Forager mobility organization in seasonal tropical environments of western Thailand

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Abstract

This paper investigates forager mobility organization in seasonal tropical environments and, specifically, how mobility strategies have affected subsistence and settlement organization. The proposed model, based on cross-cultural comparisons, suggests that two mobility organizational systems exist in seasonal tropical environments: residential mobility in the wet season and logistical mobility as an organizational response to the dry season. The model is evaluated against archaeological data from Lang Kamnan, a Late and post-Pleistocene cave site in western Thailand. Results of the analyses of archaeological and environmental data indicate Lang Kamnan was occupied sporadically from the Late Pleistocene to Holocene, and that residential mobility was employed by small groups of foragers using a generalized subsistence technology during the wet season. The site currently lacks evidence of dry season occupation, and thus it is not yet possible to argue for the use of a logistical mobility strategy in the dry season. The proposed mobility model provides an important approach for examining variability in Late and post-Pleistocene cultural systems in tropical environments, particularly in Southeast Asia where such variability continues to be viewed as the consequence of sequential occupation by different 'cultures' such as 'Hoabinhian'.

Keywords

'Hoabinhian'; mobility organization; seasonal tropical environments; Lang Kamnan.

Introduction

Over the past several decades, archaeologists have made significant progress in understanding the range of variability in the archaeological record of hunter-gatherers, particularly through insights gained from the ethnographic record and ethnoarchaeological research. Attempts to isolate factors influencing behavioural and cultural processes through constructing general models has expanded our knowledge of a wide range of behavioural strategies and organizational processes in hunter-gatherer societies (e.g., mobility, sedentism, exchange, sharing). However, our understanding of such processes in foragers inhabiting tropical environments remains poor in comparison. Thus, this paper aims to further our knowledge of such groups by testing a model of hunter-gatherer mobility in seasonal tropical environments using data from Lang Kamnan Cave, a Late and post-Pleistocene site located in western Thailand (Fig. 1). General models, such as the one examined here, have not been applied before to seasonal tropical foragers.

The first section of the paper presents the conceptual framework and archaeological implications of forager mobility organization in response to seasonal tropical environments in Southeast Asia. It also highlights contributions of the research to an anthropological model of hunter-gatherer mobility. The second part summarizes the analyses and evaluates expectations derived from the model. The final section discusses the significance of Lang Kamnan Cave for our understanding of Late and post-Pleistocene adaptations in Southeast Asia, and outlines some of the key issues that have emerged from the research.

Definition of terms

Before proceeding to a discussion of the archaeological data, several terms – mobility, seasonal tropical environments and 'Hoabinhian' – require definition. Mobility refers to movements of individuals or groups from one location to another in order to cope with social and environmental variations. Mobility organization refers to the way foragers arrange their camp movements in relation to subsistence activities in response to environmental variability (Shott 1986).

The tropics refers to the geographic zone between 23° 27′ north and 23° 27′ south of the equator (Longman and Jenik 1987: 13). Tropical environments can be broadly classified on the basis of vegetation (e.g., Bourlière and Hadley 1983; Golley 1983; Longman and Jenik 1987). Seasonal tropical forests (or monsoon forests), of semi-evergreen and deciduous trees, generally occur in tropical zones with a pronounced dry season (Whitmore 1984: 3; Whittaker 1975: 137). However, tropical environments represent a continuum from virtually no dry season (in the ever-wet equatorial tropics) to very long and severe dry seasons characterized by savannas.

The term Hoabinhian is placed in quotation marks to indicate its use for reasons of convenience in referring to archaeological phenomena that have historically been so designated, and to indicate that its validity as a chronological or cultural concept in Southeast Asia is a subject of debate. 'Hoabinhian' is not used here to refer to a specific ethnic group, time period, subsistence economy or technology. In spite of this lack of a well-defined meaning, I use the term 'Hoabinhian' to connote artefacts and assemblages with certain formal characteristics, and thus as a convenience to organize a body of archaeological data, and to enable systematic comparison of sites and regions previously examined by other Southeast Asian archaeologists.

Theoretical framework

The importance of mobility strategies has been recognized in anthropological research on hunter-gatherers for many years (Binford 1978, 1980, 1982, 1990; Hitchock and Ebert

1989; Jochim 1976, 1981; Kelly 1983, 1985, 1995; Perlman 1985; Shott 1986; Winterhalder and Smith 1981). From a general ecological approach, mobility is viewed as a way by which hunter-gatherers adapt to their environments. Researchers (e.g., Kent 1989; Kelly 1995; Wiessner 1982) have also shown that social and political factors influence mobility strategies. While acknowledging these other factors, my research focuses primarily on environmental variables to understand mobility organization. Over a decade ago, Binford (1980) and Kelly (1983) proposed models linking hunter-gatherer mobility patterns to resource structures; this relationship helps to explain adaptive processes within the context of subsistence and settlement systems. These models propose two types of mobility: logistical mobility and residential mobility. They represent, however, idealized endpoints of a continuum in response to the temporal and spatial clustering of resources.

According to Binford (1980), residential mobility is characterized by frequent moves of all members of a camp from one place to another, low bulk inputs and regular daily foraging activities in relatively homogeneous environments. In contrast, logistical mobility is characterized by a pattern in which members of a group establish a base camp from which task groups fan out to exploit specific resources in heterogeneous environments. Like Binford, Kelly (1983) uses the terms 'forager' and 'collector' or 'residential mobility organized systems' and 'logistical mobility organized systems' as heuristic devices in order to develop a mobility model for examining inter-assemblage variability and regional settlement patterns. Kelly (1983) has expanded Binford's arguments about the relationship between mobility strategies and resource structure by rigorously testing them using cross-cultural and cross-environmental ethnographic data. He too considers effective temperature as a determinant of resource structure, but proposes two additional variables that affect mobility strategies in seasonal environments: resource accessibility and monitoring information (discussed below).

Archaeological research on mobility has generally focused on foragers living in the highly seasonal environments of the arctic, sub-arctic and temperate zones, reflecting an extreme attention towards 'collector mobility systems'. Little is known about mobility strategies in tropical environments. The tropics are generally assumed to be less seasonal environments, and that, accordingly, foragers have only a residential mobility strategy. Such a view disregards the complexity and diversity of tropical ecosystems.

Drawing on general ecological principles (e.g., Pianka 1978), Binford's (1980) and Kelly's (1983) models, and studies of hunter-gatherer mobility (e.g., Hitchcock 1982; Binford 1978; Gould 1980; Yellen 1977), I propose that mixed mobility strategies are also observed in seasonal tropical environments. Specifically, I posit that there are strongly contrasting settlement patterns in the wet and dry season, with residential strategies in the wet season and logistical strategies in the dry season (see Shoocongdej 1996b for details). Below I consider how variability in seasonal resource availability and in mobility strategies may be expressed in the archaeological record (Shoocongdej 1996a: 125–7).

Wet season

Wet season residential mobility strategies should involve comparatively small groups that are more effective in exploiting a relatively larger variety of resources distributed more evenly over the landscape. Under such conditions, emphasis in the settlement pattern is on residential camps as the centre of subsistence activities. Such camps should be smaller in size than those occupied during the dry season because foragers disperse into smaller groups. The foraging radius around each camp should be relatively small (c. 5km). In addition, due to the high frequency of residential moves, the duration of occupancy of individual camps will tend to be short. Therefore, sites deriving from such camps are likely to be small and have very low archaeological visibility. The archaeological assemblages at such sites would be expected to observe the following patterns:

a) a relatively high diversity of both floral and faunal remains indicating resource diversity;
b) among the faunal remains, a relatively unbiased representation of different animal parts indicating field processing and transport back to the camp of complete animals due to the relatively short foraging radius;
c) relatively small, lightweight and multi-functional tool kits indicating both relatively high diversity in extractive activities and constraints in transporting elaborate assemblages in the context of frequent residential moves;
d) relatively limited use of storage technologies;
e) predominantly local lithic types and an expedient stone-tool technology.

Dry season

In the dry season, a preference for logistical mobility strategies is expected in response to the temporal and spatial heterogeneity in resource availability. Such a strategy would involve a small number of residential moves, the organization of task groups to procure specific resources from a wider foraging radius, the transport of these resources to the residential camps and provisions for storage. Consequently, short logistical mobility strategies can be recognized in terms of settlement patterns involving residential camps, specialized extractive locations and caches. The residential camps are the centre of subsistence activities, the locus from which foraging parties operate and where some processing and manufacturing occurs. The residential camps will be represented by large and highly visible sites. Specialized extractive locations refer to places away from the central camp where particular subsistence tasks are carried out (e.g., plant harvesting and processing areas, lithic processing areas, kill and butchering sites). Such sites will generally have relatively low visibility, except where a single location was visited and used consistently for many years. The caches refer to places where resources were stored in bulk. The archaeological assemblages would be expected to exhibit the following patterns:

a) relatively low diversity of floral and faunal remains in the residential camps indicating lower resource diversity and a higher degree of ‘targeting’ by specialized task group;
b) a strong bias in the proportional representation of different body parts (particularly of larger animals) among the faunal remains in residential camps, indicating field processing and transport of high utility portions over relatively long distances;
c) tool kits in the residential camps should show a relatively high level of diversity of functionally specialized tool types, indicating the activities of specialized task groups and less concern over transport of complete residential inventories;

d) artefactual assemblages, faunal remains and floral remains in special activity sites should be of very low diversity and highly specialized;
e) at residential sites, high density and low diversity of floral or faunal remains should be found, and should be associated with special archaeological features indicating storage and cache facilities;
f) non-local lithic raw materials and a curated stone tool technology.

Lang Kamnan cave: archaeological data from a seasonal tropical site

The archaeological data analysed here derive from Lang Kamnan site in the lower Khwae Noi river area in Kanchanaburi, western Thailand (Fig. 1). Topographically, the area has relatively discrete boundaries, and is presently characterized by a highly seasonal tropical savanna environment which can be divided into three periods: a hot dry season from March to May, a hot rainy season from May to October and a cool dry season from November to February (Senanrong 1969; Senanrong and Njamniasai 1986). Archaeological evidence attests to the presence of post- Pleistocene hunter-gatherers in this region (Bronson and Natapintu 1988; Glover 1980; Heider 1957, 1958; Intakosai and Van Liere 1979; Pookajorn et al. 1977, 1979, 1984; Sangvichien et al. 1969; Sørensen and Hatting 1967; van Heekeren 1962, 1963; van Heekeren and Knuth 1967; You-Di 1969, 1970, 1986).

