

# **Approaches to Flaked Stone Artefact Archaeology in Thailand: A Historical Review**

Ben Marwick

## **Abstract**

Research into stone artefact archaeology has a long history in Thailand and has made significant contributions to our understanding of Southeast Asian prehistory. Since the 1960s there has been a series of archaeological projects by foreign and Thai archaeologists that include substantial studies of stone artefacts. This review of these projects shows how research priorities, methods and conceptual frameworks have changed (or not) over time. The review also shows the current state of knowledge of stone artefacts in Thai archaeology. Finally, it suggests some promising themes for future work.

**Key Words:** archaeology; anthropology; stone artefacts; Thailand; Hoabinhian

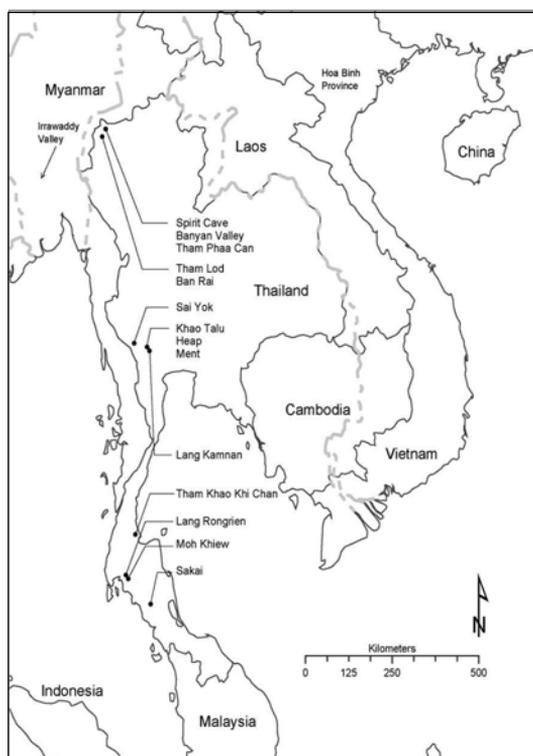
## **Introduction**

If we cannot usefully employ the stone tools, we cut out a very large part of our direct data from the past, data which provide many of the foundations of our more theoretically oriented upper stories. (White, 1977).

There are a number of very good reasons to study stone artefacts even in a country like Thailand where more impressive and monumental relics are abundant. One of the primary reasons is that stone artefacts are usually the most durable and numerous remains of past human activity, surviving under conditions that other types of artefacts cannot. A second reason is that for vast periods of human history – from first habitation until the metal-using period in Thailand – stone artefacts have played a crucial role in mediating between groups of people and between people and their environment. Stone artefacts are therefore a significant source of information on the diversity of responses people had to various social and environmental conditions. Finally, they are not just the object of academic recreation; stone artefact sites are frequently encountered during cultural heritage management projects and are easily recognised by local people as evidence of earlier inhabitants. New methods and concepts towards understanding these sites provide new ways for archaeologists to make informed management recommendations that are sensitive to current scientific and social interests.

The purpose of this review is to briefly describe some previous analytical and theoretical approaches to stone artefact archaeology in Thailand, identify the important contributions of these analyses and identify topics deserving further attention. More specifically, the focus is on flaked stone artefacts from excavated cultural deposits because they open a window into technologies of the past that undated surface sites cannot. To understand the earliest work in Thailand I briefly discuss influential work in Vietnam and Myanmar to provide some context to archaeology in

Thailand (Figure 1). Then I discuss a selection of the most detailed and important studies from Thailand (Table 1). Archaeologists in Thailand are among the most advanced and productive in Southeast Asia and although the examples here are limited to Thailand, they generally represent the trends and problems of work throughout mainland Southeast Asia. Finally, a summary of issues that might be the focus of future research efforts is presented. Although there is some Thai language literature available on this topic, this paper focuses on English language publications because these are the most widely available sources and the most accessible to the majority of archaeologists interested in stone artefact archaeology.



**Fig. 1** Map showing locations discussed in the text

**Table 1** Summary of recent research into stone artefact archaeology in Thailand

Principle authors	Date of work	Main sites	Location	Contribution	Criticism
Sarasin	1933		Chiang Mai Ratchaburi	First descriptions, integrated with regional themes	
Heider	1958		Kanchanaburi		
van Heekeren	1960-1962	Sai Yok	Kanchanaburi	First large excavation	No radiocarbon dates little detail
Matthews	1964	Sai Yok	Kanchanaburi	Statistical study of lithics, showed problems of typology	No behavioural interpretation no publication
Gorman	1965-1971	Spirit Cave	Mae Hong Son	Many new ideas and re-defining of concepts	Little detail
White and Gorman	1972-1979	Tham Phaa Chan	Mae Hong Son	Hoabinhian is not homogenous, new methods	No behavioural interpretation no timely publication
Pookajorn	1977-1979	Ban Kao	Kanchanaburi	refined definition of Hoabinhian	Little detail, dated methods
Anderson	1983-1984	Lang Rongrien	Kanchanaburi	First pre-Hoabinhian site, integrated with regional themes	Little detail, dated methods
Reynolds	1989	Tham Khao Chan	Surat Thani	Studied artefact technology and behaviour	Little detail and integration with previous work
	1992	Banyan Cave	Mae Hong Son		
Shoocongdej	1989-1996	Lang Kamnan	Kanchanaburi	Problem-oriented research in an anthropological framework	Little detail and integration with previous work
	1998-present	Tham Lod, Ban Rai	Mae Hong Son		

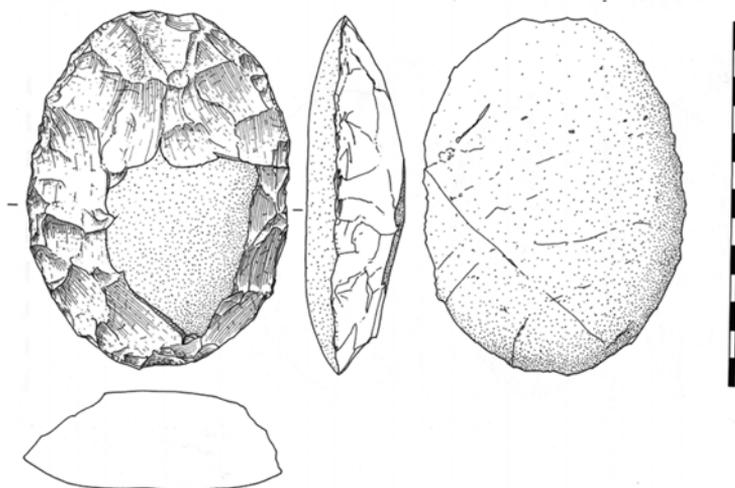
## Colani and the Hoabinhian of Vietnam

The earliest writings on the stone artefact archaeology of Thailand were strongly influenced by work on either side of the country, with French archaeologists in Vietnam and American archaeologists in Myanmar. French archaeologists working in northern Vietnamese province of Hoa Binh in the 1920s and 1930s argued for the presence of distinctive archaeological assemblage that they called 'Hoabinhian' (Colani, 1927). As a result of this work the First Congress of Prehistorians of the Far East in 1932 agreed to define the Hoabinhian as

a culture composed of implements that are in general flaked with somewhat varied types of primitive workmanship. It is characterised by tools often worked only on one face, by hammerstones, by implements of sub-triangular section, by discs, short axes and

almond shaped artefacts, with an appreciable number of bone tools (Matthews, 1966).

Despite the general terms of the definition, Colani's Hoabinhian is an elaborate typology as indicated by the 82 artefacts from Sao Dong that she classified into 28 types (Matthews, 1966). Despite this complex system, most Hoabinhian sites are identified simply by the presence of sumatraliths (White and Gorman, 2004), which are river cobbles that are flaked around the complete circumference but on one surface only, so that when the cobble is turned over only the original rock surface, known as cortex, is visible (Figure 2). The chronology of Hoabinhian artefacts was assumed by Colani and others - working before radiocarbon dating methods appeared in the 1950s - to be Holocene because of the absence of extinct ice-age fauna. The validity of the Hoabinhian as a chronological or cultural concept in Southeast Asia is a subject of ongoing and lengthy debate (Shoocongdej, 1996). It has been variously used as a label for an ethnic group, time period, a form of subsistence economy and a technology of making stone tools.

