal remains previously recovered from the Preceramic deposits at Leodivico Capiña and Miguel Supnet include wild pig (probably *Sus philippensis*), deer, rat and bird, together with riverine shellfish, fish and turtle (Tsang *et al.* 2002). The botanical macroremains recovered from Leodivico Capiña and Miguel Supnet in 1998 suggest a presence of tubers and nuts, probably including wild yam, but no evidence was found for cereals, such as rice or millet (Paz 2001).

In Southeast Asia, pre-Neolithic coastal and riverine shell midden sites dated to between >7000 and 4500 cal BP are reported from Vietnam, Thailand, Peninsular Malaysia, Sumatra, Sulawesi, Mindanao and southern China (Figure 6) (e.g. Van Stein Callenfels 1936; Ha 1996; Bolunia 2005; Zhang & Hung 2012, 2016; Higham 2014; Bellwood 2017; Hung 2019; Hung & Zhang 2019). Many were created by foragers of Australo-Papuan skeletal affinity (Matsumura *et al.* 2019), and many in northern Vietnam and southern China contained pottery, although neither pottery nor human remains have yet been recovered from the Preceramic middens in the Cagayan Valley.

The Neolithic period (4200/4000–2400 BP)

The Neolithic of the Cagayan Valley saw the introduction of a new assemblage that included pottery, baked clay spindle whorls, polished stone adzes, bark-cloth beaters and body ornaments. The latter include penannular ear pendants, bracelets and beads that were variously made of shell, baked clay, quartz schist and semi-precious stones, including Taiwan nephrite (jade) from the Fengtian source near Hualian, eastern Taiwan. Small numbers of chert flakes appear occasionally in these Neolithic assemblages, but most functional stone tools appear to have been wholly polished (Ogawa 2005; Hung 2008) (Figure 7: 13–23).

According to the available radiocarbon dates, the Cagayan Neolithic began *c.* 4200–4000 BP (Figure 3; Table S1). This dating is coeval with that of the related cultural horizon in the Batanes Islands to the north of Luzon (Bellwood & Dizon 2013). From a linguistic perspective, the Batanes Islands and Luzon were settled at around the same time by people of a shared language community (Ross 2005; Blust 2019). While this migration apparently brought the

