SOUTHERN ASIA, AUSTRALIA *and the* SEARCH *for* HUMAN ORIGINS

EDITED BY

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Southern Asia, Australia and the Search for Human Origins

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www.cambridge.org
Information on this title: www.cambridge.org/9781107017856

First published 2014

Printed in the United States of America

A catalog record for this publication is available from the British Library.

Library of Congress Cataloging in Publication data
Southern Asia, Australia and the search for human origins / [edited by] Robin Dennell, Martin Porr.
pages cm.
Includes bibliographical references and index.
ISBN 978-1-107-01785-6 (hardback)
1. Human evolution – South Asia. 2. Human evolution – Australia. 3. Human beings – South Asia – Origin. 4. Human beings – Australia – Origin. I. Dennell, Robin. II. Porr, Martin.
GN281.S685 2013
599.93'80954–dc23 2013027296

ISBN 978-1-107-01785-6 Hardback

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Chapter 11

Modern Humans in the Philippines Colonization, Subsistence and New Insights into Behavioural Complexity

Alfred F. Pawlik, Philip J. Piper and Armand Salvador B. Mijares

Introduction

The Philippines consist of 7,107 islands located at the northern limits of Wallacea and the northeastern fringes of the islands of Southeast Asia at latitude 13°N and longitude 122°E. It is separated from Borneo to the southwest by the Sulu Sea, from Mainland Southeast Asia to the northwest by the South China Sea, from Taiwan to the north by the Luzon Strait and from Sulawesi to the south by the Celebes Sea, and it is bounded to the east by the Philippine Sea.

The Philippine archipelago straddles two distinct biogeographic zones, with Palawan located on the northeastern edge of the Sunda Shelf, and hence shares a fauna and flora with many of its closest relatives within Island Southeast Asia (Madulid 1998). A posited land bridge either in the Upper Pleistocene (Fox 1970; Cranbrook 2000) or more likely in the Middle Pleistocene (Heaney 1985; Pawlik & Ronquillo 2003) possibly facilitated the colonization of the island by Sundaic Island species, including perhaps hominins. The main archipelago islands of Luzon, the Visayas and Mindanao, situated in Wallacea, on the other hand, have never been physically linked to the Sundaic region, and a sea crossing has always been needed to reach them (Heaney 1993; Oliver & Heaney 1996; Esseltyn et al. 2010).

Most of the oldest palaeontological sites in the Philippines have been identified on the island of Luzon (Figure 11.1). It possesses an impoverished island faunal community dominated by good successful open-sea migrants that once reached Luzon and diversified to produce the high endemism characteristic of remote archipelagos in Wallacea (Heaney 1986, 1993, 2002; Jansa et al. 2006; Morwood & van Oosterzee 2007; Oliver & Heaney 1996). Surveys of northern Luzon have produced an archaic vertebrate fauna containing giant tortoise (*Geochelone*), proboscideans (*Stegodon* and *Elephas*), bovines, cervids, suids and a rhinoceros (*Rhinoceros luzonensis*), and isolated fossil finds that could date to more than 500,000 years ago have been found in the Mindanao and Visayan areas of the Philippines (Koenigswald 1958; Fox 1978; Bautista & Vos 2001; Morwood & van Oosterzee 2007).

The Philippines are also home to some of the earliest records of anatomically modern humans in the Island Southeast Asian (ISEA) and Australasian regions. Among them are the remains of

In: Dennell and Porr 2014, Southern Asia, Australia and the Search for Human Origins, 135-147. Cambridge University Press

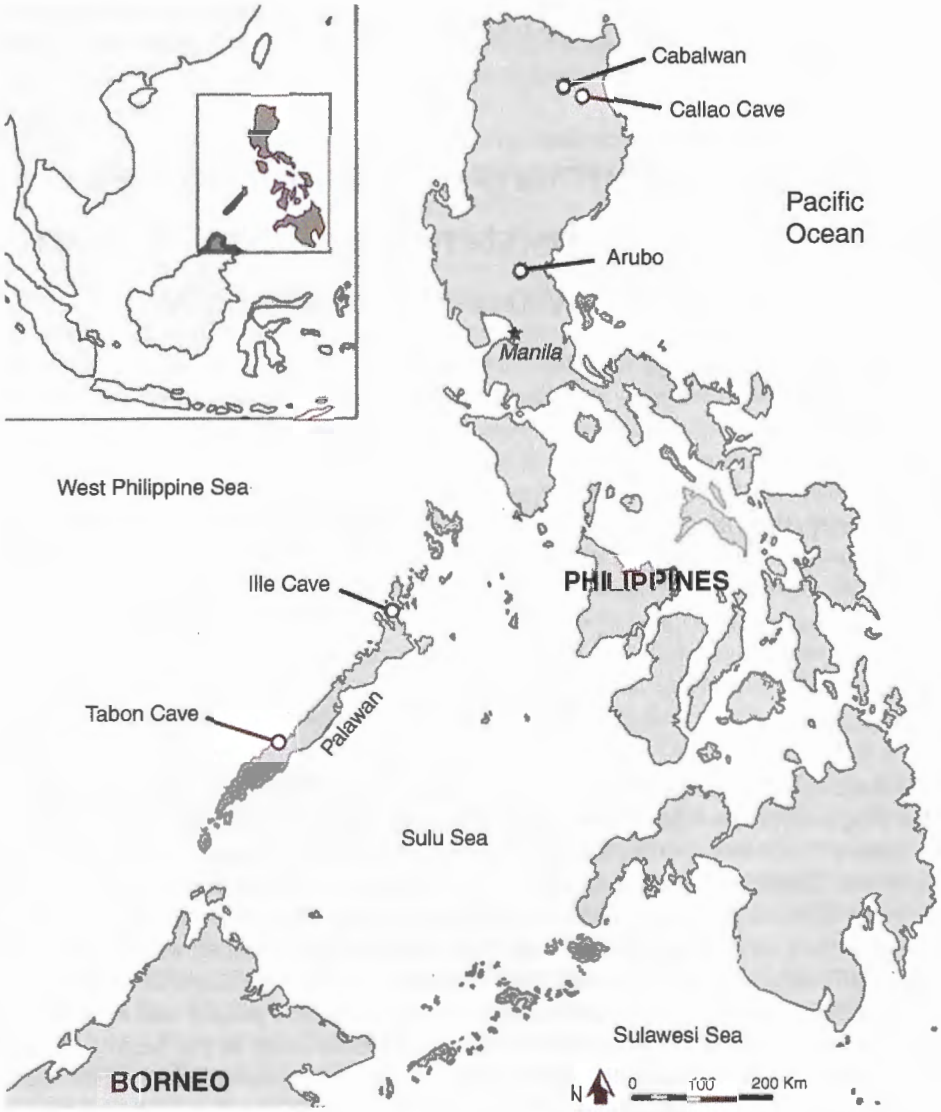

Figure 11.1. Map of the Philippine Islands with archaeological and palaeontological sites mentioned in the text (illustration by the authors).

