

The archaeology and palaeobiological record of Pasimbahan-Magsanib Site, northern Palawan, Philippines

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Recent excavations in northern Palawan, Philippines provide zooarchaeological and macrobotanical evidence documenting human occupation and changes in faunal composition and subsistence strategies. Here we present the archaeobiological record of Pasimbahan-Magsanib site dating from c. 10,500 yr. BP to the sub-recent. The terrestrial vertebrate record provides for a more robust Palawan biostratigraphy and chronicles Late Quaternary changes in mammalian composition and human responses to the changing abundance of large mammal communities. Well-stratified shell layers and middens contain a wide variety of taxa derived from freshwater, estuarine and marine environments that also provide insights on varying subsistence strategies and the local ecology. Macrobotanical evidence provides further evidence for both foraging and possible plant management strategies in the Holocene.

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INTRODUCTION

Archaeological and palaeobiological evidence from island environments provide an essential window for investigating biogeographic patterns, extinction dynamics and the versatile patterns of plant and animal resource use by *Homo sapiens*. In the past decade, the Southeast Asian archaeobiological record has grown tremendously, thereby situating the regional data within global investigations on Late Quaternary palaeoecology and human adaptation in tropical environments. The Philippine Islands, along with the continental and oceanic islands of Southeast Asia, have complex geological histories (Hall 2002) that have driven the evolution of terrestrial biota. The changing geological configuration and climate of the region have shaped the dispersal and diversification of insular vertebrates, including its human inhabitants (Voris 2000, Sathiamurthy and Voris 2006, Meijer et al. 2010). Palaeogeographic and climatic changes have also shaped the distribution and contributed to the demise of various

KEYWORDS

archaeology, Palawan Island, zooarchaeology, archaeobotany, biogeography, Southeast Asia

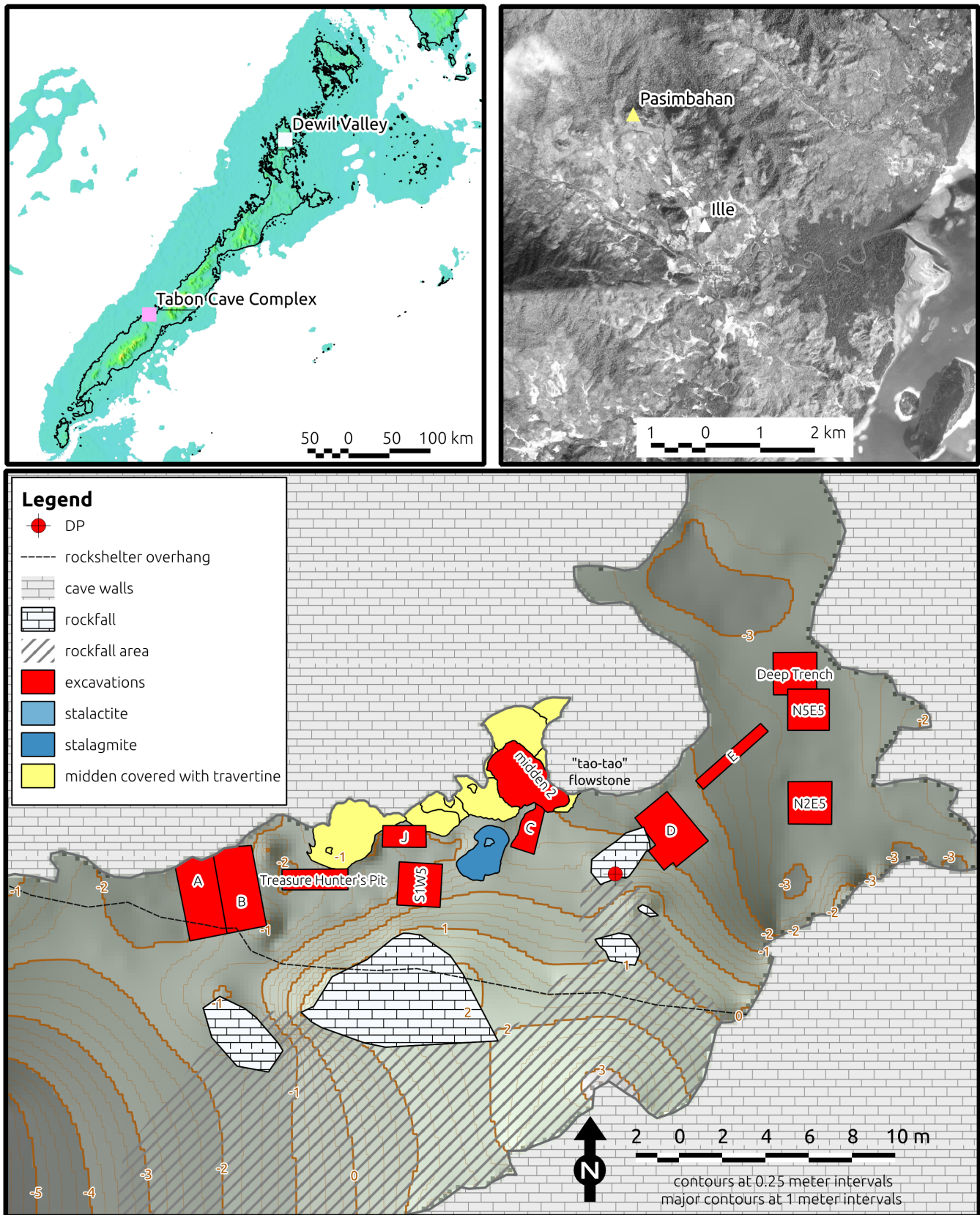


Figure 1. Map and plan of Pasimbahan-Magsanib Site, northern Palawan Island, Philippines. 'Trench A/B' derives from two adjacent excavation units: Trench A and Trench B that were later on joined and excavated together as one unit. DP stands for the site datum point. Mapped and drawn by Emil Robles.



Figure 2. Panoramic photograph of Pasimbahan Site. Photograph was taken by Emil Robles at the datum point of the site (as shown in Figure 1) and it shows the extent of the rockshelter platform, the entrance to the cave and the location of the various archaeological trenches.

vertebrate species during the Late Quaternary (Louys et al. 2007, Piper et al. 2011, Ochoa and Piper, in press). Deep archaeological sequences coming from Borneo, Java and Flores provide evidence for Pleistocene faunal turnovers in these islands (van den Bergh et al. 2001; Cranbrook and Piper 2007; Morwood et al. 2008). In the Holocene, the increasing impacts of human activities in island environments have left archaeological traces that lend substance to debates surrounding the roles that ancient human communities have played in Late Quaternary Extinctions (LQE) (Steadman 1995, Koch and Barnosky 2006, Corlett 2010).