Lang Kamnan Cave is located at approximately 13° 58′ 52″ north latitude and 99° 25′ 12″ east longitude. The cave, which faces northeast, is about 110m above sea level and is situated in Khao Takotone, a limestone upland near Tung Nagarat village in the Muang district. It is approximately one kilometre from the cave to the closest underground water source and about four kilometres to the Khwae Noi river. The surrounding vegetation is mixed-deciduous and dry dipterocarp forest; there is also an abundance of bamboo.

The cave is 50m long; it varies in width from 7 to 40m and is 11m in height (Fig. 2). There are many rocks on the surface, especially in the front and central areas. During the rainy season water drips into the middle of the cave. Unfortunately, parts of the cave, in particular the front area, have been seriously disturbed several times by guano diggers, and by pot hunters who searched for Japanese gold because of the presence of a few Japanese potsherds on the surface of the site. The disturbance extends down to one metre in depth.

Earthenware sherds, pebble tools, human and animal bones and a few shellfish occur on the surface of the front area of the cave. Inside the cave is very dark and moist, particularly in the northwest corner (close to unit N5 W1) which is inhabited by bats. All surface artefacts were collected during the excavation season in 1991. The location of excavation units was based on the distribution of surface artefacts and systematic augering throughout the cave at one metre intervals. A total of 15 square metres was excavated: three 2 x 2m squares were excavated in the central and west wall areas and two 1 x 1.5m squares in the front area. The data analysed here derive from three of the units (as the other two unit were sterile): N4 E4 (1.5 m2) located in the front, N3 E2 (4 m2) located in the centre next to the disturbed area, and N2 E4 (1.5 m2) located along the west wall (Fig. 2). Stratigraphic layers I-V yielded cultural materials.

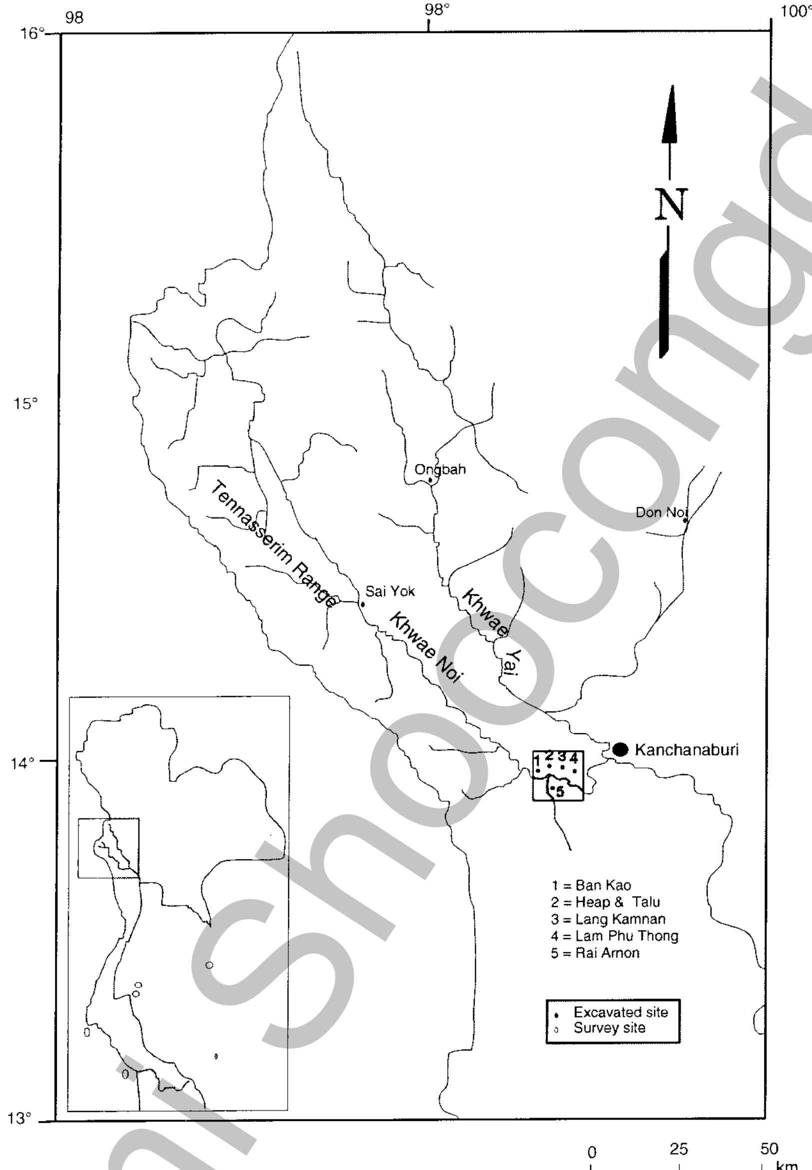

Figure 1 Lower Khwae Noi research area and location of sites in Kanchanaburi.

Chronology

The chronological sequence at Lang Kamnan Cave was established on the basis of twenty-two radiometric assays (four accelerator mass spectrometric (AMS) and eighteen conventional radiocarbon dates from Beta Analytic, Inc., the Office of Atomic Energy for Peace (Thailand) and Geochron Laboratories) on landsnail and riverine shells, charred wood and sediments deriving from secure cultural contexts (Table 1). Because there was very little charcoal available from the site, the majority of radiocarbon dates were run on landsnail shells. Radiocarbon age estimates obtained from landsnail and freshwater

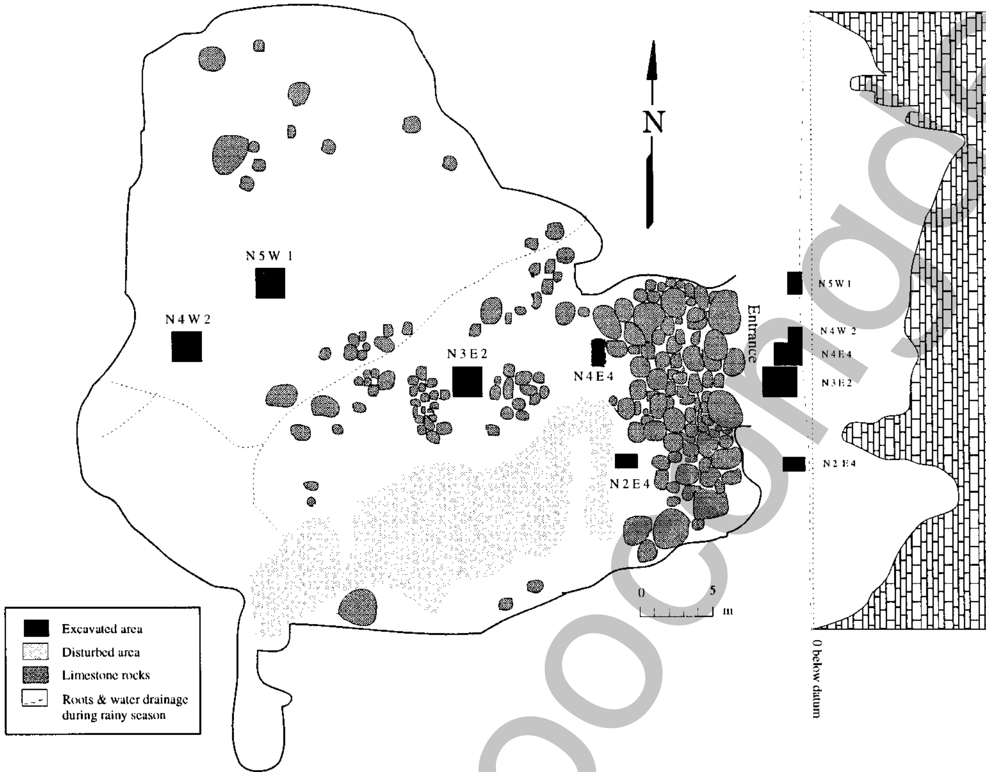

Figure 2 Plan and cross-section of Lang Kamnan Cave.

gastropods are often considered unreliable because some snails obtain carbon from the ingestion of limestone (Taylor 1987: 52). However, several recent experimental studies (e.g. Goodfriend 1987, 1989; Tamers 1970) have attempted to examine the source of land-snail shell carbonate to determine the validity of 14C dates on terrestrial shells, and the results of these studies have been encouraging.

Based on three lines of evidence – radiometric determinations, geological processes and archaeological remains – three major cultural periods can be defined (for a detailed discussion of chronology, see Shoocongdej 1996b: 198–228): Period I (Late Pleistocene), Period II (Early Holocene) and Period III (Middle Holocene) (see Table 1 and Fig. 3).

