The Earliest Bone Tools in the Philippines: Patterns and Issues

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The study of bone tools is an area that is underrepresented in Philippine archaeology. Only a few publications note the occurrence of these tools in the country (e.g. Coutts 1980, Hutterer 1980, Alba 1987, Solheim 2002) and detailed studies are lacking. In effect, very little is known about the distribution of these tools in space and time in prehistory and the behavioral implications this distribution may have. This paper synthesizes data on the earliest bone implements in the Philippines and is subdivided into three major sections: the early section of the paper reviews the sites with bone tools in Island Southeast Asia and the Philippines; the next traces the development of methods in bone tool analysis; and the last explores the issues raised by the occurrence of bone tools and suggests directions for future research.

Bone Implements in Southeast Asia

Bone tools appear frequently in Pleistocene and Early Holocene archaeological sites in Island Southeast Asia. The earliest bone tools come from the site of Ngandong, Java, reportedly in association with skulls of *Homo erectus* and other fossils of animal bones, stone tools, and antler tools (Bellwood 1997). These remains were found in a questionable context and the bone tools were not in a secure association with the rest of the finds that date to around 40,000 to 100,000 years ago. Better archaeological associations and dates are found in several cave sites in Java especially in Gunung Sewu, a mountainous area in the southeastern half of the island (Prasetyo 2002a–c). The most abundant finds are in the Braholo and Keplek caves with a date range of 12,000 to 4,000 years ago. Prasetyo (2002a–c) suggests that these tools are spatulas, points, needles, and antler tools of unspecified types manufactured from long bones and hip bones of Cervidae, Bovidae, Suidae and tusks of Elephantidae. The working ends of the spatulas were ground to produce either a unifacial or bifacial edge. The points were made in the same manner and are also classified as worked on one or two sides to produce the point (Prasetyo 2002a–c). Similar tools were recovered at the site of Song Terus in good contexts with dates of 10,000 to 5,000 B.P. (Setiagama 2006, pers. comm.). These tools occurred with chert stone tools, shells, and remains of vertebrates previously mentioned. Other Javan sites that contain bone tools are Tuban, Bojonegro, Besuki, Tulangagung, and Puger. Outside Java bone tools have been recovered from Pecatu, Badung in Bali and Tabalong in South Kalimantan though the finds are not as numerous as those in Java (Prasetyo 2002a–c). In Mainland Southeast Asia, bone tools are reported in Hoabinhian sites such as Gua Bintong. Bellwood (1997:161) states that bone tools are one of the basic elements of the Hoabinhian toolkit along with bifacially flaked cobble tools, flake tools, stone mortars, and pounders. These tools are also found in Borneo, but the most well known is the cave site of Niah in Sarawak, which has had several seasons of excavations (Barker *et al.* 2000, 2001, 2002, 2003). The tools of Niah are of various kinds and were found even at the base levels that date up to 40,000 years ago.

The most exhaustive and recent review of the occurrence and analysis of bone implements is provided by Ryan Rabett (2005) who covers the majority of bone tool sites across Island and Mainland Southeast Asia, including those cited above in addition to several dated sites in Thailand, West Malaysia, East Java, and Vietnam (see Rabett 2005:15–158). Rabett (2005) shows that they have a wide spatial distribution but are most frequent in coastal sites dated between the end of the Pleistocene and the middle of the Holocene, around 11,000 B.P. to 4,000 B.P. He acknowledges that this association could very well be a sampling bias and perhaps even an effect of the failure to identify bone finds as tools. However, he argues that the constant occurrence of bone implements in coastal sites could relate to subsistence in coastal environments. He cites several ethnographic records noting the importance of bone tools in many woodworking activities—for example, in the removal of bark from lumber for the building of canoes. In other regions bone tools are useful in making shafts for spears. None of these activities are ethnographically observed in Southeast Asia but these illustrate the wide range of applications such tools might have had for early coastal settlers. Also, Rabett's study incorporates an experimental framework that showed that woodworking leaves a distinct pattern on the tool's edge, which in turn was observed on some of the tools from archaeological contexts.

Bone Tools in the Philippines

It is not clear when the first bone implements appear in the archaeological record. To date, those sites with record of bone tools are Holocene in date. In sites with earlier dates, bone tools are noticeably absent, though implements of shell appear in upper layers. The data surveyed here is presented in a geographical scheme starting with the sites in Luzon. Moving south, the sites in the islands of Visayas are described followed by those in Mindanao and the small islands around it (refer to Figure 1).

Bone Implements in Luzon

Cagayan Valley is one of the earliest sites to be excavated in the Philippines. This area is generally hilly because it is close to the Sierra Madre mountain range, which is the longest in the Philippines. In these hills nestle several limestone formations with several cave sites rich in archaeological materials but bone implements are sparse. For example, Thiel (1988–1989) reports only three bone tools from the cave of Musang. Recovered were two bone points from a depth of 31 to 41 cm below the surface and one from a depth of 41 to 51 cm below the surface. No dates were obtained at this level from this pit though another pit at this depth had a date of 4,980±150 B.P. (GaK-7044). The points were produced by grinding. One bone fragment, which showed signs of working was also recovered but no further description of this is given.

Musang is believed to have been used continuously over a period of 12,000 years. Cultural Level I contains a date of 11,450±170 B.P. (ISGS-496) obtained from shell. At this period, the cave appears to have been inhabited by individuals who subsisted mainly on shellfish, and large fauna like pig (*Sus* sp.) and deer (*Cervus* sp.) According to Thiel (1988–1989) this level has the densest concentration of fauna and lithic materials. In Cultural Level II where the bone points were found, Thiel (1988–1989) notes the appearance of pottery with a reduction in the frequency of flake tools and fauna. Stone tools sampled for functional analysis showed evidence of "woodworking, bamboo working, bone working, and bamboo cutting" (1988–1989:77). However, it is not mentioned how these interpretations were derived and no detailed description of the evidence is given. The three bone tools were associated with gastropods (*Thiara scabra*) that are common in the rivers in the vicinity.

Arku Cave, another site in Peñablanca excavated by Thiel (1986–1987), contained archaeological materials comparable to those in Musang. Arku is a burial site and is 1.5 kilometers away from Musang. The first layer of one pit (H4/5) was 1.12 m thick and this was excavated in spits of 20 cm; all spits yielded a total of six bone awls and ten bone points. This layer contained burials of ten adults and one juvenile but it is not clear whether the points are associated with the burials or were part of the fill. Also recovered in this thick layer were ornaments, sherds, and occasional flake tools. A date of 2,740±120 B.P. (GaK-7040) was obtained at a depth of 62 cm but no clear description of the context is given so it is not certain whether these can be associated with the bone implements. Another pit (J5) yielded four implements made from horn and Thiel suggests that these were used as tattooing chisels. No dates are available for these. The last pit (J5) had a solitary bone point occurring above a layer dated 2,390±160 B.P. (GaK-7042). Thiel (1986–1987:243) has illustrations for these tools. Five of the points are 3 cm to a little over 4 cm long and have blunted tips. Five points are barbed and some of these are less than 3 cm long. The six bone awls measure from 3 cm to 4 cm long. No other descriptions are provided. No clear dates are available for these finds but Thiel's observation is that the Arku assemblage is "generally associated with Neolithic agricultural people" (1986–1987:260).