Recent excavations and new radiocarbon dates from the Pasimbahan-Magsanib Site provide an 11,000-year sequence of human occupation in the Dewil Valley of northern Palawan, Philippines (Figure 1). Palawan Island is located between Borneo and the main Philippine archipelago on the northeastern margins of the Sunda Shelf. It has served as one of the main island corridors facilitating the expansion of humans and other terrestrial vertebrates from Sunda into the oceanic Philippines. Its Late Quaternary fossil record is known for some of the earliest *Homo sapiens* remains in the region coming from Tabon Cave, dated to c. 47,000 yr. BP +/- 11,000 BP (Détroit et al. 2004). It is also important for understanding the evolution of Sundaic and Philippine biotic communities (Reis and Garong 2004, Piper et al. 2011). Nearly a century of surveys and excavation projects in the island has made Palawan archaeology a centerpiece in Philippine and Island Southeast Asian archaeology (Guthe 1927, Fox 1970, Lewis et al. 2008, Paz and Ronquillo 2004).

The excavation of Pasimbahan during the past six years is part of the Palawan Island Palaeohistoric Research Project (PIPRP), which has explored numerous cave and open sites in the Dewil Valley since 2004 (Paz and Ronquillo 2004, Paz et al. 2012). One focal point of study of the PIPRP is the archaeology of Ille site and it has produced tens of thousands of well-stratified and well-preserved cultural remains spanning the last 16,000 years (Lewis et al. 2008). The findings in Ille include the oldest known human cremation burials in the Southeast Asian region at ca. 9,000 years ago (Lara et al 2013). Here we present new

archaeological evidence and direct dates from Pasimbahan that expand the northern Palawan archaeological dataset and the Late Quaternary palaeobiological record of the island.

SITE DESCRIPTION AND METHODS

Study Site

Pasimbahan is a rockshelter and cave site within the Magsanib district of the karstic Dewil Valley of El Nido, Palawan (Figure 1 and 2). It has been granted the National Museum Site Code IV-2007-Q-1932. El Nido is situated in the northern part of the island at 11°20' N 119°41' E. The site is located in the southwest face of one of the largest karst formations in the Dewil valley called Istar and it is about 6 km from the present-day coastline. The archaeology of this cave is reported and described by Paz and Ronquillo (2004) and Paz et al. (2012). In front of the current cave entrance are signs of ancient cave roof collapses, which created a long and tall (approximately 25 meters at highest point) rockshelter perpendicular to the main cave entrance. Much of the archaeology discovered in the site is concentrated in this rockshelter area, which is the area focused on by excavations.

Excavation and Recovery of Archaeological Finds

Since 2007, thirteen trenches have been opened and investigated (Figure 1 and 2) producing stratified midden deposits and many other cultural remains spanning the whole of the Holocene (Paz et al. 2012). The excavation method employed was a contextual excavation approach (Harris 1989). Deposited sediments were removed, guided by the approach of single context excavation and recording. In this approach, all sediment types, features, structures, clusters of artifacts, and layers are given individual context numbers, which are then organized in a matrix that illustrates the formation and chronological sequence of these deposits. These numbers are referred to as 'context #' or 'c.' in the body of the text and in the stratigraphic profiles (Figure 3). Within contexts, a spit excavation approach was utilized to systematically remove thick layers of sediments encountered on

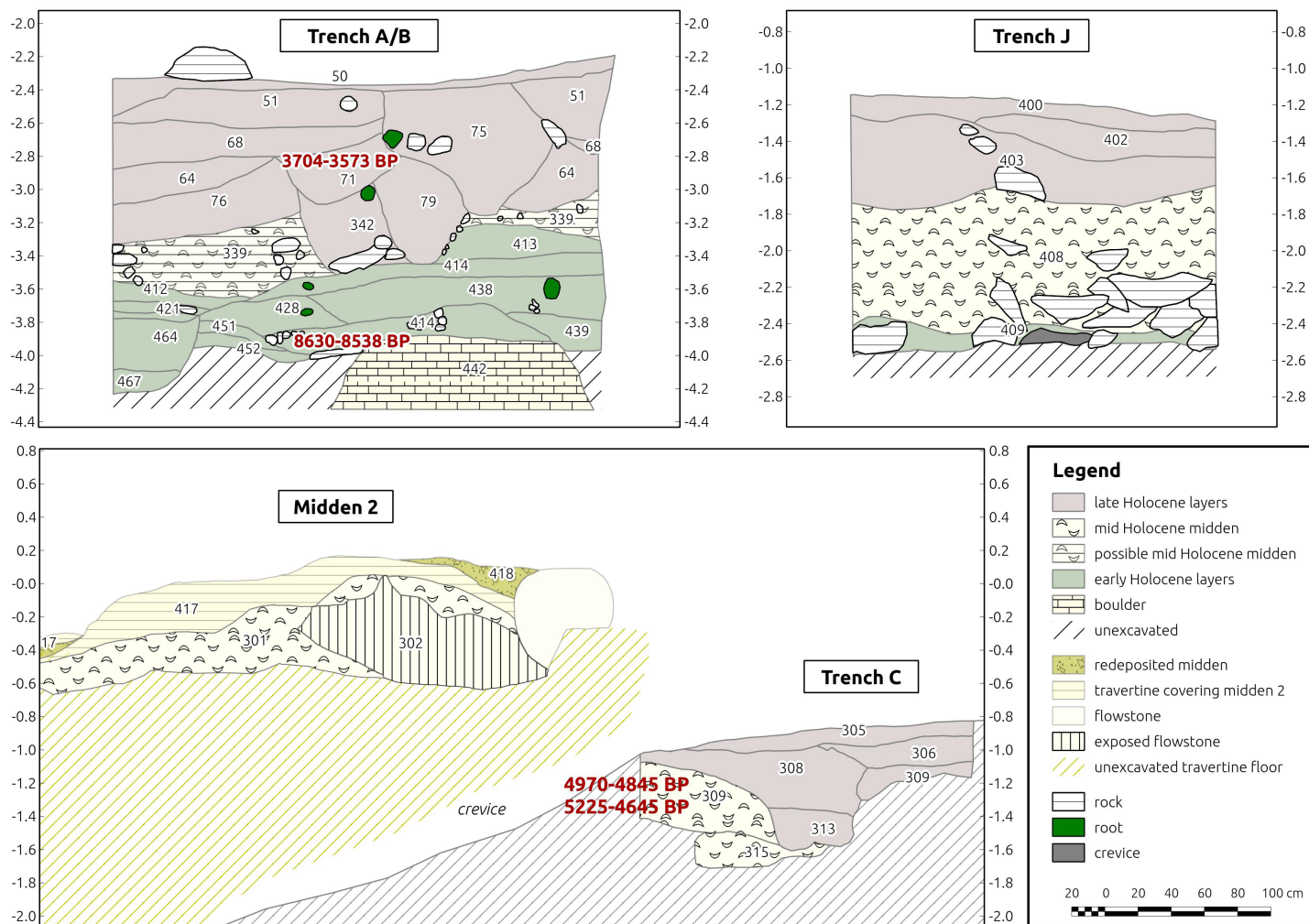


Figure 3. Stratigraphic profiles of Trenches A/B, J, C and Midden 2. Digitized by Emil Robles.

a site – usually done at increments of 10 to 20 cm per spit. All elevation values (Z) are based on one reference point, the Datum Point (DP) of the site. Recovered artifacts were bagged and recorded according to square, quadrant, context and depth. The archaeological finds were accessioned following the inventory protocols of the National Museum of the Philippines (NMP).