Period I: Late Pleistocene (c. 27,000–10,000 BP)

The earliest cultural layers in Lang Kamnan Cave (stratigraphic layer 4) are dated to approximately 27,110±500 BP (uncalibrated). A rock fall occurred after the initial occupation (layer 4 lies beneath the collapsed ceiling). Layer 4 yielded a large quantity of shell-midden, animal bones (charred and uncharred), a lithic assemblage representing different reduction processes and a few features. The dating of the boundary between middle and early Period I is based on two dates: 15,170 ± 70 BP (CAMS-12038) and 15,345 ± 190 BP (GX-20065) (18,317–17,869 cal. BP and 18,659–17,845 cal. BP, respectively) from habitation contexts in stratigraphic layer 3 of unit N3 E2 which also had possible hearth features. These radiometric dates agree well with dates from units N2 E4 and N4 E4 (Table 1). The

Table 1 Radiocarbon determinations from Lang Kamnan Cave, western Thailand

Sample no.	*Unit*	*Stratigraphic layer*	*Material and context*	*Sediment*	*Conventional age* BP *(± 1 s.d.)*	*Calibrated age range* BP *(± 2 s.d.)*	*Lab no.*	*Remarks*
1	N 3 E 2	III	carbonized wood from feature, depth 45cm from surface	clay loam	15,170 ± 70	18,317–17,869	Beta-70982 CAMS-12038	hearth
2	N 3 E 2	III	organic sediment (ash) from feature, depth 55cm from surface	clay loam	15,345 ± 190	18,659–17,845	GX-20065	hearth
3	N 4 E 4	II	charcoal from feature, depth 35cm from surface	clay loam	150 ± 160	299–0	Beta-70981 CAMS-12217	
4	N 4 E 4	IIA	ash and charcoal from feature, depth 54cm from surface	clay loam	15,150 ± 70	18,298–17,849	Beta-70983 CAMS-12039	disturbance (rejected)
5	N 4 E 4	II	landsnail shell from feature, depth 55cm from surface	clay loam	8,305 ± 90	9,456–8,991	OAEP-1178	
6	N 4 E 4	IIA	riverine shell from feature, depth 70cm from surface	clay loam	10,030 ± 110	12,127–10,992	GX-20066	disturbance (rejected)
7	N 4 E 4	II	landsnail from shell-midden, depth 60cm from surface	clay loam	7,540 ± 180	8,646–7,940	OAEP-1179	
8	N 4 E 4	III	burnt clay mixed with ash and charcoal, depth 75cm from surface	clay loam	6,110 ± 60	7,168–6,801	Beta-70984 CAMS-12218	
9	N 4 E 4	III	landsnail, depth 85cm from surface	clay loam	6,680 ± 150	7,757–7,238	OAEP-1180	
10	N 4 E 4	IV	landsnail from shell-midden, depth 90–100cm from surface	clay	15,640 ± 150	18,874–18,212	OAEP-1181	
11	N 4 E 4	IV	landsnail from shell-midden, depth 90–100cm from surface	clay	23,165 ± 330	too old to calibrate	GX-20067	
12	N 4 E 4	IV	landsnail from shell-midden, depth 125cm from surface	clay	30,880 ± 760	too old to calibrate	GX 20068	
13	N 4 E 4	IV	a piece of wood, depth 130cm from surface	clay	160 ± 60	303–0	Beta-70986 CAMS-12040	modern roots (rejected)
14	N 4 E 4	IV	landsnail, depth 140cm from surface	clay	26,920 ± 210	too old to calibrate	Beta-70985	

Table 1 Continued

Sample no.	*Unit*	*Stratigraphic layer*	*Material and context*	*Sediment*	*Conventional age* BP *(± 1 s.d.)*	*Calibrated age range* BP *(± 2 s.d.)*	*Lab no.*	*Remarks*
15	N 2 E 4	II	landsnail, depth 40cm from surface	clay	7,990 ± 100	9,197–8,506	GX-20069	
16	N 2 E 4	II	landsnail, depth 30cm from surface	clay	7,740 ± 140	8,956–8,180	OAEP-1192	
17	N 2 E 4	II	riverine shell, depth 65cm from surface	clay	16,170 ± 175	19,531–18,662	GX-20070	
18	N 2 E 4	III	landsnail, depth 95cm from surface	clay	20,020 ± 240	too old to calibrate	GX-20071	
19	N 2 E 4	III	landsnail, depth 105cm from surface	clay	18,280 ± 320	22,680–20,941	OAEP-1193	
20	N 2 E 4	IV	landsnail, depth 115cm from surface	clay	17,130 ± 230	21,047–19,574	OAEP-1194	
21	N 2 E 4	IV	landsnail, depth 135cm from surface	clay	21,120 ± 460	too old to calibrate	OAEP-1195	
22	N 2 E 4	IV	landsnail, depth 145cm from surface	clay	27,110 ± 500	too old to calibrate	GX-20072	

Notes
Dates were calibrated using the CALIB 3.0 by Stuiver and Reimer (1993); results are reported using the 2 sigma values. Radiocarbon ages are calibrated to years BP. 13C correction was made for the fourteen samples analysed by Beta Analytic, Inc. (Beta) and Geochron Laboratories (GX). 13C age adjustment were not made on eight 14C dates from Office of Atomic Energy for Peace (OAEP).

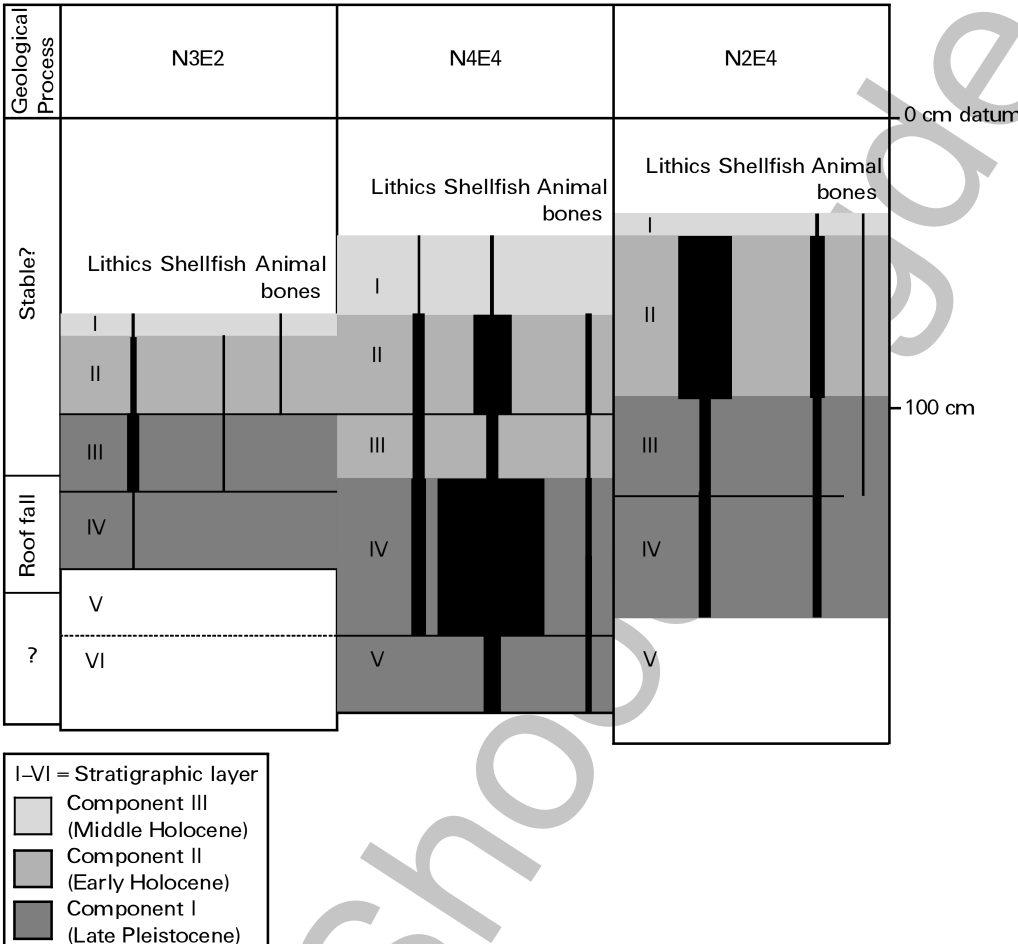

Figure 3 Total weight of artefacts, shellfish and animal bones by component and stratigraphic layer.

overall age for the early period at Lang Kamnan Cave is about 27,110 ± 500 BP (GX 20072) to 10,030 ± 110 BP (GX-20066) (the latter calibrated to 12,127–10,992 BP).

The lithic assemblage is mainly cobbles, including waste cores and flakes, and utilized cores (i.e., 'choppers', 'scrapers'). The lithic assemblages from the front area (N4 E4) and near the wall area (N2 E4) represent the entire production sequence from initial flaking to finished products. Small and medium-sized animals and shellfish remains were also recovered. Hunting and collecting was probably the general subsistence pattern. Lang Kamnan probably represents one part of the Late Pleistocene settlement pattern. The spatial distribution of materials in N2 E4 suggests it may have been a refuse area where larger pieces of lithic materials and animal bones (mostly foot bones of cervids and bovids) were tossed against the wall. The features in N3 E2 possibly represent a hearth and locus of habitation that was intentionally cleared of debris. The lithic artefacts, fragmentary faunal remains and large amount of shellfish in N4 E4 suggest that the front of the cave may have been used as an area for food processing, such as butchering animals and processing shellfish, as well as for tool manufacture and maintenance.

Period II: Early Holocene (c. 10,000–7500 BP)
Stratigraphic layer 2 represents a reoccupation of the cave after several episodes of roof collapse during the early period. The geological process in this period appeared to be more stable than in Period I. Radiocarbon determinations derived from stratigraphic layer 2 of unit N2 E4. Two sets of landsnail samples were analysed by two laboratories and the dating results seem to be consistent with each other (Table 1). Earthenware sherds were recovered from the uppermost part of this layer, and it is likely that they were transported from an upper layer since the sediments of stratigraphic layer 1 are very loose. This period dates from 7740 ± 140 BP (OAEP 1192) to 7990 ± 100 BP (GX-20069) (or 8956–8180 to 9197–8506 cal. BP).

The Holocene archaeological record is similar to that of the Late Pleistocene. Faunal remains of small–medium-sized animals and shellfish remains have been found. In terms of lithic artefacts, these two periods share similar assemblages (e.g., utilized cores and flakes, waste core and flakes). The lithic assemblages from three areas indicate primarily tool repair. As in the Late Pleistocene period, hunting and collecting would probably also have been the general subsistence strategy during this period. The remains of small and medium-sized animals were also transported to and processed at the site, along with collected landsnails and freshwater shellfish. Cave sites in the region were continuously occupied by the early Holocene population. The spatial distribution of archaeological evidence was similar to that for the Late Pleistocene occupation.