several individuals, all assigned to *Homo sapiens,* recovered at Tabon Cave, Palawan Island, during excavations in the 1960s by Robert Fox (1970; 1978), and more recently in a re-investigation of the cave by the National Museum of the Philippines and the Muséum national d'histoire naturelle, Institut de Paléontologie Humaine. These remains have been variously dated between 16 and 47 ka. Recent excavations at Callao Cave in the Peñablanca karst limestone region of northern Luzon have produced the third metatarsal of an enigmatic hominin, which has been provisionally ascribed to an anatomically modern human and directly dated using U-series ablation to 67 ± 1 ka (Mijares et al. 2010). If this specimen is eventually ascribed to *Homo sapiens*, it will provide further support for the posited early migration from Africa and colonization of Island Southeast Asia by modern humans suggested by sites like Punung in Java (Storm et al. 2005) and Lenggong in Peninsula Malaysia (Zuraina Majid 1994). If the Callao hominin should turn out to be that of a different hominin species, then it will indicate that non-sapient hominins were more widely distributed throughout Wallacea than just on the island of Flores. What has been made absolutely

clear through the evidence of cut marks identified on the animal bones recovered in association with the Callao specimen is that this was a tool-using hominin (Piper & Mijares 2007).

In ISEA, lithic assemblages are characterized by simple, mostly unretouched flakes and cores without preparation, which has led to the interpretation that these implements were primarily made and used as part of an expedient technology (Mijares 2002; 2008) that showed no characteristics commonly designated elsewhere (e.g., Europe and Africa) as a part of a "package of modern human behavioural traits" (Mellars 1989a; Bar-Yosef 2002; Haidle & Pawlik 2010; Pawlik 2010). Recent studies of use wear on a lithic assemblage from Ille Cave in northern Palawan, however, have demonstrated that not all such seemingly simple lithic artefacts were used expediently and that evidence of residues on stone tool surfaces could indicate that some may have even been hafted (Pawlik 2010).

In this chapter, we discuss how new discoveries of a hominin in northern Luzon, palaeoenvironmental studies and lithic use-wear analysis associated with the Philippine Palaeolithic are contributing to debates on the timing of the migration into, and colonization of, Island Southeast Asia; revise our understanding of technological functions of stone artefacts; and provide evidence for more advanced human behaviour in the preparation of complex composite tools in the Upper Pleistocene.

Early Human Colonization of the Philippines

The presence of hominins in the Middle Pleistocene of the Philippines has been postulated for the Cagayan Valley in northern Luzon since the 1950s. Surface collections of artefacts and faunal remains have included extinct mammals supposedly associated with stone tools from an industry known as the Cabalwanian (Koenigswald 1958). A National Museum survey of the Cagayan Valley headed by Robert Fox claimed to have found at least 64 sites that contained mostly unretouched flakes, choppers and other unifacially retouched pebble tools and fossils of extinct mammals (Fox 1971, 1978, 1979; Fox & Peralta 1974). Although all the lithic artefacts were found on or close to the surface of eroded terraces and not necessarily in direct association with the animal remains, on the basis of the inferred chronological associations between the stone tools with their 'archaic' morphology and the extinct vertebrate faunas, Fox (1978) suggested that the lithic assemblages were produced by a precursor to modern humans who had reached Luzon during the Middle Pleistocene some 250,000 to 300,000 years ago. However, as yet no clear association between artefacts, tool-producing hominins and the extinct fauna has been demonstrated, and no geochronological sequence for the isolated fossil finds exists (Bautista & Vos 2001).

However, Pawlik (2004) recently claimed the existence of a possible Early Palaeolithic lithic assemblage at the site of Arubo, in the province of Nueva Ecija in Central Luzon. The artefacts included several cores and flakes, a straight-edged chopper and two bifacial artefacts, a large cleaver fragment and a 'proto-handaxe' (Pawlik & Ronquillo 2003), which was then in following publications labelled as a (developed) handaxe (Pawlik 2009a; Dizon & Pawlik 2010) after its 'Acheulian' character was confirmed by the curator of the type locality's assemblage of Saint Acheul, Claire Gaillard (personal communication 2006). Unfortunately, the Arubo site was heavily disturbed before excavation, caused by the dredging of a fishpond. Although that activity led to the discovery of the site, most of the artefacts were recovered from on or close to the ground surface, making it impossible to get a reliable chronometric date. Nevertheless, the morphological affinity with East Asian Early Palaeolithic material is striking. Unlike the Cabalwanian sites, Arubo shows a bifacial component. The evidence for curation and re-use was noted in microscopic use-wear analyses (Pawlik 2002; Teodosio 2006), as well as variation in core preparation and core reduction. Among the several core forms recovered at Arubo is a so-called horsehoof core, similar to those found in Java seemingly associated with Early Palaeolithic assemblages (Koenigswald 1936; Heekeren 1972; Bartstra 1984; Soejono 1984; Sémah et al. 1992; Simanjuntak

et al. 2001). Another similarity was noted with several excavated Early Palaeolithic sites in South China (Pawlik 2004, 10), where handaxes and other bifacial and unifacial forms similar to Arubo are frequently recovered (e.g., Huang 1989; Xiang Anqiang 1990; Xie Guangmao 1990; Schick & Zhuan 1993; Leng Jian & Shannon 2000; Peng Shulin n.d.) and where bifacial technology may have begun circa 800,000 years ago (Hou et al. 2000). The discoveries at Arubo may suggest that there is yet still an Early Palaeolithic colonization of Luzon Island by a hominin species that has so far evaded identification and characterization.