It has been the aim of the excavations of the PIPRP to practice high-resolution recovery of all possible evidence of past human activity, especially human-plant and human-animal interactions; there is a constant aim to understand both ecological and cultural patterns in the landscape. The matrix associated with known surfaces and features such as shell middens and hearths were subjected to flotation. The heavy fraction that remained after the wet sieving were sun-dried, sorted for biological remains and artifacts while at the field base. The light fraction samples from the flotation were brought back to the laboratories for further sorting and analysis. The sediments from the shell middens were also sampled for flotation and wet sieving. Additional sampling

was also conducted for pollen studies, radiometric dating and soil micromorphological analysis.

Dating and Chronology

Six radiocarbon dates were generated from wood charcoal, bone and shell samples (Table 1). The samples were processed and analyzed by the Waikato Radiocarbon Dating Laboratory (WRDL - University of Waikato) under the direction of Dr. Alan Hogg and Dr. Fiona Petchey using Accelerator Mass Spectrometry (AMS) analysis. The pre-treatment, target preparation and AMS measurement used follow protocols of the WRDL and the Keck Radiocarbon Laboratory (Petchey et al. 2011). The determinations were calibrated using Oxcal v4.17 (Bronk Ramsey 2010). The radiocarbon dates provide a secure temporal anchor by which it can be compared to other sites, particularly the well-dated sequence of Ille. Based on the calibrated radiocarbon determinations, the archaeology of the site is discussed and divided into three main periods of Early, Middle and Late Holocene. Due to the complex

Table 1: Radiocarbon dates from Pasimbahan-Magsanib Site.

Waikato Lab Number	NM Accession Number	Excavation Unit & Context Number	Material and Taxon	Conventional Radiocarbon Age BP	cal BP (2 σ)	$\delta^{13}\text{C}$	D^{14}C
Wk-34844	IV-2007-Q-1932	Trench A/B - 71	pig maxilla (<i>Sus cf. ahoenobarbus</i>)	3401 +/- 26	3704 - 3573	-	-345.2 \pm 2.1
Wk-33712	IV-2007-Q-2012	Trench C - 309	deer mandible (<i>Axis calamianensis</i>)	4333 +/- 25	4970 - 4845	-	-416.9 \pm 1.8
Wk-33716*	IV-2007-Q-1541	Trench C - 309	marine gastropod (<i>Chicoreus capucinus</i>)	4697 +/- 25	5225 - 4645	-5.9 \pm 0.2	-442.7 \pm 1.7
Wk-35099	IV-2007-Q-2270	Trench A/B - 441	wood charcoal	7793 +/- 25	8630 - 8538	-27.2 \pm 0.2	-620.9 \pm 1.2
Wk-35495	IV-2007-Q-881	Trench A/B - 425	wood charcoal	7590 +/- 25	8421 - 8370	-25.7 \pm 0.2	-611.3 \pm 1.2
Wk-34845	IV-2007-Q-2151	Trench A/B - 446	wood charcoal	9442 +/- 46	10790 - 10559	-26.6 \pm 0.2	-691.3 \pm 1.8

Radiocarbon samples from Pasimbahan-Magsanib Site were analyzed by the Waikato Radiocarbon Dating Laboratory (University of Waikato) under the direction of Dr. Alan Hogg and Dr. Fiona Petchey. Oxcal v4.1.7 was used for calibration (Bronk Ramsey 2010). * ΔR (for marine shell sample): 28 \pm 91.

depositional history of the site, dating samples were only taken from stratified midden deposits, hearth contexts and shell layers. These features are discrete and distinct from deposits associated with rockfall events, bioturbation and other forms of disturbance. Four samples from Trench A/B produced dates, three of which are from the early Holocene and from wood charcoal, and another sample from bone from the late Holocene. Two middle Holocene dates were generated from bone and shell samples from Trench C. Artifacts such as pottery, metal implements and glass beads also provide relative age ranges for the late Holocene deposits.

RESULTS

Pasimbahan Archaeology

Site Formation. Stratigraphic sequences show the complex sedimentary history of the site (Figure 3). The earliest archaeological deposits dated to the Early Holocene are only found in the eastern part of the rockshelter platform in Trench A and B. During this period the cave mouth was probably located further west of the the present cave mouth in the area where Trench A/B is situated. Evidence for this is provided by roof collapse in the archaeological deposits and the existence of inactive stalactites along the rockshelter wall. Occupation during the mid-Holocene was much more extensive and archaeological remains directly or relatively dated to this time period were recorded at Trenches A/B, C, D, and J. A major rockfall event also occurred after the mid-Holocene occupation that instigated the vertical displacement of the platform and formed a very extensive crevice (Figure 2). A large part of the platform collapsed and a major displacement of one to two meters is observed along the rockshelter platform. The timing and the extent of this event can be readily seen in the stratigraphic profiles of Trench C and Midden 2 (Figure 3). The middle Holocene midden layer in Trench C is displaced by around 1 meter compared to the same layer in Midden 2. In Midden 2, this layer is capped by an extensive flowstone which is not seen in the equivalent layer in Trenches C, D and J, suggesting that the formation of this flowstone layer occurred after the displacement of the platform. It also suggests that after the major platform displacement, this part of the rockshelter was still located in the

interior part of the cave to allow the formation of the extensive flowstone. In many areas in Midden 2, gours are also seen suggesting water sheet flow in these areas (Figure 2). At present, the speleothems in the platform appear to be inactive. Another collapse of the cave roof is hypothesized to have occurred after the speleothem formation to change the rockshelter morphology and render these speleothem formations inactive. This event is likely represented by the huge boulders in front of the cave, including the boulder where the datum point of the site was established.

Early Holocene Levels (ca. 8,000-10,500 yr. BP). Trench A/B contains the deepest culture-bearing levels excavated at about 3 meters below the surface (Z: -430 cm as of the 2013 excavation season) and contains the oldest dated layers of the site. This trench derives from two adjacent excavation units, namely, Trench A (western portion) and Trench B (eastern portion) that were later on joined and excavated together as one unit called Trench A/B. Three radiocarbon dates were obtained from wood charcoal from three archaeological contexts - context numbers 425, 441 and 446. The three charcoal dates provide an early Holocene age range of 8,000 to 10,500 yr. BP (Table 1 – dates). Contexts 425 (Z: -375 cm) is a combustion feature in Trench A. Context 441 (Z: -370 cm) is a feature consisting of a concentration of shell deposits localized in the southeast quadrant of Trench A. Context 446 (Z: -405 cm) is a layer exposed across the northern quadrants of Trench A/B consisting of compact mid reddish brown clayey silt with numerous burnt sediments, fragments of limestone rocks and some chert flakes. The charcoal sample from context 446 provides the oldest age at 10,559 -10,790 cal BP (Wk-34845).