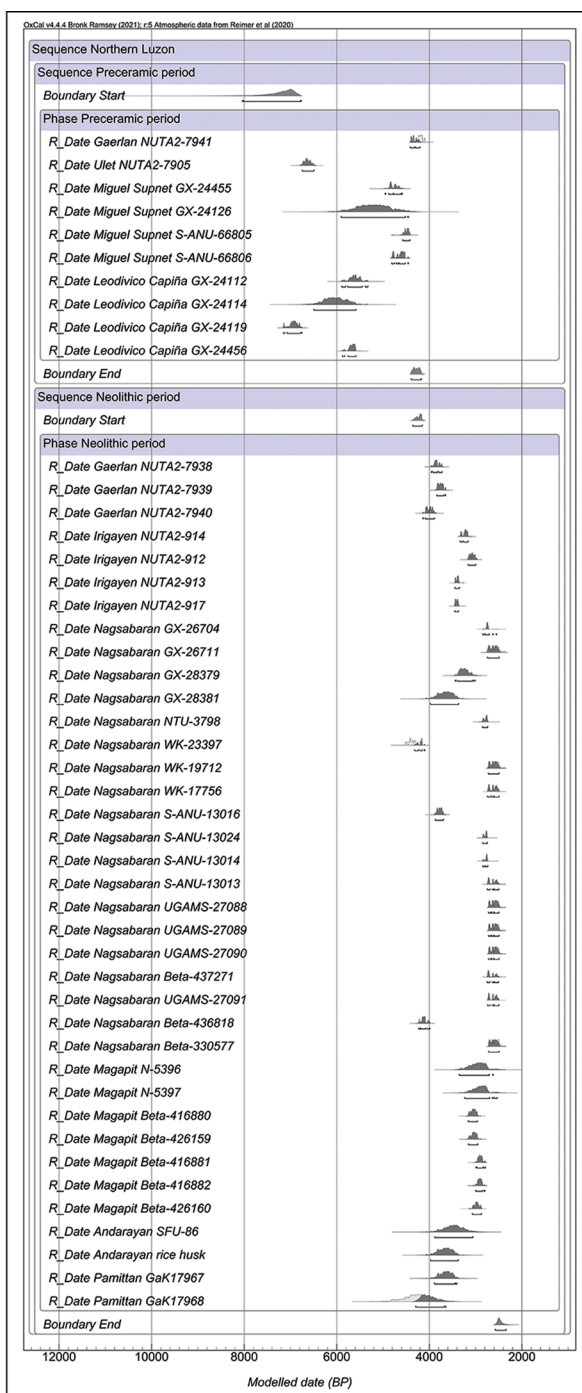


Figure 3. Radiocarbon dates on charcoal, bone and crop remains from all sites discussed in the Cagayan Valley. Riverine shell dates are excluded here owing to uncertain limestone effects but see Table S1 in the online supplementary material (OSM). The dates have been calibrated in a Bayesian model incorporating phasing (Bronk Ramsey 2009), using OxCal v4.4.4, with IntCal20 (Reimer et al. 2020).