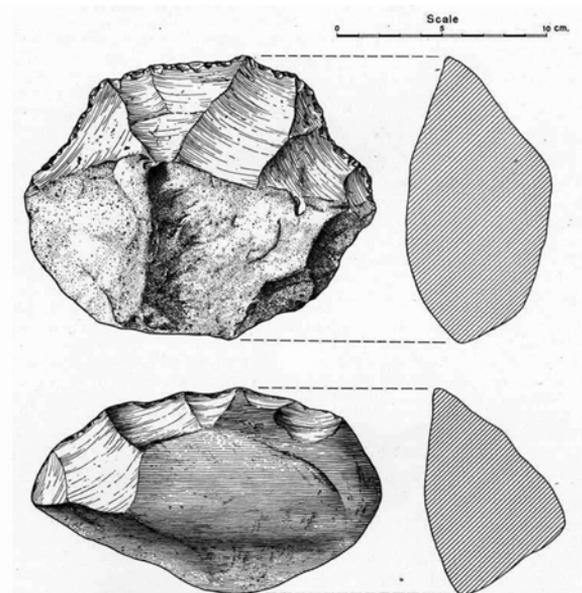


**Fig. 2** Typical sumatralith from Jeremie & Vacher (1992)

## Movius and the Chopper-Chopping Tool Complex of Myanmar

From his work in the Irrawaddy Valley of southern Myanmar in the 1930s Movius (1944, 1948, 1943) suggested that a technological line existed separating the unifacial (with flaking only on a single surface) “chopper-chopping tool” tradition of eastern Asia from the bifacial (with flaking on a both upper and lower surfaces) “handaxe” tradition of western Asia, Africa and Europe. Movius (1949) defined chopping tools (Figure 3) as

core implements usually made on pebbles, or rough, more or less tabular, chunks of rock, with a cutting edge that has been worked from both sides. This edge is usually markedly sinuous, since in the majority of cases it is produced by alternate flaking, or rather by the intersection of alternating flake scars. This results in the formation of an edge that is in the form of a broad ‘W’.



**Fig. 3** Chopper-chopping tools from de Terra & Movius (1943)

These types of artefacts were attributed to the Pleistocene because of their association with *Homo erectus* at Zhoukoudian in China and other pre-modern hominids in Europe and Africa. The difference between chopper-chopping tool complex and assemblages from elsewhere in the world is explained by Movius as result of differences in raw material differences and ethnicity. Although an important early step in understanding Southeast Asian stone artefact technology, Movius' concepts have made less impact than Colani's Hoabinhian, and have been criticized for assuming that absence of evidence (of bifacial artefacts) is evidence of absence (Boriskovsky, 1971), for ignoring bifacially worked artefacts in east Asia (Hutterer, 1977) and for not allowing for the diversity and complexity of east Asian assemblages that have subsequently been described (Yi and Clark, 1983).

### **The first contributions from Thailand**

The earliest published work on stone artefacts in Thailand was on some excavations of caves and rockshelters south of Chiang Mai and in the west-central of Thailand at Ratchaburi (Sarasin, 1933). Sarasin described the stone artefacts as amorphous and generally without any indication that they were intentionally manufactured except for two or three cobbles with unifacial flaking. Sarasin did not discuss his finds in detail, but these artefacts were later interpreted by Heider (1958) as 'probably either of the Palaeolithic chopper-chopping tool tradition or of the Mesolithic Hoabinhian tradition.' This statement reflected a common view in Southeast Asian archaeology that the Chopper-Chopping Tool Complex is a Pleistocene assemblage and the Hoabinhian is a Holocene assemblage, and also reflects the absence of clear differences between the two stone artefact assemblages. It is noteworthy that Heider identified the Thai assemblage with both Vietnamese and Burmese assemblages, suggesting a large homogenous culture area for prehistoric Southeast Asia.

## **Van Heekeren's work at Sai Yok 1960-1962**

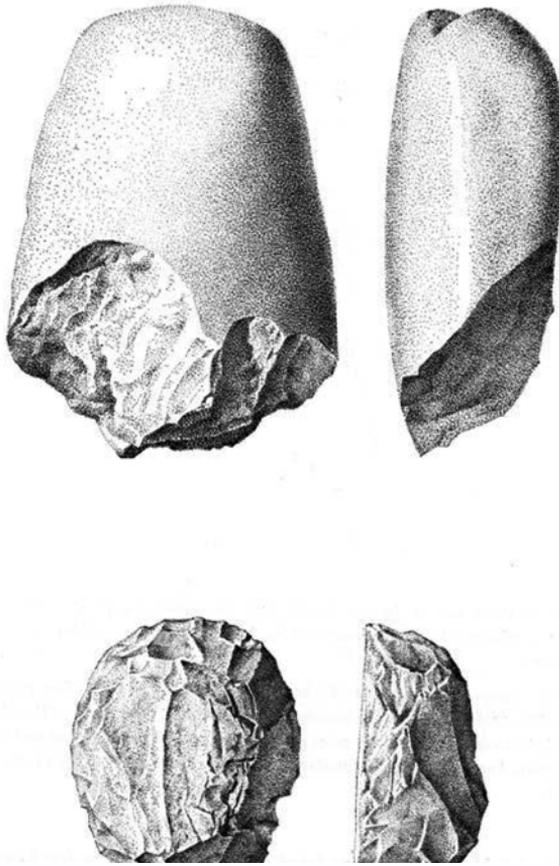
In 1948 van Heekeren published a brief account of his archaeological discoveries in Kanchanaburi Province, west-central Thailand. His account describes a small number of artefacts encountered while working on the Thai-Myanmar Railway as a Japanese prisoner of war in 1943-44. He identified these as a local expression of the Chopper-Chopping Tool Complex which he named the "Fingnoian". The age of these artefacts is uncertain because it is based only on their location in a gravel bed assumed by van Heekeren to have been formed during the Pleistocene (van Heekeren and Knuth, 1967). Eight stone artefacts were also recovered from in a cave near Wan Po and described by van Heekeren as Hoabinhian from the Holocene period because of their association with un-mineralised animal bone and molluscs.

Van Heekeren's finds of flaked and polished stone artefacts in surface assemblages in during the 1940s (in addition to Heider's (1958) collection of over one hundred artefacts from surface sites in the same area) encouraged him to return in 1960 with a team of Danish and Thai specialists. The most important result of this work is the publication of the excavation at Sai Yok rockshelter in Kanchanaburi. Over 50 square meters were excavated between 1960 and 1961, some sections to a depth of 425 cm below the surface. No radiocarbon dates were obtained apparently because no datable material was found, but the maximum age is estimated by the excavators to be about 10,000 years before the present (BP) because of the associated extant fauna. The 1,500-odd stone artefacts, mostly made from quartzite, were classified by 'visual inspection' according to a typology devised by van Heekeren (1967) (Figure 4). Three major categories of artefacts were recognised, 'massive high-domed tools, sturdy choppers with a minimum of trimming, and proper Hoabinhian implements' and were further subdivided (van Heekeren and Knuth, 1967). Using an analogy to Australian Aboriginal ethnographic data, they suggest that the Sai Yok artefacts were used for skinning and dismembering game

and manufacturing hunting tools of wood and bamboo. Several hundred flakes and flake fragments were also found throughout the deposit but are not described in detail. No data about artefact dimensions or attributes are presented in the publications but van Heekeren (1967) observes that

We noticed that generally the later tools tended to grow smaller and finer and there was a greater discrimination in selecting the raw material, i.e. smaller, more shapely and more suitable pebbles were chosen as raw material in the later periods of occupation. At the same time, however, it must be admitted that there was an extraordinary slow rate of technical development in tool manufacture and that tools of the simplest and crudest type continued to be found in the more recent layers. Lines of demarcation of types, if they could be drawn at all, would in no way correspond to those separating upper from lower strata. This suggests that the pebble tool industry went through an uninterrupted period of hardly any change. The term 'pre-ceramic pebble tool industry' therefore is used to cover the entire collection.

The unchanging nature of the artefacts is attributed to their suitability to the tropical forest environment and the availability of wood and bamboo as raw materials for implements (van Heekeren and Knuth, 1967). Like Movius, van Heekeren notes that evidence from Sai Yok supports find from Myanmar, Malaya, India and China in suggesting that Southeast Asian Pleistocene assemblages do not contain bifacial, prepared core or standardised blade technologies like those found in Africa, Europe and west Asia. Van Heekeren (1967) explains this difference as a result of environmental differences, with Southeast Asia 'characterised by a tropical climate with heavy rainfall and there were perhaps no major climatic and faunistic changes at the termination of the Pleistocene period.' He also suggests that Southeast Asian stone technology may have developed in isolation from other parts of the world because of 'a lack of initiative and creative activity.'



**Fig. 4** Flaked stone artefacts from Sai Yok (van Heekeren & Knuth 1967) (no scale in original)

This work is an excellent reflection of European archaeology from the 1960s with the strict typological approach to the stone artefacts (Trigger, 1989, Lyman et al., 1997). The concern with culture-historical themes is also typical, such as the problem of the absence from Southeast Asia of the typological sequences and chronological markers found in Europe, Africa and west Asia, as well as the apparent stagnation of Southeast Asian lithic assemblages over long periods. The most important limitations of the work were noted shortly after its publication by Gorman

(1969) who criticised the absence of radiocarbon dates or pollen analyses that could have provided the chronological and palaeoecological data to support van Heekeren's conclusions. Gorman also found that this work was difficult to compare with other Southeast Asian sites because of the ambiguity of stratigraphic continuity, the lack of supportive evidence for many statements concerning prehistoric behaviours and the minimal detail in the stone artefact data.