The 2013 excavations have gone below c. 441 and 446 to expose another shell-rich layer (context 451) characterized by numerous terrestrial gastropods, limestone rocks, chert flakes and some animal bones. Contexts 425, 441 and 446 are stratigraphically between two main shell deposit layers labeled as context 339 and context 451 shown in the Trench A/B east wall profile (Figure 2). The midden deposits and combustion features indicate intermittent usage of the cave during the early Holocene. Chert flakes and obsidian debitage are also common in the aceramic levels of Trench A/B. Several *Tridacna* spp. shell

Table 2: Number of identified specimens (NISP) of vertebrate taxa from selected early, middle and late Holocene contexts from Pasimbahan Site.

Taxon	Scientific name	Late Holocene				Middle Holocene			Early Holocene							Total
		64	71	402	403	309	339	408	421	423	425	428	429	441	452	
deer	<i>Axis calamianensis</i>	2	1		2	2		6								13
wild pig	<i>Sus ahoenobarbus</i>	83	79	7	28	49	14	129	8	5		8		3	11	418
macaque	<i>Macaca fascicularis</i>	27	25		13	16	2	57	4	1	3	6	2	1	11	168
viverrids	<i>Viverridae</i>	1	14		1	1	2	6				2	1		2	30
porcupine	<i>Hystrix pumila</i>	3	2		1			5		1					1	13
pangolin	<i>Manis culionensis</i>				1										1	3
domestic dog	<i>Canis familiaris</i>	1														1
squirrels	<i>Sundasciurus, Hylopetes</i>				1	1		1				3				6
stink badger	<i>Mydaus marchei</i>							2				2	1		1	6
rats	<i>Muridae</i>	1	4	1				5					1	1	9	22
turtles	<i>Cyclemys, Cuora</i>	2	4		1			8				5		1	10	31
monitor lizard	<i>Varanus cf. palawensis</i>	3	8		1			13				5	1	2	19	52
snakes	<i>Serpentes</i>	6	16	1	2			26							38	89
fish	<i>Osteichthyes</i>	1						8							10	19
birds	<i>Aves</i>	6	2		6	7		8								29
Total		136	149	11	56	75	18	274	13	7	3	31	6	8	113	900

Context 309 is from Trench C, Contexts 402, 403 and 408 are from Trench J and the rest are from Trench A/B (64,71, 421, 423,425,428,429,441,452).

valves and modified *Melo* bailer shells have also been individually deposited within these layers. The placement of and modification on the shells may indicate ritualized significance, along with the hearth remains, combustion episodes and possible human-made pits in these layers. This perspective also implies that ‘subsistence strategies’ and the interpretation of bioarchaeological remains can go beyond palaeoeconomics to include knowledge systems through which past peoples gave meaning to their landscapes.

Mid Holocene Levels (ca. 5,000 yr. BP). The Middle Holocene in Pasimbahan Site is primarily represented by an extensive shell midden deposit that is spread across the rockshelter. The layer is quite distinctive due to the guano-rich dark grey silt matrix. The ‘dark’ midden is characterized by numerous *Batissa* clams, angular limestone rocks, pig bones and various other small and intermediate vertebrates. The shell midden deposit is observed in several excavation units, namely Trench C (context 309), Trench D (context 452), Trench J (context 408) and Midden Two (context 301) (Figure 2). The midden deposit context 339 in Trench A/B is hypothesized to be contemporaneous with these ‘dark’ midden deposits.

Two dates have been obtained from this layer (Table 2), both coming from context 309 of Trench C. One date is from the marine shell species *Chicoreus capucinus*, and another is from a deer (*Axis calamianensis*) mandible fragment. The shell sample produced a radiocarbon date of 5225-4645 cal BP (Wk-33716)

and the bone sample provided an age of 4970-4845 cal BP (Wk-33712). Due to the resultant small sample size obtained from the deer bone specimen, additional isotopic analysis ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$) could not be done and the age retrieved here can only be considered as a minimum age (Fiona Petchey, personal communication). The date nonetheless corresponds well with the age obtained from the shell sample and both indicate an age around 5,000 yr. BP. A biostratigraphic correlation with the well-dated Ille assemblage also points to the mid-Holocene as the probable age of this aceramic midden layer because of the predominance of pig remains and the scarcity of deer (see below).

Late Holocene (ca. 3,500 yr. BP and younger). The youngest levels of the site contain several midden deposits and numerous commingled human remains. A radiocarbon date was obtained from one of these midden deposits, labeled as context 71 (Figure 2). The dated material is from a pig (*Sus ahoenobarbus*) maxilla fragment and produced an age of 3,704-3,573 cal BP (Wk-34844; Table 1). Context 71 is a midden deposit where a deer (*Axis*) distal tibia was identified, but this specimen failed to produce enough collagen for radiocarbon dating. Hence, the associated age of another bone from the same context is used instead as a temporal marker of deer presence.

The use of caves as burial sites is a widespread practice in the Philippines and Southeast Asia particularly in the late Holocene (Anderson 1997, Barker et al. 2007, Dizon 1996, Fox 1970).

Taxon \ Age	<i>Cyclenys dentata</i>	<i>Cuora amboinensis</i>	<i>Siebenrockiella leytenis</i>	<i>Varanus cf. palawanensis</i>	<i>Macaca fascicularis</i>	<i>Manis culionensis</i>	<i>Hylopetes nigripes</i>	<i>Sundasciurus</i> sp.	<i>Hystrix pumila</i>	<i>Canidae</i> **	<i>Canis familiaris</i> *	<i>Panthera tigris</i> **	<i>Prionailurus bengalensis</i>	<i>Amblyonyx cinereus</i>	<i>Mydaus marchei</i>	<i>Herpestes brachyurus</i>	<i>Arctictis binturong</i>	<i>Paradoxurus hermaphroditus</i>	<i>Viverra zangalla</i>	<i>Sus ahoenobarbus</i>	<i>Axis calamianensis</i> **	<i>Rusa</i> sp.**
Late Holocene	X	X		X	X	X	X	X	X		X				X			X		X	X	
Mid-Holocene	X			X	X	X	X	X	X						X			X	X	X	X	
Early Holocene	X			X	X	X	X	X	X						X			X		X	X	
Terminal Pleistocene																						

ILLE
 PASIMBAHAN

Figure 4. List of terrestrial vertebrate taxa from Pasimbahan and Ille Sites.*some domestic dog remains from Ille may have been interred; **extirpated/extinct on Palawan Island.

Indo-Pacific beads and tradeware sherds from Vietnam and China found in the uppermost levels of the trenches (e.g. context 51 and 57 in Trench A/B, context 401 in Trench J, Context 348 in Trench D) provide an age range within the last millennia. These artifacts are hypothesized to be associated with the commingled human remains that are mixed with the uppermost midden deposits of the site. Based on their state of preservation and the associated tradeware, the human bones are hypothesized to be later deposits and secondary interments that were placed in jars that broke and became scattered in antiquity.