Period III: Middle Holocene (c. 7500–2500 BP)
During this period, Lang Kamnan Cave was occupied by people who used ceramics. Stratigraphic layer 1, which represents this late period of use, can be dated to the middle Holocene. Although there are no 14C determinations younger than c. 7000 BP, the best estimate of the age of Period III is 1770 to 1300 cal. BC based on the presence of black burnished pottery which is found at the Ban Kao site (and dated, along with stone axes/adzes, in reference to dates of 3720 ± 140 BP to 3250 ± 120 BP [Sørensen and Hatting 1967; Tauber 1973: 109–110]) and Talu Cave (Pookajorn 1984). Although the evidence shows that earthen ceramics, bone and stone beads, stone discs and stone axes/adzes were introduced in this period, other classes of archaeological materials (e.g., pebble tools) continued to be used by the middle Holocene occupants.

Geographically, middle Holocene sites in this region are often found in the alluvial zone, particularly on the second terrace (e.g., Fine Arts Department 1986, 1987; Kanchanaburi Cultural Center 1988), along the piedmont area (Fine Arts Department 1988; Shoocongdej 1991b) and in the limestone mountains (e.g., Fine Arts Department 1986, 1987; Pookajorn 1988).

Domesticated cereals have not yet been discovered *in situ* from sites in this region (though rice has been found from the contemporary site of Khok Phanom Di which is located outside the region [Higham and Maloney 1989; Higham and Thosarat 1993; Thompson 1996]). The Ban Kao site has yielded remains of domesticated pigs and chickens. In general, very little is known about the subsistence economy and settlement patterns of this period, although middle Holocene populations probably continued to engage in hunting and collecting activities.

Late and post-Pleistocene palaeoenvironments in the lower Khwai Noi region

The end of the Late Pleistocene was accompanied by dramatic changes in climate, geology, and vegetation, which generally have been assumed to have had tremendous impact on human adaptations and cultural developments in many areas of the world, especially the shift from hunting-gathering to domestication (e.g., Bar-Yosef and Valla 1991; Flannery 1973). Southeast Asian archaeologists have also been concerned with questions of climatic and environmental changes during this period (e.g., Bellwood 1985; Gorman 1971). Based on palaeoenvironmental evidence from south China, Indonesia and Thailand, mainland Southeast Asian environments appear to have been only slightly affected by the 'Younger Dryas', the swing back to glacial conditions in the northern hemisphere at the end of the Pleistocene when the climate was unstable. Viewed from a global perspective, the Younger Dryas would have affected local environments in Southeast Asia as the climate changed abruptly from warm to cold, then from cold to a considerably warmer and wetter climate at 10,000 BP (Kerr 1993: 890). Given the rather limited available data for more fine-grained reconstructions of palaeoenvironments in Southeast Asia, only a tentative reconstruction of the lower Khwae Noi palaeoenvironment can be made.

Recent research in northeastern Thailand (Kealhofer 1996) and China (e.g., Zhisheng et al. 1993) suggests that the Late Pleistocene environment of Thailand was more highly seasonal than at present. Marine sediments in the Bangkok area indicate that prior to 15,000 BP the entire Gulf of Thailand was exposed land with dry climatic conditions (Kengkoom 1992). Palynological data suggest that gallery forests would have appeared along the Khwae Noi and Khwae Yai rivers, indicating a moister regime during the Late Pleistocene. The remains of bovids from sites in the lower Khwae Noi river imply open grassy plains, dry dipterocarp forests and mixed deciduous vegetation, suggesting the local environment was similar to the present.

During the early Holocene, as sea levels rose in the Gulf of Thailand and moved closer to Kanchanaburi province, the lower Khwae Noi area experienced a remarkably warmer and moister climate. Seasonality would have been less pronounced and similar to the present, though the vegetation may have been much denser. The faunal and floral remains (e.g., Canarium sp.) from Lang Kamnan Cave indicate that the local vegetation was tropical monsoon forest including mixed-deciduous, dry dipterocarp and semi-evergreen forests. No extinct animals have been documented at the site. Faunal and microvertebrate assemblages show characteristic modern mammals and reptiles. Spore and pollen of ferns and grasses were also recovered from the site and suggest the typical plant species that are widely distributed in tropical environments. Ferns in particular are very abundant in the moist areas of the seasonal tropics. Most of the fern spores are *Laevigatosporites ovatus* Wilson and Webster 1964 and *Cyathidites* minor Couper 1953; a few spores of *Magnastriatites grandiosus* Kedves and Porta emend Duenas 1980 and *Polypodiisporites* spp. were also recovered. The grass pollen includes *Monoporopllenites gramineoides* Meyer 1956, *Quercoidites* spp., and *Rhoipites* spp.

Khwai Noi forager mobility strategies

The Lang Kamnan Cave evidence contributes to our understanding of forager adaptations and culture change during the Late and post-Pleistocene periods in Thailand and Southeast Asia, and complements research currently being conducted elsewhere in the region (e.g., Anderson 1990; Majid 1990; Pookajorn 1994). Although the archaeological and ecological evidence from this one site is too restricted to evaluate the mobility model proposed above adequately, analyses of the Lang Kamnan materials allow partial testing of the model, specifically in regard to task activities, site function and changes in composition of material remains through time.

Task activities

The model proposes that hunter-gatherers would use a residential strategy during the wet season and employ a generalized subsistence technology. Archaeological and ecological evidence from Lang Kamnan Cave, discussed below, indicates such a generalized pattern of subsistence exploitation and technology, and also provides information on several activities carried on in various parts of the site, such as tool manufacture and maintenance, food processing and cooking.

Generalized subsistence exploitation

Six hundred and sixty-five bones (NISP) were examined from N2 E4 (n = 258) and N4 E4 (n = 407) (Table 2); N3 E2 contained very few animal bones. Most faunal remains were charred. Analysis suggests that the cave's occupants employed a generalized subsistence strategy, involving a mixed strategy of hunting and collecting over a wide range of habitats, including evergreen forest in the uplands area, deciduous dipterocarp and bamboo forests in the upland and lowland areas, shrubs and grassy areas near swamps or rivers. Lang Kamnan Cave is located about 4 kilometres from the Khwae Noi river and about 1.5 kilometres from two small tributaries, Huai Bo Thong and Huai Wang Lan Nung.

Snails and floral remains indicate that the cave was occupied during the wet season. Ethnographic accounts of seasonal tropical hunter-gatherers indicate that during the wet season, when plant foods were evenly distributed and abundant, gathering of vegetables, roots, bamboo shoots, seeds, and fruits, and hunting of herbivorous animals occurred. The Lang Kamnan faunal remains indicate that flying squirrels, porcupines, bamboo rat, wild water buffalo, possibly banteng, turtle, landsnail, freshwater shellfish and especially cervids (barking deer, hog deer, Eld's brow-antlered deer, sambar deer) were exploited. No single species was preferentially targeted, although cervids are the predominant taxa. All sizes of game were taken, probably on an encounter basis. Medium-sized animal bones predominate in the Lang Kamnan faunal assemblage. The limb bones of the large and medium-sized animals suggest the animals were killed elsewhere and brought back to the site. In contrast, entire small and medium-sized animals appear to have been transported to the cave. Two plausible explanations (see Shoocongdej 1996b) are that either the animals were killed a relatively short distance from the camp, but for various reasons (e.g., small number of hunters) the entire carcasses were not transported to the cave; or, alternatively, the animals were killed far from the site. As the total size of the assemblage is quite small, it is more likely that the first explanation is correct.

Table 2 Summary tables of unidentified bones

Layer	Large mammal					
	Vert		Ribs		Long bones	
	#	Wt	#	Wt	#	Wt
N 4 E 4						
1					1	2.7
2					6	47.5
3	1					
4		3.6			4	36.5
5						
N 2 E 4						
2	1	2.1			1	6.9
3					1	6.9
4			1	6.0	7	81.3
5						

Layer	Medium mammal							
	Vert		Ribs		Long bones		Skull	
	#	Wt	#	Wt	#	Wt	#	Wt
N 4 E 4								
1					3	5.1		
2	1	1.1	4	3.7	98	60.7		
3			1	0.7	44	40.0		
4	2	1.7			90	120.0	1	9.3
5					2	2.6		
N 2 E 4								
2			1	0.6	13	17.3		
3			1	2.0	9	13.2	1	0.6
4	2	1.5			149	178.7	4	3.2
5					1	1		

Layer	Small mammal					
	Ribs		Long bones		Skull	
	#	Wt	#	Wt	#	Wt
N 4 E 4						
1						
2	12	5.0	21	6.2		
3	1	0.1	6	2.7		
4			8	4.2		
N 2 E 4						
2			8	5.5	3	1.4
3						
4			5	5.3		
5						

Layer	Turtle					
	Shell		Long bones		Burned long bones	
	#	Wt	#	Wt	#	Wt
N 4 E 4						
1	1	1.4				
2	83	94.1	1	0.4		1.9
3	2	3.5	2	2.7		1.6
4	4	8.8				
N 2 E 4						
2	18	28.9	2	3.6		
3	2	1.1	1	0.7		
4	5	12.1			9	18.6
5						

The upland limestone areas also provided food resources. The landsnail and floral remains suggest that collecting strategies were used during the wet season. Landsnails are localized resources which would have been found abundantly in limestone habitats. Though macrobotanical remains were rarely recovered from the site due to preservation problems, the Canarium nut shells indicate a locally available plant food that matures in the rainy season.

Overall, the evidence suggests that foragers moved frequently during the rainy season to procure a variety of resources. Based on ethnographic comparisons, it may be reasonable to assume that the Lang Kamnan foragers' movements covered well-known ranges and that they did not move far from their previous camps. Interestingly, sites recorded during survey in this area, especially Wong Phrachan Cave, have assemblages similar to Lang Kamnan (which is approximately 1.5 kilometres away).

Generalized technology

A total of 874 stone tools and debitage were recovered from throughout the sequence: 150 (17.16 per cent) from surface collection, 91 (10.41 per cent) from N3 E2, 148 (16.93 per cent) from N2 E4 and 485 (55.49 per cent) from N4 E4 (Table 3). Ten lithic categories are defined including: waste cores, utilized cores, grinding stones, utilized flakes, resharpening flakes, hammers, broken hammers, broken utilized flakes and broken utilized cores (Figs 4, 5 and 6). The lithic data have been analysed according to technical characteristics related to manufacture, use, maintenance and discard (Binford 1977; Kelly 1983; Nelson 1991; Shott 1986).