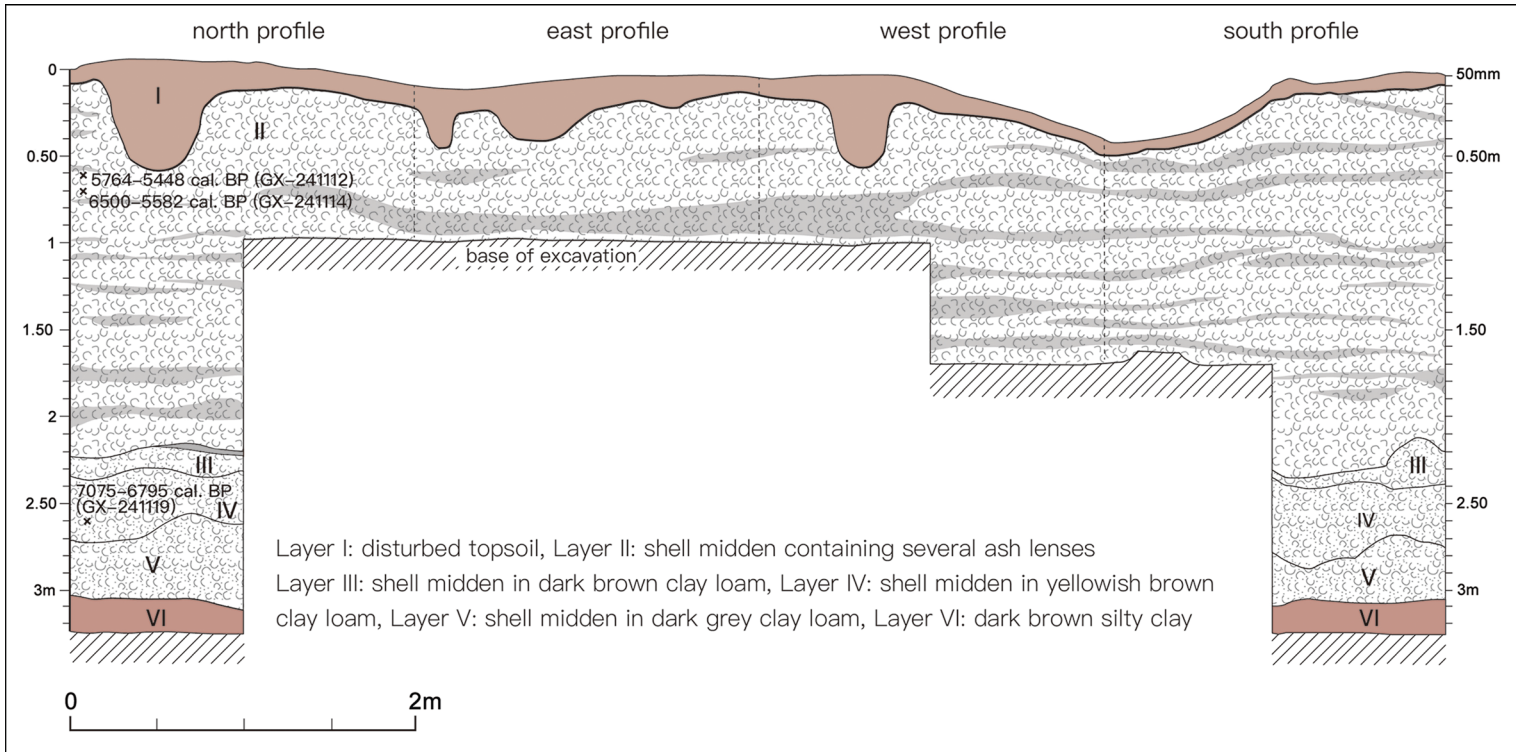


Figure 4. North, east, west and south profiles of square P1 at Leodivico Capiña shell midden, with the locations of three radiocarbon dates on charcoal (GX-241112, 241114 and 241119) (figure credit: H.C. Hung).

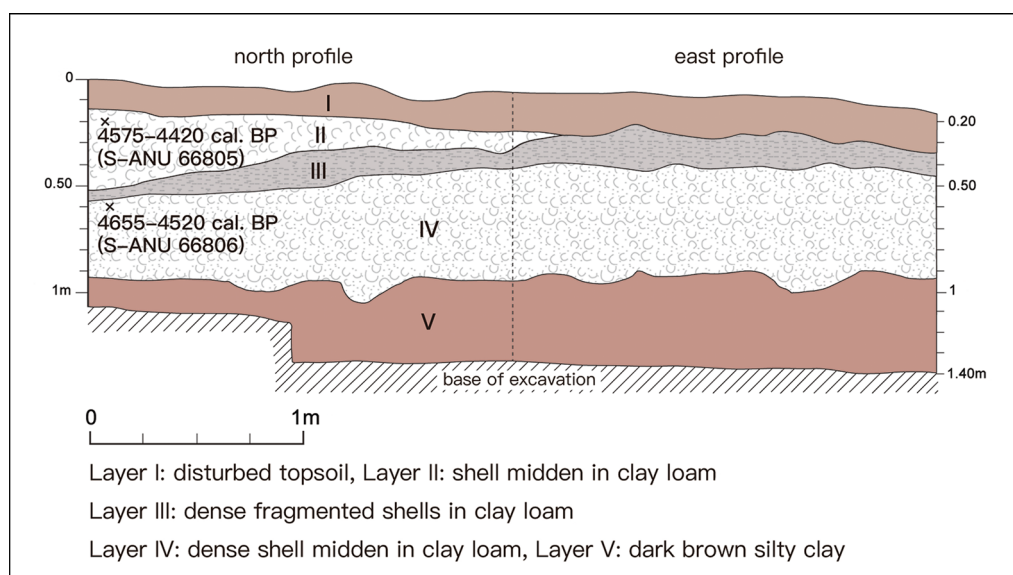


Figure 5. North and east profiles of square P2 at Miguel Supnet shell midden, with the locations of two radiocarbon dates on pig bone, unidentified to species (S-ANU 66805 and 66806). A wild pig species, *Sus philippensis*, is endemic to the Philippines (figure credit: H.C. Hung).

first people ever to live in the Batanes (based on current evidence), it also introduced an overlay of people into the already-inhabited land mass of Luzon.

