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Prehistoric Hunter-Gatherers in the Philippines—Subsistence strategies, adaptation, and behaviour in maritime environments

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Archaeological research in the Philippines has produced a timeline of currently over 700,000 years of human occupation. However, while an initial presence of early hominins has been securely established through several radiometric dates between 700 ka to 1 ma from Luzon Island, there is currently little evidence for the presence of hominins after those episodes until c. 67 to 50 ka for Luzon or any of the other Philippine islands. At approximately 40 ka, anatomically modern humans had arrived in the Philippines. Early sites with fossil and/or artifactual evidence are Tabon Cave in Palawan and Bubog 1 in Occidental Mindoro, the latter situated in the Wallacean part of the archipelago. This paper presents an overview of the archaeological research on the prehistory of the Philippines from the Pleistocene until the Late Holocene and the arrival of the first farmers, presumably from Austronesian language groups approximately 4,000 years ago. Research on this topic has significantly intensified over the past 20 years and is providing a variety of evidence for the successful adaptation of those first islanders to maritime environments, the diversity of technological and subsistence strategies, and increasingly complex interrelationships across Island Southeast Asia.

KEYWORDS

hunter-gatherers and Fishers, maritime interaction, behavioural adaptation, pleistocene, holocene, Island Southeast Asia, Philippines

Introduction

The recent discovery and excavation of the *in-situ* fossil remains of a rhinoceros at the Rizal site in Kalinga, northern Luzon (Figure 1: 3), could confirm the presence of hominins in the Philippines during the early Middle Pleistocene and around 700 ka through a series of radiometric dates (Ingicco et al., 2018; 2020; Antoine et al., 2022). Archaeologists have long suspected a connection between stone tools found in northern Luzon and other parts of the Philippines that were possibly used by early hominins and fossils of an extinct Pleistocene megafauna from the same locations (Beyer, 1947; Koenigswald, 1958; Fox and Peralta, 1974; Fox, 1978; Shutler and Mathisen, 1979;

Ronquillo, 1981; Pawlik, 2001; Pawlik and Ronquillo, 2003; Dizon and Pawlik, 2010; Ingicco et al., 2018). However, a reliable stratigraphic correlation of fossil remains and lithic artifacts and/or reliable radiometric dating had been lacking until then. In the case of the Kalinga rhinoceros, cut marks on several bones, as well as broken bones, clearly show that the rhinoceros was slaughtered and that its nutritious bone marrow was extracted (Ingicco et al., 2018; 2020). Furthermore, several stone tools were found associated with the fossil.

For the remaining Middle Pleistocene and until the beginning of MIS 4, no securely dated evidence for human occupation has been currently reported. A metatarsal and a femur fragment together with several teeth were retrieved from Callao Cave near the Kalinga site (Figure 1: 11; Détroit et al., 2019). Initially identified as modern humans (Mijares et al., 2010), the fossils are now recognized as the remains of a diminutive pre-modern species, dubbed "*Homo luzonensis*". Several U-series dates on a human tooth and associated faunal remains produced ages of approximately 50 ka BP, while a single date obtained from a human metatarsal fragment showed a U-series age of 66.7 ka BP (Grün et al., 2014; Détroit et al., 2019). Questions about the reliability of early U-series dates, which also tend to be older than AMS 14C dates from the same area, have been raised for several sites in the region, including Callao and Tabon, while the ambiguity in the taxonomic identification of the Callao metatarsal added further uncertainty (Choa, 2018; O'Connell et al., 2018; Ono et al., 2023). Also, no artifacts were found associated with the fossil remains.

While the arrival of anatomically modern humans (AMH) in the sundaic part of the Philippines has been securely established at Tabon Cave in Palawan (Figure 1: 12) by several AMS dates to c. 39 ka to 33 ka (Choa et al., 2016; Choa, 2018), and less securely through U-series to as early as 47 ka (Détroit et al., 2004; O'Connell et al., 2018), evidence of the open sea crossing into the Wallacean islands of the Philippines has been found in the southwestern part of Mindoro. Mindoro, like most Philippine islands, lies east of Huxley's Line (Figure 1), the modification of the biogeographical boundary known as Wallace's Line, which separates the palaeobiogeographical region of Sundaland from the oceanic part of the Southeast Asian archipelago or "Wallacea" (Huxley, 1868). Its proximity to Palawan at the northeastern end of Sundaland suggests that it may have served as an entry point into the Wallacean part of the Philippines. Excavations of three sites, Bubog 1 and 2 on Ilin Island, San Jose, Occidental Mindoro, and Bilat Cave in nearby Sta. Teresa, Magsaysay, on the Mindoro mainland (Figure 1: 14), revealed, that Mindoro has been occupied by early modern humans during the Late Pleistocene and Holocene (Pawlik et al., 2014; Reyes et al., 2017; Pawlik and Piper, 2019; Pawlik, 2021). Bubog and Bilat are located less than 100 km from the enlarged Palawan landmass that was exposed due to the Pleistocene sea-level regressions, and it seems likely that migration of these early seafarers into the country's oceanic archipelago occurred via Palawan (Pawlik et al., 2014).