Warren Peterson (1974) surveyed the foothills of the Sierra Madre in the province of Isabela and Nueva Vizcaya, southeast of Cagayan in the late sixties, and later excavated Pintu Rockshelter. Pintu had eleven layers but only the first seven layers contained cultural remains. The first five layers had sherds of pottery and lithics, while the seventh and eighth had very little cultural materials. The stone tools were mostly knapped from andesite and basalt but tools of fine-grained materials were also present. Peterson identified seven flake tools, which he classified as saws potentially used in bone, burins or gravers, and awls or borers used to work bone (1974:101–104). Not too many bone artifacts were recovered at the site but Peterson (1974:105–107) identifies three tool types: antler points, v-shaped points, and keel-shaped bone needles. His descriptions are quite extensive. There were two antler points, one with a length of 2.7 cm and a diameter of .8 cm and the other, a length of 3 cm and a diameter of .9 cm. These were ground to a point but no usewear is evident on the edge. Two artifacts were made from long bones carved to a point. These are 7 cm and 2.8 cm long and 2.5 to .6 cm wide respectively. Neither shows signs of wear according to Peterson. Finally, he describes two artifacts "resembl[ing] a boat or prow keel" that might have functioned as bone needles used to make roof shingles of rattan or grasses. Polish and silica sheen were observed on the points along with striations that run parallel to the length of the tool. These finds are from the third layer but no date is available for this. The range of radiocarbon dates obtained from the fourth to the tenth layers is 2,178 B.P. to 4,236 B.P. The bone tools occurred after this time range but the idea is that the site functioned as a temporary shelter for small bands of hunters and gatherers who subsisted on pig, deer, and freshwater shellfish (see also Latinis 1996 for a reassessment of the assemblage).

One site in the central part of Luzon yielded bone tools in contexts dated to the 14th to 15th century. Bolinao in Pangasinan contained several human burials with a few associated bone artifacts. Legaspi (1974:12) describes ornaments and "tubular bone objects with circular indention or incision all over the body" but is uncertain what the functions of these were. Iron daggers, gold ornaments, Chinese coins, and pottery were found as grave goods. The most spectacular finds were the articulated human remains with gold dental peggings. All these point to a highly complex society with established trade networks just before the colonization of the islands by Spain.

Sites in the southern region of Luzon have a few undated bone artifacts recovered from the surface. Calamianes, just north of Palawan had an artifact of "ivory bone or button" (Solheim 2002:115). Leta-Leta Cave in El Nido, Palawan yielded a bone knife measuring 24.4 cm. Other cave sites in the island were explored by Guthe in the 1920s and excavated by several teams (Fox 1970; Kress 2002; Paz n.d., 2001; Paz and Ronquillo 2004; Teodosio 2004) in the past three decades but none delivered bone tools though these caves contain plenty of archaeological materials[1].

The Eastern Regions and Panay

In the seventies, Hutterrer excavated numerous sites along the Basey River in Samar in the eastern region of the Visayan islands. He discovered bone points in association with lithic artifacts and fauna in the site of Sohoton I, an "endogen cave" with two chambers (Hutterer 1973). Nine layers were identified in the stata, and Hutterer divided these into four archaeological horizons. Similar flake and bone tools were found in these horizons (1973:81). The bone tools functioned as awls or points, and some of this have "two pointed ends." Hutterer recovered pottery in the upper horizons occurring with the flake and bone tools. The stone tools are typically amorphous but he believes some of these were used for working bamboo and wood. Fauna was present in all of the layers. The most dominant were remains of pig, deer, rodents, some amphibians, and riverine mollusks. Marine mollusks were present in the upper layers. Two dates were obtained. One was from the lowest layer of bat guano and this is dated 10,500±160 B.P. while charcoal recovered in the top layer gave a date of 385±105 B.P. Huterrer (1973:85) recovered "about a dozen bone tools" but does not indicate how they are distributed. Although he notes the presence similar tools in the archaeological horizons, he also states that in the lowest layer only spare flake tools occur so it is not clear whether this basal date can be associated with the bone tools. At any rate, the occurrence of these bone tools in a series of layers shows that the use of bone for toolmaking was continuous for a long span of time. The thinking is that the cave was occupied by passing bands of hunter-gatherers at several periods. Unfortunately, the description of the tools is spare and dates are not available for all layers.

Guthe's renowned exploration of the 1920s also led to the discovery of bone artifacts in Samar and the neighboring islands. These undated tools from Samar are believed to be handles made from ribs, with the surface well polished at one end (Solheim 2002:93). Comparable discoveries were in Camotes, a small island off the present coast of Leyte. Here, a bone hilt with an embedded iron tang fragment was recovered (Solheim 2002:69). South of Camotes is the island of Bohol (which Guthe labeled C11), which yielded what Solheim (2002:90) describes as follows:

> C11-410—bone artifact: two pieces from a frame or handle—one with rust stains, several channels cut through one side, piece with rust 3.6 cm long, 1.7 cm wide; other piece shows no rust stains but has the same type of channels, perforated at either end with a conical drill, 5.1 cm wide.
>
> C11-411—worked bone: one fragment perforated lengthwise with rust stains in channel.
>
> C11-415—worked bone: three cut fragments, possibly for use as handles which would make use of the hollow structure of the bone though no wear is evident in the center, one piece cut square at one end and with wedge-shaped cuts from both sides at other end, maximum length 7.5 cm.

With the exception of Hutterer's finds, the bone implements in this eastern group of islands are quite complex in form and are already associated with metals.

Another area where bone tools have been recovered is Panay in Western Visayas (Coutts 1983). This is a triangular island and has had very little archaeological research. Coutts' excavation focused on the eleven sites in the central and southern part of the island. Two tools were recovered from Gui-ub Cave (Calinog, Iloilo, Southern Panay) in a layer dated 1,380±170 B.P. (SUA–1701). Coutts suggests that these were used as awls. One of the tools "had been extensively modified, having longitudinal facets" and the other "bear[s] striations, which suggest that the point was fashioned by carving; both the tip and the base have been broken post-depositionally" (Coutts 1983: 138). Eight layers were present in the cave but the archaeological deposits are concentrated in the third to fourth layers. Coutts observed the variations in the density of materials, especially with the fauna, which is very dense in the fourth and fifth layers. Recovered in these layers were remains of various vertebrates (pig, deer, and others). The density of lithics and pottery also varies in the cultural layers but these are definitely associated with the bone tools. Shell is present but not in great numbers, suggesting that this did not figure greatly in the subsistence of the cave's occupants. A remarkable observation is that in cave sites farther up north, river shells occur in the archaeological layers that Coutts tentatively puts at 4,000 to 1,000 years ago. To Coutts (1983:165), this interesting combination of cultural materials suggested a "broad spectrum economy focused on the forest and riverine environments" that was still based on hunting and gathering. It is for these sites that the "smash and grab" type of lithic technology hypothesis was proffered. Another idea is the late date and the association with pottery indicate that a very simple lithic and bone technology persisted even when settlements with agriculture were already present in the area (Coutts 1983:169).