The Neolithic assemblages from Nagsabaran and Magapit (Figure 1: 2–4; Figure 2: locations 8 & 10) contain bones of domestic pigs (directly radiocarbon dated to 4448–4246 cal BP at Nagsabaran; see Hung 2008; Piper *et al.* 2009) and macro-botanical remains of rice (*Oryza sativa*) and Job’s tears (*Coix lacryma-jobi*). The Neolithic layer of Nagsabaran yielded 79 rice grains and fragments, as well as 224 grains and fragments of Job’s tears, from a 4 × 4m trench excavated by Hung, Bolunia, Carson and Deng in 2016 (Figure 8). Foxtail millet (*Setaria italica*) then made an appearance in the Metal Age layers. Similar evidence was recovered at Magapit in 2015, where rice spikelet bases with domesticated-type abscission scars were identified in our preliminary study (Figure 9). One carbonised rice grain from the Magapit profile has been directly radiocarbon dated to *c.* 3200–3000 cal BP (Beta-416880), but the lower stratigraphy in this site has not yet been exposed. In addition, the Neolithic layer of Magapit has produced possible banana phytoliths (*Musa* sp.), the domestication status of which is unknown.

Recently, archaeobotanical evidence for Neolithic mixed rice and millet agriculture has been recovered in adjacent regions, associated with dates of 4600–4800 cal BP, at Gancaoling, in the Pearl River Delta of coastal Guangdong (Deng *et al.* 2022), and >4500 cal BP at Nanganlidong, in southern Taiwan (Tsang *et al.* 2017).

Approximately 80km south of Magapit, the Neolithic site of Andarayan (Figure 2: location 12) has also produced red-slipped pottery with an AMS date of 3935–3378 cal BP from a rice husk inclusion, together with another charcoal date of 3890–3060 cal BP (Snow *et al.*



Figure 6. The location of the study area (lower Cagayan Valley, North Luzon), and the locations of representative (pre-farming) shell middens in southern China and Southeast Asia during the Middle Holocene, c. 7000–4500 years BP (figure credit: CartoGIS Services, ANU Scholarly Information Services, The Australian National University).

1986). A macro-botanical presence of rice is therefore now attested at three Neolithic sites in the Cagayan Valley (Nagsabaran, Magapit and Andarayan), although there was less available lowland, alluvial farmland at that time (Carson & Hung 2018) (Figure 2: lower left).

Two major characteristics of the oldest Neolithic pottery in the Cagayan Valley are the use of a sand temper and a distinctive red slip (Aoyagi *et al.* 1993; Hung 2008) (Figure 10). These attributes are paralleled closely in the red-slipped pottery from Andarayan, and from the sites of Chaolaiqiao (4200 cal BP) in south-eastern Taiwan (Hung 2005, 2008) and Minanga Sipakko in West Sulawesi (3500–3200 cal BP; Anggraeni *et al.* 2014). Both Chaolaiqiao and Minanga Sipakko have also yielded plentiful rice phytoliths (Deng *et al.* 2018, 2020) (Figure 10: 6 & 15). Furthermore, a red-slipped pottery assemblage with the same rim forms and vessel shapes as those in the Cagayan sites has been radiocarbon dated via associated charcoal to 3560–3380 cal BP at Yinian, in south-eastern Hainan Island (Wang



Figure 7. Nagsabaran Metal Age Indo-Pacific glass beads (1), bronze bell-shaped ornaments (2), iron knife (3) and black pottery (4–12); Neolithic red-slipped pottery (13–14), clay spindle whorls (15–16), clay object (17), flaked chert (18–19), polished andesite adze (20), tuffaceous sandstone stepped-adze preform (21), green quartz schist beads (22) and Taiwan nephrite bracelet fragment (23) (scales in cm) (photographs by H.C. Hung).

et al. 2016) (Figure 10: 11–12). Notably, Hainan has never been considered as part of the Austronesian expansion during its Neolithic phase. Tsat is descended from a population that fled from Vietnam to Hainan after the fall of the northern Cham capital to the Vietnamese in AD 982 (Blust 2019). Today, the Hlai people in Hainan still speak Kra-Dai (Tai-Kadai) languages, which are part of a family considered by several linguists (e.g. Ostapirat