Identified human bones consist mostly of foot and hand bones although fragments of larger elements (e.g., humerus and femur) were also recovered. The state of preservation of human bones differs from other animal remains and indicates that the former are later/younger deposits. At least 41 teeth have been identified from Trench A/B representing a minimum number of four individuals and consisting of three adults and one juvenile. Some of the recovered anterior teeth exhibited intentional filing of the labial and/or incisal surfaces, similar to those identified in a nearby coastal Site (Sibaltan, El Nido) and Bongabong Site in Mindoro Island (Lara, forthcoming). Aside from the isolated bones found in the excavated trenches, an assemblage of human remains was also discovered in a small ledge in the cave. This is labeled as the ossuary context 18 which is situated directly on top of a large flowstone that is deemed meaningful because of the perception by the locals that it resembles a human form and hence identified as “tao-tao” (Paz 2012) (Figures 1 and 2). In the vernacular, “tao” or “tau” means human and “tao-tao” roughly translates to ‘human-like’. The flowstone has two rimstone pool formations and the human remains are contained in the first southeast rimstone pool. The flowstone is right beside Midden 2, a shell midden that is cemented by travertine deposits but was later on damaged by treasure-hunting activities.

Based on the teeth remains, the ossuary contains a minimum number of six individuals, with at least two juveniles. The most striking feature of context 18 is that the human remains contained in it, as well as the whole feature itself, are all covered in red pigment, specifically red ochre. Geochemical analysis of the pigment covering Context 18 burial was conducted using an X-ray diffractometer (XRD) and an X-ray Fluorescence Spectrometer (XRF). The XRD results show the presence of hematite (Fe₂O₃), quartz, calcite and other trace elements. Majority of the recovered bones are encrusted in calcium carbonate due to the microenvironment of the flowstone where it was interred. A small, tanged, dagger-like metal blade with its tip broken in antiquity was also found within the assemblage and was similarly covered in hematite. Several postulations can already be generated from this context alone including the underlying reasons for applying red pigment on the bones of their dead, choosing the said flowstone among all the other speleothem formations present in the cave, and the inclusion of the metal implement in the assemblage. It is posited that certain speleothem and cave formations can have meaningful affinities when direct archaeological deposits are present within the feature (Paz 2012). The flowstone that was utilized as an ossuary can be a product of a group's subjective perception of what the feature resembles. In the case of the “tao-tao” flowstone, because it has the earmarks of a human profile, it seems appropriate for them to place the remains of their dead in this natural receptacle.

The interment of votives and other ritual activity appears to be common across the Holocene sequence of the Pasimbahan Site. Further examples include the feature labeled as context 79, which is a pit containing three bangles buried from a later period that most likely cuts through the upper midden layer contexts 76, 64 or 71 (see Trench A/B profile of Figure 3). Two *Tridacna* shell bangles were found neatly stacked on top of a copper alloy

bangle. The bangles appear as if they were directly deposited straight from a person's arm to a small hole made in the ground as a form of offering or votive to the powers associated with the Pasimbahan cave system. Another significant feature is a pit at the northern edge of Trench A/B labeled as context 416. The feature contains a small bowl covering a hammer stone and a *Melo* bailer shell fragment. The pit is lined by three limestone slabs and a fragment of a human fibula was also recovered. Other evidence of ritual activity include the possible interment of large marine shells such as *Tridacna* valves and a large *Charonia* trumpet shell. Some of the midden and hearth deposits can also be interpreted as remains from intermittent ritual food consumption. In Trench N2E5, a stone marker was also found composed of natural and worked limestone rocks that were shaped and arranged in the shape of a boat.

At present, local residents of the Dewil Valley (both indigenous and migrant) consider the Pasimbahan Site and the formations in it as sacred and symbolic features in the landscape (Paz 2012). Caretakers of the site – Mr. Romie Fines and Mrs. Rosie Fines – previously recovered human remains, a long blade bent into a U-shape, and a small dagger encrusted with multi-coloured beads while digging in the cave. Lodged within a small crevice at the base of the “tao-tao” in Pasimbahan, Mr. Fines also previously discovered a small medallion and a small green jar that had a dragon design and white stone ‘marbles’ inside (Paz 2012, Paz et al 2012). The specimens were shown to the excavation team for identification and they remain in the custody of the Fines family.

The Terrestrial Vertebrate Assemblage

Initial quantification and analysis of the Pasimbahan Cave assemblage reveal the presence of many of Palawan's extant mammal and reptile species including many of those described from Ille Cave (Figure 4 and Table 2). The deepest and oldest accumulations of animal bone are found in several aceramic midden deposits from 10,000 yr. BP to the mid-Holocene and they consist of a variety of intermediate-sized vertebrates such as macaques, civets and monitor lizards, along with a few pig and deer remains.

In the mid-Holocene, the shell midden deposits contain an increased concentration of animal bones, which are dominated by wild pig (*Sus ahoenobarbus*) remains. Intermediate mammals and reptiles are also present, while deer is quite rare. A similar composition is reflected in the late Holocene midden deposits, wherein pig is the most abundant taxon followed by macaques (*Macaca fascicularis*) and other intermediate vertebrates.

The analysis of the Pasimbahan fossil assemblage documents the late Holocene presence of one locally extinct species, the Calamian hog deer (*Axis calamianensis*) (Table 2). The latest occurrence of deer in the site is recorded from three midden contexts: context 64 and 71 in Trench A/B and context 403 from

Trench J (Figure 2). The hog deer remains are represented by two proximal phalanges from context 64, a fused distal tibia fragment from context 71 and two proximal femur fragments from context 403. The midden context 71 has a direct radiocarbon date from a pig mandible fragment of ca. 3,500 yr. BP. A young midden deposit (context 403) in Trench J with Indo-Pacific glass beads and tradeware also has deer remains, and this may even indicate a temporal context within the last millennia. However, redeposition also characterizes the upper layers (i.e., due to hydrological activity and mixing of deposits due to the interment of human remains) and hence we retain a conservative estimate for hog deer extirpation based on the radiocarbon determination on the bone from the midden.

The current analysis of the vertebrate fossils provides several insights regarding the changing community structure of the vertebrate fauna. One familiar pattern already stands out in the Pasimbahan bone assemblage: the pig is the dominant large mammal prey, and deer remains are scarce throughout the archaeological sequence. In the middle Holocene midden deposits, pig remains are abundant and dominate the assemblage. These patterns observed in the Pasimbahan Holocene record is also reflected in fossil assemblages from other Palawan sites and this shall be discussed below in light of our growing knowledge of Palawan biogeography.

Molluscan Remains

Preliminary identification of shell remains have been conducted for sixty-seven (67) contexts across the trenches of the Pasimbahan - Magsanib Site (Table 3). Bivalves and gastropods that were identified to the species, genus and family levels, total to sixty-one (61) taxa while another ten (10) shell types are determined to the class level only. The molluscs derive from various habitats—marine, mangrove, freshwater and terrestrial environments. Initial analysis across the whole sequence reveals that molluscs deriving from mud and sand flats (35 taxa out of 57 taxa) are most numerous across the assemblage, followed by those from rocky shores (18 taxa). Only a few species are from shallow subtidal habitats (4 taxa). While there is a big number of marine species (29 taxa), only a few of these are from the deep waters (*Tridacnidae*, *Lambis* sp. and *Melo* sp.). The mud/sand flats or tidal flats are in the shallow marine and mangrove areas that are mostly within the intertidal zone. The shell species from the rocky shore area are also in the shallow water areas.