Coutts (1983) also recovered an antler fragment believed to be a chisel from the surface of Pilar Cave, Iloilo but this is not dated. The cave is part of a limestone formation close to a mangrove swamp. One radiocarbon date of 490±180 B.P. was obtained, proving that the cave was still actively used just before Spanish colonization. As with Gui-ub, this cave contained the remains of the aforementioned vertebrates, most of which are burnt. Other effects in the strata show reliance on the resources from the sea, river, and land. The chisel is a little over 10 cm long with a diameter of 2 cm at its widest measurement. Its working edge is produced by two opposing facets that meet at the tip to form the sharp cutting edge of the tool. The edge appears to have been produced by shaving rather than grinding as indicated by the cut marks close to the edge. According to Coutts, the working edge is polished and rounded so the manufacture marks are not defined. The opposite end of the tool has cut marks, which could have been produced by a metal or stone tool. It is unfortunate that this tool was found on the surface of the cave and therefore could not be associated with any date.

Butuan and Tawi-Tawi

Further south but still in the eastern half of the archipelago are the Ambangan sites of Butuan. This is the site of the famous Butuan boats with a radiocarbon date of 1,630±110 B.P., 700±90 B.P. and 960±70 B.P. (Bautista 1991b:161). The tools are varied. Bautista (1991b) analyzed the faunal remains from the five sites and noted pieces of carved bone measuring 65 mm long used as baits for squid. Awls with lengths of 79.9 to 160 mm made from long bones of unspecified mammals and even dagger hilts were also found. Associated with these are shell tools and other modified artifacts from shell, bone, and teeth. Alba (1998:69–71) provides an illustration of some of these tools. Remains of ocean fishes like the shark and reef and open sea fishes were also recovered along with deer, macaque, and python. On the whole, the materials recovered at these sites paint a picture of a fairly recent complex society that relied on water resources as they did on terrestrial ones and had an established trade network.

Finally, in the southernmost region of the Philippines are the islands of Tawi-Tawi that are close to Borneo. Ronquillo *et al.* (1993) excavated the Balobok Rockshelter in Sanga-Sanga Island, Tawi-Tawi in the early nineties after previous excavations revealed the potential of the site. Four cultural layers were identified and these have Early to Late Holocene dates. The dates were obtained from shell samples and the earliest is 8,000±110 B.P., the latest, 5,140±100 B.P. A single bone tool was recovered in the excavation (Ronquillo et al. 1993) but Bautista (2001, pers. comm.) discovered more when the sediment collected from all the layers was floted. These tools were made from pig bones by sawing and grinding (Bautista 2001). The bones are damaged and the species cannot be determined. However, Bautista (2001:103, 113) notes that *Sus barbatus* and *Sus philippinensis* are part of the local fauna so the remains could be of these species. The bone tools vary from 3 to 4 cm in length and all taper to a distinct point. The cave has three occupation phases: the earliest date cited above falls within the Early Phase of occupation when Balobok was inhabited by individuals that subsisted on marine shells and pigs. The bone tools in this layer occurred with flake tools, débitage and evidence for shellworking. This is followed by the Middle Occupation Phase with a date of 7,290±120 B.P. Earthenware pottery, polished shell tools, and polished stone tools appear at this level. By the Late Occupational Phase (5,140±100 B.P.), the same materials occur with metal and glass (Ronquillo *et al.* 1993). Bone tools were in all of these layers (Bautista 2001:150).

Interestingly, this site also shows that the absence of bone tools in many archaeological sites in the Philippines might be that they are not always identified during excavation. Bone tools can become encrusted with sediment because of their diminutive size and mistaken to be part of the matrix. This greatly illustrates the need for more cautious excavation and recovery techniques. Methods in the analysis of bone tools themselves have rapidly developed and the next section discusses how these have enhanced the understanding of bone tools.

Methods in the Analysis of Bone Tools

Early studies on bone tools focused on form and the interest was mainly to categorize implements into types with corresponding functions. Awls and points are the simplest and most common types. Others include gouges, spatulas, and digging sticks. A good example of this is Harrisson and Lord Medway's (1962) typological analysis of the tools of Niah Cave. Harrisson and Lord Medway (1962) identified several types of tools made from pig tusks, mammalian long bones and teeth, turtle subdermal bone, fish bones, and bones of extinct species. Of the eighteen types they identified, seven are tool types while the rest are classed as ornaments. The tools are drifts and rods, turtle tools, pig tusks tools, awls, simple points, gouges, and spatulas. Awls, according to Harrisson and Lord Medway (1962:352), "are shafts of bone worked to a sharp point." The awls in their illustrations are generally wider than the bone points and have a wide U-shaped cross-section. The points on the other hand are simply "slivers from large bone shafts or small bone shafts sharpened without splitting," which could either have a flat or rounded cross-section depending on the material it is made from (Harrisson and Lord Medway 352–353). Some of the tools show parallel striations at the tip, which the authors interpret as signs of working or contact with a harder material like sandstone. Though the typology is very thorough, the authors acknowledge that bone fragments produced by butchering might mimic tools.

Other scholars also acknowledge that morphology alone is not a reliable indicator of the function of any given tool or if the piece in question is a tool at all. Bone fragments can exhibit wear that is not anthropic in origin (Lyman 1994). Scavenging animals can leave marks on a piece of bone that can mimic marks derived from butchering or use. The examples are numerous—sea lions, large cats, canine, and other animals that typically gnaw on bone. For Island Southeast Asia, rodents like the porcupine and the rat can be an agent of modification. Also, even if the marks seen on a piece bone are indeed anthropic in origin, these may not necessarily be from use (see also Olsen 1988, Olsen and Shipman 1988). For example, the processing of a carcass by butchering can leave striations on bone but the bone—though classified as an ecofact—is not a tool in the conventional sense of the word. In this case, butchery marks are but "incidental byproduct[s] of the human behavior of modifying animal carcasses into consumable resources" and "as such, butchery marks would be unintentional epiphenomena of the intended modification" (Lyman 1994:339). Clearly, this makes the identification of what constitutes modified and used bone in a given assemblage very difficult.