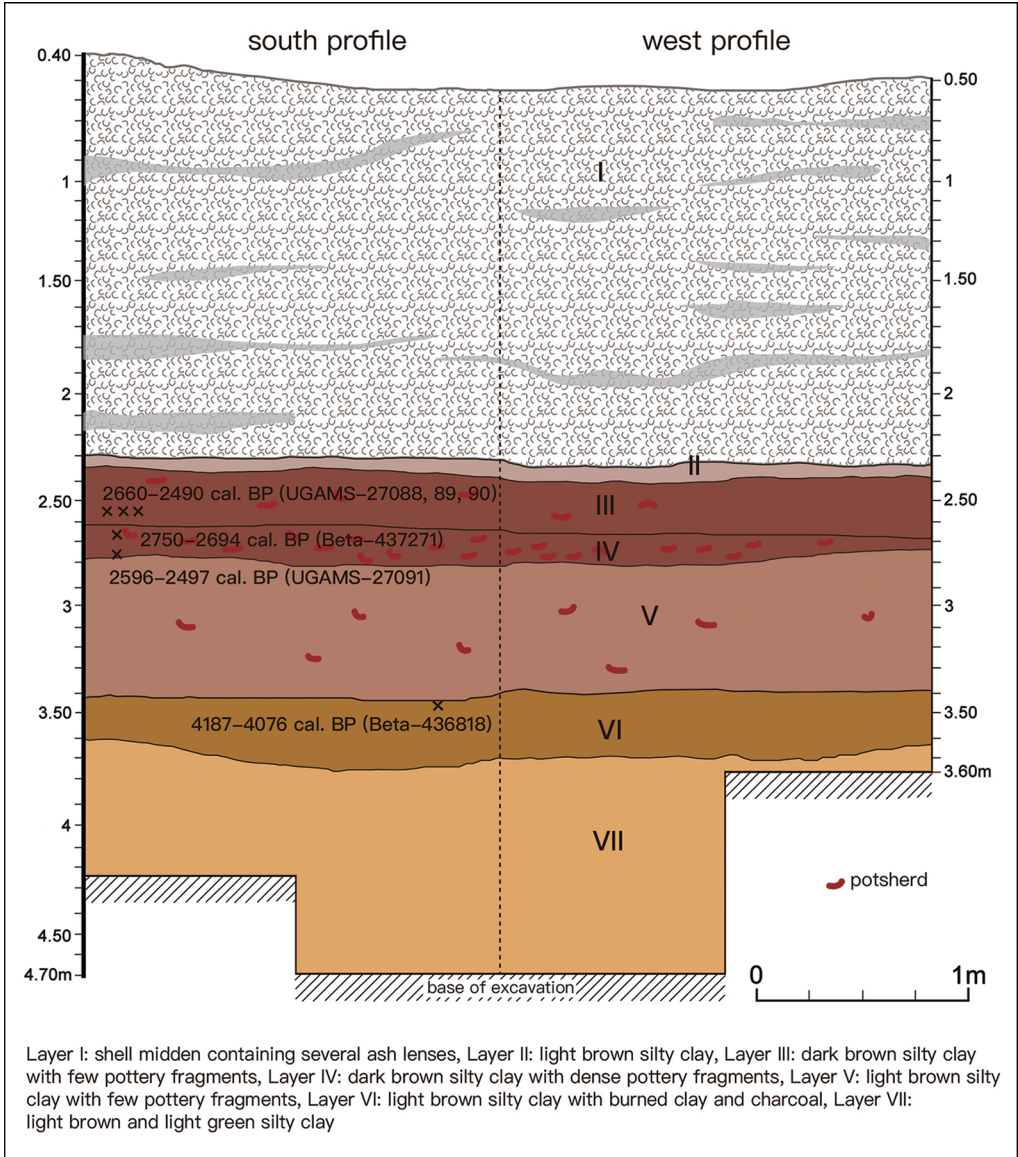


Figure 8. South and west profiles of square P15 at Nagsabaran, with six radiocarbon dates, comprising UGAMS-27088 and UGAMS-27091 on Job's tear (*Coix lacryma-jobi*) grains; UGAMS-27089, UGAMS-27090, and Beta-437271 on rice (*Oryza sativa*) grains; and Beta-436818 on charcoal (figure credit: H.C. Hung).

2005; Sagart 2005) to be distantly related to Austronesian, and especially Malayo-Polynesian languages in Island Southeast Asia, thus suggesting the probability of ancient contact.