Chronology

The timeline of human occupation in the Philippines currently begins during the early stage of the Chibanian age (previously the unofficial *Middle Pleistocene*; Hornyak 2020) and MIS 17 (Figure 2). At the Kalinga site in Northern Luzon, a direct ESR/U-serial date of 709 ka ± 68 ka BP was obtained from the enamel of an almost complete though disarticulated skeleton of a rhinoceros, while the deposits beneath and above the skeleton were dated between 1.0 and 0.7 ma BP by OSL and Ar/Ar (Ingicco et al., 2018; 2020).

In Palawan, several caves have provided a combined chronological sequence from the Late Pleistocene onwards until the Holocene. The current oldest fossil remains of several individuals of an anatomically modern human (AMH) were found together with lithic assemblages in Tabon Cave in Palawan (Fox, 1970). A re-investigation of Tabon Cave in 2,000 revealed a human tibia and a right mandible fragment that were U-series dated 47 ka + 11/-10 ka BP and 31 ka + 8/-7 ka BP, respectively (Détroit et al., 2004), while the famous skull cap of "Tabon Man" was directly dated 16.5 ka ± 2 ka BP by U-series (Dizon and Pawlik, 2010). While the very high standard errors of the U-Series dates raise some concerns about their reliability, more recent AMS radiocarbon dates of hearth features suggest the beginning of the human occupation of Tabon Caves close to 40 ka cal. BP (Choa et al., 2016; Choa, 2018; Pawlik, 2021; Xhauflair et al., 2023).

From Pilanduk cave near Tabon (Figure 1: 12), AMS dates between 24 ka and 20 ka cal. BP have been reported, confirming human presence in Palawan during the peak of the Last Glacial Maximum (LGM). The reported associated fauna, particularly the remains of a tiger, indicate a connection to the extended landmass of the Sunda region (Ochoa et al., 2022). The only site in the Wallacean part of the Philippines that produced AMS dates for the LGM is Bilat Cave in southern Occidental Mindoro with 22 ka to 21 ka cal. BP (Ono, Pawlik, and Fuentes, 2020; Pawlik, 2021).

Several sites on both sides of Huxley's Line have provided archaeological data that relate to the important transition from the Pleistocene to the Early Holocene and then throughout the Holocene. In Palawan, the earliest layers of Ille Cave in the north of the island (Figure 1: 13) are dated c. 14 ka to 12 ka, while its early Holocene layers have produced early human cremations dated c. 8 ka (Morwood et al., 2008; Lara et al., 2013). Three sites located in the southern part of Mindoro have produced a series of AMS radiocarbon dates with a combined record from fairly recent times to as early as c. 35 ka cal. BP. In Bubog 1 on Ilin Island just off the coast of San Jose, Occidental Mindoro, a dense stratified shell midden was dated from c. 4,000 cal. BP at the upper layers to 28 ka to 33 ka for the lowest layer of the shell midden. Underneath the shell midden, c. 2 m of silty terrestrial deposits containing lithic artifacts and the remains of pelagic fishes have been exposed although no absolute dates have been produced so far (Pawlik and Piper, 2019; Boulanger et al., 2019; Pawlik, 2021). The site was considerably disturbed by treasure hunters, and it is possible that its occupation went on until well after 4,000 BP. This is suggested by the stratified record from the neighboring site of Bubog 2 in c. 400 m distance that currently includes the Pleistocene/Holocene boundary and c. 11 ka to 12 ka BP to the Late Holocene and until the 16th century AD for several hearth features close to the surface (Pawlik et al., 2014; Pawlik and Piper, 2019). No radiocarbon dates have yet been obtained for the period between 12 ka and 27 ka BP in Bubog 1 and the time before and after the Last Glacial Maximum. The reason for this hiatus is currently undetermined although it is