Initial presence/absence data across sampled contexts reveal preliminary trends. Among the marine species, 93% (27 out of 29 identified taxa) are recorded in the early Holocene contexts, 48% (14 out of 29 taxa) are present in the mid-Holocene and 35% (10 out of 29 taxa) are in the late Holocene contexts. For the mangrove species, 89% (16 out of 18) of these are documented in both the early and mid-Holocene layers while 72% (13 out of 18) are in the late Holocene layers. All freshwater species (3) are present in both early and mid-Holocene contexts while only 2 freshwater species

Table 3. Presence/Absence of mollusc taxa at Pasimbahan Site. 'Mixed Habitat' pertains to habitats ranging from freshwater to estuarine.

	Marine	Estuarine	Mixed Habitat	Fresh Water	Terrestrial
Context	<i>Chama</i> sp. <i>Pinctada</i> sp. <i>Tellina</i> sp. <i>Tridacna</i> <i>Cellana</i> sp. <i>Glypeomorus</i> sp. <i>Certhium</i> sp. <i>Haliotis</i> sp. <i>Litoraria</i> sp. <i>Drupa</i> sp. <i>Polinices aurantius</i> <i>Nerita antiquata</i> <i>Nertodryas dubia</i> <i>Nerita planospira</i> <i>Oliva reticulata</i> <i>Siphonariidae</i> <i>Lambis</i> sp. <i>Laevistrombus canarium</i> <i>Terebra</i> sp. <i>Monodonta</i> sp. <i>Tectus pyramis</i> <i>Turbo</i> sp.	<i>Placuna</i> sp. <i>Anadara</i> sp. <i>Anadara granosa</i> <i>Polymesoda erosa</i> <i>Isognomon</i> sp. <i>Saccostrea</i> sp. <i>Gafrarium tumidum</i> <i>Certhidea obtusa</i> <i>Littorina</i> sp. <i>Ellobium aurisjudae</i> <i>Chicoreus capucinus</i> <i>Neritina violacea</i> <i>Neritina</i> sp. <i>Vittina waigensis</i> <i>Vittida aquatilis</i> <i>Unidentified neritid</i> <i>Terebra sulcata</i> <i>Telescopium telescopium</i>	<i>Batissa violacea</i> <i>Cithon</i> sp. <i>Cithon squarrosus</i> <i>Vittina cumingiana</i> <i>Neritina lurrina</i> <i>Vittina coromandeliana</i> <i>Pteridae</i> <i>Eamissella corrugata</i>	<i>Septaria</i> sp. <i>Melanooides torulosa</i>	<i>Calocochlia</i> sp. <i>Helicostyla</i> sp. <i>Amphidromus</i> sp. <i>Cyclophorus</i> sp. <i>Unidentified Land snail</i>
37	x		x	x	x
57	x			x	x
76	x			x	x
78	x			x	x
79	x			x	x
339	x			x	x
358	x			x	x
421	x			x	x
422	x			x	x
425	x			x	x
426	x			x	x
441	x			x	x
446					x
451					x
452					x
466					x

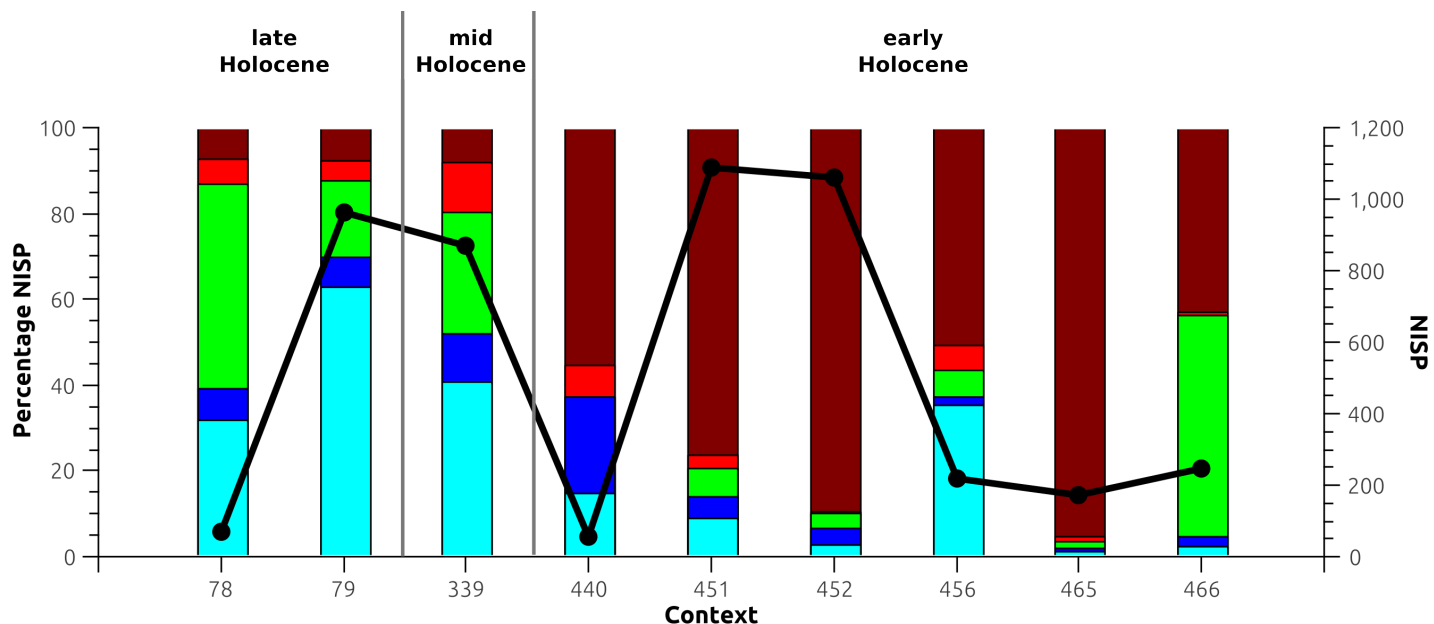


Figure 5. Distribution and number of identified specimens (NISP) of mollusc taxa. 'Mixed' pertains to habitats ranging from freshwater to estuarine.

are recorded in the late Holocene. All 5 terrestrial species are present in the early Holocene while only 2 out of the 5 identified taxa are present in both the mid- and late Holocene layers.

Several shell-bearing layers have been quantified and a total of 4,880 specimens have been identified to date. Figure 5 shows the number of identified specimens or NISP data for several early, mid and late Holocene midden contexts. The early Holocene is dominated by terrestrial species. By the mid-Holocene, terrestrial species decline in number and marine, estuarine and freshwater species become more abundant. This trend continues into the late Holocene. A dominant species in the mid and late Holocene middens is the *Batissa violacea* clam. A note must be made though regarding identification and nomenclature. The identification of this taxon is based on the existing literature wherein *Batissa* is a known freshwater species. Nonetheless, locals of the Dewil Valley identify the clams recovered in the middens as 'kibaw', a species from the mangrove area that up to now is foraged and eaten by residents. The middle Holocene and late Holocene middens largely consist of *kibaw*. The habitat of *Batissa* is hence classified here as 'mixed habitat' from freshwater to estuarine environments.