In the Cagayan sites, 1 per cent or less of all red-slipped pottery fragments have fine incised and impressed decoration that includes *pointillé* (or punctate) stamped geometric motifs,

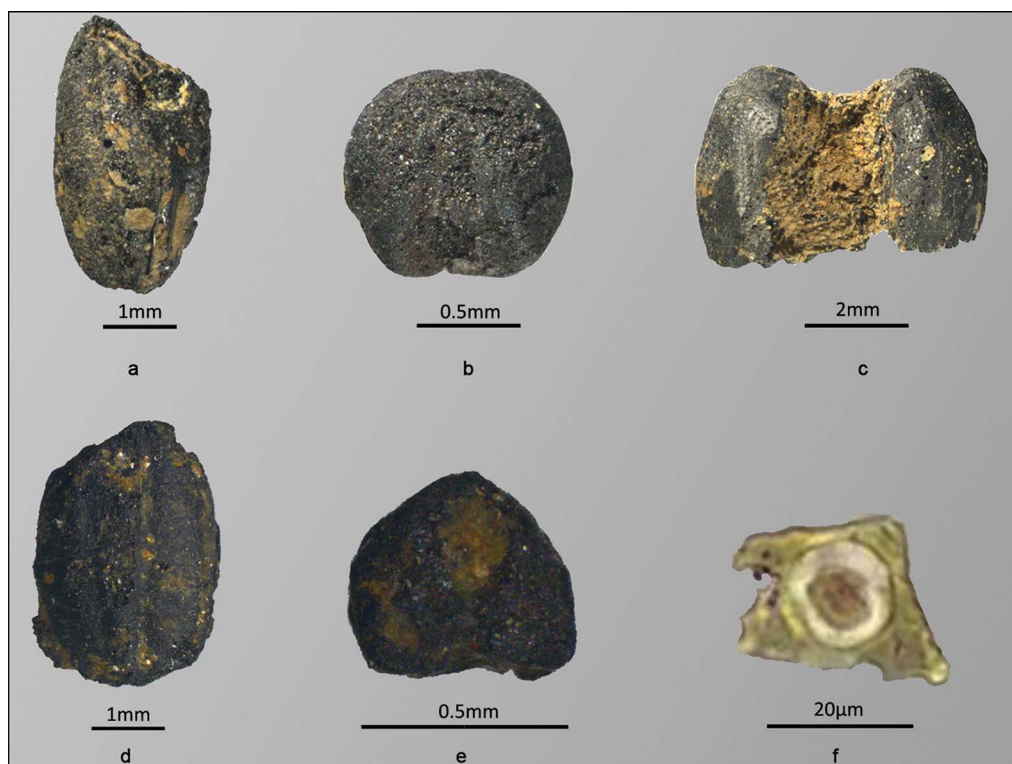


Figure 9. Plant remains from Nagsabaran (a–c) and Magapit (d–f): a & d) rice (*Oryza sativa*) grains; b) foxtail millet (*Setaria italica*) grain; c) Job's tear (*Coix lacryma-jobi*) grain; e) rice spikelet base; f) phytolith of cf. *Musa* sp.; item (b) is Metal Age, while all others are from Neolithic layers (figure credit: Z. Deng).

created from rows of small, round and pointed impressions interspersed with stamped circles, and sometimes organised within fields outlined by incised lines. This type of decoration is well represented in Nagsabaran and Magapit (Figure 10: 16–20). Most of this stamped decoration occurs on rims, carinated shoulders and ring feet, forming straight or zig-zag lines and geometric patterns. Punctuate decoration in the Cagayan Valley suggests the use of a toothed, comb-like tool, and the impressions often retain traces of white lime or white clay infill.