Results of the analyses of the lithic assemblage indicate that raw materials were probably procured locally within a 5-kilometre radius of the site. A possible local lithic source is located on a small tributary, the Huai Lum Phu Thong, approximately 2.5 kilometres from the site. Lithic debitage at the Lang Rongrien Tung Nagarat site, near the Huai Lum Phu Thong stream, suggests that artefacts were also manufactured at the source area (Fig. 7). Medium-grained quartzite is the predominant locally available raw material used at the site during all periods; this material is of relatively low quality. In addition to the quartzite, small amounts of a wide variety of raw materials were observed, including quartz, limestone, chert, chalcedony and shale. A small number of river cobbles of various sizes were transported back to the cave. Raw materials were thus abundant and easily available.

Technologically, the Lang Kamnan lithic assemblages display an expedient technology, involving the production of amorphous, unpatterned sizes and shapes of tools. Cores and flake tools were made with little effort and for immediate use. The persistence through time of an expedient technology and amorphous tools might also be due to the easy availability of organic materials (e.g., shell, bamboo, bone) in tropical deciduous, dipterocarp and bamboo forests, which are more abundant, lightweight, portable and flexible than stone materials (Hutterer 1977). Unfortunately, the Lang Kamnan analyses could not answer questions on the role of organic tools.

Tool-manufacturing and maintenance activities occurred at the site. Lithic artefacts broken during production and use were also recovered. Based on the large number of flakes compared to cores and the ratio of primary decortication to tertiary decortication flakes, some of the cores may have been manufactured for use elsewhere. Cores were used both as tools and as sources of flakes. Most flakes are unmodified by retouch. Morphologically unpatterned cores and unmodified flakes represent generalized tool

Table 3 Frequency distribution of lithic assemblages by unit and stratigraphical layer

Tool cat.	*Surface collection*	*N 3 E 2*				*N 2 E 4*				*N 4 E 4*				*Total* (excavations)*
		1	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	
WC	21 [0.14]	–	–	–	–	–	4 [4.17]	3 [7.69]	2 [15.39]	–	–	1 [0.82]	1 [0.82]	11 [1.52]
UC	48 [32.00]	–	–	6 [7.79]	–	–	5 [5.21]	–	1 [7.69]	–	1 [7.69]	–	5 [3.07]	18 [2.48]
WF	39 [26.00]	3 [100]	8 [100]	69 [89.61]	2 [66.67]	–	81 [84.38]	31 [79.49]	10 [76.92]	5 [100]	179 [91.80]	113 [92.62]	141 [86.50]	642 [88.67]
UF	19 [12.67]	–	–	–	1 [33.33]	–	3 [3.12]	4 [10.26]	–	–	6 [3.08]	7 [5.74]	7 [4.29]	28 [3.87]
H	2 [1.33]	–	–	1 [1.30]	–	–	–	–	–	–	–	–	–	1 [0.14]
R	5 [3.33]	–	–	1 [1.30]	–	–	2 [2.08]	1 [2.56]	–	–	9 [4.62]	–	8 [4.91]	21 [2.90]
BUC	12 [8.00]	–	–	–	–	–	1 [1.04]	–	–	–	–	1 [0.82]	1 [0.61]	3 [0.41]
BUF	2 [1.33]	–	–	–	–	–	–	–	–	–	–	–	–	0 [0.00]
BH	1 [0.67]	–	–	–	–	–	–	–	–	–	–	–	–	0 [0.00]
BG	1 [0.67]	–	–	–	–	–	–	–	–	–	–	–	–	0 [0.00]
TOTAL	150 [100]	3 [100]	8 [100]	77 [100]	3 [100]	0 [100]	96 [100]	39 [100]	13 [100]	5 [100]	195 [100]	122 [100]	163 [100]	724 [100]

Notes
WC = waste cores; UC = utilized cores; WF = waste flakes; UF = utilized flakes; H = hammer; R = resharpening flakes; BUC = broken utilized cores; BUF = broken utilized flakes; BH = broken hammer; BG = broken grinding stone

* Total assemblages from excavations.
% in brackets

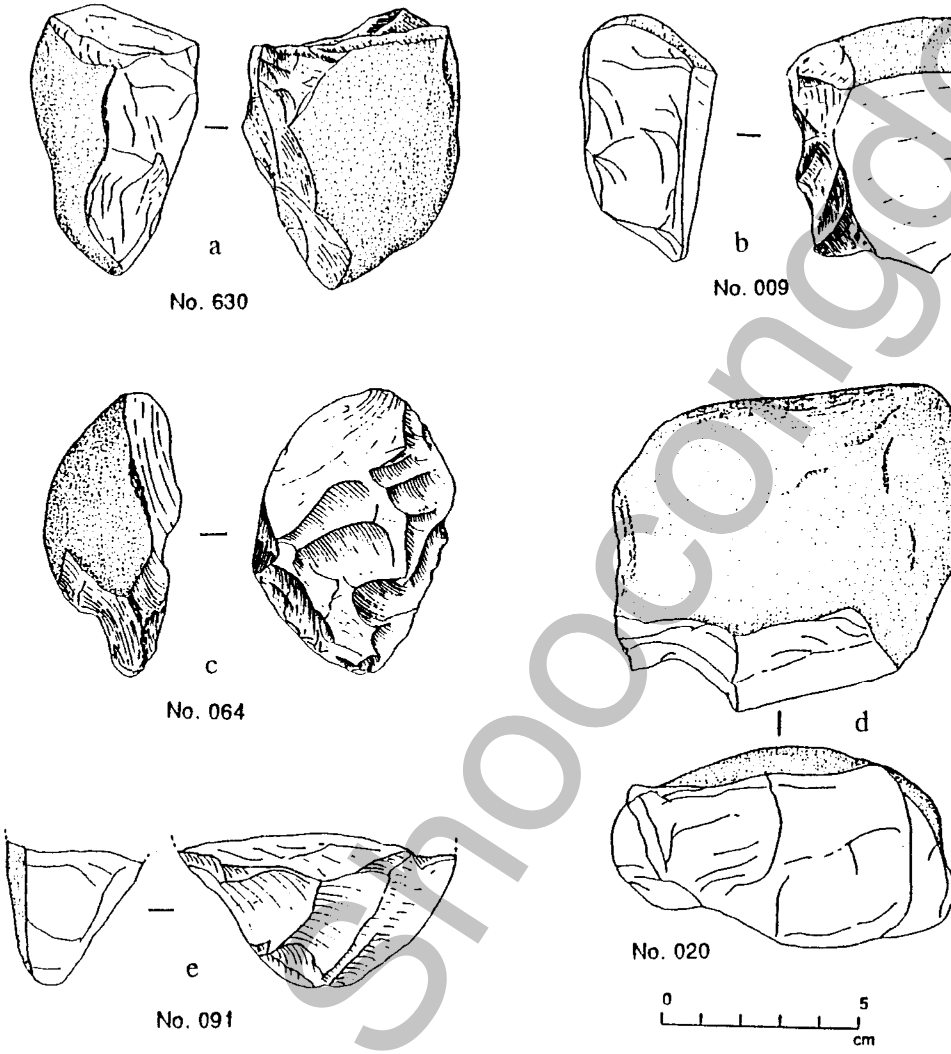

Figure 4 Lithic categories from N3 E2 and N2 E4, Lang Kamnan Cave. a) Utilized core from layer 1, N3 E2, b-c) utilized cores from layer 3, N3 E2, d) hammer from layer 3, N3 E2, e) broken core from layer 2, N2 E4.

functions; utilized cores may have been employed as heavy duty tools, while utilized flakes may have been used as light duty tools. No distinct patterns in location of retouch on utilized core and flake tools were observed. The lithic assemblage may indicate tool manufacture and maintenance, the processing of animal carcasses and other immediate tool uses at the site.

Site function

The Lang Kamnan site was probably sporadically occupied by small groups of highly mobile foragers for brief periods of time given the low density of archaeological remains

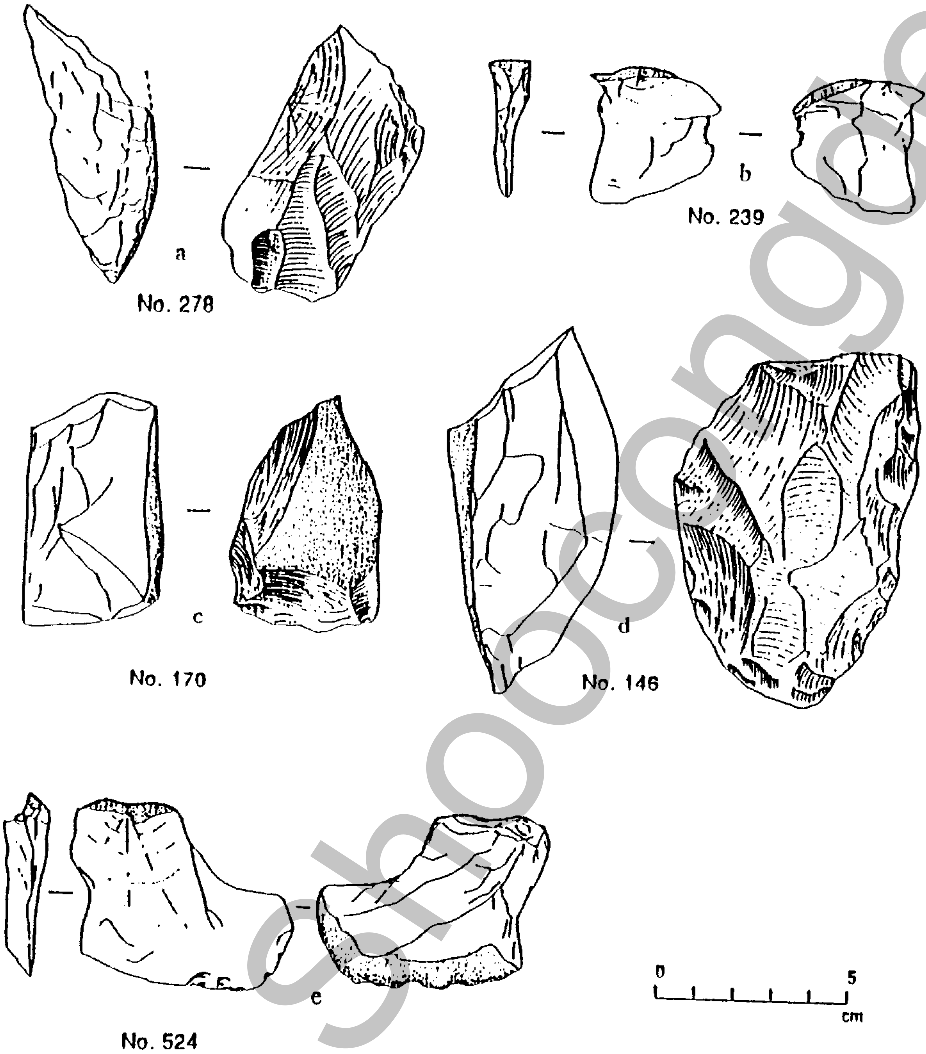

Figure 5 Lithic categories from N4 E4, Lang Kamnan Cave. a) Broken utilized core from layer 3, b) utilized flake from layer 3, c-d) utilized core from layer 4, e) resharpened flake from layer 4.