Macrobotanical Evidence

Sampling for archaeobotanical remains was conducted for the Pasimbahan - Magsanib Site with a priority on the lower layers in Trench A/B. Sediment from features such as hearths were collected for flotation. Charcoal and other macrobotanicals were likewise hand collected during excavation. Plant remains recovered include seeds, nut fragments, parenchymatous tissue fragments and wood fragments from a total of 51 samples coming from 27 contexts across the whole sequence (Table 4). Six out of the eleven plant tissues, seeds and nuts were found to be consistently

transformed, either in a charred or probably mineralized state. All fragments of *Canarium hirsutum* and another nut were carbonized, along with the parenchymatous tissues and wood fragments. All recovered seeds of *Boehmeria* cf. *platanifolia* and *Macaranga* sp. are probably mineralized. Intrusive seeds include those of *Eupatorium* sp., *Hypericum* sp., Poaceae, Solanaceae and some unidentified seeds.

***Boehmeria*, *Canarium* and *Macaranga*.** Preliminary analysis shows the presence of *Boehmeria* c.f. *platanifolia* in the early and mid-Holocene contexts only and not in the late Holocene. *Boehmeria* is a genus of fibers that includes *B. nivea* or 'ramie', known for its use as string and grass-cloth (Burkill 1966). The genus thrives in primary lowland forest. *Canarium hirsutum* has so far been recorded only in the late Holocene levels. In the nearby Ille Site, *C. hirsutum* nut fragments were abundant in the mid-Holocene levels with a decreased amount in the early Holocene levels. *C. hirsutum* is known to exist commonly in low altitude primary forests and its presence could suggest a warm(er) palaeoenvironment.

There are seventeen (17) species of *Macaranga* in the Philippines and three of these are recorded in Palawan. Of the Euphorbiaceae family, the bark, root, leaves and wood of *Macaranga* spp. are used for various purposes such as alcoholic beverages, medicine, timber, resin, glue and green manure. In southern Sumatra, Burkill (1966:1408) notes that "the fruits are put into palm-juice when it is being boiled down into sugar, and are considered to make it whiter". *Macaranga* spp. are light-demanding species, usually thriving in lowland secondary forests. Trees and shrubs of this genus are pioneer species so its presence only in the older layers of the site (early Holocene), could be an indication of more open vegetation types present during that time.

Table 4. Summary of macrobotanical data.

Context	seeds							charred nuts	charred fragments		
	<i>Macaranga</i> sp. whole	<i>Macaranga</i> sp. fragments	<i>Boehmeria</i> cf. <i>platanifolia</i>	sclerotia	Poaceae	<i>Eupatorium</i> sp.	others		<i>Canarium</i> sp.	undidentified	parenchyma
18								1			
50										m	m
51										m	
58								1		s	m
64								3		m	m
79											f
226										f	f
309			n							m	m
414										s	m
421											s
422										f	
423		2									f
425											s
426		16									s
427		6									
429										f	s
430										f	s
440	3	27		63	4	1	2			m	m
441		18			3	1				m	m
443	3		58		1		2			m	m
444	4	122	10	1						m	m
446		19									
447		6					1				f
451	1	12									
452	1	4									
462		6									
467		2									

Legend: f <20; s 20<50; m 50<100; n >100

Context numbers highlighted in grey = late Holocene, in boldface = mid Holocene, regular font = early Holocene.

This correlates with the presence of *Dioscoreaceae* species in the terminal Pleistocene to early Holocene levels at Ille which also reinforces the suggestion of Barton and Paz (2007:56) that a more open, fractured type of forest would have favored many edible plant species, particularly those of the yam family *Dioscoreaceae* and other tuberous plants. These species may have occurred in higher densities in this period than in the mid-Holocene when the forests became more homogeneous and ‘closed’ as global climates warmed. This is further supported by carbon isotope records from Makangit ang Gangub Caves in Palawan, which indicate that a C₄-dominated grassland or sparsely wooded savanna was present in the locality during the Last Glacial Maximum, and that this was eventually replaced by C₃-dominated closed tropical rainforest species in the Holocene (Bird et al. 2007, Wurster et al. 2010). A more open landscape may also have favored indirect strategies of plant management, such as burning to increase or maintain forest gaps and edge habitats. Parenchymatous tissue fragments were also present in the Pasimbahan macrobotanicals but these await further determination.

DISCUSSION

Palawan Biogeography and Biostratigraphy

The Pasimbahan vertebrate assemblage provides an important record that enhances our understanding of mammalian community structure during the Holocene. Based on the current knowledge of the terrestrial vertebrate fossil record of Palawan, several large mammals are identified in the Pleistocene but disappear by the early to mid-Holocene (Ochoa and Piper *in press*). Ille Cave has produced tiger (*Panthera tigris*) fossils and remains of a canid, possibly that of the dhole (*Cuon alpinus*) (Piper et al. 2008, Piper et al. 2011). Deer remains are abundant in the Ille record from the terminal Pleistocene until the early Holocene, after which they become progressively rarer and disappear altogether from the archaeological record. Two species of deer are recorded: *Axis calamianensis*, which is now extirpated on the island, and another extinct larger-bodied cervid ascribed to the genus *Cervus* (subgenus *Rusa*) (Piper et al. 2011). In the Pasimbahan Holocene sequence, deer is rare throughout. To date, only 13 deer bone fragments have been identified, in contrast to 418 wild pig bones sampled across the whole sequence. All of the Pasimbahan deer remains belong to the Calamian hog deer.

Records from northern and southern Palawan demonstrate deer abundance in the early Holocene and Late Pleistocene. The increased number of pig remains and scarcity of deer in the middle Holocene middens of Pasimbahan also strengthen the observation that there is a clear shift from deer to pig hunting by the middle Holocene. Such a pattern was first quantified and observed in the Ille record (Piper et al. 2011, Lewis et al. 2008) and is now also detected in the Pasimbahan sequence. This biostratigraphic inference based on the well-dated Ille assemblage has also been corroborated by two radiocarbon dates from Trench C of Pasimbahan at around 5,000 yr. BP (Table 2). Ille and Pasimbahan

are only about three kilometers apart and hence environments and biotic communities are likely similar for both areas.

The evidence from northern Palawan may point to an island-wide phenomenon related to changing environments during the Pleistocene-Holocene transition. Although the animal remains from the Tabon Cave complex excavated in the 1970s and the 1980s have not been quantified in detail, several authors (Fox 1970, Kress 1977, Heng 1988) have similarly noted the Late Pleistocene and early Holocene abundance of deer in several cave sites in southern Palawan (e.g., Tabon, Pilanduk, and Guri Caves). They also remark on the absence of deer and the predominance of pig in the Neolithic and later periods from the Tabon Cave complex.