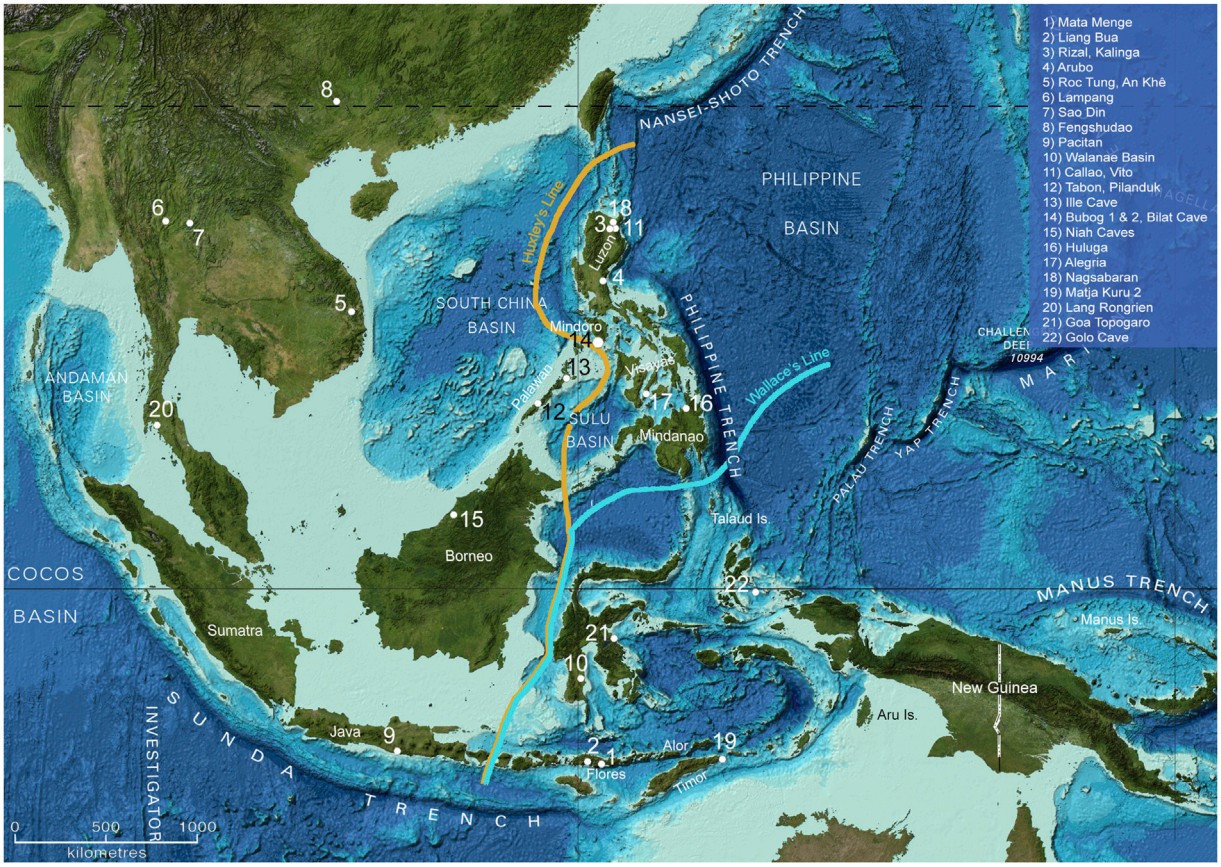

FIGURE 1
Map of Southeast Asia with locations mentioned in the text. 1) Mata Menge, 2) Liang Bua, 3) Rizal, Kalinga, 4) Arubo, 5) Roc Tung, 6) Lampang, 7) Sao Din, 8) Fengshudao, 9) Pacitan, 10) Walanae Basin, 11) Callao, 12) Tabon, Pilanduk, 13) Ille Cave, 14) Bubog 1 and 2, Bilat Cave, 15) Niah Caves, 16) Huluga, Cagayan de Oro, 17) Alegria, 18) Nagsabaran, 19) Matja Kuru, 20) Lang Rongrien, 21) Goa Topogaro, and 22) Golo Cave. The areas shown in light green indicate the exposed land areas of the Sunda shelf and Sahul during the Last Glacial Maximum at a sea level of approximately −130 m. Image reproduced from the GEBCO world map 2014, www.gebco.net.

possible that the Bubog sites were too high uphill around that time. At present, these are located just 35 m–42 m above sea level and can be reached by a 10-min walk from the shore. However, during periods of extremely low sea levels in the Pleistocene, the sites were approximately 150 m–170 m above sea level. Numerous other caves and rock shelters were probably exposed in the karstic formation of Ilin Island situated at lower elevations and much closer to the Pleistocene shore that was more attractive as campsites. Indications of human presence in the area during that time come from nearby Bilat Cave located on the mainland of Mindoro approximately c. 8 km from Bubog. Bilat is situated directly on the coast at 2 m–3 m above sea level and with two of its three entrances open onto the Ilin Channel. Here, AMS radiocarbon dates of 13 ka to 14 ka and 21 ka to 22 ka provided evidence for human occupation during and after the LGM (Pawlik and Piper, 2019; Pawlik, 2021).

Foraging as the main subsistence strategy of hunter-gatherer populations continued throughout the Late Holocene and after immigrant farming settlements were established in the Philippines (Hung 2008, 2019; Piper et al., 2009). In several cave sites in Peñablanca, Northern Luzon, such as Vito Cave (Figure 1: 11), a largely unchanged behavior of its occupants between 4,000 and 2,000 BP is observed (Fuentes, 2015). With the exception of the appearance of pottery in the archaeological record, subsistence strategies and lithic artifact manufacture and use remained constant. This introduction of pottery to Peñablanca after 4,000 BP probably reflects contact and material exchange between the indigenous foraging communities in the uplands and the newly arrived pottery-making farmers. The current earliest date indicating the arrival of the first Austronesian-speaking farming groups in the Philippines is a direct date on an upper 4th molar of *Sus scrofa* from the Nagsabaran shell midden site with 4,450 to 4,240 cal. BP (Figure 1: 18), and it is also the earliest known introduction of domestic pig although the bulk of the 14C dates from the lowest Layer 3 date between 4,000 and 3,800 cal. BP (Piper et al., 2009; Hung et al. 2011; Amano et al., 2013). This arrival appears to coincide with the climate anomaly and rapid cooling associated with the 4.2 Event and it is possible that the Austronesian Diaspora was triggered by this drastic climate change.