### **Matthew's analysis of Sai Yok stone artefacts 1964**

As part of his PhD research at the Australian National University, Matthews (1964) analysed some metric and technological attributes of flaked cobble artefacts from Sai Yok. His aim was to determine if Hoabinhian artefact types were real types or an arbitrary system imposed by Colani. His method was to test if the artefact types could be defined as clusters of constantly recurring metric and non-metric attributes. Matthews' analysis supported van Heekeren's conclusions that the unifacially flaked cobbles became smaller as the depth of deposit decreased and that there were no marked changes in the assemblage over time. However, the most significant conclusion of Matthews' work was that he could not define Colani's Hoabinhian types in terms of constantly recurring attributes. In other words, Hoabinhian types did not exist at Sai Yok and Hoabinhian artefacts simply reflect a continuous blend of shapes and sizes. Van Heekeren (1967) had similarly suggested that 'no hard and fast rules can be made to differentiate the many types of implements, as some types almost imperceptibly merge into others'. Matthews' more objective statistical study lends some empirical support to van Heekeren's observation.

Matthews (1966) later published some of his critical assessment of Colani's work that defined the Hoabinhian and concluded that

Colani has neither defined a satisfactory typology for the collections of Hoa Binh province, nor has she isolated three chronological phases based on the stratification of the excavated deposits. However, it appears that the flaked artefacts, which presumably served as simple cutting and scraping tools, were larger in the lower parts of the deposits and that the diminution of size with decreasing depth was a gradual process.

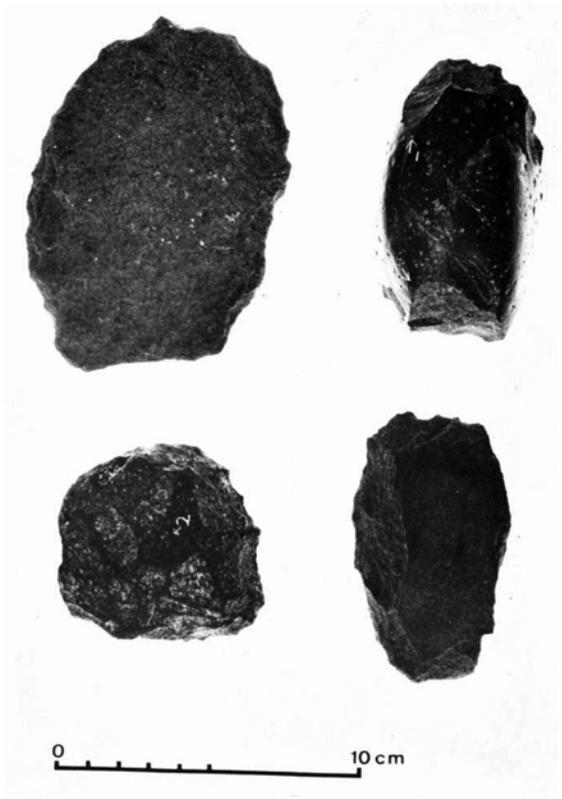
This statement summarises the knowledge of Southeast Asian stone artefacts in the 1960s. Despite the publication of elaborate and well-illustrated typological classifications, Matthews shows that these typologies do not accurately reflect the range of variation in the assemblages. The only robust conclusion from Sai Yok and the northern Vietnamese sites is that flaked artefacts tend to get smaller in more recent times. His work shows that Southeast Asian stone artefact assemblages need to be analysed in a materialist framework that recognises observational units (such as the sumatralith type) as a commonly occurring shape on a continuum of gradually changing shapes rather than the essentialist framework of discrete and immutable types proposed by the early French archaeologists.

Matthews' conclusions about typological methods have been validated by more recent work outside of Thailand which argues that essentialist typologies hide much of the variation found in stone artefact assemblages that is important for explanations of cultural change (Dunnell, 1982, Lyman et al., 1997) and mask many of the underlying processes of artefact manufacture, use and discard (Kuhn, 1992, Schiffer and Skibo, 1997). The main limitation of Matthews' work is that it seems to have been exclusively methodological and he made little contribution to understanding how changes in the artefact assemblages related to the life and history of the people who produced them. In addition, Matthews did not publish a detailed account of his analysis and results, so his most important findings are not widely known and have had little impact.

## **Gorman's work at Spirit Cave 1965-1971**

Gorman (1969) recognised that Matthews' work implied that stone artefacts could not uniquely define Hoabinhian cultures (with the methods available at the time) so he chose to focus on the human ecology of the Hoabinhian at Mae Hong Son Province, northwest Thailand. As part of his PhD work at the University of Pennsylvania he excavated a series of one meter squares at Spirit Cave to a depth of about one meter. Fourteen radiocarbon samples were submitted and the results indicated that most of the excavated materials were deposited at 12,000-7,500 BP (Gorman, 1969). Although Gorman's (1972) main aim was to 'argue for the importance of the humid tropics as hearths of early plant and animal domestication', and much of his analysis is dedicated to organic materials, he made several important contributions to the analysis of Southeast Asian stone artefacts.

Gorman followed the materialist framework of Matthews and based his approach on Peter White's (1969:22) work in New Guinea where he concluded that 'it is probably more accurate to regard a stone implement as the record of a series of discrete processes which have acted on it than as an attempt to create a specific formal type.' Gorman (1971) analysed artefacts from Spirit Cave using 'technological criteria (i.e. technique and area of preparatory flaking, length, width, breadth, weight of the implement etc.), and usewear criteria (edge damage patterns such as step-flaking, chipping etc.)'. Following his analysis, Gorman (1972) proposed that the frequent use of the Eurocentric terms 'Palaeolithic', 'Mesolithic' and 'Neolithic' to describe Southeast Asian archaeology was inappropriate because the defining characteristics of those periods were not present (Figure 5). Gorman, like van Heekeren, suggested that the absence of any significant changes in stone artefact technology probably resulted from the apparent continuity of environmental conditions from the terminal Pleistocene to the Holocene (Gorman, 1972).



**Fig. 5** Flaked stone artefacts from Spirit Cave (Gorman 1972)

Preliminary results published in 1970 show two cultural levels at Spirit Cave, the older level (c. 12,000-9,000 BP) containing a Hoabinhian assemblage of 'large unifacially worked cobble cores, grinding stones and retouched and utilised flakes' and the younger level (c. 9,000-7,000 BP) containing this Hoabinhian assemblage plus 'flaked and quadrangular adzes, small ground and polished slate knives and cord-marked and burnished ceramics' (Gorman, 1972). Gorman's (1972) microscopic edge-damage analysis indicates that many artefacts were used, with sumatraliths having 'severe step flaking' and striations, abrasions and use-fractures are present on edges of about 30% of retouched and utilised flakes.

Most of the stone artefacts at Spirit Cave were made from readily available coarse-grained quartzite river cobbles.

These lithics formed a small part of Gorman's analysis, which included ceramics, animal and plant remains. These data led him to redefine the Hoabinhian from a simple description of stone artefacts to include ecological dimensions (Gorman, 1972):

1. A generally unifacial flaked tool tradition made primarily on water rounded pebbles and large flakes detached from these pebbles;
2. Core tools ("Sumatraliths") made by complete flaking on one side of a pebble and grinding stones also made on rounded pebbles, usually in association with iron oxide;
3. A high incidence of utilized flakes (identified from edge-damage characteristics)
4. Fairly similar assemblages of food remains including remains of extant shellfish, fish, and small-medium-sized mammals;
5. A cultural and ecological orientation to the use of rockshelters generally occurring near fresh water streams in an upland karstic topography (though Hoabinhian shell middens do indicate at least one other ecological orientation);
6. Edge-grinding and cord-marked ceramics occurring (though perhaps as intrusive elements), individually or together, in the upper layers of Hoabinhian deposits

Gorman's work is notable because it included a number of important redefinitions relevant to Hoabinhian stone artefacts that encourage recognition and explanation of its unique qualities. As with the work of others, the weaknesses of Gorman's publications are the absence of detailed discussions or data about the stone artefacts. This is probably due to Gorman's interest in agricultural origins at Spirit Cave and the importance of botanical and zoological remains in his project.

## **White and Gorman's work on Tham Phaa Chan 1972-1979**

Following from his work at Spirit Cave, Gorman returned to Mae Hong Son and excavated Tham Phaa Chan (also known as Steep Cliff Cave) and Banyan Valley Cave. The cultural deposit at Tham Phaa Chan dated from 7,500 BP to 5,100 BP and about 200 cobble artefacts and numerous flakes and other pieces were recovered (White and Gorman, 2004). In 1979 Gorman and Joyce White, then a graduate student under Gorman's supervision at the University of Pennsylvania, presented a conference paper (published unaltered in 2004) arguing against claims that Hoabinhian stone artefact assemblages were disappointingly amorphous and unpatterned. They intended to demonstrate the standardization of Hoabinhian manufacturing and curating procedures and outline a sequence of stages in the reduction of river cobbles into flaked artefacts at Tham Phaa Chan. Influenced by Collins' (1975) groundbreaking work in North America, White and Gorman proposed a lithic reduction model with five behaviour sets that have distinctive effects on stone artefacts: raw material acquisition, decortication, an edge modification cycle (use, trimming, rejuvenation, shaping), bifacial flake removal, and dorsal cortex removal.