Until recently, the earliest known anatomically modern human fossils recovered in the Philippines were those from Tabon Cave, located on Lipuun Point, Quezon Province, Palawan Island, and estimated to be as much as 40,000 years old (Fox 1970). Further study revealed that the human remains, including a frontal bone, two mandibular fragments and several teeth, actually represented several individuals. Radiocarbon-dated charcoal from the corresponding layer however pointed to a much younger age of approximately 22,000–24,000 uncal BP (Fox 1970, 40–44). The earliest date recorded by Fox (1970, 24) on charcoal, apparently associated with what he called Flake Assemblage IV, was 30,500 uncal BP (UCLA-958), but in a rough estimate of sedimentation and 'age-depth' relationships, Fox concluded that the oldest deposits and Flake Assemblage V would probably be circa 40,000 BP. Thirty years later, a frontal bone was directly dated by uranium gamma ray counting at the Institut de Paléontologie Humaine of the Muséum national d'histoire naturelle in Paris, and its date was corrected to 16,500 ± 2000 cal BP (Dizon et al. 2002). A human tibia found 21 cm below modern ground surface in a disturbed layer excavated during a re-investigation of Tabon Cave by the National Museum of the Philippines and the Institut de Paléontologie Humaine, Paris, delivered another uranium series date of 47,000 +11,000/−10,000 BP (Détroit et al. 2004). Although this is consistent with the estimate of Fox for the lowest cultural layer in Tabon Cave to ~40,000 BP, the very high standard error of the U-series dates demands a cautionary consideration of the absolute dates of the Tabon human fossils.

The upstanding karstic limestone formations of Lipuun Point currently extend out from the coast and are surrounded on three sides by the sea, but during the early occupation of Tabon Cave between 37 and 58 ka it is estimated that sea levels would have been 60–80 m below modern levels and the coast would have been 32–36 km away. Bathymetric analyses and coastline reconstructions indicate that in order to reach Palawan from the nearest island of Borneo during this period it would have required a sea crossing of approximately 13 km (ibid.) and a water craft capable of crossing open sea would have been necessary. Palaeoenvironmental reconstruction indicates that the vegetation on Palawan would probably have been dominated by open woodland and savannah rather than the tropical rainforest that is dominant on the island today (Bird et al. 2007; Wurster et al. 2010). Unlike other sites close to Tabon such as Guri Cave, Sa'gung and Duyong, which all date to the mid-late Holocene, there is no evidence of coastal shell middens, which would support the sites distance from the coast, and it is likely that subsistence strategies by the inhabitants of Tabon would have been based primarily on inland resources (see Piper & Rabett, this volume). Unfortunately, very few animal bones were recovered from the Palaeolithic layers at Tabon, and most of these were those of cavernocolous bats and birds (Fox 1970, 38–39). The only large mammals identified in the assemblage were those of the endemic Palawan bearded pig (*Sus ahoenobarbus*) and extinct deer.

A more complete record of Late Pleistocene and Holocene foraging strategies on Palawan Island has recently been recorded at Ille Cave, near El Nido in northern Palawan. The earliest recorded human occupation of the site is from approximately 14,000 cal BP and includes chert artefacts and a substantial animal bone assemblage (Ochoa 2009; Piper et al. 2008, 2011; Pawlik 2010;), which was radiocarbon-dated to an age between 13,890 and 14,048 cal BP (OxA-16666; Lewis et al. 2008). Hunting appears to have focussed on two species of deer that are now extinct on Palawan, including the Calamian deer (*Axis calamianensis*, which is still extant on the islands of Culion and Busuanga to the north of Palawan), as well as smaller proportions of the Palawan bearded pig, macaques and a range of smaller mammals and reptiles (Ochoa 2009; Ochoa & Piper in press). The tiger (*Panthera*

tigris) and possibly the wild dog (*Cuon alpinus*) are also both represented, and in combination with the other mammal fauna support other palaeoenvironmental records in suggesting that the dominant vegetation was open woodland or savannah during the Late Pleistocene. The oldest direct ^{14}C date of 9220 ± 45 uncal bp (OxA-21179) or OxCal: 8558 – 8303 cal BP on a *Canarium* nut shell indicates that this plant was being utilised by the foragers of Palawan at the beginning of the Holocene and probably earlier (Carlos 2010). Overall the record from Ille suggests that the early human colonists of Palawan used a diverse range of technologies and techniques to extract numerous different resources from various ecotones in the local and regional environment.

Recent excavations at Callao Cave in the karstic limestone region of Peñablanca in northern Luzon have produced evidence that modern humans may have reached the Philippines some considerable time before the occupation recorded in Tabon Cave (Mijares et al. 2010). Callao is the largest and longest of the caves in the Peñablanca area, being more than 350 m from the main entrance to the innermost chamber. The passages are between 14 and 30 m wide with a floor to ceiling height varying between 10 and 45 m and an elevation of 85 m above sea level. Callao was first excavated by Maharlika Cuevas, and a team from the National Museum of the Philippines in 1979 and 1980 (Cuevas 1980) and again since 2003 under the direction of Armand Mijares (Mijares 2004, 2007, 2008; Mijares et al. 2010). In 2003, 10 different stratigraphic horizons were identified during excavation. Layer 8 (105 cm to 110 cm) produced chert flakes, fragmentary animal bones and evidence of the remnants of a hearth at the south end of Sq. 1. An AMS ^{14}C determination on charcoal from this layer returned a date of 25,968 ± 373 uncal bp (Wk-14881), confirming that human populations had crossed Huxley's modification of Wallace's Line from Palawan or via the Sulu Sea and north into the main Philippine Archipelago during the Late Pleistocene.

Excavations re-started in 2007 and continued in 2009, first with the extension of the trenches excavated in 2003 to greater depths and then with new excavations to the southwest of the original trenches. Between 160 and 250 cm below the modern ground surface, archaeological remains were scarce with just a single flake, a chert core and a few deer bones recovered from Layer 11. In Layer 13 (255 cm to 265 cm depth) the bones and teeth of animals became more abundant, and at a depth of 270 cm a cemented calcium carbonate deposit was encountered (carbonised breccias) containing a relatively dense concentration of animal bones. It was within this layer and associated with the faunal remains that the human right third metatarsal was identified.