The timing of the appearance and use of metal material culture is still understudied in the Philippines. Consequently, local archaeologists often use the term “metal age”. Radiocarbon-

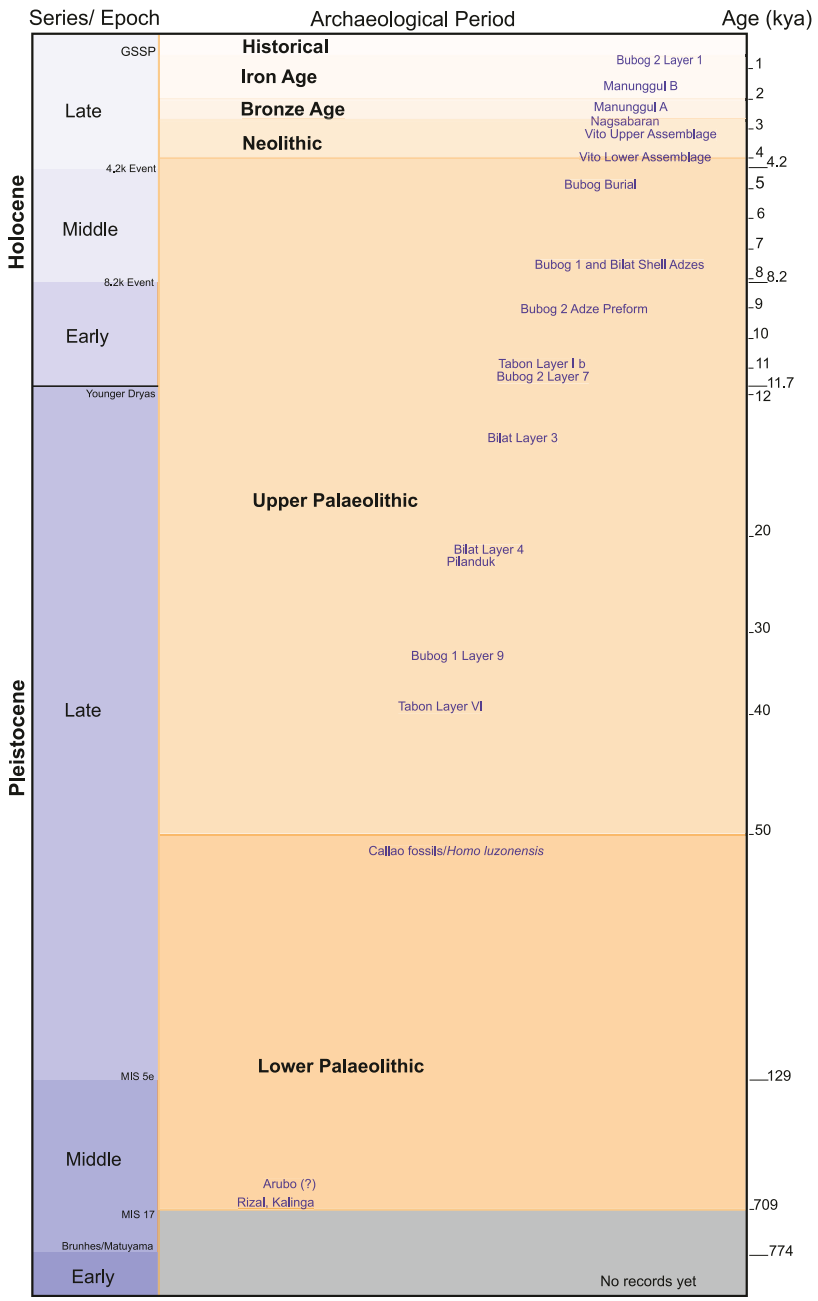

FIGURE 2
Chronology table of the Philippines with key sites.

based chronologies for the beginning of the bronze age and iron age like for the mainland of Southeast Asia are lacking (Higham et al., 2011). Robert Fox initially periodized a Bronze Age and an Iron Age based on findings and context association from Manunggul Chamber A and B at Tabon Caves (Berger and Libby, 1966); however, he later rejected the Bronze Age as a too-brief period after the returned 14C dates from the UCLA laboratory did not match his expectations (Fox, 1970). Instead, he proposed a "Metal Age" with two stages, Early and Late. The so-called *Ling-ling-o* pendants were hereby considered as a diagnostic ornament of the Early Metal Age in the Palawan sites. Early Metal Age burial sites would contain bronze and/or copper implements and stone tools, while iron objects would only appear in the Late Metal Age and after c. 2200 BP (Fox, 1970). Ironically, Fox's classification of Early Metal Age and Late Metal Age used the same criteria for Bronze Age and Iron Age and merely appear as a replacement of terms. Absolute dating remains an issue for the periodization of metal-bearing assemblages in the Philippines and more dates from good contexts are required.

FIGURE 3
(A) Flaked shell tools from Bubog 1; **(B)** Shell adze from Bubog 1; **(C)** Shell adze from Bilat Cave.