from each cultural layer. The location of the site and its material culture suggest the cave was primarily used as a temporary residential camp and as protection from wet season rains. In heavy rains, the cave would have been an ideal place to stay temporarily because it provided ready shelter. In the limestone uplands surrounding Lang Kamnan Cave several natural caves were located during the 1989–90 field seasons (Shoocongdej 1991b). Lang Kamnan Cave probably served as one of many temporary camps for prehistoric foragers inhabiting this area.

The spatial patterning of the archaeological remains indicates that the area near the entrance to the cave was primarily used for food preparation and consumption, as well as the manufacture and maintenance of stone tools. Food-processing tasks included

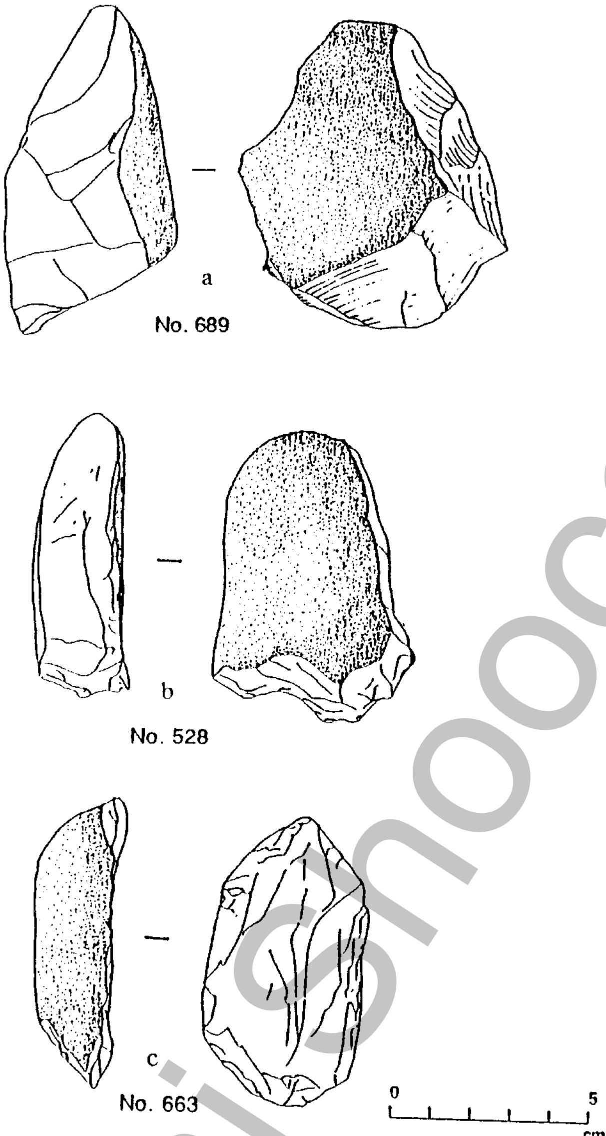

Figure 6 Lithic categories from N4 E4, Lang Kamnan Cave. a) Utilized core from layer 3, b-c) utilized cores from layer 4.

butchering animals, processing shellfish and cooking. Hearths were located in the middle of the cave; this area was mainly kept clear of refuse. The very low densities of archaeological remains in this area suggest it may have also been used as a sleeping area. The area along the cave wall may have been used as a refuse area as suggested by the larger pieces of animal bone and lithics found near the wall.

Conclusions

This paper presents a mobility model for explaining aspects of Late and post-Pleistocene cultural systems in seasonal tropical environments. It argues that, in order to study

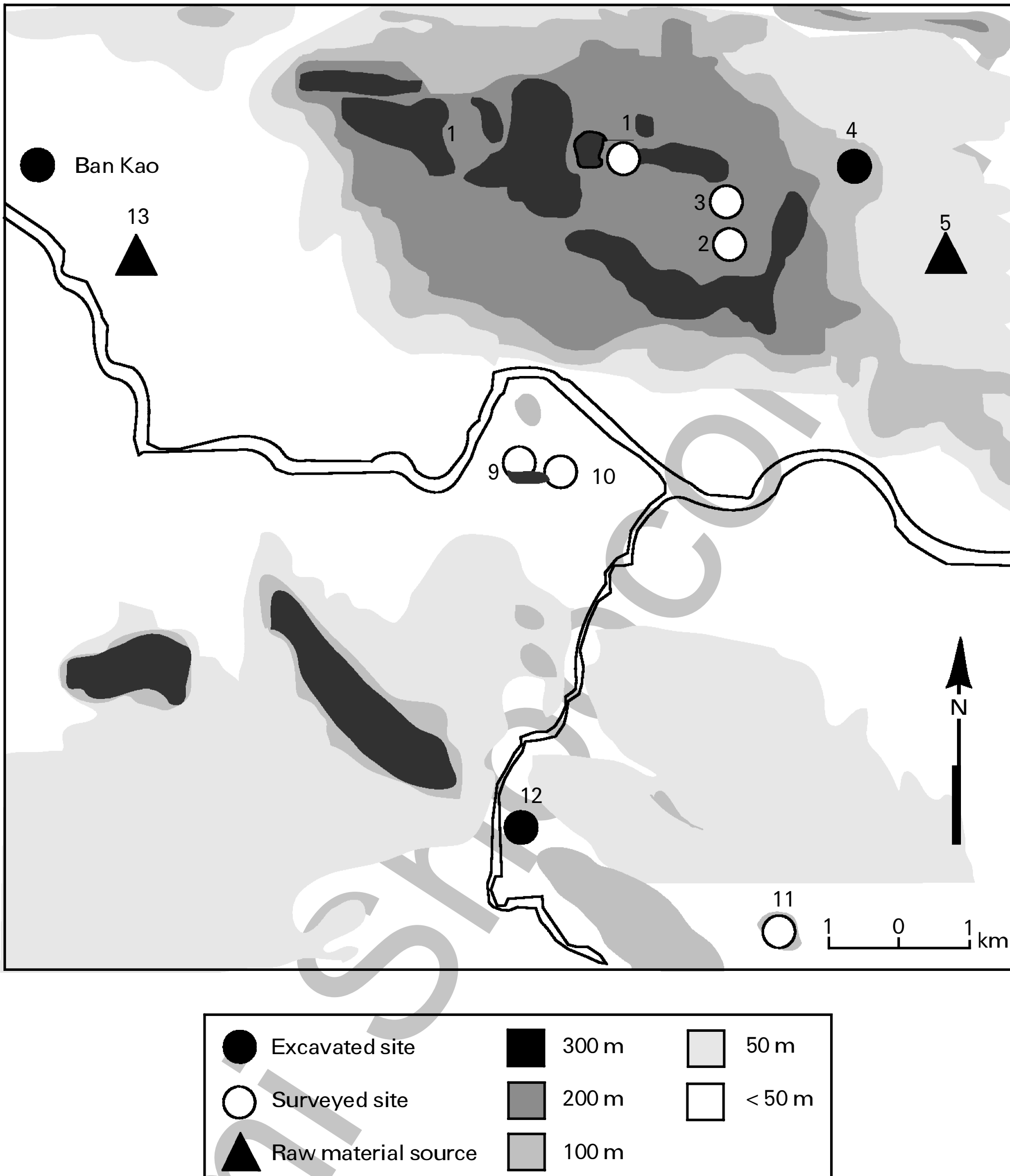

Figure 7 Map showing location of sites in the Khwae Noi Area. 1) Sane Cave; 2) Wong Phra Chan Cave; 3) Khru Manat Cave; 4) Lang Kamnan Cave; 5) Lam Phu Thong (Lang Rongrien Tung Nagarat); 6) Wang Ta Kien Cave; 7) Nong Khang Pong; 8) Ang Hin Cave; 9) Uan Cave; 10) Sai Cave; 11) Talu Cave; 12) Rai Arnon; 13) Na Rongrien Ban Kao.

the process of organizational change, we must understand hunter-gatherer mobility organization and how mobility can be analysed using archaeological assemblages. In general, the analyses of Lang Kamnan Cave have verified that a residential mobility strategy was employed during the wet season, as suggested by the model. However, it has not yet been shown archaeologically that logistical mobility was a strategy applied in the dry season, as the model also predicts. Further archaeological research must be pursued to test the model completely.

Various lines of evidence from Lang Kamnan Cave serve to increase our current knowledge of Late and post-Pleistocene cultural systems in Southeast Asia. Seasonal Southeast Asian tropics appear to have had cultural developments unparalleled in contemporary systems in other parts of the world. Technology and subsistence-settlement patterns during the Late Pleistocene and early Holocene indicate changes in response to the availability of local resources in seasonal tropical environments. 'Amorphous' pebble tools persisted through time, which may be explained by the availability of organic materials, and their use for maintenance purposes (e.g., Hutterer 1977). However, we still do not yet understand the overall technological system since lithic artefacts have been the focus of analysis. The roles of bone and shell tools require further research.