Initially, two cervid teeth (Callao 1 and 2) were chosen for U-series and electron spin resonance dating from the top and bottom of the breccia layer. They produced U-series ages of 52 ± 1.4 ka and 54.3 ± 1.9 ka respectively (Mijares et al. 2010). However, as uranium accumulation in bones may be delayed after burial, these dates were considered by the analysts to be absolute minima. Electron spin resonance (ESR) dating yielded a combined ESR/U-series result (see Grün et al. 1988) for Callao 1 of 66 + 11/−9 ka, while Callao 2 did not yield a result (the closed system ESR age estimate was younger than the U-series result). The discordant combined ESR/U-series results suggest some re-working of the faunal remains, as was confirmed by the taphonomic analysis of the bones. The hominin metatarsal was dated using U-series ablation to a minimum age of 66.7 ± 1 ka. The brecciated deposit containing the faunal remains and human bone is therefore considered to have a minimum age between 60 and 70 ka (Mijares et al. 2010).

The enigmatic metatarsal has many morphometric characteristics similar to anatomically modern humans as well as some of archaic hominins, such as the size and shape of the proximal articular end that barely fall within the expected range of human variation, but the specimen has been provisionally assigned as that of a *Homo sapiens* (Mijares et al. 2010). The presence of an anatomically modern human in northern Luzon 60–70 ka raises important issues for the initial timing of the migration into and colonization of Island Southeast Asia. Conventional theory places the timing for the initial migration of modern humans into Southeast Asia at no more than 50 ka (e.g., Mellars 2005) on route to Australasia. Although an initial arrival of modern humans in the Sahul region as early as 60 ka has been proposed (Roberts et al. 1990; Chappell et al. 1996),

a review by Allen and O'Connell (2003) of the five sites in the Sahul region that have delivered dates beyond 45 ka and up to 62 ka concluded that these early dates were questionable and secure dating evidence for human occupation of Sahul can be considered to have occurred only around 45 ka (O'Connell & Allen 2004; Habgood & Franklin 2008). Hiscock (2009), however, has pointed out that this date likely represents an absolute minimum for initial colonization and the first peopling of Australia along the now submerged west coast of the continent was probably somewhat earlier than 45 ka.

For modern human populations to have reached northern Luzon the most likely route would have been across the exposed Sunda Shelf linking Peninsula Malaysia to Sumatra, Java and Borneo. It would then have required at least two or possibly three sea crossings between Borneo and Palawan, Palawan to Mindoro and then from Mindoro or, on a longer southern route with one or two sea crossings, from Borneo to the Sulu archipelago, then Mindanao and the Visayas to reach Luzon (Voris 2000; Sathiamurth & Voris 2006). Thus, it is possible that *Homo sapiens* were in ISEA substantially earlier than has been previously considered likely. Storm et al. (2005) have argued for a modern human presence at Punung III in eastern Java as early as MIS 5, and Zuraina Majid (1994) has claimed that the lithic material from Lenggong in Peninsula Malaysia dating to circa 74 ka was produced by anatomically modern humans, though no human fossils have been recovered at the latter location. It is also possible that stone tools and animal bone assemblages recorded in Java during MIS 3 and 4 at sites like Song Gupuh (Morwood et al. 2009) and Song Terus (Sémah et al. 2004) where human remains are absent in the early sequences were also conceivably produced by modern humans already present in ISEA. Further afield, Liu et al. (2010b) have argued that two molars and an anterior fragment of mandible from Zhirendong dating between 100 and 113 ka have morphological traits comparable with those of anatomically modern humans. Dennell (2010), on the other hand, considers also the possibility of a gracile late *H. erectus* for the Zhirendong fossils. If the Callao MT3 specimen indeed belonged to an anatomically modern human, then the initial migration of modern humans entering the Philippine archipelago would have happened more than 20 ka earlier than the current earliest southern migration to Sahul and would support these other regional studies in suggesting that occupation of mainland Southeast Asia and greater Sundaland by anatomically modern humans probably occurred prior to 70 ka.

The alternative scenario is that the Callao bone is not that of a modern human at all but that of a different species of hominin altogether. Morwood and van Oosterzee (2007) hypothesized that *Homo floresiensis* and some of the archaic vertebrate faunas with which this diminutive hominin was associated had not crossed from Java but were more likely to have arrived via a route from the Philippines and Sulawesi. They observed that the archaic Middle Pleistocene vertebrate faunas have a higher diversity in these northern islands than those to the south and contain giant tortoise (*Geochelone*), proboscideans (*Stegodon* and *Elaphas*), bovines, cervids and rhinoceros (*Rhinoceros luzonensis*) (Bautista & Vos 2001; Morwood & van Oosterzee 2007). The only species capable of reaching Flores, transported on the Pacific's Black Current flowing past the Philippines and between Sulawesi and Borneo southwards, were those with the greatest dispersal abilities, such as proboscideans, *Geochelone*, monitor lizards, rats and *Homo floresiensis* (Bergh et al. 2009). This line of reasoning would suggest that the Philippines should have an older record of hominin occupation than Flores, which currently stands at a million years (Brumm et al. 2010). There is, however, as yet no solid evidence of a Middle Pleistocene hominin colonization of the Philippines, and further research will be required to determine how long humans have actually been in the archipelago.

The Paleoenvironmental Setting of the Callao Hominin

So far no stone tools have been recovered associated with the Callao specimen, but it was recovered with a small but important animal bone assemblage (Piper & Mijares 2007). Most of the