Material culture

Only a few lithic assemblages can be assigned to the early Palaeolithic. Together with the discovery of the rhinoceros, 57 lithic artifacts in close context with the fossil remains were retrieved. The relatively small flakes (< 100 mm in length) remain mostly unretouched and were mainly manufactured from siliceous rocks, such as chert, flint, or quartzite, as well as igneous rocks. The assemblages included cores and hammerstones, suggesting that at least some of the flakes were manufactured at the site (Ingicco et al., 2018; Ingicco et al., 2020). Microscopic use-wear analysis conducted by one of the authors (AP) indicated that some tools may have been used in butchering the rhinoceros and for other uses, e.g., processing of plants. Presumably of similar age is an early Palaeolithic assemblage that was reported from Arubo 1, General Tinio, Nueva Ecija, Central Luzon c. 300 km distance to Kalinga (Figure 1: 4). It contains several larger core tools with unifacial and bifacial modifications, including a bifacial hand axe and a cleaver (Pawlik, 2001; 2004; Dizon and Pawlik, 2010). Those and several other artifacts from Arubo exhibit a characteristically formal morphology, rather untypical for the Pleistocene and also Holocene lithic assemblages in the Philippines but similar to lithic tools from other early Palaeolithic sites in Southeast and East Asia such as Pacitan in Java (Figure 1: 9; Sémah and Sémah, 2012) and Mata Menge on Flores (Figure 1: 1; van den Bergh et al., 1996; Morwood et al., 1998; Brumm et al., 2006; Simanjuntak et al., 2010), as well as Roc Tung in Vietnam (Figure 1: 5; Derevianko et al., 2016), Lampang and Sao Din in Thailand (Figure 1: 6 and 7; Zeitoun et al., 2012), or Fengshudao in South China (Figure 1: 8; Huang, 1989; Schick and Zhuan 1993; Hou et al., 2000). On the other hand, while the Rizal and Arubo artifacts differ in size and morphology, similarities exist with regard to core preparation and morphology and the lithic raw material they were made of (Pawlik, 2004; 2021; Ingicco et al., 2018; 2020).

While no lithic or other artifacts had been found together with the fossil hominin remains at Callao Cave, the fossils of the oldest anatomically modern human (AMH) found in the Philippines at Tabon Cave in Central Palawan are associated with a stratified sequence of lithic assemblages (Fox, 1970). For the so-called Flake Assemblage V, Robert Fox proposed an age of c. 50 ka to 45 ka BP or even earlier, estimated through "age–depth" relationships to have an age (Fox, 1970). "Flake Assemblage IV" is reported from Tabon with an associated radiocarbon date of 37.1 ka to 32 ka cal. BP which appears to go fairly along with more recent radiocarbon dates on