A sample of 417 flakes was analysed and a series of metric and technological variables were recorded for each flake. They analysed flakes because they wanted information about each stage in the manufacturing process rather than just the final stage represented by the flaked cobble. This focus on flakes is a major departure from the cobble-based analyses of previous stone artefact studies in Thailand and Southeast Asia generally. White and Gorman (2004) suggest that the Hoabinhian reduction sequence at Tham Phaa Chan has three major stages:

- (1) the systematic selection of locally available raw materials, namely somewhat flattened ovaloid quartzite river cobbles, and continuing with (2) the cobbles' systematic modification by

flaking beginning with initial shaping by unifacial circumferential decortication, followed by (3) various differentiated shaping and resharpening activities repeated as needed throughout the tool's use-life (with the majority of flakes struck circumferentially from a single cortical surface).

They concluded that flakes were produced to resharpen the cobble rather than for flake-tools because they believe the average size of flakes is too small for use as tools.

Gorman and White's study represents a significant turning point in stone artefact analysis in Southeast Asia for two reasons. Firstly, their study shows that previous statements about the primitive and inscrutable character of Hoabinhian stone artefacts are not accurate and that these assemblages do contain discernable patterns. Secondly, they demonstrate that flakes may be more useful than flaked cobbles for understanding Hoabinhian artefacts. For its time, the study used a progressive and relatively complex method involving metrical and technological variables for recording stone artefacts in a materialist framework. The main limitations of the study are the unclear definitions of stone artefact attributes which make it difficult to understand the differences between the patterns identified. Further limitations include the absence of any theoretical framework for interpreting the patterns in terms of what behaviours they represent and how they change over time. Like Matthews, White and Gorman did not publish their findings in a timely manner, depriving subsequent workers of its important innovations.

It is worth noting that 28 cobble tools from Tham Phaa Chan were analysed by Bannanurag (1988) for traces of usewear using low-power magnification (20-100 magnifications). The presence of steep edge angles, microscopic polish and micro-flake scars suggested to Bannanurag that the artefacts were probably used for working wood and bone rather than meat or soft vegetable matter. Bannanurag (1988) appropriately cautions that her findings are

only tentative because of the absence of relevant comparative experimental work and the small sample analysed.

### **Pookajorn's work at Ban Kao District 1977-1979**

In the late 1970s Surin Pookajorn led a team of Thai archaeologists from Silpakorn University to excavate three rockshelters in Kanchanaburi, Western Thailand. This work was published in English after Pookajorn completed graduate studies on material from the sites in the United States and Germany. The aim of the work was to use ethnographic information from the Mlabri hunter-gatherers of northern Thailand to interpret the archaeology of the Hoabinhian and to determine if the Hoabinhian is more accurately considered a culture or a 'technocomplex' (1988, 1990, Pookajorn, 1984, 1996, 1992). The three cultural layers of Khao Talu, Ment and Heap caves were dated from 11,000 to 2,000 BP (Pookajorn, 1990). The oldest cultural level is labelled as Early Hoabinhian (10,000-4,500 BP) with large flaked cobbles and flakes, the second cultural level is distinguished by the addition of pottery and called the Late Hoabinhian (4,500-2,000 BP) and the third cultural level is called the transitional Neolithic-Bronze Age level (2,500-1,000 BP) and in addition to similar material from the previous levels, includes ground-edge stone artefacts, some new kinds of potsherds and beads (Pookajorn, 1990).

Pookajorn (1988) recovered 3,000 stone artefacts from the three sites and analysed 86 of these by recording some metric and non-metric variables. Differences in artefact shape were used to classify flaked cobbles into four types and flakes into six types. The assemblage was further classified into six types according to edge angles. Low power microscopic inspection of some of the artefacts apparently suggested that they were used for woodworking but it not clear how this was determined. From his analysis and the absence of undefined 'hunting implements' in the assemblages, Pookajorn (1990) concludes that the stone artefacts were not used directly to extract subsistence resources but used for

tool maintenance purposes, such as making wood and bamboo implements.

According to Pookajorn, the stone artefact data indicates that the Hoabinhian is a 'technocomplex ...defined by the environment in which the sites are situated, and by the resources available to prehistoric communities there' (1990). He updates Gorman's six traits for the Hoabinhian with evidence from the Ban Kao sites, showing that bifacially flaked cobbles appear with the more ubiquitous unifacially flaked cobbles when fine grained raw material such as chalcedony and chert are available, and that used flakes may not always be as abundant as Gorman suggested (Pookajorn, 1990). The stone artefacts from Pookajorn's Ban Kao sites were later investigated in two undergraduate theses and one MA thesis (Auetrakulvit, 1995) from Silpakorn University but these findings have not been published. More recently, Moser (2001) published a brief analysis of stone artefacts from Moh Khiew and found that the assemblage was generally unretouched flakes made from coarse-grained raw materials. He concludes that the cobble tool typology does not show chronological variation.

The stone artefact analysis appears to have been a minor component of Pookajorn's work compared to the floral and faunal analyses and the ethnographic descriptions (which do not include stone artefacts, the Mlabri use only organic and metal tools). The main limitation of the work is the absence of metric, technological and usewear data in any of the publications which means that many of his statements about the Ban Kao assemblages are unconvincing because they lack supporting evidence. It also makes it very difficult to compare the Ban Kao assemblages with any other assemblages (Bulbeck, 2003). This criticism also applies to Pookajorn's (1996) later work at Moh Khiew and Sakai Caves, Krabi Province, where the emphasis is on past environmental reconstruction rather than the stone artefact assemblages. In general, Pookajorn's approach to the stone artefacts at Ban Kao appears anachronistic with its formal typological focus, lack of detailed

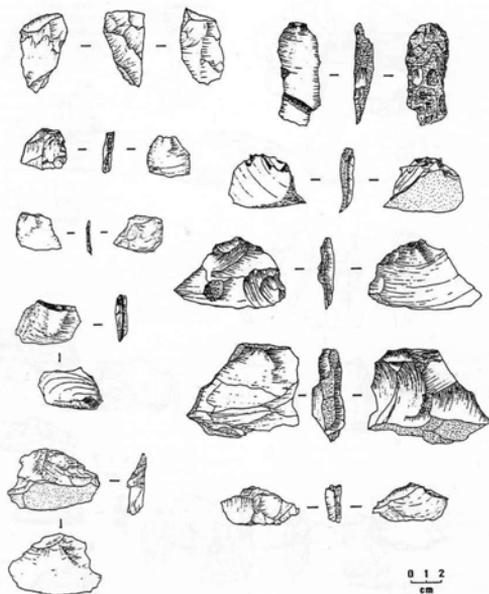
data and its concern with most the precise definition of the Hoabinhian rather than questions of human behaviour and history.

These criticisms might be considered unfair in light of Glover's (1993) observations that aims and motives of Thai and western archaeologists frequently differ with 'Thai archaeologists [showing] rather little interest in generalized explanations couched in terms of evolutionary processes, and not very much in comparative archaeology outside Thailand' (Glover, 2001:45). However, Pookajorn's papers in journals such as *World Archaeology* (1985) and an edited volume with western scholars (1996) suggest that he intended his work to be consumed by an international audience, so international standards of criticism are appropriate.

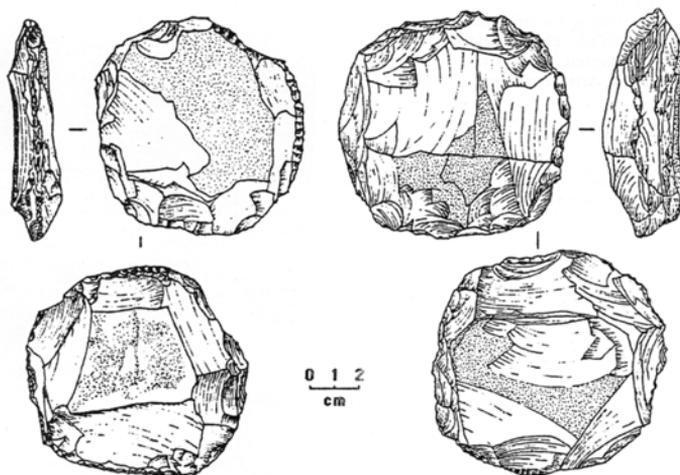
### **Anderson's work at Lang Rongrien 1983-1984**

The aim of the Anderson's excavation was to 'trace the archaeological, biological and geological history of southwestern Thailand, or more broadly speaking, the northwesternmost edge of the Sunda Shelf' (Anderson, 1990). To achieve this aim Anderson excavated Lang Rongrien rockshelter at Krabi and revealed a stratified deposit with one of the oldest cultural sequences in Southeast Asia. The occupational layers date from >43,000 BP to about 7,500 BP (Anderson, 1997). The sequence is divided into three phases: late Pleistocene, dating between 27,000 and >43,000 BP; early Holocene, between 9,600 and 7,500 BP; and middle Holocene, probably between 4,000 and 3,500 BP. The Pleistocene archaeological assemblage is mostly small, unifacially retouched flake tools (Figure 6). The early Holocene assemblage differs because it is dominated by large heavy, unifacially and bifacially flaked core tools typical of the Hoabinhian industry (Figure 7). The middle Holocene deposits include four burials with pedestal pots and small cord-marked vessels (Anderson, 1987). The most unique and important result of this work is the suggestion that Southeast Asian Pleistocene assemblages may be flake industries

rather than cobble-based industries as initially suggested by Movius.