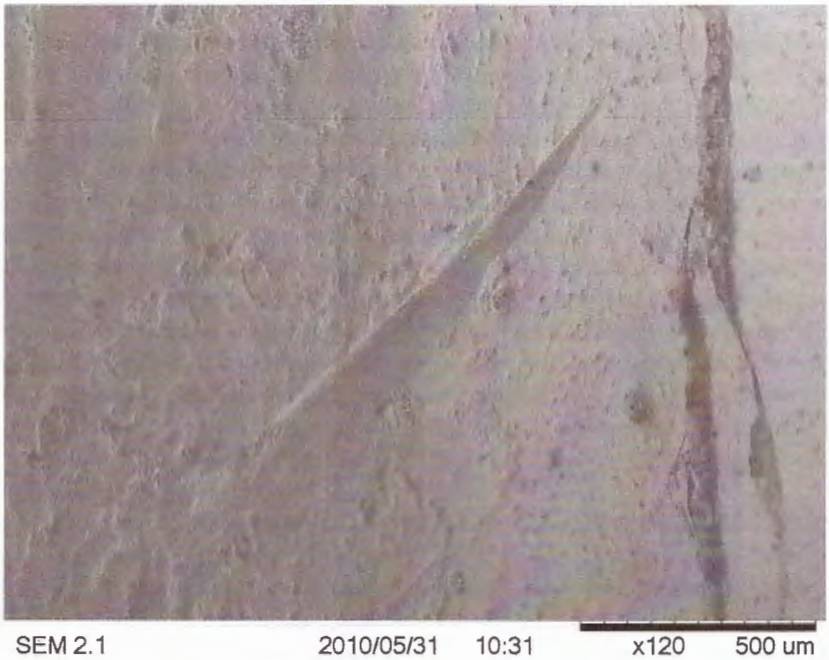

Figure 11.2. A cut mark on an animal bone from the 67 ka layer in Callao Cave (after Manalo 2011; photograph by the authors).

bone assemblage was heavily fragmented and demonstrated the taphonomic effects of sub-aerial weathering and differential transportation and erosion by water. Nevertheless, seven unidentified long bone shaft fragments and a deer right tibial shaft fragment produced evidence of cut marks indicating that the Callao hominin was in fact a tool user and that the bone assemblage had principally been introduced to the cave by humans (Figure 11.2).

The only taxon with enough skeletal elements represented to allow any comments on skeletal representation is the deer *Rusa marianna* (NISP = 157; based on counts from the 2004–2009 excavations). The articular ends of long bones such as humeri, femora, metapodials, radii and tibiae and complete extremities are all represented in the assemblage in small numbers. Loose teeth of both the maxilla and mandible indicate that both crania and lower jaws were originally introduced to the site. Taking into consideration the differential destruction of these less dense blade-like structures of the scapula, mandible and pelvis, and spongy cancellous bone of the vertebrae, it is likely that most body parts were being introduced to the site. At least six individuals were identified in the assemblage on the basis of maxillary and mandibular M3s. All the M3s are moderately worn indicating that they were from mature individuals. A single right lower dp4, a left distal tibia and distal metapodial shaft fragment with unfused epiphyses suggest that at least one sub-adult is represented. In addition a total of 35 fragments were identified as an endemic pig, which on Luzon is almost certainly the Philippine warty pig *Sus philippensis*. Two fragments of mandibular molar column recovered from Squares 1 and 2 at a depth of 280 cm are from an unidentified, extinct bovine. On Luzon the only records of a *Bubalus* sp. have been associated with the Middle Pleistocene fossil record (Croft et al. 2006). Two other *Bubalus* species are known from the Philippine archipelago: the extant *B. mindorensis* on the island of Mindoro and the extinct diminutive *B. cebuensis* on Cebu Island. Croft et al. (2006) suggest that the small size of both known *Bubalus* taxa might result from size reduction on isolated islands. The new fragmentary teeth from Callao imply that a now extinct bovine also once inhabited Luzon in the Late Pleistocene.

Even though just three mandibles identifiable to different species of rodent murid were recovered from Callao, they still provide some useful information of biodiversity and Pleistocene environments (Heaney et al. 2011), for example, the recovery of a species of *Batomys* in the lowland forests of Peñablanca. The only extant species known on Luzon inhabit the Central Cordillera on the other side of the Cagayan River Valley and live only in montane forest from circa 1350 to 2480 m above sea level dominated by trees such as oaks. Environmental records suggest a climatic minimum at around 70 ka (Oxygen Isotope Stage 4; Johnson et al. 2006; Wang et al. 2008), and pollen studies have produced evidence of elevational lowering of vegetation bands and different plant communities during the Late Pleistocene and early Holocene (Stevenson et al. 2010), but they do not record the presence of the montane oak-myrtle-conifer plant community at this low elevation. Perhaps it is more likely that the species of *Batomys* recorded at Callao was adapted to inhabiting different ecological communities from those of its montane relatives, but it does imply that there were much cooler lowland temperatures and, as a result, that vertebrate communities inhabiting these environments have no modern analogies.

Microwear Analysis and Modern Human Behaviour

Despite the presence of anatomically modern humans in the Philippines' Upper Pleistocene, possibly up to circa 70,000 years ago, visible evidence for traits of modern behaviour in the archaeological record is extremely scarce. It is generally considered that the lithic assemblages in Southeast Asia do not show clear signs of technological advancement, and a formal component as compared to the European and African record is mostly lacking (Haidle & Pawlik 2009; Pawlik 2009a). Most Late Pleistocene and Early Holocene flaked artefacts were manufactured with a simple and opportunistic reduction process, and the flakes are mostly unretouched. Advancement in morphology and technology is hardly observed, and stone tools appear widely unchanged from the Later Palaeolithic to the Early Neolithic, like the Hoabinhian in Mainland Southeast Asia or the Tabonian in the Philippines (Colani 1927; Pookajorn 1988; Anderson 1990; Moser 2001; Kamminga 2007; Fox 1970, 1978; Patole-Edoumba 2002; Pawlik & Ronquillo 2003; Mijares 2004; Xhauflair 2009). Also, a true blade technology does not appear in the entire Southeast Asian lithic record, and the few reported 'blades' or 'microblades' are often dismissed as accidental products, having no further characteristics than an elongated shape (Tulang 2000; Moser 2001, 33; Pawlik 2004, 2009a; see Patole-Edoumba 2006 for a dissenting view). The wide absence of 'modern' tool types and formal tools in Southeast Asia's Palaeolithic industries in general and especially in comparison to the European lithic record has been considered as due to the lack of ability in early humans in eastern Asia to make sophisticated tools (Colani 1927; Movius 1944; Mijares 2002) and is nowadays explained by the existence of a wooden or bamboo tool industry replacing formal stone tools and/or the poor availability and difficult acquisition of lithic raw material (e.g., Narr 1966; Solheim 1970; Pope 1989; Schick & Dong Zhuan 1993; Reynolds 1993; Mijares 2002; Dennell 2009). Owing to taphonomic reasons, these 'vegetal industries' are hypothetical. Tools made of bamboo and wood have not so far been found in Pleistocene and early Holocene archaeological assemblages. On a practical point, it would be necessary to have at least some stone tools to produce those made of organic materials. The wood or bamboo tool hypothesis does not consider factors of tool mechanics or tool uses (Haidle & Pawlik 2010; Pawlik 2010), nor does it deal with the fact that large lithic assemblages have long been known in the Southeast Asian archaeological record (e.g., Saurin 1966; Gorman 1971; Heekeren 1972; Harrisson 1972; Hutterer 1977; Fox 1978; Anderson 1990). Certainly, it can be assumed that a wide variety of tools and utilitarian objects were made of vegetal materials, including bamboo and wood, but they were more likely complementing the lithic tool kit rather than acting as replacements, like the few bone tools found in Southeast Asia (Barton et al. 2009; Pawlik 2009a). Furthermore, the causality that the production of vegetal tools led to a simplification of lithic industries has not been