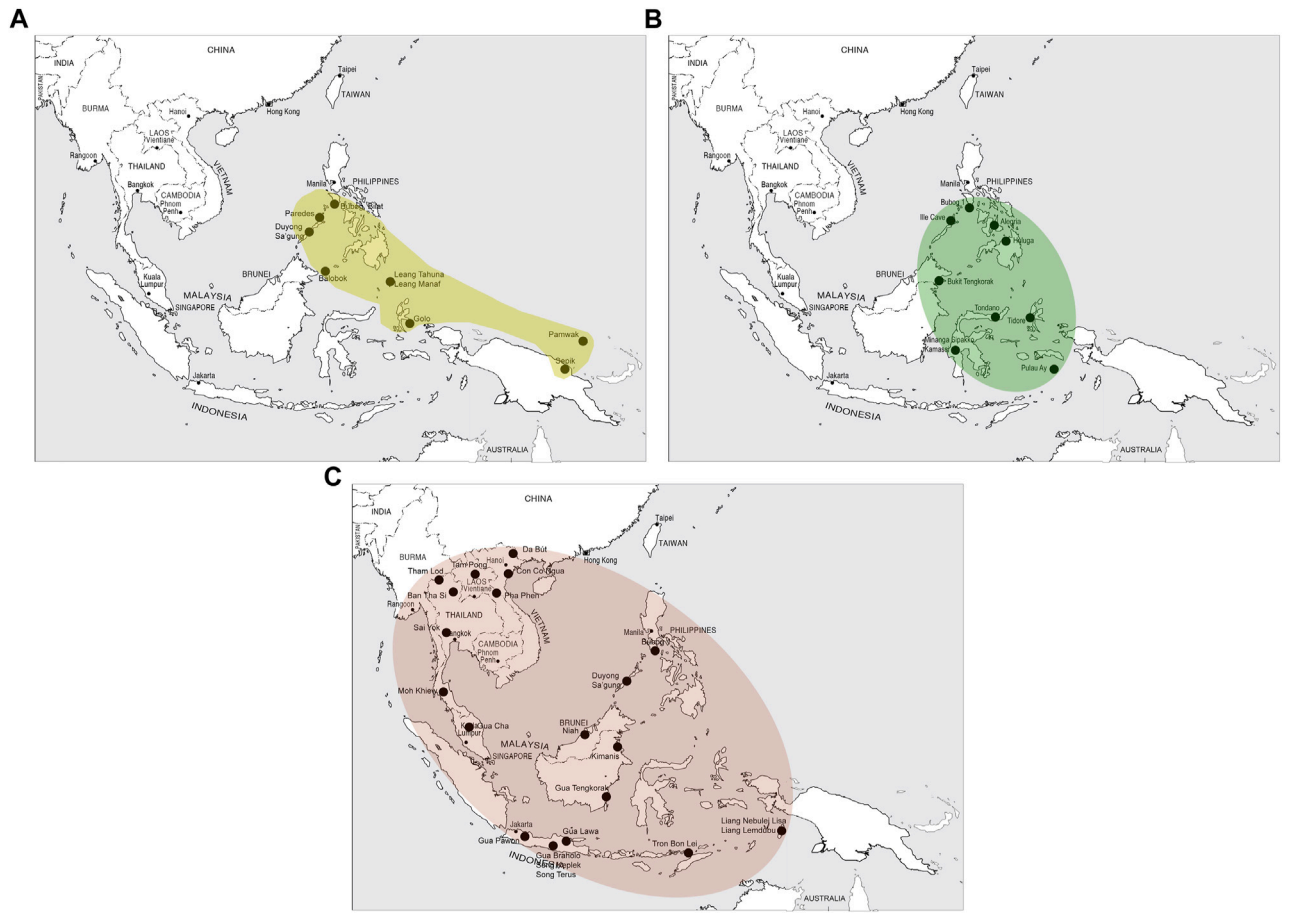

FIGURE 4
Interaction/distribution spheres. **(A)** Edge-ground shell adzes (after Pawlik et al., 2015); **(B)** Obsidian artifacts (after Reepmeyer et al., 2011; Neri et al., 2015); **(C)** Flexed burials (after Pawlik et al., 2019).

hearth features of 39 ka to 32 ka cal. BP (Choa 2016). By at least 35 ka BP, modern humans had traversed from Palawan and the Sunda region into Mindoro Island and the Wallacean part of the Philippines and adapted to dominantly maritime-oriented subsistence strategies, and produced some of the earliest flaked shell tools dated 31 to 28 cal. BP (Pawlik et al., 2014; Pawlik and Piper, 2019; Pawlik, 2021).

In general, there is limited apparent production of formal stone tools until the Late Holocene (Patole-Edoumba, 2002; 2009; Pawlik and Ronquillo, 2003; Pawlik, 2010; 2012; 2021; Patole-Edoumba et al., 2012; Pawlik et al., 2014; Fuentes, 2019). Several authors have suggested that the lack of formality and sophistication of Southeast Asia's lithic industries was due to a scarcity of lithic raw materials of adequate quality and the alternative use of abundant organic raw materials like bamboo and wood (Narr, 1966; Solheim, 1970; Hutterer, 1977; White, 1977; Pope, 1989; Schick and Zhuan, 1993; Forestier, 2000; 2003; Dennell, 2009; Xhauflair, 2014; Xhauflair et al., 2016). On the other hand, artifacts made of lithic materials with good or satisfactory knapping quality, including flint, jasper, or even obsidian, are not uncommon (e.g., Beyer, 1947; Fox, 1970; Charoenwongsa 1988; Pawlik, 2004; 2010; Moore and Brumm, 2007; Moore et al., 2009; Ono et al., 2010; Neri et al., 2015; Fuentes et al., 2019; Pawlik and Piper, 2019; Ono et al., 2020; Xhauflair et al., 2020; Fuentes et al., 2021), and long-distance exchange systems existed for obsidian probably since the Late Pleistocene (Reepmeyer et al., 2011; Neri et al., 2015; Pawlik, 2021). Bamboo, wood, and other plants were certainly important parts of the prehistoric technologies of ISEA, and this is supported by several use-wear and residue analyses. However, tools made of these materials are yet to be identified in the archaeological record and, if ever, were perhaps just an addition to lithic toolkits instead of a replacement, such as the bone tools found in the region (Barton et al., 2009; Pawlik, 2010; 2012; Xhauflair, 2014; Barton, 2016; Xhauflair et al., 2016; Xhauflair et al. 2017; Xhauflair et al. 2023; Fuentes et al., 2019; Fuentes et al. 2020; Fuentes et al. 2021; Ono et al., 2021).

Although artifactual evidence of Pleistocene bone tools in Southeast Asia is rather sparse, it has been suggested that bone technologies already arrived together with the first modern humans reaching Southeast Asia and were carried by them into the Wallacean part of Island Southeast Asia (ISEA) (Anderson, 1990; 1997; Olsen and Glover, 2004; Barton et al., 2009; Rabett and Piper, 2012; Piper and Rabett, 2014; O'Connor et al., 2014; Pawlik and Piper, 2019; Ono et al., 2021). In the Philippines, there is limited

evidence for bone technology in the Late Pleistocene and Early Holocene. Notable is a bone fishing gorge from Bubog 1 which is considered part of the technology used for open sea bait fishing that was retrieved from currently undated deposits below the lowest shell midden layer and AMS dated between 33 ka to 28 ka cal. BP (Boulanger, 2015; Boulanger et al., 2019; Pawlik and Piper, 2019). Together with the base of a hafted point from Matja Kuru 2 in East Timor (Figure 1: 19) dated c. 34 ka cal. BP, this is currently the earliest evidence of bone technology east of Huxley's Line (O'Connor et al., 2014; Pawlik and Piper, 2019) although similarly old bone artifacts have been reported from the Sahul region (Allen et al., 2016; Ono et al., 2020; Ono et al., 2021). Older bone artifacts were found in the Sundaic parts of Southeast Asia at Lang Rongrien in Thailand (Figure 1: 20) dated c. 42 ka cal. BP and Niah Caves in Borneo, c. 45 ka (Figure 1: 15; Anderson, 1990; 1997; Rabett et al., 2006; Ono et al., 2021), while hafted bone points appeared on the east coast of Central Sulawesi in Goa Topogaro (Figure 1: 21) in the Terminal Pleistocene (Ono et al., 2020; Ono et al., 2021).