Finally, I suggest we should drop the term 'Hoabinhian' in Southeast Asia (though it may have some validity for Vietnamese assemblages). The term lacks a well-defined meaning, though recently it has been used narrowly to refer to a lithic industry rather than a culture or a technocomplex (Solheim 1994: 10). More importantly, no clear distinction exists between Late and post-Pleistocene artefacts and assemblages prior to the appearance of ceramic artefacts in the middle Holocene. For example, core and flake tools coexist with 'Hoabinhian' tool types (e.g., sumatraliths, short-axes – Fig. 8) over long periods of time. Thus the term is not useful in investigating and explaining cultural variability during the Late and post-Pleistocene periods, and does not aid in translating our lithic data into a generally meaningful social reality.

Research on forager mobility is just beginning in Southeast Asia, and long-term archaeological projects are required to answer the questions posed in this paper. Of as great an importance is the need for systematic analysis and comparison of Late and post-Pleistocene archaeological data, both synchronically and diachronically, across Southeast Asia.

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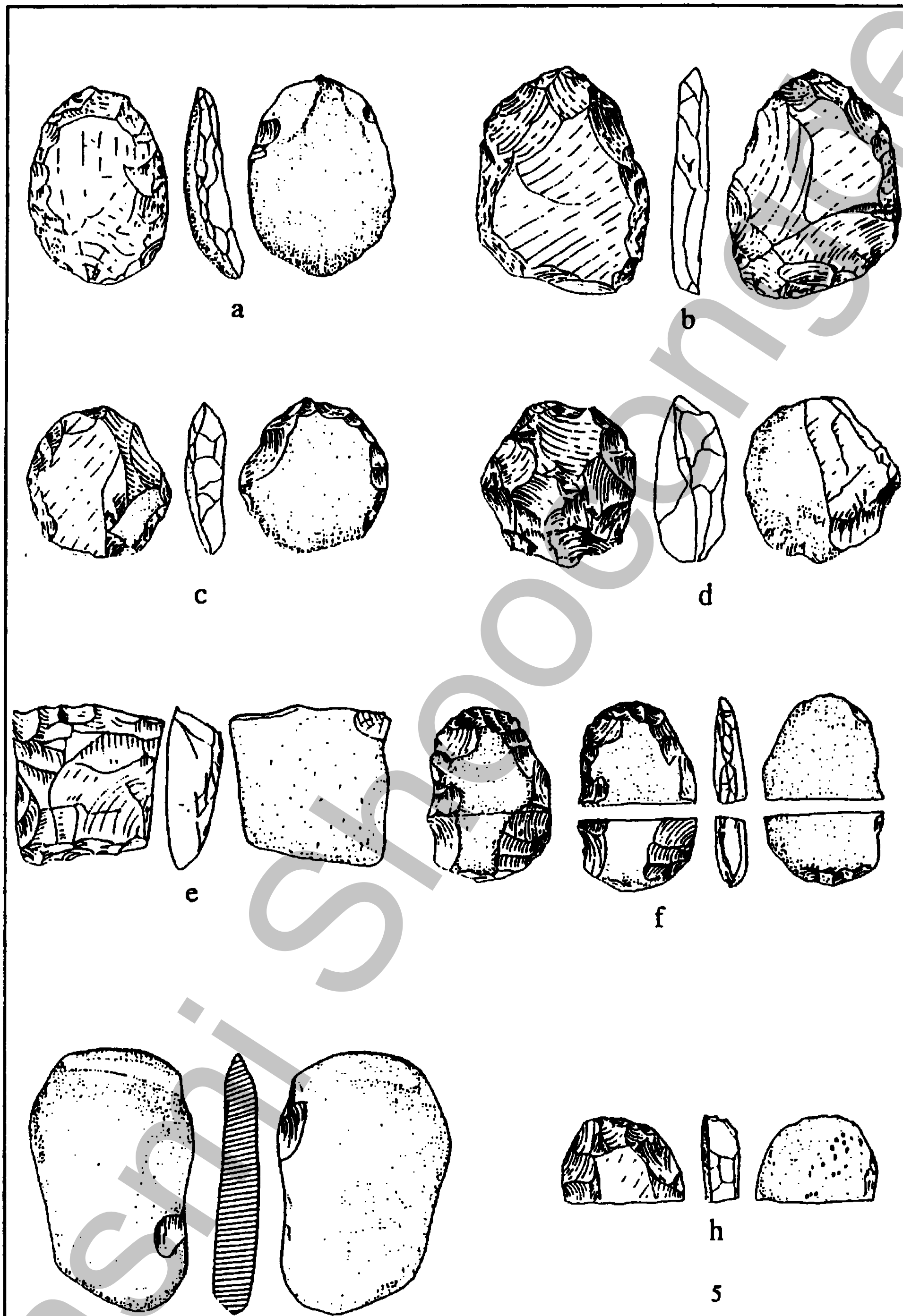

Figure 8 Diagnostic 'Hoabinhian' tool types from Xom Trai, Viet Nam. a-e) Sumatraliths, f-g) short-axes, h) edge-ground stone tool (redrawn from Ha Van Tan 1994: 13–14).

References

Adi Taha. 1985. The re-excavation of the rockshelter of Gua Cha, Ulu, Kelantan, West Malaysia. *Federal Museums Journal*, 30.

Anderson, D. 1988. Excavations of a Pleistocene rockshelter in Krabi and the prehistory of southern Thailand. In *Prehistoric Studies: The Stone and Metal Ages in Thailand* (eds P. Charoenwongsa and B. Bronson). Bangkok: Papers in Thai Antiquity.

Anderson, D. 1990. *Lang Rongrien Rockshelter: A Pleistocene, Early Holocene Archaeological Site from Krabi, Southwestern Thailand*. The University Museum, University of Pennsylvania, Philadelphia.

Bar-Yosef, O. and Valla, F. R. 1991. *The Natufian Culture in the Levant*. Ann Arbor, MI: International Monographs in Prehistory.

Bellwood, P. 1985. *Prehistory of the Indo-Malaysian Archipelago*. New York: Academic Press.

Binford, L. 1977. Forty-seven trips. In *Stone Tools as Cultural Markers* (ed. R. V. S. Wright). Canberra: Australian Institute of Aboriginal Studies, pp. 24–36.

Binford, L. R. 1978. Dimensional analysis of behavior and site structure: learning from an Eskimo hunting stand. *American Antiquity*, 43(3): 255–73.

Binford, L. R. 1980. Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity*, 43: 255–73.

Binford, L. R. 1982. The archaeology of place. *Journal of Anthropological Anthropology*, 1: 5–31.

Binford, L. R. 1987. Research ambiguity: frames of reference and site structure. In *Method and Theory for Activity Area Research: An Ethnoarchaeological Approach* (ed. S. Kent). New York: Columbia University.

Binford, L. R. 1990. Mobility, housing, and environment: a comparative study. *Journal of Anthropological Research*, 46: 119–52.

Bourlière, F. and Hadley, M. 1983. Present-day savannas: an overview. In *Tropical Savannas* (ed. F. Bourlière). Amsterdam: Elsevier, pp. 1–15.

Bronson, B. and Natapintu, S. 1988. Don Noi: a new flaked tool industry of the middle Holocene in western Thailand. In *Prehistoric Studies: The Stone and Metal Ages in Thailand* (eds P. Charoenwongsa and B. Bronson). Bangkok: Papers in Thai Antiquity, pp. 91–106.

Charoenwongsa, P. and Bronson, B. (eds) 1988. *Prehistoric Studies: The Stone and Metal Ages in Thailand*. Bangkok: Papers in Thai Antiquity.

Dunn, F. 1970. Cultural evolution in the Late Pleistocene and Holocene of Southeast Asia. *American Anthropologist*, 72: 1–28.

Dunn, F. and Dunn, D. 1977. Maritime adaptations and exploitation of marine resources in Sundaic Southeast Asian Prehistory. *Modern Quaternary Research in Southeast Asia*, 3: 1–28.

Fine Arts Department 1986. *Report of Chiew Lan Archaeological Project*. Bangkok: Archaeological Division. In Thai.

Fine Arts Department 1987. *Archaeology of Four Regions*. Bangkok: Hattasilpa Press. In Thai.

Fine Arts Department 1988. *Archaeological Sites in Thailand*, Vol. 2. Bangkok: Chumnum Sahakorn Kan Kraset. In Thai.

Flannery, K. 1973. The origins of agriculture. *Annual Review of Anthropology*, 2: 271–310.

Fox, R. 1970. *Tabon Cave: An Archaeological Exploration on Palawan Island, Philippines*. Manila: National Museum.

Glover, I. 1977. The Hoabinhian: hunter-gatherers or early agriculturists of Southeast Asia. In *Hunters, Gatherers, and First Farmers Beyond Europe* (ed. J. V. S. Megaw). Leicester: Leicester University Press, pp. 145–66.

Glover, I. 1980. Ban Don Ta Phet and its relevance to problems in the pre- and protohistory of Thailand. *Bulletin of the Indo-Pacific Prehistory Association*, 2: 16–30.

Glover, I. 1985. Some problems relating to the domestication of rice in Asia. In *Recent Advances in Indo-Pacific Prehistory* (eds V. N. Misra and P. Bellwood). New Delhi: Oxford & IBH Publishing, pp. 265–74.

Golley, F. B. (ed.) 1983. *Tropical Rain Forest Ecosystem: Structure and Function*. Amsterdam: Elsevier.

Golson, J. 1985. Agricultural origins in Southeast Asia; a view from the past. In *Recent Advances in Indo-Pacific Prehistory* (eds V. N. Misra and P. Bellwood). New Delhi: Oxford & IBH Publishing, pp. 307–14.

Goodfriend, G. A. 1987. Radiocarbon age anomalies in shell carbonate of landsnails from semi-arid area. *Radiocarbon*, 29: 159–67.