convincingly explained. Finally, artefacts made from rocks highly suitable for knapping (i.e., chert or even obsidian) are not uncommon in Southeast Asian archaeological sites (e.g., Beyer 1947; Gorman 1970; Charoenwongsa 1988; Pookajorn 1988; Moser 2001; Pawlik 2002, 2004; Mijares 2002, 2004; Neri 2002, 2005).

Two technocomplexes belonging to the Upper Palaeolithic of the Philippines have been morphologically and technologically analysed and published so far, the so-called Tabonian Industry of Palawan (Fox 1970; Patole-Edoumba 2002) and the Peñablanca expedient technology in Northern Luzon (Mijares 2002). The human remains at Tabon Cave were associated with a lithic assemblage consisting primarily of flakes produced mostly on radiolarian chert (Schmidt 2008). Intentional modification of these flakes is rarely observed, and edge retouches and alterations are usually caused by use (Fox 1970; Ronquillo 1981; Patole-Edoumba 2002; Mijares 2004). A comparison of the Palaeolithic assemblage of Tabon Cave with the lithic materials from several Holocene sites in Palawan, for example, Duyong Cave, Guri Cave and Pilanduk Rockshelter (Fox 1970, 45–65; 1978; Kress 1979; Tulang 2000; Patole-Edoumba 2002; Pawlik & Ronquillo 2003), has demonstrated a continuation of the so-called Tabonian from the Upper Pleistocene into the Holocene until the Early Neolithic.

The excavation at Callao Cave in the northern part of Luzon Island produced a small assemblage of flaked artefacts. Similar to Tabon, the Later Palaeolithic industry of Callao and several other sites of the same limestone formation at Peñablanca such as Laurente Cave, Minori Cave and Rabel Cave continue without significant morphological changes into the mid-Holocene (Ronquillo 1981; Mijares 2002, 2007, 2008; Pawlik & Ronquillo 2003). In general, the Peñablanca lithic technology, at more than 1,000 km distance from Tabon Cave, appears related to the Tabonian and consists of simple flake assemblages without formal elements, made predominantly of andesite and chert. On the basis of a technological study combined with microscopic use-wear analysis, these assemblages have been characterised as products of an 'expedient technology' where flakes were produced from locally available raw material by direct percussion and without further modification, used for single tasks and discarded afterwards (Mijares 2002). This interpretation corresponds with recent microwear studies on artefacts from Tabon Cave where the limited appearance of microwear traces suggest a similar strategy for the Tabonian industries on Palawan (Mijares 2004; Xhauflair 2009). Also the newly excavated chert assemblage from the Pleistocene layer of Callao Cave fits into an expedient technological tradition in terms of technology and use wear (Mijares 2008).

If this kind of strategy for lithic tool production and use predominates in the Philippine Palaeolithic, then it is not surprising that the stone tools demonstrating the more complex manufacturing and reduction sequences observed in Europe and elsewhere are missing. Expedient technology lacks curation, core preparation, indirect percussion and therefore specialized blade production and geometric tool forms. Formal tools in general are extremely rare. The simple and indifferent technology that produced an overall amorphous small flake industry is dominant until the developed Neolithic and the beginning of the Austronesian expansion (Bellwood 1997). Non-lithic traits like tools made of bone, antler and shell, projectile points, figurative art, musical instruments and personal ornaments are also absent until the mid-Holocene. Only a few shell artefacts appear in the earlier stages of the Philippine Neolithic but not before 7,000 BP (Ronquillo et al. 1993; Szabó 2005). Although the Philippine Later Palaeolithic assemblages are almost certainly associated with modern *Homo sapiens* since at least about 50 ka ago, they do not comprise a distinctive package of modern traits and behaviour. This leaves us with two possibilities: Either the cognitive, cultural and technological behaviour of their makers was completely different from modern hominins in Europe and Africa and not 'modern' at all, or the hypothesis developed for and on cultural assemblages from Europe and Africa cannot be directly applied to materials from the ISEA and Pacific region and needs to be revised (Habgood & Franklin 2008, 2011; Haidle & Pawlik 2010). Furthermore, signs of behavioural and cognitive abilities of Southeast Asian hominins might be found elsewhere and with the aid of other methods.

One potential source of clues and traces of modern traits could be microwear analysis on lithic tool surfaces. Microwear analysis allows the determination of stone tool uses and functions and reconstructs prehistoric technology and behaviour (Semenov 1964; Keeley 1974; Tringham et al. 1974). This method applies basic physical principles of interacting surfaces in relative motion and studies the wear and tear created during such interaction between a working tool and the worked object (Yamada 1993). The effects are the same for modern as well as for prehistoric tools made from stone, usually chert and flint. Experiments have demonstrated that almost any kind of contact, even with much softer materials, will result in wear traces on the stone tool (e.g., Kamminga 1979; Keeley 1980; Odell 1981; Vaughan 1985; Unrath et al. 1986; Beyries 1988; Pawlik 1992; Anderson et al. 1993).