For example, the gouge—documented by Harrisson and Medway (1962) as a tool made from a long bone that fractures across its length obliquely—can occur unintentionally as a spiral fracture. The genesis of such a fracture is not very clear. Under certain conditions, for instance when the fracture runs between collagen bundles in the bone's microstructure a long bone can fracture into a smooth point, especially when the bone is very dry when it fractures and when both static and torsional loading are applied to the bone (Lyman 1994). Static loading happens when "constant compressive pressure, generally with an even distribution of force" is applied on the bone (Johnson 1985: 192, cited in Lyman 1994). Torsional loading, on the other hand, is a combination of a force that pulls the material apart that one part slides away from the other. The amount of moisture in a bone affects the fracture because it affects the mechanical properties of the material. Moisture decreases the hardness, tensile strength, and compressive strength of a bone. A long bone is less brittle when fresh and will not fracture easily when loading is applied (Lyman 1994). Dry bone, on the other hand, yields more easily when the loading is small. As well as the type of loading and the condition of the bone, another variable that greatly affects the resulting type of fracture is the physical property of the bone itself. For example, the epiphysis of a long bone, which is trabecular[2] in nature, tends to be more tolerant to stress, thus it is the diaphysis of a long bone that tends to yield more often (Lyman 1994).

Davis (in Lyman 1994), sums up the variables that affect the type of fracture: the physical properties of bones both at the macro and micro level—for example, the alignment of collagen; the type of loading; third, the condition of the bone—for example, presence or absence of moisture and weathering. All these make clear that although humans can induce fracturing, it must not be ruled out that natural conditions can induce the same and even those that are anthropic might not be indicative of use. In practical terms, smoothing, tapering, and symmetry seen in a piece of bone must not at once be attributed to a human agent. And in this regard, the typological classification of bone tools can be quite misguided and arbitrary. In fact, in Harrisson and Lord Medway's (1962) documented experiment, fragments and splinters comparable to true tools can be produced simply by smashing a long bone with a cobble.

The Microwear Analysis of Bone Tools

A more recent approach to the classification of bone tools in Southeast Asia is presented by Rabett (2005) who uses a three-tiered method of classification. Here, tools are partly classified into types generated from a mathematical description of their edges. These are then categorized further based on what Rabett calls an "exploitation ratio" or the "measure of how efficiently a tool had been used relative to the amount of work that had gone into manufacturing it." The final category is based on function that can be induced from the features observed on the tool under the low and high-power microscopes. These features are varied and include flaking, polish, and striations. The location of these features relative to the tool's edge and other factors help determine the function of the tool.

Semenov (1960), who also pioneered the microwear analysis of stone tools, first illustrated the efficacy of this method. To Semenov however, use-wear on bone is limited to scratches or striations and attrition. The latter is made easier to identify by the bone's natural parallel periosteum across which striations often occur. Such wear tells not only what type of motion occurred during use but also what kind of material came in contact with the bone tool. What can complicate the identification of bone use-wear however is the fact that working on bone to modify it also leaves traces comparable to that of use. But because working leaves a more systematic wear on bone, it is very often identifiable from use-wear. Notable among the working traces identified by Semenov in highly complex Upper Palaeolithic bone implements[3] are parallel striations. These are left on bone by grinding against a very granular lithic material such as sandstone.

Semenov relied on both high and low power examination using binocular and monocular microscopes for the analysis. Recent analysts have at their disposal a wider variety of equipment but rely on essentially the same features he identified. Campagna (1980, in Echols, n.d.), who conducted an analysis of bone tools with an experimental framework, identified scratches and gouges as the typical wear. One focus of Campagna's work is to make a distinction between use-wear and traces left by working on the tool. His experiments showed that it is the distribution of features on the surface of the tool that distinguishes one from the other. For instance, striations and gouges that are oriented parallel to each other or are evenly distributed on the tool is more likely to be an effect of manufacture than of use. Those that are uneven and spare are likely to be from use. Likewise, polish due to manufacture is deposited in a more even than that of polish from use.

The scanning electron microscope used with image analysis techniques also proves to be an even more efficient aid in describing and interpreting edge features (Backwell and D'errico 2003). This method was used to analyze materials associated with the Swartkrans hominid fossils dated to around 1.8 to 1.0 million years ago. This experiment involved the production of bone tool replicas used in purported hominid actions such as digging for tubers and termites. Comparisons between the archaeological and experimental pieces showed concrete evidence for the hominid origins of the wear on the tools. Traces of wear like striations were found on the functional tips of the artifacts decrease in intensity farther away from the edge. An overall morphological analysis of the tools suggested that there was a preference for particular tool sizes and shapes. These hominids apparently preferred "stout bone pieces as digging tools" (Backwell and D'errico 2003:259).

As in the analysis of microscopic use-wear on stone tools, use-wear identification in bone tools is complicated by taphonomic factors. Bone is a soft material and is more prone to post-depositional scratches and abrasions (see Olsen 1989). Secondly, wear traces can be erased by further use. This is often the case especially when the tool is used in a soft material (Campagna 1980, in Echols n.d.). Third, practical experience shows that distribution of wear is not always a signature mark of human agents. In other words, bone tools can undergo plenty of natural taphonomic processes that can alter its morphology and limit the functional analysis derived from it. Researchers have responded to this by designing experiments testing the effect of post-depositional processes to bone. An example is Shipman and Rose's (1988) study investigating the relationship between natural processes and wear with experiments modeling processes like water and wind induced abrasion. In particular, they were interested to see whether the wear on some proffered expedient tools could have been caused by natural processes rather than humans. The authors discovered that water transport and sediment abrasion may significantly erase traces of wear on a tool. "Cutmarks on bones lose all of their diagnostic, microscopic features after as little as 5 hours of abrasion although the indentations are still visible after 80 hours" (Shipman and Rose 1988:320). Surprisingly, none of these "hydraulic abrasion experiments" produced significant linear features than can be mistaken for usewear. Smoothening and polishing can easily happen on a damaged bone surface than on non-damaged bone. Particles carried by wind were found out to have little or no effect to bone surface though they acknowledge that more prolonged contact could have more significant effects. The authors show that expediency may be tested but this have to be coupled with a rigorous experimental framework.

There are other problems inherent in any method that models a phenomenon like use-wear formation but the works cited above illustrate that with due caution better inferences can be had regarding bone tools. This method is valuable because, first, it allows a more replicable scheme of typology or classification; and second, it allows a scheme for the verification of the functional inferences generated for a tool. Significantly, answers to the potential issues discussed below will depend to some extent in the creation of an appropriate framework of macroscopic and microscopic analysis.

Emerging Patterns and Questions in the Occurrence of Bone Tools

It is difficult to explore the implications of the distribution of bone tools in space and time in Philippine prehistory given the amount of data reviewed here. The lack of absolute dates for most sites and the fact that there are plenty of assemblages still to be fully analyzed make the conclusions generated in this paper very preliminary. On the other hand, the little information presented here can outline the aspects along which future lines of inquiry should be directed. There are three clear aspects that need verification: first, the "absence" of bone tools in early periods of prehistory; second, the association of bone technology with specific environments; and third the technology involved in their making.