**Fig. 6** Pleistocene artefacts from Lang Rongrien (Anderson 1990)



**Fig. 7** Holocene artefacts from Lang Rongrien (Anderson 1990)

Anderson's (1990:38) stone artefact classification system is a typology derived from van Heekeren's work at Sai Yok and is based largely on artefact shape, size and presumed function. Although some comments are made about retouch and inspection of artefact use-edges by low power magnification, there are no data in the publications. Metric and technological variables do not appear to have been part of Anderson's stone artefact analysis.

Anderson's interpretation of the stone artefact data is an attempt to explain the geographic spread and time span of the Lang Rongrien assemblage. He compares the artefact types in the Pleistocene layers of Lang Rongrien to other Pleistocene assemblages in Vietnam, Malaysia, Philippines, South Sulawesi and southern China. He notes a series of differences but emphasises that all assemblages are characterised by flake tool assemblages with high proportions of amorphous flakes with steep unifacial retouch and very low proportions of cobble artefacts (Anderson, 1990:66). Anderson (1990) interprets this regional pattern of Pleistocene flake assemblages as evidence that Movius' Chopper-Chopping Tool Complex is not an accurate label for Southeast Asian assemblages because cobble chopping artefacts are not common, and the label emphasises wide-area homogeneity and cultural conservatism that is contradicted by the available evidence. Anderson also notes that despite the amount of archaeological research conducted since Movius' time, the apparent Pleistocene antiquity of the Movius' Irrawaddy cobble assemblages remains unproven (cf. Hutterer, 1985).

Anderson similarly compares the frequencies of types in the Holocene layers of Lang Rongrien assemblage to a number of mainland and insular Southeast Asian sites and shows that the Lang Rongrien assemblage is most similar to the Malaysian Hoabinhian because of the low proportions of sumatraliths (Lang Rongrien has none) and because 'nearly all of the flake tools from the middle levels of Lang Rongrien have flat retouch, a feature that sharply distinguishes them from the Hoabinhian assemblages of Vietnam' (Anderson, 1990:46).

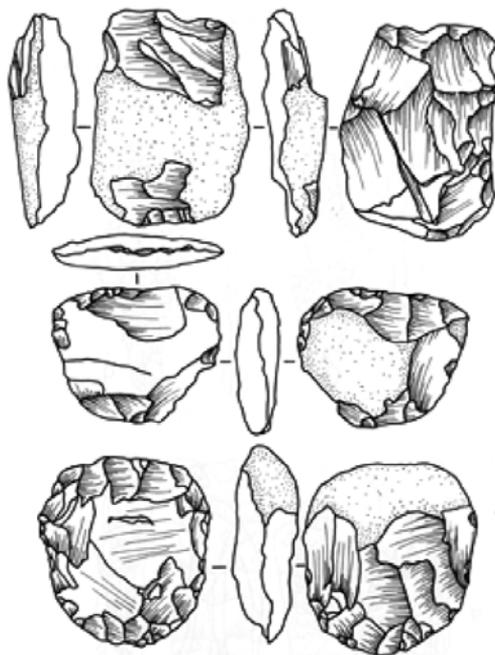
Anderson suggests an ecological explanation for the origins of the Hoabinhian at Lang Rongrien, suggesting that the change from Pleistocene flake assemblages to Holocene cobble assemblages at Lang Rongrien is a response to reduced seasonality, increased precipitation and warmer temperatures during the Holocene. Anderson suggests that the Pleistocene flake assemblage was used by hunters who exploited open savannas and animal movement patterns that were made predictable by the use of valleys as refuges from the low air temperatures. During the Holocene the increased precipitation caused the open savannas to disappear and the warmer temperatures reduced the need for biogeographical refuges. He proposes that the cobble assemblages may be related to agricultural tasks such as forest-clearing or ground-breaking or shellfish procurement, but acknowledges that 'the evidence is not strong' (Anderson, 1988:56). This interpretation contrasts with Gorman and van Heekeren who believe that there were no substantial changes in technology and climate at the terminal Pleistocene and early Holocene.

Anderson's work is important because Lang Rongrien has a long cultural sequence and his interpretation of the material is an unusually detailed engagement with historically and anthropologically significant themes in Southeast Asian archaeology. However, it is problematic that his conclusions about the Pleistocene flake industry are based on only 58 artefacts (47.9% of the Pleistocene assemblage) which may be the result of a series of isolated short episodes rather than reflecting a long term pattern (Bulbeck, 2003). The most important problems with his work, like those before him, are the absence of detailed stone artefact data and the failure to acknowledge contemporary developments in hunter-gather anthropology and archaeology. At the time Anderson was working, there were important debates in hunter-gatherer archaeology by American and European archaeologists about interpreting sites and stone artefacts which resulted in new approaches and methods (Bordes and de

Sonneville-Bordes, 1970, Binford and Binford, 1966, Rolland, 1981, Dibble, 1987, Binford, 1980). As an American scholar, Anderson might be expected to have engaged more with this work and perhaps have used Lang Rongrien as an opportunity to test these new methods and concepts.

### **Reynolds' work on Tham Khao Khi Chan and Banyan Valley Cave, 1989-1992**

Reynolds' work is unique in mainland Southeast Asian archaeology because he had experience in European stone artefact archaeology from his PhD research before working on stone artefacts from two sites in Thailand. Firstly, he analysed and described stone artefacts from Tham Khao Khi Chan, Surat Thani Province in southern Thailand, excavated by the Tharapong Srisuchat and the Thai Fine Arts Department for a salvage project in 1985 (Reynolds, 1989). The site was excavated to a depth of 2.6 metres and four radiocarbon dates span 6,100 BP to 4,700 BP (Reynolds, 1989:42). The second site Reynolds (1992) analysed stone artefacts and other material from was Banyan Valley Cave in the northwest province of Mae Hong Son, excavated by Gorman in 1972 (Figure 8). The final depths of the excavation were not recorded but were probably little more than the lowest hearths at 80-90 centimetres below the surface. Two radiocarbon dates indicate that the site was used between 900 BP and 5,300 BP and six thermoluminescence dates on ceramics fall within this period. Reynolds classifies the artefacts using a typology that is based on metric and non-metric attributes relating to the manufacture and use of artefacts. Like previous typologists such as van Heekeren, Reynolds' method of analysis is to compare the frequency of types in different layers.



**Fig. 8** Flaked stone artefacts from Banyan Valley Cave (Reynolds 1992) (no scale in original)

In his publication about Tham Khao Khi Chan Reynolds (1989) makes a number of important observations about stone artefacts and human behaviour. Firstly he argues against White and Gorman's proposal that the majority of utilised flakes in Hoabinhian assemblages are the result of core resharpening or reshaping. White and Gorman suggest that usewear on flakes derives from use of the core from which the flake is detached, but Reynolds notes that usewear on the utilised flakes from Tham Khao Khi Chan occurs on the lateral margins of the flakes which would not have been exposed while the flake was still attached to the core. Similarly, Reynolds argues that the high ratio of 'plain' flakes to utilised flakes suggests that the production of flakes is often independent of core resharpening. The second observation is that

although flakes outnumber cores in each of the three analytical units, the single conjoin found and the low ratio of numbers of negative flake-scars on cores to numbers of flakes suggests to Reynolds that many flakes are missing from the rockshelter and that stages of the reduction sequence occurred off-site. The third observation is that there are no major technological changes associated with an increase in the proportion of artefacts made from fine-grained raw materials (which have more predictable flaking characteristics) in the upper unit. Reynolds (1989:42) concludes that the Tham Khao Khi Chan assemblage

...appears to be a fairly typical Hoabinhian for southern Thailand, with many steep-edged core tools retouched in such a way as to retain cortex adjacent to the flaked edge. Flakes are an important part of the assemblage both technologically and functionally. The reduction strategy employed was generalised and not aimed at producing specific blank forms. Rather such pieces as were suitable were selected from a range of flakes. Resharpener flakes were rare. Differential use of raw materials does not appear to have been significant, but further study of the raw materials and replicative experiments would be most informative.