Another resource that has likely played an important role in Late Pleistocene technology in the ISEA region is shell. Tools made of shells have been found across ISEA in Java, Borneo, Palawan, Mindoro, Flores, East Timor, Maluku Islands, the Bismarck Archipelago, and in Oceania and were often interpreted as scraper-like implements (Willems, 1939; van Heekeren, 1972; Solheim 1975, 1992; Bronson and Glover, 1984; Glover, 1986; Arifin, 2004; Bulbeck, 2004; Simanjuntak and Asikin, 2004; Szabó et al., 2007; Morwood et al., 2008). At Bubog 1, an assemblage of modified, flaked, and fragmented shell artifacts was retrieved from its lowest shell-midden layer, composed of numerous valves of the bivalve *Geloina coaxans*. Two shell tools were directly AMS radiocarbon dated 31 ka to 28 ka cal. BP (Figure 3A), while associated *Conus* and *Strombus* shells produced dates between 33 ka to 31 ka cal. BP (Pawlik and Piper, 2019). The use of *Tridacnidae* or giant clams for tool making is archaeologically evident in ISEA since the Early Holocene (Hardy and Hardy, 1969). While flaked artifacts have been occasionally observed, for instance in both Bubog sites on Ilin Island, hafted edge-ground shell adzes appear as the more common tool form and are found across the Philippines, Maluku Islands, and in Melanesia (Fox, 1970; Glover, 1986; Spriggs 1989; Spriggs 1997; Bellwood, 1997; Bellwood et al., 1998; Szabó & Summerhayes, 2002; Szabó, 2005; O'Connor et al., 2006; Pawlik et al., 2015). In Mindoro, two *Tridacna* adzes from Bilat Cave and Bubog 1 on Ilin Island were directly dated between 7.5 ka and 7.3 ka cal. BP (Figures 3B, C; Pawlik et al., 2015; Pawlik and Piper, 2019). The recovery of a *Tridacna* adze preform from Bubog 2 on Ilin Island directly AMS-dated c. 9 ka cal. BP suggests that local production of large *Tridacna* tools already existed in the Philippines during the Early Holocene (Pawlik and Piper, 2019; Pawlik, 2021).

Use-wear analyses employing low and high-power microscopy have identified the use of mostly unretouched flakes across ISEA on a variety of different materials such as bone, wood, rattan, and bamboo, as well as implements for hunting gear. Those studies have also demonstrated the usefulness of seemingly simple, unretouched flakes for various working processes and activities, as well as the application of advanced technologies, such as composite tools and resinous adhesives (Pawlik, 2001; Davenport, 2003; Pawlik, 2004; Teodosio, 2005; Pawlik, 2006; Xhauflair and Pawlik, 2010; Pawlik, 2012; Xhauflair, 2014; Fuentes, 2015; Xhauflair et al., 2016; Xhauflair et al., 2017; Fuentes et al., 2019; 2020; 2021; Fuentes and Pawlik, 2020; Xhauflair et al., 2020). At Bubog 1 and 2, unmodified igneous beach pebbles were utilized in several ways but mainly as hammers to open the larger marine shells like *Strombus, Trochus,* and *Lambis* for consumption, indicated by the diagnostic pitted surfaces that were caused by recurring blows (Pawlik et al., 2014; Pawlik and Piper, 2019). Some of the hammerstones were later reused as weights for fishing nets or fish traps (Skakun et al., 2014; Boulanger, 2015; Boulanger et al., 2019; Pawlik and Piper, 2019), while use-wear traces on several hammerstone fragments with sharp edges indicated that they were not discarded once broken but used as tools for the working of harder organic materials (Fuentes and Pawlik, 2020). This illustrates an efficient use of available resources, but also the importance of traceological analysis in evaluating seemingly simple lithic assemblages rather than just looking at them from a technological perspective. While none of the few bone tools reported from the Philippines have been subjected to traceological analysis so far, use-wear studies have been conducted on the Bubog shell adzes and preform made from giant clam, showing that they were used for heavy-duty activities, and on flakes produced from the mangrove shell *Geloina coaxans* from the lowest shell midden layer of Bubog 1 (Pawlik et al., 2015; Benz, 2016; Pawlik and Piper, 2019). The *Geloina* flakes were used for the processing of hard and soft materials, similar to 30 ka old limpet shells from Golo Cave on Gebe Island (Figure 1: 22; Szabó and Koppel, 2015). The artifacts from Bubog and Golo not only date the manufacture of shell tools back to before the LGM but they also demonstrate their versatility for various purposes.