Early Humans in the Philippines and Bone Tools

It can be seen from the data reviewed above that bone implements are not well distributed in the archipelago and do not occur in contexts older than 8,000 years ago. The dates generally associated with bone tools range from 8,000 years ago to as late as the 14th century. And in this period, only simple forms like points and awls appear. Only the site of Balobok Rockshelter of Tawi-Tawi has this oldest date in a secure context so it is not certain if at this period other cultures in the Philippines relied on bone as raw material for tools. The few bone tools in Cagayan Valley are not directly associated with dates and the general observation is that the bone tools here belong to Neolithic agricultural societies.

An interesting observation is that in other sites in Island Southeast Asia bone tools were found in layers occupied in the last glacial maximum and even in sites with remains of *Homo erectus* though this association is not clearly established. This raises questions about the tools of the earliest humans that colonized the archipelago as early as 40,000 years ago[4] (Dizon 2003; see also Détroit *et al.* 2004).

Several excavations have established the antiquity of humans in at least two localities in the Philippines—Palawan and the sites in Cagayan. The oldest secure dates come from Palawan (Fox 1970, Dizon 2003, Détroit *et al.* 2004), which in the seventies had been thoroughly excavated by Fox. More recent excavations yielded fossilized human remains, which now have a date of 47,000 +11,000/ -10,000 B.P. (Dizon 2003). Flake tools, débitage, and other lithic materials have been excavated here and in other sites in Palawan but bone tools are not mentioned. It was Fox (1970:39) who first pointed out the lack of bone tools in Palawan, saying that "bone artifacts are notably scarce …in all of the Palawan cave sites regardless of their age." He explained their absence in Tabon by the abundance of chert in Lipuun point, where chert can be found as cobbles and pebbles in rivers. Results of recent excavations at Tabon Cave (see Orogo 2002; Dizon, Ronquillo, and Orogo 2001) do not mention bone tools.

The same is true for Northern Palawan even where lithic materials for the making of appropriate tools are also absent (Paz 1997, Paz and Ronquillo 2004, Teodosio 2004). Chert and obsidian are present in the archaeological record but have not been found near the cave. The lithic materials recovered in the 2004 excavations at Ille Rockshelter and Makangit Cave are only pebble-sized and typical are small flake tools, small exhausted cores, and small pieces of débitage. The lithic assemblage recovered from both cave sites suggests a relative scarcity of chert or other fine-grained materials for the manufacture of stone tools.

As to why this should be the case is not yet certain but many reasons are possible. Rabett's (2005) observation that bone technology in Southeast Asia is often linked to coastal subsistence might partly explain the "absence" of bone tools in Palawan, which was several kilometers away from the coast when it was occupied during the Pleistocene but not after the last glacial maximum (Voris 2000). This is an idea that might be supported by the appearance of marine shells in post-Pleistocene layers in major Palawan sites like Tabon and Ille caves.

On Bone Technology and Coastal Subsistence

Balobok Rockshelter offers the best argument for the association between coastal subsistence and bone tools. As discussed earlier, this site has three dated cultural layers that contain bone tools, suggesting that the technology continued for more than two thousand years. In this span of time, the rockshelter had been quite close to the coast. One idea is that at the end of the Late Pleistocene, most of the islands that used to form a bridge-like link to the island of Borneo (Bautista 2001) had started to become submerged so that by 6,000 years ago these islands appeared as they do today. So close is the shelter to the sea that a wide variety of mollusks were recovered across the layers. This sea-based subsistence—with preference for abalones, turbans, nerites, and chitons—remained unchanged for the time that the shelter was inhabited. Though the other sites in the Philippines contain bone tools, this is the only site that exhibits continuity across a long span of time.

The relationship between coastal habitations and the development of bone technology is not yet fully understood, but this might relate to the constant availability of water-based resources in these areas. A ready supply of goods could induce the manufacture and curation of similar tools over time and perhaps even the formalization of these tools. Subsistence in coastal areas might also demand tools with specific edge morphologies that bone, due to its unique physical properties, can give. However, it must also be stressed that some inland sites in the Philippines have bone tools. These sites—the cave sites of Panay, Sohoton, and the Cagayan cave sites—had occupants that appeared to have relied heavily on terrestrial fauna; a river-based subsistence was also suggested by the presence of gastropods.

On Expedient Bone Technologies and Bone Shatter

The argument of formalization above leads to another potential hypothesis—the expediency of bone implements in inland environments. In other words, the absence of bone tools in sites not associated with coastal or lacustrine locations might not be a real one. That is, formalized bone technology could have been absent but these inland folks could very well have used tools from bone and disposed these as needed. This "expedient hypothesis" is one to which many turn to interpret the amorphous assemblage of implements in the archipelago but confirmation is difficult to obtain. The argument is that in the tropical setting, prehistoric individuals would have had a wider array of organic materials to exploit for tool-making. For example, practical experience will show that bamboo and rattan can be made into efficient extractive or procurement tools (see Pope 1989 for bamboo). Actual evidence of such tools has yet to be discovered in any archaeological site. However, the presence only of a simple flake tool technology and the absence of a clear bone-based technology might point to reliance on this other raw material for tool-making.

Analysts of bone tools have proffered such an "expedient" hypothesis more than a decade ago, arguing that prehistoric individuals could also have used pieces of non-modified bone as tools. With a carefully designed experimental framework focused not only on use-variables but also on natural post-depositional factors that can affect bone, expedient tools can actually be identified (see Shipman and Rose 1988). Likewise, the numerous works on bone and the taphonomic processes that affect it characterize in detail the microtopography of bone, making identification of anthropic-induced wear less difficult (see Olsen 1988, 1989; Rackham 1994). The testing of expedient use of bone tools has become very amenable with the rich data now available. This allows an easier verification of whether unmodified bone fragments were used nonetheless. The idea of expediency in bone technology is one that is worthwhile testing since shattered bone occurs frequently in many sites across the island[5]. Covering these points will lead to a more comprehensive understanding of the role of bone in prehistoric technologies in the Philippines and its relationship with the assemblages of the greater region of Southeast Asia.

Endnotes

[1] There are twenty-nine caves in the area of Lipuun Point, Southwestern Palawan: Agung, Batu Puti, Bubulungan I, Bubulungan II, Decalan, Diwata, Dugyan, Guri, Igang, Kabuwan, Kaarung, Liyang, Manunggul, Mutya, Ngipe't Duldug, Nigi, Pagayona, Pawikan Ledge, Pugay, Ranggaw, Rito-Fabian, Sarang, Fissure, Tabon, Tadyaw, Tarungtung, Ukir Ukir, Uyaw, and Wasay. Sixteen were excavated but none of these caves produced bone tools.

[2] This pertains to the sponge-like and porous structure found in the internal portion of some bones.

[3] The tools that Semenov analyzed come from several sites: Luka-Vrublevetskaya, an early Tripolye settlement site; several sites in Chukotsk Peninsula of the Bering Sea that represent the Uellen-Okvik stage of Eskimo culture; and others.