Reynolds' (1992:84) observations on the stone artefacts from Baynan Valley Cave are less detailed because of plans to publish them in more detail in the future. Differences in the stone artefact assemblage suggest that the four stratigraphic units recorded by Gorman can be grouped into Hoabinhian and non-Hoabinhian layers. The upper, or younger, two non-Hoabinhian units 'lack the pebble tool element, flakes are thinner, and they have fewer step-flaked dorsal surfaces' and has a higher proportion of ground edge artefacts (Reynolds, 1992:85). Only the lower two units contained small numbers of 'sumatraliths (unifacially flaked discoids), short axes, steep-edged pieces [unifacially and bifacially flaked] and axes, all of which are characteristic of the Hoabinhian technocomplex in Thailand' (Reynolds, 1992:85).

Detailed comparisons of data from the two sites examined by Reynolds might suggest some important differences in stone artefact technology between north and south Thailand but this is not discussed in his publications. Like White and Gorman, Reynolds made a significant and progressive contribution to stone artefact studies in Southeast Asia. Reynolds goes beyond White and Gorman because he shows how the analysis of technological attributes can be used to reconstruct behaviours relating to reduction intensity and how they changed over time. He also shares their limitations, including the absence of detailed metric data and the lack of discussion of the wider anthropological implications and regional significance. Given Reynolds' background in lithic studies, it might be expected that he engage more than he does with work on identifying and interpreting artefact attributes (cf. Cotterell and Kamminga, 1987, Phagan, 1985, Speth, 1972, Dibble and Whittaker, 1981, Bamforth, 1986) which could have contributed towards a more detailed picture of stone artefact technology in Thailand.

### **Shoocongdej's work at Lang Kamnam, 1989-1996**

For her PhD thesis at the University of Michigan, Rasmi Shoocongdej (1996) worked on the material from a series of 2.5 metre deep excavations at Lang Kamnan rockshelter, Kanchanaburi to study mobility organisation of hunter-gatherers in tropical seasonal environments during Late and post-Pleistocene periods. Mobility organisation is defined as 'the way foragers arrange their camp movements in relation to subsistence activities in relation to environmental variability' (Shoocongdej, 1996:11). Her interpretive framework was based on the work of Binford (1980) and Kelly (1992) who argue from ethnographic evidence that mobility organisation is an environmental adaptation exerting strong influences on hunter-gatherer cultural processes and social organisation. To evaluate mobility organisation and investigate temporal change, the excavated sequence at Lang Kamnan was

divided into three analytical units based on radiocarbon dates, stratigraphy and archaeological remains: Late Pleistocene (c. 27,000–10,000 BP), Early Holocene (c. 10,000–7,500 BP) and the Middle Holocene (c. 7,500–2,500 BP). The only significant change in the stone artefact assemblage appears to be the introduction of ground-edge artefacts in the Middle Holocene unit.

Shoocongdej's aim for the lithic analysis was to determine if the assemblage technology is expedient (where artefacts are made with a minimum of production effort and discarded after a relatively brief use-life) or curated (where artefacts have a relatively long use-life and are frequently repaired and resharpened). This is based on Binford's (1986) now-famous classification of hunter-gatherers along a spectrum of mobility from foragers (hunter-gatherers who exploit resources by moving residential camps to the resource locations) to collectors (hunter-gatherer groups who do not move residential camps as often, but organize task groups to exploit resources at remote locations, often in bulk, and bring these resources back to the residential base camp for the entire group). In their analysis of ethnographic and archaeological studies, Binford (1980), Kelly (1992), Shott (1986) and others found a strong positive correlation exists between mobility frequency and the curated component of lithic assemblages and an inverse relationship between technological diversity and residential mobility. In brief, they conclude that 'the more you move, the less you carry and the more you conserve what you carry' (Shott, 1989:221)

To fulfil this aim, Shoocongdej created a techno-typology similar to Reynolds' by classifying stone artefacts into types according to technological characteristics relating to their manufacture, use, maintenance and discard. The proportions of these types were then compared to understand the level of curatedness at Lang Kamnan. Shoocongdej also collected metric data from the artefacts and flakes were examined at 10-40 magnifications in an attempt to identify traces of use.

Shoocongdej recovered 874 stone artefacts from Lang Kamnan and classified them into ten categories. Quartzite is the most common raw material throughout the assemblage. She interprets a relatively high ratio of flakes to cores and a relatively high ratio of tertiary to primary flakes as evidence of tool production. Similarly, the small proportions of resharpened cores and flakes suggest a relatively minor tool maintenance component (Shoocongdej 1996:260-282). The assemblage apparently changes very little over time.

The unprepared cores and unsystematic production, use and retouching of flakes at Lang Kamnan suggested to Shoocongdej an expedient assemblage that is typical of a residential mobility strategy (1996:280-2, 2000:28). As proposed by many previous researchers (eg. Boriskovsky, 1971, Pope, 1989), Shoocongdej explains this as an adaptation to the ready availability of lithic raw materials and organic raw materials (such as shell, bamboo and bone) from which more lightweight, portable, flexible and ephemeral tools can be made.

Shoocongdej's work represents a watershed in stone artefact archaeology and archaeology generally in Thailand for two reasons. Firstly, she used a research strategy directed to answering important and timely questions explicitly about human behaviour and then developed and tested relevant hypotheses. This contrasts with the more inductive and descriptive character of earlier work on stone artefacts. Secondly, she interpreted the data in an explicitly anthropological framework that focuses on explaining the human behaviours that produced the archaeological material. This should be a priority for future work and indicates a greater awareness of recent developments in archaeological explanation than is evident in any previous work.

That said, Shoocongdej's stone artefact methods are similar to Reynolds' and are similarly uninformed by contemporary methodological work on artefact attributes, especially analysis of artefact reduction as a measure of the level of assemblage curation

(e.g. Dibble, 1987, Kuhn, 1990, Dibble and Pelcin, 1995, Barton, 1988). Other limitations of this work include a lack of detailed discussion of temporal and spatial change in the lithic assemblage, except to note that the shift from flake-based to cobble-based assemblages from the Pleistocene to the Holocene observed at Lang Rongrien was not apparent at Lang Kamnan. The reluctance to discuss temporal change may be due to some problems with the site's chronology. Some radiocarbon dates come from snail shells lacking cultural contexts and some of the dates are out of sequence (Bulbeck, 2003).

Shoocongdej does not engage with specific problems of Hoabinhian technology raised by White and Gorman (2004) and Reynolds (1992, 1989) about whether the majority of flakes result from core resharpening or other behaviours and why stages of the reduction sequence seem to be missing from some rockshelter assemblages. Quantitative analysis of the metric data is limited and claims that the artefacts were used to process fauna are not supported by evidences such as cut marks on the bone or identification of residues and usewear on the artefacts.

### **Shoocongdej's work at Tham Lod and Ban Rai, 1998-present**

Following from her PhD work, Shoocongdej (2004) began a project in Mae Hong Son to develop a cultural and environmental history and study the relationship between humans and their environment from the Pleistocene to recent times. The project also aims to create opportunities for training and professional development of Thai archaeologists. It has excavated two rockshelters with cultural sequences dating to the late Pleistocene. Ban Rai was excavated to a depth of about two and a half metres and has eight radiocarbon dates spanning 10,600-7,250 BP. The deepest of the three areas excavated at Tham Lod has a depth of about five metres and has four radiocarbon and two thermoluminescence dates spanning 32,400-12,100 BP

(Shoocongdej, 2004). Data collection and analysis is ongoing for Ban Rai and Tham Lod and so far over a dozen Thai-language technical reports have been prepared (eg. Shoocongdej and Staff, 2003, 2003) and one popular book has been recently published (Shoocongdej, 2005) as well as an edited volume of conference papers, both in Thai (Shoocongdej, 2006). One preliminary report on Ban Rai was recently published in English (Treerayapiwat, 2005). Treerayapiwat (2005) follows Shoocongdej's methods but does not present any details of the stone artefacts from Ban Rai beyond numbers of artefacts in each stratigraphic layer, only noting that 'the entire spectrum of production, repair, and use, with the inclusion of utilized cores and flakes, wasted cores and flakes, hammers, and resharpening flakes' were found.

## **Conclusion**

Despite the variation in aims and methods, these case studies suggest a basic and familiar (Reynolds, 1990) outline of culture-history from the stone artefacts. Firstly, the earliest record is a Pleistocene assemblage of flakes from Lang Rongrien, possibly used by mobile hunter-gatherers in a highly seasonal environment. The Hoabinhian and Chopper-Chopping Tool Complex do not seem to be important in Thailand during the Pleistocene. Secondly, in the late Pleistocene – early Holocene period the classical Hoabinhian cobble artefacts appear, possibly in response to denser forest environments and less seasonal climates, although recent work has shown that terminal Pleistocene environments were more complex and diverse than previously thought (White et al., 2004). Many more sites are occupied for the first time, but the assemblages are still dominated by flakes, mostly unretouched. The cobble artefacts may have been used by mobile hunter-gatherers for woodworking, particularly for making other tools out of hard wood and bamboo. There seems to be a lot of variation in assemblages from this period. Finally, in the later Holocene the cobble artefacts become less important and

disappear from some sites to be replaced by polished-edge artefacts and ceramics. These new forms are usually associated with horticultural populations rather than hunter-gatherers (Higham, 2002:29-30). Future work should aim to add detail to this basic outline, refining the chronology, determining the specific characteristics of the technological changes, their behavioural implications, and their relationship to local and regional environmental changes.