As an initial case study, a lithic assemblage from the lowest layer of Ille Cave in the Dewil Valley in El Nido, northern Palawan Island, underwent a microwear analysis. Radiocarbon dates delivered an age for this layer of 13,890 to 14,048 cal BP (OxA-16666; Lewis et al. 2008). The morphology of the artefacts appears similar to Tabon and Peñablanca, with simple and irregular flakes manufactured by direct percussion and an absence of formal tools (Pawlik 2009b). Perhaps even more characteristic for modern behaviour are traces and residues that resulted from the working of shell and the use of pigment as indicated by residues of red ochre on some artefacts. On one endscraper-like flake, traces of red pigment appear in combination with hide working (Figure 11.3, A–C). Although it cannot be determined with absolute certainty whether the pigment stains are directly associated with hide processing or resulted from a different activity, the use of red ochre as a colouring or tanning agent for skins and leather in the Palaeolithic has frequently been observed (e.g., Vaughan 1985; Büller 1988; Juel Jensen 1988; van Gijn 1989; Pawlik 1995; Barham 2002). The surfaces of several artefacts from Ille Cave also carry so-called bright spots. They are commonly regarded as the result of non-intentional, repetitive rubbing contacts between siliceous artefacts, for example, when carried together in a pouch for some time (Unrath et al. 1986; Levi-Sala 1996). The appearance of such traces can, therefore, be considered as signs of curation, the process reflecting a tool's actual use relative to its maximum potential use (Andrefsky 2008). This can also be interpreted as an advanced behavioural concept, contrary to the use-once-and-discard expedient technology model (e.g., Mijares 2002).

Impact scars as well as the presence of polish spots on the tip and longitudinal striations on elevated parts of the microtopography of both faces on a triangular flake, (Figure 11.3, D–G), suggest that it was used as projectile implement (e.g., Fischer et al. 1984; Lombard 2005a, 2005b; Lombard & Pargeter 2008). The interior surface of the base displays polish that is not use-related but does conform to what is expected from minor movements of a tool within its haft (Cahen et al. 1979, 681). Blackish residues that appear along with such polishes are probably the remains of organic resin used as hafting mastic (Figure 11.3, H). The combination of impact wear, hafting traces and residues is quite remarkable and identifies these artefacts as hafted armatures that were attached to shafts. Two more working tools exhibit characteristic hafting polishes associated with a blackish-reddish residue film, one laterally retouched flake displaying traces of working harder organic material as well as bright spots (Figure 11.3, I–M). This kind of adhesive appears to be very similar to resin residues found on projectile points made of bone and stingray spine from the West Mouth of Niah Cave in Borneo, dated to 11,700–10,690 cal BP (OxA-12,391 and OxA-11865; Barton et al. 2009). Resins recovered from Niah Cave have been identified as deriving from either *Shorea* spp. or *Canarium* spp. (Lampert & Thompson 2002). These trees and their resins are also common in the Philippines. Residues with an appearance very similar to the resins from Niah Cave have been found as remains of appliqués on shell disk beads in the Neolithic layers of Ille Cave. Scanning electron microscope (SEM) imaging of the residues showed embedded remnants of plant tissues and structures, while energy dispersal X-ray analysis (EDX) confirmed the presence of metal elements in the residue matrix indicating that metal pigments were also a part of this multi-component coating (Basilia 2011). *Shorea* resin appears to be especially suitable for hafting purposes because it becomes soft again when heated up above 75° C (Tschirch