[4] Early scholars like Fox and Peralta suggested that humans could have been in Cagayan Valley by the Mid-Pleistocene because stone tools were found there along with remains of megafauna. The association between the two still has not been clarified despite the numerous excavations and geological studies (see Von Koenigswald 1958, Fox and Peralta 1974, Fox 1978, Shutler and Mathisen 1979, Bondoc 1979, and Mathisen 1981). I believe, however, that finding early dates for these tools is not remote.

[5] A case in point is the assemblage recovered at Makangit Cave of El Nido, Northern Palawan. Flake tools, some with clear signs of retouch were found with these shattered faunal remains, along with débitage, and exhausted cores on the surface of the cavern (Teodosio 2004). One hundred and ninety-four pieces of bone material were collected here and the majority of these are small unidentifiable fragments and splinters from bigger bones. The initial microscopic analysis showed no convincing signs of use but this does not preclude the potential of finding expedient tools. Ille Rockshelter in Northern Palawan yielded plenty of hitherto classified shattered bones and so did Pilanduk and Tabon Caves Fox does not discuss these in any of his major publications (Kress 2004; pers. comm.). Recent excavations at Tabon also recovered plenty of bone fragments.

References

Alba, Elenita. 1998. Modified bones and shells from Philippine archaeological sites. *National Museum Papers* 8(1):45–80.

Anderson, D.D. 1997. Cave archaeology in Southeast Asia. *Geoarchaeology* 12(6):607–638.

Andrefsky, W. 1998. *Lithics: A macroscopic approach to analysis.* Edinburgh: Cambridge University Press.

Backwell L.R. and F. D'errico. 2003. Additional evidence on the early hominid bone tools from Swartkrans with reference to spatial distribution of lithic and organic artifacts. *South African Journal of Science* 99:259–266.

Barker, G. H. Barton, P. Beavitt, S. Chapman, M. Derrick, C. Doherty, L. Farr, D. Gilbertson, C. Hunt, W. Jarvis, J. Krigbaum, B. Maloney, S. MacLaren, P.Pettitt, B. Pyatt, T. Reynolds, G. Rushworth, M. Stephens. 2000. The Niah Cave Project: Preliminary report on the first (2000) season. *Sarawak Museum Journal* 55(76):111–49.

Barker, G., D. Badang, H. Barton, P. Beavitt, M. Bird, P. Daly, C. Doherty, D. Gilbertson, I. Glover, C. Hunt, J. Maser, S. McLaren, V. Paz, B. Pyatt, T.

Reynolds, J. Rose, G. Rushworth, and M. Stephens. 2001. The Niah Cave Project: The second (2001) season of fieldwork. *The Sarawak Museum Journal* 56(77):3–119.

Barker, G., H. Barton, M. Bird, F. Cole, P. Daly, D. Gilbertson, C. Hunt, J. Krigbaum, C. Lampert, H. Lewis, L. Lloyd-Smith, J. Manser, S. McLaren, F. Menotti, V. Paz, P. Piper, B. Pyatt, R. Rabett, T. Reynolds, M. Stephens, J. Thompson, M. Trickett, amd P. Whittaker. The Niah Cave Project: The third (2002) season of fieldwork. *Sarawak Museum Journal* 57(78):87–178.

Barker, G., H. Barton, M. Bird, F. Cole, P. Daly, A. Dykes, Lucy Farr, D. Gilbertson, T. Higham, C. Hunt, S. Knight, E. Kurui, H. Lewis, L. Lloyd-Smith, J. Manser, S. McLaren, F. Menotti, P. Piper, B. Pyatt, R. Rabett, T. Reynolds, J. Shimmin, Gill Thompson, and Mark Trickett. 2003. The Niah Cave Project: The fourth (2003) season of fieldwork. *The Sarawak Museum Journal* 58(79):45–119.

Barton, Huw. 2005. The human use of caves in Peninsular and Island Southeast Asia: Research Themes. *Asian Perspectives* 44(1):1–15.

Bautista, Angel. 1991a. Recent zooarchaeological researches in the Philippines. *Jurnal Arkeologi Malaysia* 4:45–58.

Bautista, Angel. 1991b. A zooarchaeological perspective on the Ambangan Site, a prehistoric settlement in Butuan, Agusan Del Norte, Southern Philippines. *Indo-Pacific Prehistory Assn. Bulletin* 10:161–170.

Bautista, Angel. 2001. An analysis of animal remains recovered from Balobok Rockshelter, Sanga-Sanga, Tawi-Tawi province. Master's Thesis. Manila: University of Santo Tomas.

Bellwood, Peter. 1997. *Prehistory of the Indo-Malaysian Archipelago*. Honolulu: University of Hawa'ii Press.

Bondoc, N. H. 1979. *A Re-investigation of the Espinosa Archaeological Sites: Cagayan and Kalinga-Apayao.* Anthropological Papers No. 6. Manila: National Museum.

Burkill, Isaac Henry. 2002. *A dictionary of the economic products of the Malay Peninsula.* Kuala Lumpur: Ministry of Agriculture.

Coutts, Peter J.F. 1983. *An archaeological perspective of Panay Island, Philippines.* Cebu City: University of San Carlos.

Détroit, Florent, Eusebio Dizon, Christophe Falguères, Sébastien Hameau, Wilfredo Ronquillo, and François Sémah. 2004. Upper Pleistocene *Homo sapiens* from the Tabon Cave (Palawan, The Philippines): Description and dating of new discoveries. *C.R. Palevol* 3:705–712.

Dizon, E. 2003. "New direct dating of the human fossils from Tabon Cave, Philippines." *Proceedings of the Society of Philippine Archaeologists, Semantics and Systematics: Philippine Archaeology.* Edited by Amalia dela Torre and Victor Paz, pp. 63–67. Manila: The Katipunan Archaeologist ng Pilipinas, Inc.

Dizon, E., W. P. Ronquillo and A. Orogo. 2001. Recent field campaign at Tabon Cave in Lipuun Point, Quezon, Palawan, Philippines. Manuscript. Manila: National Museum of the Philippines.

Echols, Emily. (n.d.). Bone tool production at Vesto-Bikeri. Retrieved 3 April 2005 from http://www.anthro. fsu.edu/research/koros/fieldschool/field2001/papers/echols.pdf.

Fox, R. 1970. *The Tabon Caves.* Manila: National Museum of the Philippines.

Fox, R. 1978. "The Philippine Paleolithic," in *Early Paleolithic in South and East Asia.* Edited by Fumiko Ikawa-Smith, pp. 50–85. Paris: Mouton.

Fox, R. and J. Peralta. 1974. "Preliminary Report on the Palaeolithic Archaeology of Cagayan Valley, Philippines and the Cabalwanian Industry. In *Proceedings of the first Regional Seminar on Southeast Asian Prehistory and Archaeology*, June 26–July 4, 1972, Manila, pp. 100–47. Manila: National Museum of the Philippines.