At Gaerlan, Irigayen, Nagsabaran and Magapit, the layers containing red-slipped earthenware include both decorated and undecorated sherds, and a definitive starting date has been difficult to ascertain for the decorated pottery. Our current estimate, based on available radiocarbon dates and stratigraphic contexts, is c. 3700–3500 cal BP. From a broader geographical perspective, similar incised and impressed decoration with lime infill also occurs at Neolithic sites in northern Vietnam, such as Man Bac and Xom Ren (Figure 10: 26–30), where it is dated to between 3900 and 3500 cal BP. Vessel forms and rim shapes here, however, are significantly different from those in Luzon, and have little of the diagnostic red slip that dominates in Island Southeast Asia and Oceania (Khan 2009; Nguyen *et al.* 2011). At the same time, specific forms of baked clay earring also suggest possible cultural contacts between

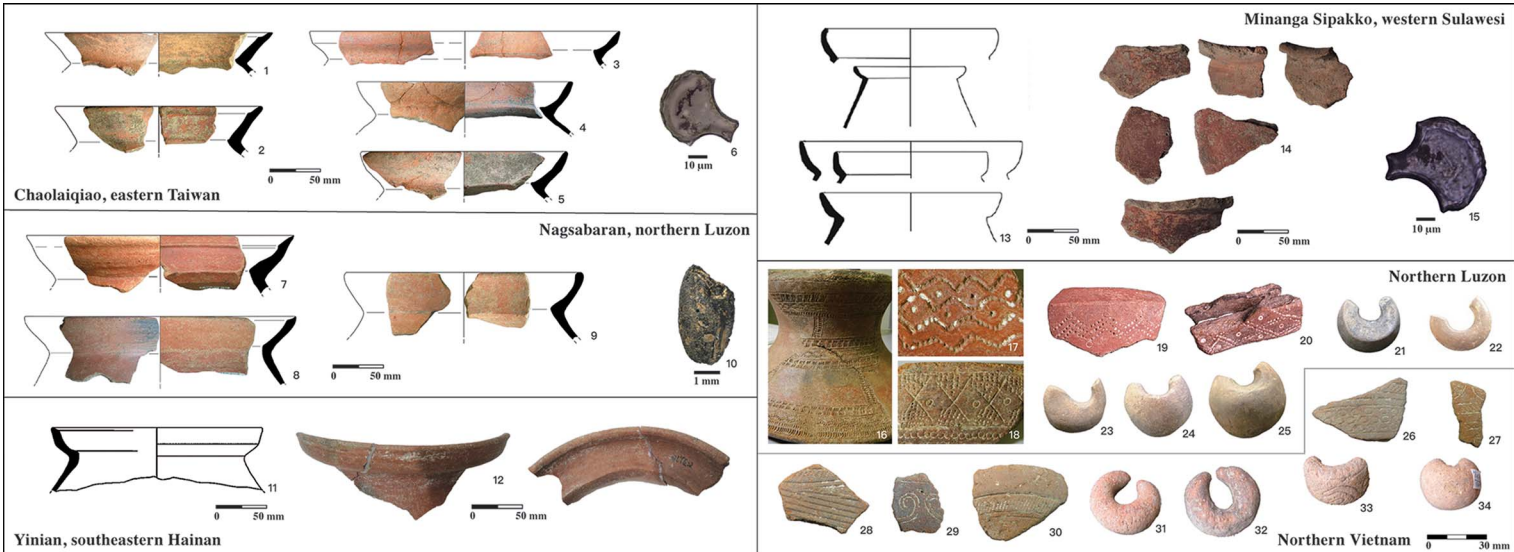


Figure 10. Red-slipped pottery (1–5, 7–9 & 11–14) and associated rice (*Oryza sativa*) remains (6 & 15: phytoliths; 10: grain) from Chaolaiqiao, Nagsabaran, Yinian and Minanga Sipakko. Incised and impressed red-slipped pottery from Magapit: 16) open-mouthed pot on a pedestal, shown upside-down to reveal the stamped circles and possible fingernail impression decoration; 17) punctate-stamped sherd with lime or white clay infill in decoration; 18) sherd also displaying traces of white infill in incised lozenge motif with punctate infilling and impressed circles. Similarly decorated, red-slipped pottery from Nagsabaran (19–20) and Xom Ren (26–30 but without red slip). Baked clay earrings from Nagsabaran (21–25) and similar from Thach Lac (31–34). Sources: 11) Wang et al. 2016: 119; 13) Anggraeni et al. 2014: 745 (both reproduced with permission); 6, 10 & 15) photographs by Z. Deng; 16–18) photographs by P. Bellwood, courtesy of K. Tanaka; 1–5, 7–9, 12, 14 & 19–34) photographs by H.C. Hung.