The progress observed in work discussed here suggests a few themes deserving of future attention. Firstly, if we are going to go to the time-consuming trouble of collecting and describing stone artefacts, it is only a small step further to use the data to solve problems about prehistoric human behaviour. Description of finds is not an end unto itself; research should be framed by an explicit conceptual framework derived from hunter-gatherer theory, starting with questions about human behaviour and ending with possible explanations and solutions. Problem-oriented studies will also benefit from the recognition that stone artefact analysis is a specialised sub-discipline requiring special training similar to physical anthropology, zooarchaeology or rock art studies. Secondly, to ensure that the problems that we are working on are relevant, it is important that we use methods and conceptual frameworks that are internationally current. The recent spectacular finds on Flores and Java have revealed Southeast Asia to be an important region for understanding human origins (Morwood et al., 2005, 2004, 1998). We must be technically and theoretically prepared for similarly important finds in Thailand. Finally, research needs to be presented through the normal channels of scholarly and popular communication. Even the most current and systematic work will have no impact unless other researchers can obtain reliable information about it. This means publishing in reputable English-language journals in a timely and detailed fashion. Research should also be accurately presented in popular magazines to educate the public about the relevance of

stone artefact archaeology to humanity generally, because after all, it is the public who ultimately makes this research possible.

## **Acknowledgements**

This paper derives from a seminar delivered to The Australian National University Department of Archaeology and Natural History. Thanks to those who provided feedback at that seminar. Thanks to Rasmi Shoocongdej and her staff at the Highland Archaeology Project, especially Cholawit Thongcharoenchaikit, for stimulating discussions and sharing their ideas about stone artefacts in Thai archaeology. Thanks to Supaporn Nakhunlung and Michael Smithies for careful readings of a draft. Thanks to Joyce White for forwarding unpublished work and advice. Thanks also to Peter Bellwood for providing unpublished and hard-to-find references. This work was supported by a PhD scholarship from the Department of Archaeology and Natural History at the ANU. Any errors, opinions, omissions and offences are of course solely the responsibility of the gibbons at Tham Lod.

## References

- Anderson, D. D. (1987) A Pleistocene - Early Holocene rockshelter in Peninsular Thailand. *National Geographic Research*, 3: 184-198.
- Anderson, D. D. (1988) Excavations of a Pleistocene rockshelter in Krabi and the prehistory of Southern Thailand. IN Bronson, B. & Charoenwongsa, P. (Eds.) *Prehistoric Studies: The Stone and Metal Ages in Thailand*. Bangkok, Thai Antiquity Working Group.
- Anderson, D. D. (1990) *Lang Rongrien rockshelter: a Pleistocene-early Holocene archaeological site from Krabi, Southwestern Thailand*, Philadelphia, University Museum, University of Pennsylvania.
- Anderson, D. D. (1997) Cave archaeology in Southeast Asia. *Geoarchaeology*, 12: 607-638.
- Auetrakulvit, P. (1995) การวิเคราะห์เทคนิคการกระแทกเครื่องมือหิน: กรณีศึกษาตัวอย่าง เครื่องมือหินที่พบในหลุมขุดค้นแหล่งโบราณคดีถ้ำหมอบีเยว 2 อำเภอเมือง จังหวัดกระบี่. Department of Archaeology. Bangkok, Silpakorn University.
- Bamforth, D. B. (1986) Technological Efficiency and Tool Curation. *American Antiquity*, 51: 38-50.
- Bannanurag, R. (1988) Evidence for ancient woodworking: A microwear study of Hoabinhian tools. IN Bronson, B. & Charoenwongsa, P. (Eds.) *Prehistoric Studies: The Stone and Metal Ages in Thailand*. Bangkok, Thai Antiquity Working Group.
- Barton, C. M. (1988) *Lithic Variability and Middle Paleolithic Behaviour: New evidence from the Iberian Peninsula*, Oxford, British Archaeological Reports.
- Binford, L. R. (1980) Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity*, 45: 4-20.
- Binford, L. R. & Binford, S. R. (1966) A Preliminary Analysis of Functional Variability in the Mousterian of Levallois Facies. *American Anthropologist*, 68: 238-295.
- Bordes, F. & De Sonneville-Bordes, D. (1970) The Significance of Variability in Palaeolithic Assemblages. *World Archaeology*, 2: 61-73.
- Boriskovsky, P. I. (1971) *Ancient Stone Age of South-Eastern Asia*, Leningrad, Nauka.

- Bulbeck, F. D. (2003) Hunter-gatherer occupation of the Malay Peninsula from the Ice Age to the Iron Age. IN Mercader, J. (Ed.) *Under the Canopy: The Archaeology of Tropical Rainforests*. Piscataway, NJ, Rutgers University Press.
- Colani, M. (1927) L'âge de la pierre dans la province de Hoa Binh. *Mémoires du Service Géologique de l'Indochine*, 13.
- Collins, M. C. (1975) Lithic technology as a means of processual inference. IN Swanson, E. (Ed.) *Lithic Technology: Making and Using Stone Tools*. The Hague, Mouton.
- Cotterell, B. & Kamminga, J. (1987) The Formation of Flakes. *American Antiquity*, 52: 675-708.
- De Terra, H. & Movius, H. L. (1943) Research on Early Man in Burma. *Transactions of the American Philosophical Society*, 32: 271-393.
- Dibble, H. L. (1987) The Interpretation of Middle Paleolithic Scrapper Morphology. *American Antiquity*, 52: 109-117.
- Dibble, H. L. & Pelcin, A. (1995) The Effect of Hammer Mass and Velocity on Flake Mass. *Journal of Archaeological Science*, 22: 429.
- Dibble, H. L. & Whittaker, J. C. (1981) New experimental evidence on the relation between percussion flaking and flake variation. *Journal of Archaeological Science*, 8: 283-296.
- Dunnell, R. C. (1982) Science, social science, and common sense: the agonizing dilemma of modern archaeology. *Journal of Anthropological Research*, 38: 1-25.
- Glover, I. (1993) Other people's pasts: Western archaeologists and Thai prehistory. *Journal of the Siam Society*, 81: 45-53.
- Glover, I. C. (2001) Archaeology, Nationalism and Politics in Southeast Asia. *Hukay: Bulletin of the University of the Philippines Archaeological Studies Program*, 3: 37-65.
- Gorman, C. (1969) Hoabinhian: A pebble tool complex with early plant associations in Southeast Asia. *Science*, 163: 671-673.
- Gorman, C. (1969) Review of 'Archaeological Excavations in Thailand, Volume 1: Sai Yok: Stone Age Settlements in the Kanchanaburi Province. Dr H. R. van Heekeren and Count Eigil Knuth. Copenhagen: Munksgaard, 1967. *Asian Perspectives*, 11: 124-127.
- Gorman, C. (1971) The Hoabinhian and After: Subsistence Patterns in Southeast Asia during the Late Pleistocene and Early Recent Periods. *World Archaeology*, 2: 300-320.

- Gorman, C. (1972) Excavations at Spirit Cave, North Thailand: Some interim interpretations. *Asian Perspectives*, 13: 79-107.
- Heider, K. G. (1958) A pebble-tool complex in Thailand. *Asian Perspectives*, 2: 64-67.
- Higham, C. F. W. (2002) *Early Cultures of Mainland Southeast Asia*, Bangkok, River Books.
- Hutterer, K. L. (1977) Reinterpreting the Southeast Asian Palaeolithic. IN Allen, J., Golson, J. & Jones, R. (Eds.) *Sunda and Sahul: Prehistoric studies in Southeast Asia, Melanesia and Australia*. London, Academic Press.
- Hutterer, K. L. (1985) The Pleistocene archaeology of Southeast Asia in regional context. *Modern Quaternary Research in Southeast Asia*, 9: 1-23.
- Kelly, R. L. (1992) Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology*, 21: 43-66.
- Kuhn, S. L. (1990) A geometric index of reduction for unifacial stone tools. *Journal of Archaeological Science*, 17: 581-593.
- Kuhn, S. L. (1992) Blank Form and Reduction as Determinants of Mousterian Scrapper Morphology. *American Antiquity*, 57: 115-128.
- Lyman, R. L., O'Brien, M. J. & Dunnell, R. C. (1997) *The Rise and Fall of Culture History*, New York, Plenum Press.
- Matthews, J. M. (1964) *The Hoabinhian in Southeast Asia and elsewhere*. Canberra, Australian National University.
- Matthews, J. M. (1966) A Review of the 'Hoabinhian' in Indo-China. *Asian Perspectives*, 9: 86-95.
- Morwood, M. J., Brown, P., Jatmiko, Sutikna, T. & Et Al. (2005) Further evidence for small-bodied hominins from the Late Pleistocene of Flores, Indonesia. *Nature*, 437: 1012.
- Morwood, M. J., Soejono, R. P., Roberts, R. G., Sutikna, T. & Et Al. (2004) Archaeology and age of a new hominin from Flores in eastern Indonesia. *Nature*, 431: 1087.
- Morwood, M. J., Sullivan, P. B. O., Aziz, F. & Raza, A. (1998) Fission-track ages of stone tools and fossils on the east Indonesian island of Flores. *Nature*, 392: 173.
- Moser, J. (2001) *Hoabinhian: Geographie und Chronologie eines steinzeitlichen Technocomplexes in Sudostasien*, K In, Lindensoft.