Harrisson, Tom. 1958. The caves of Niah: A history of prehistory. *The Sarawak Museum Journal* 8(12):549–595.

Harrisson, Tom and Lord Medway. 1962. A first classification of prehistoric bone and tooth artifacts (Based on material from Niah Great Cave). *The Sarawak Museum Journal* 10(19–20):335–362.

Hutterer, Karl. 1973. Basey archaeology: Prehistoric trade and social evolution in the Philippines. Dissertation. Hawaii: University of Hawaii.

Kamminga, Johann. 1982. *Over the edge: Functional analysis of Australian stone tools.* Queensland: University Printery.

Kress, Jonathan. 2004a. Recent excavations at Ille Rockshelter. *Test Pit* 4:19–22.

Kress, Jonathan. 2004b. "The necrology of Sa'gung Rockshelter," in *Southeast Asian Archaeology: Wilhelm G. Solheim II Fetschrift.* Edited by Victor Paz, 239–275. Quezon City: University of the Philippines Press.

Kress, Jonathan. 1987. Harrisson, North Borneo, and Palawan: A preliminary assessment. *Asian Perspectives* 20(1):75–86.

Latinis, Kyle. 1996. Prehistoric lithic technology, workshops, and chipping stations in the Philippines. *Asian Perspectives* 35(1):27–50.

Legaspi, Avelino. 1974. Bolinao: a 14th–15th century burial site. Manila: National Museum.

Lewis, Helen. 2005. To see the world in a grain of sand: Soil micromorphology studies of landscape and occupation history at Tabon Cave, Palawan, Philippines. Unpublished report to CSEAS, Evans Fund and the National Museum of the Philippines.

Lotschert, Wilhelm and Gerhard Beese. 1994. *Tropical plants. trans. Clive king. Planzen der Tropen.* London: Harpercollins.

Lyman, L. 1994. *Vetebrate taphonomy.* Cambridge: Cambridge University Press.

Maeda, Y., F. Siringan, A. Omura, R. Berdin, Y. Hosono. S. Atsumi, T. Nakamura. Higher-than-present Holocene mean sea levels in Ilocos, Palawan and Samar, Philippines. *Quaternary International* 115–116: 15–26.

Maeda,Y. and F. Siringan. 2004. Atlas of Holocene notches and the corral reef terraces of the Philippine Islands. *Nature and Human Activities* 8:97–175.

Mathisen, M.E. 1981. Plio-Pleistocene Geology of the Cagayan Valley, Northern Luzon, Philippines. Dissertation. Iowa: Iowa State University.

Mudar, Karen. 1997. Patterns of animal utilization in the Holocene of the Philippines: A comparison of faunal samples from the Philippines. *Asian Perspectives* 36(1):6–105.

Olsen, Sandra. 1988. "The identification of stone and metal tool marks on bone artifacts," in *Scanning Electron Microscopy in Archaeology.* Edited by S. L. Olsen, pp. 337–360. Oxford: BAR International Series.

Olsen, Sandra. 1989. On distinguishing natural from cultural damage on archaeological antler. *Journal of Archaeological Science* 16:125–135.

Orogo, A.B. 2000a. Result of the archaeological re-investigation and re-excavation of Tabon Cave at the Municipality of Quezon, Palwan Province, May 4 to June 2, 2000. Manuscript: National Museum of the Philippines.

Orogo, A.B. 2000b. Second progress report: Archaeological re-investigation and re-excavation of Tabon Cave municipality of Quezon, Palawan Province, August 24 to September 23, 2000. Manila: National Museum of the Philippines.

Orogo, A.B. 2002. Progress report: Results of the fourth phase of archaeological re-excavation of Tabon Cave, Lipuun Point, Quezon Palawan, September 12–October 11 2001. Manuscript. Manila: National Museum of the Philippines.

Paz, Victor. 1997. Participant report: Archaeological survey of El Nido, Palawan. Unpublished manuscript.

Paz, Victor. n.d. The Palawan Island palaeohistoric research: A project proposal. Unpublished manuscript.

Paz, Victor and Wilfredo Ronquillo. 2004. Report on the Palawan Island palaeohistoric research project for 2004. Unpublished Manuscript.

Peterson, Warren. 1974. Anomalous archaeology sites in Northern Luzon. Dissertation. Hawaii: University of Hawaii.

Pope, Geoffrey. 1989. Bamboo and human evolution. *Natural History* (October):49–56.

Prasetyo, Bagyo. 2002a. "The bone industry," in *Gunung Sewu in prehistoric times.* Edited by T. Simanjuntak, pp. 181–189. Bulaksumur: Gadjah Mada University Press.

Prasetyo, Bagyo. 2002b. "Double points from Braholo Cave" in *Gunung Sewu in prehistoric times.* Edited by T. Simanjuntak, pp. 189–190. Bulaksumur: Gadjah Mada University Press.

Prasetyo, Bagyo. 2002c. "The distribution of bone tool tradition," in *Gunung Sewu in prehistoric times.* Edited by T. Simanjuntak, pp. 191–194. Bulaksumur: Gadjah Mada University Press.

Rabett, Ryan. 2005. The early exploitation of Southeast Asian mangroves: Bone technology from caves and open sites. *Asian Perspectives* 44(1):154–179.

Rackham, J. 1994. *Animal bones.* Berkeley: University of California Press.

Ronquillo, Wilfredo, Rey Santiago, Shijun Asato, Kazuhiko Tanaka. 1993. The 1992 archaeological reexcavation of the Balobok Rockshelter, Sanga-Sanga, Tawi-Tawi Province, Philippines: A preliminary report. *Journal of Historiographical Institute* 18:162–178.

Shipman, Pat and Jennie Rose. 1988. "Bone tools: An experimental approach," in *Scanning electron microscopy in archaeology.* Edited by S.L. Olsen, pp. 303–335. Oxford: BAR International Series.

Shutler, R., Jr. and M. Mathisen. 1979. Pleistocene Studies in the Cagayan Valley of Northern Luzon, Philippines. *Journal of the Hongkong Archaeological Society* 8:105–114.

Solheim, Wilhelm. 2002. *Archaeology of Central Philippines: A study chiefly of the Iron Age and its relationships.* Quezon City: Archaeological Studies Program, University of the Philippines.

Solheim, Wilhelm. 2004. Excavations of the Ille Rockshelter, Palawan, Philippines (Preliminary report). Unpublished manuscript.

Paz, Victor. n.d. The Palawan Island palaeohistoric research: A project proposal. Unpublished manuscript.

Paz, Victor and Wilfredo Ronquillo. 2004. Report on the Palawan Island palaeohistoric research project for 2004. Unpublished Manuscript.

Peterson, Warren. 1974. Anomalous archaeology sites in Northern Luzon. Dissertation. Hawaii: University of Hawaii.

Pope, Geoffrey. 1989. Bamboo and human evolution. *Natural History* (October):49–56.