northern Luzon and northern Vietnam—especially globular or flattened globular earrings. There are also a number of ring-shaped items (usually partly damaged, having lost their hooks) from the Cagayan sites (Figure 10: 21–25) that resemble similar items from sites such as Thach Lac in north-central Vietnam (Figure 10: 31–34).

The beginning of the Metal Age, c. 2400 BP

At many of the Cagayan Valley midden sites, the layers containing Neolithic red-slipped pottery are overlain by layers with black-surfaced pottery (Ogawa 2005; Tsang 2007; Hung 2008). Ethnographic observations suggest that the black surface colour results from firing in an oxygen-deprived environment, perhaps beneath rice husks. Associated with the black pottery are objects of iron, such as knives, and of cupreous metal, such as small bronze ornaments. There are also many monochrome glass beads (Hung 2008; Bellwood 2017) (Figure 7: 1–12). The sources of these Metal Age artefacts have not been determined, but previous research has suggested that most of the Indo-Pacific glass beads (see Figure 7: 1) were imported from South Asia or Mainland Southeast Asia (unpublished data analysed by Yoshiyuki Iizuka in 2005).

Although most Metal Age vessel forms are distinct from those of the red-slipped Neolithic pottery, a transitional range from one to the other has been observed within the continuous stratigraphic sequences at Magapit and Nagsabaran. Additionally, aDNA studies of Metal Age skeletons from Nagsabaran confirm a close genetic link with modern Amis (Ami) people in eastern Taiwan (McColl *et al.* 2018). Because of the apparent continuity in the archaeological record through time, this link is consistent with expectations of genetic continuity rather than population replacement in the Cagayan Valley after the commencement of the Neolithic. No aDNA, however, has so far been recovered from Cagayan skeletons of Neolithic date.

Conclusion

The estuarine shell middens of the lower Cagayan Valley are unique in the Philippines in terms of their size and density. They first appear in the archaeological record associated with Preceramic foragers, who used chert and flake tools during peak Holocene sea-level conditions from approximately 7000 years ago. Similar shell middens were created by later groups exploiting the unparalleled estuarine food resources of the lower Cagayan Valley, through into the Metal Age and more recent times. Today, many villages along the Cagayan River are still located on these shell middens, and local people continue to consume shellfish.

By the Neolithic period, the Preceramic shell middens of the lower Cagayan Valley were already large, reaching approximately 100 × 50m in area and 3m in depth at Leodivico Capiña, for example. While the occupation of most Holocene shell middens in southern China, Vietnam and Malaysia ceased during the Neolithic, especially after the arrival of rice farming at c. 4500–4000 BP (Zhang & Hung 2016), the Cagayan shell middens continued in use into later periods, and some even increased in size. The Magapit shell midden (>3700–2700 cal BP), for instance, covers more than 800 × 20m in area, to a depth of more than 3m of loose shell deposit.

During the Neolithic period, the people of Luzon developed excellent skills in canoe construction and navigation. Characteristic red-slipped and incised/impressed pottery with Cagayan parallels is found far beyond Luzon: 1000km to the west on Hainan Island; 2500km to the east in the Mariana Islands (Hung *et al.* 2011; Pugach *et al.* 2021); 1200km to the south in Sulawesi (Bellwood 2017: pl. 9); and 3500km to the south-east in the Bismarck Archipelago, with its Lapita pottery (Summerhayes 2010; Carson *et al.* 2013). While Taiwan stands unchallenged as the immediate homeland for the entire Austronesian language family, the spread of the Malayo-Polynesian subgroup and its early speakers must have been involved in the Cagayan Valley from the very start.

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Supplementary material

To view supplementary material for this article, please visit <https://doi.org/10.15184/aqy.2022.65>

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