Discussion and conclusion

Wallacea has been occupied by various hominins for one million years. The excavation of a rhinoceros in context with traces of butchering and a lithic assemblage produced the currently earliest securely dated evidence of the presence of hominins in the Philippines at around 700 ka BP (Ingicco et al., 2018; 2020). The open site of Arubo 1 could be of similar age although it remains undated and there are finds of choppers, chopping tools, and flakes reported from other open-air sites in Cagayan and Kalinga (Fox and Peralta, 1974; Pawlik and Ronquillo, 2003; Dizon and Pawlik, 2010), and also a small assemblage of choppers and chopping tools from Cagayan de Oro on Mindanao Island (Neri, 2006). After these episodes on Luzon Island, no presence of hominins is currently recorded until the onset of MIS 4. However, south of the Philippines, the presence of an unidentified hominin in Wallacea was manifested in an excavation in South Sulawesi at the site of Talepu in the Walanae Basin of South Sulawesi where lithic artifacts associated with large mammals including Stegodon were recovered and dated between 200 ka to 100 ka BP (van den Bergh et al., 2017). This indicates that hominins were very likely present in the southern parts of the Wallacean region during the transitional period from the middle to the late

Pleistocene. The archaeological record of the Philippines from the Pleistocene until the end of the Mid-Holocene currently remains fragmentary and most research has focused only on certain areas of Luzon, Palawan, and Mindoro, while major parts of this diverse archipelago remain largely unexplored as of today. Furthermore, for the Late Pleistocene and Early/Mid-Holocene records, almost all archaeological materials have been acquired from caves and rock shelters, while no open-air sites are currently known from this period. While one reason for this fragmentary record can certainly be seen in the limited amount of archaeological research conducted in the Philippines so far, particularly for the coastal areas during the Pleistocene, we must also assume that the majority of settlements and camps, whether located near the shore or inside low-lying caves and rock shelters have, meanwhile, disappeared due to rising sea level in the Holocene.

Modern humans migrated into ISEA at least 45,000 years ago and may have reached the Philippines by c. 40,000 years ago. Considering a potential migration route from Borneo and Palawan, Mindoro may have served as an entry point for human migration into the Wallacean part of the Philippines. Those first modern human islanders developed new organic and inorganic technologies, sophisticated fishing strategies, social and ideological thought, and expanded maritime interaction and movements. The Bubog and Bilat sites in Mindoro have delivered evidence for open seafaring and long-distance movements of people, as well as the transfer of material and immaterial culture, between the islands and the mainland of Southeast Asia over the last 35,000 years. Various findings hereby link Mindoro and other Philippine islands to technological and social networks spanning from the SE-Asian mainland to as far as Near Oceania (Figure 4). This includes a variety of modern behavioral traits such as open sea fishing, long-distance acquisition of obsidian, and also the emergence of a diversity of burial rituals (Piper et al., 2011; Reepmeyer et al., 2011; Pawlik et al., 2014; 2019; Pawlik, 2015; Neri et al., 2015; Boulanger et al., 2019; Pawlik and Piper, 2019; Shipton et al., 2019). While early evidence for cremation has been discovered in the Early Holocene deposits of Ille Cave (Lara et al., 2013; 2016), a tightly flexed burial was uncovered at Bubog 1 and directly AMS-dated c. 5,200 years ago (Pawlik et al., 2019). Although poorly preserved and despite the absence of grave goods, it could be identified as an organized burial where stone slabs were intentionally placed at the bottom of the burial pit and also used to cover the interment. This kind of flexed burial is widespread on the Southeast Asian mainland and the Sunda region, dating back to as early as 31,000 BP (Maloney et al., 2022), and was probably adopted from there (Pawlik et al., 2019). The behavioral, cultural, and ideological traits identified in Mindoro and Palawan predate the "Austronesian Diaspora" and the arrival of early farming populations in the Philippines at approximately 4,500 to 4,000 BP, considerably (Thiel, 1987; 1990; Bellwood, 1997; 2005; 2017; Simanjuntak, 2008; 2017; Piper, 2016; Pawlik and Piper, 2019).

The Philippine archipelago's proximity to Borneo, Sulawesi, and Taiwan provided a strategic position to facilitate movements of people, material culture, technologies, and innovations across Mainland and Island Southeast Asia. This connectivity between populations over long distances enabled the dissemination of information and ideas along a widespread maritime network that was established and utilized long before the arrival of early farming populations in the Late Holocene. During the Late Pleistocene and Early Holocene, the Philippine islands were inhabited by fisher-hunter-gatherer groups that were well adapted to various inland and coastal environments and capable of responding to changing climates. Their toolkits included handheld and hafted implements made of chert, obsidian, igneous rocks, bone, and shell that were employed in a diversity of functions and activities on various materials. Tropical plants, hereby, played a particularly important role. Together with evidence for a long-distance acquisition of raw material, this puts the cliché of a simple and unchanging technology that has been repeatedly brought forward for the prehistory of this region into question. The bearers of these technologies not only used the available materials for every conceivable purpose but also had the nautical skills to exploit the marine fauna of the open sea and to reach remote islands and coasts. By the Late Pleistocene, they had already successfully adapted to marine environments and efficiently used its rich resources and established maritime networks across Sunda and Wallacea, sharing material culture and knowledge with various communities living in the region.

Author contributions

Both authors contributed to conception and design of the study. AP and RF wrote the first draft of the manuscript. Both authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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