Prasetyo, Bagyo. 2002a. "The bone industry," in *Gunung Sewu in prehistoric times.* Edited by T. Simanjuntak, pp. 181–189. Bulaksumur: Gadjah Mada University Press.

Prasetyo, Bagyo. 2002b. "Double points from Braholo Cave" in *Gunung Sewu in prehistoric times*. Edited by T. Simanjuntak, pp. 189–190. Bulaksumur: Gadjah Mada University Press.

Prasetyo, Bagyo. 2002c. "The distribution of bone tool tradition," in *Gunung Sewu in prehistoric times.* Edited by T. Simanjuntak, pp. 191–194. Bulaksumur: Gadjah Mada University Press.

Rabett, Ryan. 2005. The early exploitation of Southeast Asian mangroves: Bone technology from caves and open sites. *Asian Perspectives* 44(1):154–179.

Rackham, J. 1994. *Animal bones*. Berkeley: University of California Press.

Ronquillo, Wilfredo, Rey Santiago, Shijun Asato, Kazuhiko Tanaka. 1993. The 1992 archaeological reexcavation of the Balobok Rockshelter, Sanga-Sanga, Tawi-Tawi Province, Philippines: A preliminary report. *Journal of Historiographical Institute* 18:162–178.

Shipman, Pat and Jennie Rose. 1988. "Bone tools: An experimental approach," in *Scanning electron microscopy in archaeology*. Edited by S.L. Olsen, pp. 303–335. Oxford: BAR International Series.

Shutler, R., Jr. and M. Mathisen. 1979. Pleistocene Studies in the Cagayan Valley of Northern Luzon, Philippines. *Journal of the Hongkong Archaeological Society* 8:105–114.

Solheim, Wilhelm. 2002. *Archaeology of Central Philippines: A study chiefly of the Iron Age and its relationships*. Quezon City: Archaeological Studies Program, University of the Philippines.

Solheim, Wilhelm. 2004. Excavations of the Ille Rockshelter, Palawan, Philippines (Preliminary report). Unpublished manuscript.

Szabo, Katherine, Maryclare Swete Kelley, and Antonio Peñalosa . 2004. "Preliminary results for excavations in Eastern Mouth of Ille Cave, Palawan," in *Southeast Asian archaeology: Fetschrift for Wilhelm G. Solheim*. Edited by Victor Paz, pp. 209–224. Quezon City: UP Press.

Teodosio, Sharon. 2004. A preliminary report of the Makangit Cave investigation. Unpublished Manuscript. Quezon City: U.P. Archaeological Studies Program.

Thiel, Barbara. 1990. Excavations at Musang Cave, Northeast Luzon Philippines. *Asian Perspectives* 28 (1):61–81.

Thiel, Barbara. 1986–1987. Excavations at Arku Cave, Northeast Luzon, Philippines. *Asian Perspectives* 27(2):229–264.

Thiel, Barbara. 1985. Austronesian origins and expansion: The Philippine archaeological data. *Asian Perspectives* 26(1):119–128.

Von Koenigswald, G.H.R. 1958. Preliminary Report on a Newly-Discovered Stone Age Culture from Northern Luzon, Philippine Islands. *Asian Perspectives* 2(2):69–70.

Voris, H.K. 2000. Maps of Pleistocene sea levels in Southeast Asia: shorelines, river systems and time durations. *Journal of Biogeography* 27:1153–1167.

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Abstract

Bone tools occur in Pleistocene sites across Island Southeast Asia, but the synthesis here shows that these implements appear only in Holocene levels in the Philippines. One good example is the site of Balobok Rockshelter whose archaeological horizons yielded bone tools, showing that there is continuity in the technology at least in one isolated site. Elsewhere in the archipelago, few sites hold promise. And on the whole, there is no evidence to suggest that a developed bone technology was widespread in the islands during the Pleistocene and the Holocene, though bone artifacts appear in more complex forms later in the archaeology of the islands. Such a pattern might be explained by many factors but as the study of bone tools has not figured well in archaeological research in the Philippines, much of the understanding on bone tools is tentative. Many questions are raised by this current status and the paper shows that answers to these depend in large part in the application of appropriate frameworks of analysis.

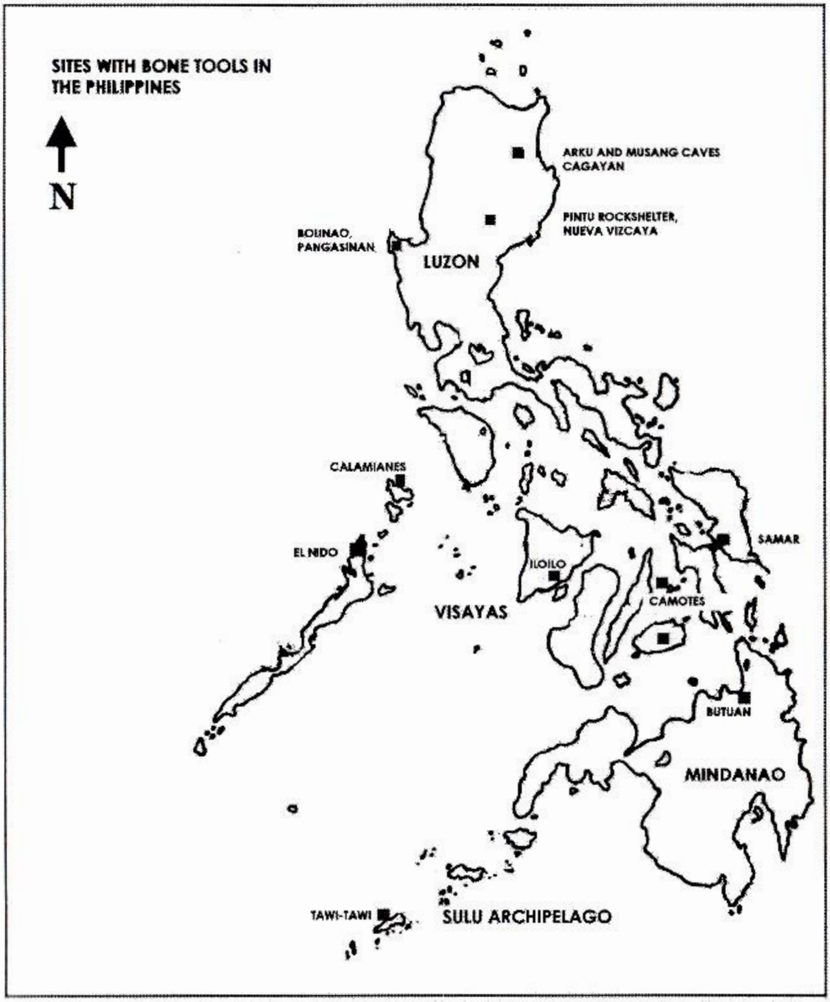

Figure 1
Sites with bone tools in the Philippines