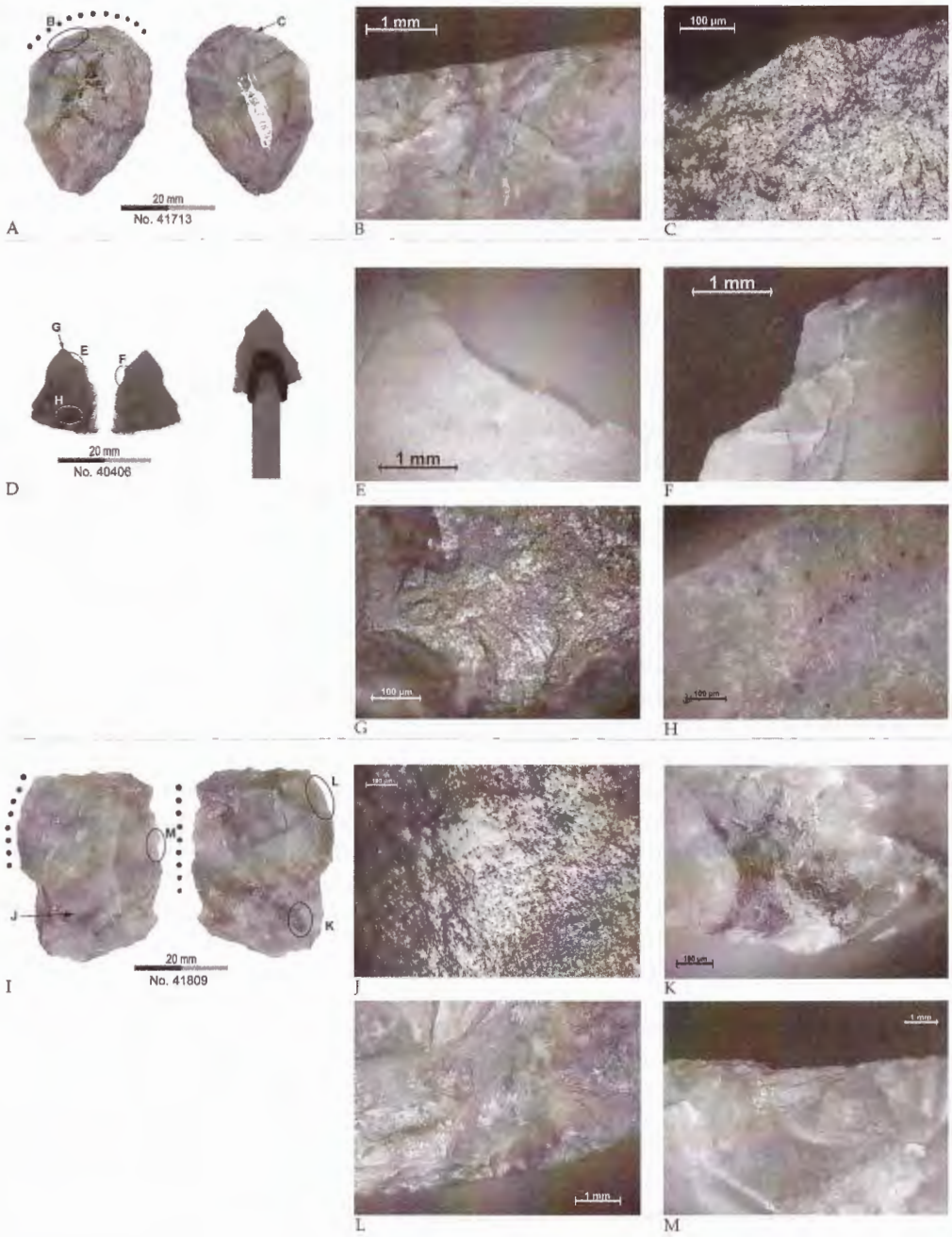

Figure 11.3. Stone tools from the Late Pleistocene layer of Ille Cave, Palawan with corresponding microwear traces and residues (after Pawlik 2010). A: Endscraper-like flake no. 41713 showing edge wear with traces of red pigment (B) and in combination with hide-working micropolish (C). D: Triangular flake no. 40406 used as projectile implement exhibiting impact scars (E, F) and micropolish with longitudinal striations (G) at the tip, and hafting residues associated with hafting polish at the basal part (H). I: Laterally retouched flake no. 41809 with 'bright spots' (J), resinous residues (K), and edge scarring caused by working harder organic material (L, M) (photographs by the authors).

& Glimmann 1896), which would make it an ideal binding material with regards to re-tooling processes and the replacement of worn-out implements. While the specialised bone points from Niah provide further proof for the availability of a Late Pleistocene hafting technology in Island Southeast Asia, the use of unretouched lithic flakes as hafted implements for multi-component tools at Ille Cave is unique and points to a technological concept that is beyond traditional morphological and typological models, but it is nevertheless a reflection of the constructive memory of its makers and their ability to perform complex sequences of action (Ambrose 2010). Use of pigments, resin, shell and hide working is a further indicator for the presence of modern behavioural traits in the Philippine Palaeolithic record.

Discussion

Palaeolithic research in the Philippines is contributing to our understanding of the timing of the initial colonization of ISEA, the landscapes human populations encountered on the different landmasses across the archipelago and how they adapted to the diverse range of environments they encountered. The tentative identification of anatomically modern humans at Callao Cave suggests that our species reached these islands circa 60–70 ka, more than 10 ka earlier than previously recorded at Tabon Cave. Landscape reconstructions have shown that to reach Luzon would have required at least two and possibly three open-sea crossings, and suggests that a form of watercraft technology perhaps already existed in MIS 3. Similar arguments for advanced boat technology have been posited for the initial colonization of Australia (Mulvaney and Kamminga 1999), the capturing of inshore and potentially offshore fishes more than 40 ka on East Timor (O'Connor 2007b) and the intermittent habitation of the Talaud Islands between Mindanao and Sulawesi more than 30,000 years ago (Ono et al. 2009).

The interpretation of human subsistence strategies on Palawan and Luzon have been instrumental in developing the larger regional picture of human adaptive responses to the mosaic of environments they encountered across ISEA and Wallacea. Late Pleistocene hunting strategies on Palawan and in northern Luzon were geared to take advantage of the open woodland and savannah environments and focused primarily on large game. On Luzon, in particular, the diversity of vertebrate fauna available was restricted by the impoverished nature of the animal community inhabiting the island. Existence in these environments would have required a very different range of skills from those appropriate to the tropical rainforests surrounding Niah Caves in Borneo at a similar time (Piper and Rabett, this volume), where a wide diversity of resources were acquired from a diverse variety of ecological zones within the forests.

Microwear analysis of the stone tools from the 25 ka occupation horizons at Callao suggest these were used in a range of tasks including the processing of hard contact plant remains such as wood, bamboo, rattan and/or palm (Mijares 2008, 29). Although Mijares (2002; 2007; 2008) considers the majority of the flakes to represent parts of an expedient tool technology, he notes that two blade-like flakes could potentially have been used as spear or arrow points (Mijares 2008, 28). If verified this would represent the earliest known evidence for a projectile technology recorded in ISEA, and it would be several thousand years earlier than the first recorded bone projectile points at the Niah Caves in Borneo and other sites across the region (Rabett & Piper 2012). The hafting of artefacts in the Pleistocene is further supported by research on the lithic materials from Ille Cave where we have the first solid evidence for composite-tool production and complex tool design in the Philippine Palaeolithic. Hafted composite tools and the making of hafting mastic for fixing lithic armatures in wooden shafts have been observed in European Micoquien and Aurignacian assemblages (Pawlik & Thissen 2011; Dinnis et al. 2009). They are considered to be components of the European and African package (Keeley 1982; Wurz 1999; Deacon 2000; Ambrose 2010) and have been regarded as a significant trait of behavioural modernity for Southeast Asia and the western Pacific region (Barton et al. 2009; Haidle & Pawlik 2010;

Pawlik 2010). However, hafting traces are easily overlooked or neglected in microwear analyses (Cahen et al. 1979; Keeley 1982). This analysis of relatively simple flakes from the Philippine Upper Palaeolithic shows that some were actually hafted armatures and parts of more complex composite tools. The dominantly small size of the flakes in Philippine lithic assemblages could even indicate the intention of the toolmakers to use them as hafted implements. This interpretation of lithic assemblages in the Philippines presents a different angle from the previously mentioned discussion of wood and bamboo industries to explain the absence of formal tools and lithic typologies in Southeast Asia. Considering bamboo and wood as prime material for the manufacturing of the shafts for composite tools and lithic armatures rather than replacements for stone tools opens up new avenues of research and provides a new view on the discussion of the 'dilemma of missing types' in Southeast Asia's Palaeolithic and Epipalaeolithic (Haidle & Pawlik 2009). The emerging evidence from the Philippine Palaeolithic record suggests that during the Late Pleistocene human foraging populations were more technologically sophisticated than previously envisaged and that they demonstrated adaptive flexibility and ingenuity and were adept at successfully colonizing and inhabiting new and varied landscapes. Far from being peripheral to the expansion of *H. sapiens* into Sunda and Sahul, the Philippines are an integral part of that history and the Palaeolithic record of the country has an important role to play in further developing our understandings of hominin migration and colonization, adaptation, evolution and behaviour.

Acknowledgments

This research was supported by an Emerging Interdisciplinary Research Grant of the University of the Philippines, OVPAA, code no. 2-002-1111212. Philip Piper was funded by the ARC Future Fellowship Grant FT100100527.