Such changes in subsistence strategies likely reflect changes in the local ecology. The Palawan fossil record documents local disappearances in the Holocene faunal community of Palawan without replacement, and such a pattern is seen in many other continents and regions, and coincides with the expansion of *Homo sapiens* in Southeast Asia. In the case of oceanic islands with disharmonic and impoverished faunas, animals are often naïve to human predation and extremely restricted in biogeographic distribution and population size, and hence susceptible to humans and the predatory species that they often introduced (van den Bergh et al. 2009, van der Geer et al. 2010). In the last few millennia, the role of humans in the depletion of island faunas has had more support in the regional archaeological record: many mammal, bird and herpetile species have become extinct only in the last few thousand years to the more recent periods due to human hunting, habitat modification and translocation of non-native species (Townsend and Daugherty 1994; Steadman and Martin 2003; Cranbrook 2009; Pregill and Steadman 2009).

What becomes clearer now because of the Pasimbahan record is that the small deer species (*Axis*) persisted well into the Late Holocene and its extirpation on Palawan Island was likely due to human impacts. The Calamian hog deer survived the climatic amelioration and extensive environmental changes of the Late Pleistocene but as evidenced from the archaeological record, this commonly hunted mammal disappeared on the island after ca. 3,500 years ago. Relict populations are now only found in the Calamianes in the north. This is in contrast to the disappearance of the tiger and larger cervid (*Cervus/Rusa sp.*) in the early Holocene, which was likely brought about by extensive environmental changes following the Pleistocene-Holocene transition (Piper et al. 2011). The asynchronous timing of mammalian extirpations suggests varied dynamics of and complex trajectories to extinction (Ochoa and Piper, in press).

Human Subsistence Patterns

As deer populations diminished in the Holocene and with the seemingly early demise of the larger cervid species, the wild pig became an increasingly important resource. This shift is likely

related to island-wide ecological dynamics linked to climatic and palaeogeographic changes (Piper et al. 2011). The occasional hunting of the hog deer (*Axis*) continued well into the late Holocene and likely contributed to or even drove the extirpation of this species on Palawan Island. The exact timing cannot be pinpointed but the Dewil Valley record provides a classic example of shifting subsistence patterns in the face of changing ecological resources.

In addition to the hunting of large game, the human foragers in the Dewil Valley also preyed on a variety of locally available smaller mammals and reptiles that would have constituted an important component to the diet. Macaques represent the most commonly hunted intermediate mammal in the Pasimbahan record. Civet cat, monitor lizard and turtle remains are also seen throughout the Holocene sequence. These intermediate-sized vertebrates are hypothesized to be regular components of the foraging diet of humans living in a highly diverse tropical rainforest environment. This is evidenced from both the Pasimbahan and Ille faunal records and it reflects the ecological knowledge and strategies of well-adapted rainforest foragers.

The record of *Canarium hirsutum* may also be indicative of plant management practices that were part of a broad spectrum of subsistence strategies. This species is also documented in the early Holocene of Ille, along with *Dioscorea sp.* (Lewis et al. 2008, Barker et al. 2011). Preliminary geometric morphometric analysis of pig molars from Ille also indicates the likely presence of the domestic pig (Amano 2011, unpublished report), although most of the pig remains across the middens are from the wild endemic, *Sus ahoenobarbus*. A domestic dog is also identified from the late Holocene levels of Pasimbahan, based on one specimen – a right occipital fragment – from context 64 (see Trench A/B profile in Fig. 3). Context 64 is likely contemporaneous or only slightly younger than the midden context 71, which has a direct date of 3704-3573 cal. BP. This association provides one of the earliest dates for the presence of domestic dog in the Philippines. Even in the Late Holocene, in what are conventionally labeled as Neolithic and Metal Period phases, the Dewil Valley subsistence record is consistently dominated by wild resources. Animal domesticates, in the form of the pig (*S. scrofa*) and dog (*Canis familiaris*) are quite rare (and domestic chicken is absent), indicating that the appropriation of domestication packages and techniques was selective and likely idiosyncratic.

The shift from deer to pig hunting, as well as the appearance of estuarine shells in mid-Holocene midden deposits are reflective of the changing environments in the vicinities of Ille after the Pleistocene and of the responses of local foragers to these changes. Robles et al. (in press) hypothesize that the island-wide appearance of dense mid-Holocene shell middens in the archaeology of Palawan is related to receding coastlines and mangrove development due to rising sea levels and landscape inundation. Hence by the middle Holocene, previously inland locales become nearer to marine and mangrove resources. In the

mid-Holocene levels of Ille, a thick shell midden layer appears, consisting mostly of mangrove and freshwater species (Szabó et al. 2004). A similar pattern is seen in Pasimbahan, wherein the early Holocene is dominated by terrestrial species and then estuarine and freshwater species become dominant in the dense mid-Holocene midden deposits spread across the site.

CONCLUSION

The zooarchaeological and macrobotanical evidence from Pasimbahan-Magsanib site documents human occupation and subsistence strategies in the Dewil Valley for the past 10,000 years. Its archaeology supports the consistent body of evidence regarding the behavioural flexibility of *Homo sapiens* and the complex system of ecological knowledge and strategies of well-adapted foragers in tropical environments (Barker et al. 2007, Lewis et al. 2008). The molluscan and terrestrial vertebrate record chronicles human responses to the environmental changes after the Pleistocene and changes in mammalian community composition during the Holocene. The macrobotanical evidence provides further evidence for both foraging and possible plant management strategies in the Holocene. Along with the evidence from other Dewil Valley sites, the palaeobiological record of Pasimbahan-Magsanib site also demonstrates the predominance and value of wild resources, even in much recent time periods, and suggests the selective appropriation of domestication practices and management strategies. Such evidence can also allow us to tap into past knowledge systems and contextualize human adaptation and behavior and appreciate their possible meanings.

Furthermore, these records contribute to our growing body of knowledge on Late Quaternary palaeoecology and palaeoenvironments of the region. Large mammal species are documented to have become extinct due to a combination of natural and anthropogenic factors. Other species have shown resiliency despite extensive environmental change throughout the LGM and the Pleistocene-Holocene transition, but the contemporary impacts of modern agricultural and industrial societies are severely threatening the island's animal habitats and communities. The baseline ecological data from Philippine archaeological contexts are not divorced from present-day biodiversity concerns and should in fact help inform modern conservationist efforts as they have done in places elsewhere around the globe.

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CONFLICTS OF INTEREST

The authors certify and declare there are no conflicts of interest associated with the presented study.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

Project and excavation directors: VP, HL, WR and WS; Preparation of manuscript: JO and VP; Excavators: VP, JO, ER, NA, MRF; Vertebrate zooarchaeology: JO, MRF, NA; Molluscan systematics and malacoarchaeology: BV, JC, NA; Archaeobotany: JC; Palaeoenvironmental reconstruction and GIS: ER; Geoarchaeology: HL; Human remains: ML and GV; XRD/XRF analysis: SAV.

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