- Movius, H. L. (1944) *Early man and Pleistocene stratigraphy in southern and eastern Asia*, New York, Kraus Reprint.
- Movius, H. L. (1948) The Lower Palaeolithic cultures of southern and eastern Asia. *Transactions of the American Philosophical Society*, 38: 329-420.
- Movius, H. L. (1949) The Lower Paleolithic Cultures of Southern and Eastern Asia. *Transactions of the American Philosophical Society, New series*, 38: 329-420.
- Phagan, C. J. (1985) Lithic technology: flake analysis. IN Vierra, R. (Ed.) *Prehistory of the Ayacucho Basin, Peru*. Michigan, The University of Michigan Press.
- Pookajorn, S. (1984) *The Hoabinhian of mainland southeast Asia: new data from the recent Thai excavation in the Ban Kao area*, Bangkok, Thai Khadi Research Institute, Thammasat University.
- Pookajorn, S. (1985) Ethnoarchaeology with the Phi Tong Luang (Mlabri): Forest Hunters of Northern Thailand. *World Archaeology*, 17: 206-221.
- Pookajorn, S. (1988) *Archaeological research of the Hoabinhian culture or technocomplex and its comparison with ethnoarchaeology of the Phi Tong Luang, a hunter-gatherer group of Thailand*, Tubingen, Verlag Archaeologica Venatoria: Institut für Urgeschichte der Universität Tubingen.
- Pookajorn, S. (1990) Hoabinhian cave excavations in Ban Kao District, West Thailand. IN Glover, I. & Glover, E. (Eds.) *Southeast Asian Archaeology 1986. Proceedings of the First Conference of the Association of Southeast Asian Archaeologists in Western Europe*. London, BAR.
- Pookajorn, S. (1992) *The Phi Tong Luang (Mlabri): A hunter-gather group in Thailand [Phon kanwikhro klumm sangkhom lasat]*, Bangkok, Odeon Store.
- Pookajorn, S. (1996) Human activities and environmental changes during the Late Pleistocene to Middle Holocene in Southern Thailand and Southeast Asia. IN Straus, L. G., Eriksen, B. V., Erlandson, J. M. & Yesner, D. R. (Eds.) *Humans at the End of the Ice Age: The Archaeology of the Pleistocene-Holocene Transition*. New York, Plenum Press.

- Pope, G. G. (1989) Bamboo and Human Evolution. *Natural History* : 48-56.
- Reynolds, T. E. G. (1989) Techno-typology in Thailand: A case study of Tham Khao Khi Chan. *Bulletin of the Indo-Pacific Prehistory Association*, 9: 33-43.
- Reynolds, T. E. G. (1990) Problems in the Stone Age of Thailand. *Journal of the Siam Society*, 78: 109-114.
- Reynolds, T. E. G. (1992) Excavations at Banyan Valley Cave, Northern Thailand: A report on the 1972 season. *Asian Perspectives*, 31: 77-97.
- Rolland, N. (1981) The Interpretation of Middle Palaeolithic Variability. *Man*, 16: 15-42.
- Sarasin, F. (1933) Prehistoric Researches in Siam. *Journal of the Siam Society*, 26: 171-202.
- Schiffer, M. B. & Skibo, J. M. (1997) The explanation of artefact variability. *American Antiquity*, 62: 27-50.
- Shoocongdej, R. (1996) *Forager mobility organisation in seasonal tropical environments: A view from Lang Kamnan Cave, western Thailand*. Ann Arbor, The University of Michigan.
- Shoocongdej, R. (2000) Forager Mobility Organization in Seasonal Tropical Environments of Western Thailand. *World Archaeology*, 32: 14-40.
- Shoocongdej, R. (2004) Preliminary report on the archaeological investigations of the highland archaeology project in Pang Mapha (HAPP), Mae Hong Son Province, between 1998-2004. *Southeast Asian Archaeology International Newsletter*, January : 6-8.
- Shoocongdej, R. (2005) โบราณคดีบนพื้นที่สูงในอำเภอปางมะผ้า จังหวัดแม่ฮ่องสอน, Nakhorn Patom, Silpakorn University Press.
- Shoocongdej, R. (Ed.) (2006) พลวัตทางสังคม วัฒนธรรม และสิ่งแวดล้อมบนพื้นที่สูงในอำเภอปางมะผ้า จังหวัดแม่ฮ่องสอน: งานวิจัยบูรณาการ โบราณคดีเชิงพื้นที่แบบครบวงจร [Social, Cultural and Environmental Dynamics in the Highlands of Pangmapha, Mae Hong Son Province: Integrated Archaeological Research into the Region], กรุงเทพฯ [Bangkok], โครงการ โบราณคดีพื้นที่สูงในอำเภอปางมะผ้า จังหวัดแม่ฮ่องสอน [Highland Archaeological Project in Pangmapha, Mae Hong Son].

- Shoocongdej, R. & Staff (2003) รายงานวิจัยฉบับสมบูรณ์ โครงการ โบราณคดีบนพื้นที่สูงในเขตอำเภอปางมะผ้า, จังหวัดแม่ฮ่องสอน ระยะที่สอง, (เล่มที่ 4: การขุดค้นแหล่งโบราณคดีเพิงผาบ้านไร่). เสนอต่อ สำนักงานกองทุนสนับสนุนการวิจัย (สกว.) ฝ่ายที่ 3 ฝ่ายสวัสดิภาพสาธารณะ. Bangkok, Highland Archaeology Project in Pang Mapha District, Mae Hong Son Province.
- Shoocongdej, R. & Staff (2003) รายงานวิจัยฉบับสมบูรณ์ โครงการ โบราณคดีบนพื้นที่สูงในเขตอำเภอปางมะผ้า, จังหวัดแม่ฮ่องสอน ระยะที่สอง, (เล่มที่ 5: การขุดค้นแหล่งโบราณคดีเพิงผาล้อด). เสนอต่อ สำนักงานกองทุนสนับสนุนการวิจัย (สกว.) ฝ่ายที่ 3 ฝ่ายสวัสดิภาพสาธารณะ. Bangkok, Highland Archaeology Project in Pang Mapha District, Mae Hong Son Province.
- Shott, M. J. (1986) Technological organization and settlement mobility: An ethnographic examination. *Journal of Anthropological Research*, 42: 15-51.
- Shott, M. J. (1989) Technological organization in Great Lakes Paleoindian assemblages. IN Ellis, C. J. & Lothrop, J. C. (Eds.) *Eastern Paleoindian lithic resource use*. Boulder, Westview Press.
- Speth, J. D. (1972) Mechanical Basis of Percussion Flaking. *American Antiquity*, 37: 34-60.
- Treerayapiwat, C. (2005) Patterns of Habitation and Burial Activity in the Ban Rai Rock Shelter, Northwestern Thailand. *Asian Perspectives*, 44: 231.
- Trigger, B. G. (1989) *A History of Archaeological Thought*, Cambridge, Cambridge University Press.
- Van Heekeren, H. R. & Knuth, E. (1967) *Archaeological Excavations in Thailand. Volume I. Sai Yok. Stone Age Settlements in the Kanchanaburi Province*, Copenhagen, Munksgaard.
- White, J. C. & Gorman, C. F. (2004) Patterns in “amorphous” industries: the Hoabinhian viewed through a lithic reduction sequence. IN Paz, V. (Ed.) *Southeast Asian archaeology: Wilhelm G. Solheim II Festschrift*. Quezon City, University of the Phillipines Press.
- White, J. C., Penny, D., Kealhofer, L. & Maloney, B. (2004) Vegetation changes from the late Pleistocene through the Holocene from three areas of archaeological significance in Thailand. *Quaternary International*, 113: 111-132.
- White, J. P. (1969) Typologies for some prehistoric flaked stone artefacts of the Australian New Guinea Highlands. *Archaeology and Physical Anthropology in Oceania*, 4: 18-46.

- White, J. P. (1977) Crude, colourless and unenterprising? Prehistorians and their views on the Stone Age of Sunda and Sahul. IN Allen, J., Golson, J. & Jones, R. (Eds.) *Sunda and Sahul: Prehistoric studies in Southeast Asia, Melanesia and Australia*. London, Academic Press.
- Yi, S. & Clark, G. A. (1983) Observations on the Lower Palaeolithic of Northeast Asia. *Current Anthropology*, 24: 181-202.