Goodfriend, G. A. 1989. Complementary use amino-acid epimerization and radiocarbon analysis for dating mixed-age fossil assemblages. *Radiocarbon*, 31: 1041–7.

Gorman, C. F. 1971. The Hoabinhian and after: subsistence patterns in Southeast Asia during the Late Pleistocene and Early Recent periods. *World Archaeology*, 2: 300–20.

Gorman, C. F. 1977. A priori models and Thai prehistory: a reconsideration of the beginning of agriculture. In *Origins of Agriculture* (ed. C. A. Reed). Mouton: The Hague, pp. 321–55.

Gould, R. 1980. *Living Archaeology*. New York: Cambridge University Press.

Ha Van Tan. 1994. The Hoabinhian and before. Paper presented at the 15th Indo-Pacific Prehistory Association Congress, Chiang Mai, Thailand, 5–12 January.

Harris, D. R. 1972. The origins of agriculture in the tropics. *American Scientist*, 60: 180–93.

Heider, K. G. 1957. New archaeological discoveries in Kanchanaburi. *Journal of Siam Society*, 45: 62–70.

Heider, K. G. 1958. A pebble-tool complex in Thailand. *Asian Perspectives*, 2: 63–7.

Higham, C. F. 1977. Economic change in prehistoric Thailand. In *Origins of Agriculture* (ed. C. A. Reed). Mouton: The Hague, pp. 385–412.

Higham, C. F. 1989. *The Archaeology of Mainland Southeast Asia from 10,000* BC *to the Fall of Angkor*. Cambridge: Cambridge University Press.

Higham C. F. and Kijngam, A. (eds) 1984. *Prehistoric Investigations in Northeastern Thailand*. Oxford: BAR International Series 231.

Higham, C. F. and Maloney, B. 1989. Coastal adaptation, sedentism, and domestication: a model for socio-economic intensification in prehistoric Southeast Asia. In *Foraging and Farming: The Evolution of Plant Exploitation* (eds D. R. Harris and G. C. Hillman). London: Hyman, pp. 650–66.

Higham C. F. and Thosarat, R. 1993. *Khok Phanom Di: Prehistoric Adaptation to the World Richest Habitat.* Fort Worth: Harcourt Brace College Publishers.

Hitchcock, R. 1982. Patterns of sedentism among the Basarwa of Eastern Botswana. In *Politics and History in Band Society* (eds E. Leacock and R. B. Lee). New York: Cambridge University Press, pp. 223–67.

Hitchock, R. and Ebert, J. 1989. Modeling Kalahari hunter-gatherer subsistence and settlement systems. *Anthropos*, 84: 47–62.

Hutterer, K. L. 1976. An evolutionary approach to the Southeast Asian cultural sequence. *Current Anthropology*, 17: 221–42.

Hutterer, K. L. 1977. Reinterpreting the Southeast Asian Paleolithic. In *Sunda and Sahul* (eds J. Allen, J. Golson and R. Jones). New York: Academic Press, pp. 31–77.

Hutterer, K. L. 1983. *The Natural and Cultural History of Southeast Asian Agriculture: Ecological and Evolutionary Considerations*. Honolulu: East-West Environment and Policy Institute.

Hutterer, K. L. and Macdonald, W. (eds) 1982. *Houses Built on Scattered Poles: Prehistory and Ecology in Negros, Central Philippines*. Cebu City: San Carlos University.

Intakosai, V. and van Liere, W. J. 1979. A bi-facial stone industry from Bo Ploi, Thailand. *Modern Quaternary Research in Southeast Asia*, 5: 27–34.

Jochim, M. 1976. *Hunter-Gatherer Subsistence and Settlement: A Predictive Model*. New York: Academic Press.

Jochim, M. A. 1981. *Strategies for Survival: Cultural Behavior in an Ecological Context*. New York: Academic Press.

Kanchanaburi Cultural Center 1988. *Kanchanaburi: The Prehistoric Land*. Bangkok: Borpid Press. In Thai.

Kanchanakom, P. et al. 1983. *Preliminary Report: Ecological and Environmental Survey along Upper Khwae Noi River*. Bangkok: Department of Archaeology, Silpakorn University.

Kealhofer, L. 1996. The human environment during the Late Pleistocene and Holocene in North-eastern Thailand: phytolith evidence from Lake Kumphawapi. *Asian Perspectives*, 35: 80–96.

Kelly, R. L. 1983. Hunter-gatherer mobility strategies. *Journal of Anthropological Research*, 39: 277–306.

Kelly, R. L. 1985. Hunter-gatherer mobility and sedentism: a Great Basin Study. Unpublished PhD dissertation, University of Michigan, Ann Arbor.

Kelly, R. L. 1995. *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Washington, DC: Smithsonian Institution Press.

Kengkoom, S. 1992. Quaternary sea-level fluctuations in the coastal area of eastern Thailand: a synoptic view in relation to mineral resources exploration. *Journal of Southeast Asian Earth Sciences*, 7: 39–51.

Kent, S. (ed.) 1989. *Farmers as Hunters: The Implications of Sedentism*. Cambridge: Cambridge University Press.

Kerr, R. A. 1993. How ice age climate got the shake. *Science*, 260: 890–92.

Leong Seu Heng 1990. A tripod pottery complex in Peninsular Malaysia. In *Southeast Asian Archaeology 1986* (eds I. Glover and E. Glover). Oxford: BAR International Series 561, pp. 65–76.

Leong Seu Heng 1991. Jenderam Hilir and the mid-Holocene Prehistory of the west coast plain of peninsular Malaysia. *Bulletin of the Indo-Pacific Prehistory Association*, 10: 150–60.

Longman, K. A. and Jenik, J. 1987. *Tropical Forest and Its Environments*. New York: Scientific & Technical.

Majid, Z. 1982. The West Mount, Niah in prehistory of Southeast Asia. *Sarawak Museum Journal*, 31.

Majid, Z. 1990. The Tampanian problem resolved: archaeological evidence of a Late Pleistocene workshop. *Modern Quaternary Research in Southeast Asia*, 11(1988–89): 71–96.

Maloney, B. 1992. Late Holocene climatic change in Southeast Asia: the palynological evidence and its implications for archaeology. *World Archaeology*, 24: 25–34.

Mourer, R. 1977. Laang Spean and the prehistory of Cambodia. *Modern Quaternary Research in Southeast Asia*, 3: 29–56.

Natapintu, S. 1988. Current research on ancient copper-base metallurgy in Thailand. In *Prehistoric Studies: The Stone and Metal Ages in Thailand* (eds P. Charoenwongsa and B. Bronson). Bangkok: Thai Antiquity Working Group, pp. 107–24.

Nelson, M. 1991. The study of technological organization. In *Archaeological Method and Theory* (ed. M. B. Schiffer). Tuscon: University of Arizona, pp. 57–100.

Perlman, S. 1985. Group size and mobility costs. In *The Archaeology of Frontiers and Boundaries* (eds S. W. Perlman and S. M. Perlman). Orlando, FL: Academic Press.

Pianka, E. R. 1978. *Evolutionary Ecology*, 2nd edn. New York: Harper & Row.

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*. Tübingen: Insitut für Urgeschichete der Universität Tübingen.

Pookajorn, S. 1994. Human activities and environmental changes during the Late Pleistocene to Middle-Holocene in Southern Thailand and Southeast Asia. Paper presented at the 59th Annual Meeting of Society for American Archaeology, Anaheim, USA, 20–4 April.

Pookajorn, S. et al. 1977. *Preliminary Report on Survey and Excavations in Ban Kao, Kanchanaburi during 1977 Field Season*. Bangkok: Department of Archaeology, Silpakorn University. In Thai.

Pookajorn, S. et al. 1979. *Results of Scientific Analyses from Survey and Excavation of Stone Age Project in Ban Kao, Kanchanaburi*. Bangkok: Department of Archaeology, Silpakorn University.

Pookajorn, S. et al. 1984. *The Hoabinhian of Mainland Southeast Asia: New Data from the Recent Thai Excavation in the Ban Kao Area*. Bangkok: Thai Khadi Research Institute No. 16.

Pookajorn, S. et al. 1991. *Preliminary Report of Excavation at Moh Khiew Cave, Krabi Province: Sakai Cave, Trang Province and Ethnoarchaeology Research of Hunter-Gatherer Group, So-called 'Sakai' of 'Semang'*. Bangkok: Department of Archaeology, Silpakorn University.

Reynolds, T. G. E. 1993. Problems in the stone age of South-East Asia. *Proceedings of the Prehistoric Society*, 59: 1–15.

Sangvichien, S. 1974. *Prehistory of Thailand*. Bangkok: Navy Press. In Thai.

Sangvichien, S. et al. 1969. *Archaeological Excavations in Thailand*. Copenhagen: Munkgaard.

Senanrong, S. 1969. *Geography of Thailand*. Bangkok: Thai Wattana Panit. In Thai.

Senanrong, S. and Njamniasai, N. 1986. *Atlas of Thailand*. Bangkok: Aksorn Charoentat. In Thai.

Shoocongdej, R. 1991a. *Relationships between Prehistoric Hunter-Gatherers and their Environments in the Lower Khwae Noi Basin*. Bangkok: Department of Archaeology, Silpakorn University. In Thai.

Shoocongdej, R. 1991b. Recent research on the Post-Pleistocene in the Lower Khwae Noi Basin, Kanchanaburi, Western Thailand. *Bulletin of the Indo-Pacific Prehistory Association*, 10: 143–9.

Shoocongdej, R. 1996a. Problem in Thai prehistory: working toward an anthropological perspectives. *Bulletin of the Indo-Pacific Prehistory Association*, 14(1): 203–15.

Shoocongdej, R. 1996b. *Forager Mobility Organization in Seasonal Tropical Environments: A View from Lang Kamnan Cave, Western Thailand*. Ann Arbor, MA: UMI.

Shott, M. 1986. Technological organization and settlement mobility: an ethnographic examination. *Journal of Anthropological Research*, 42: 15–51.

Solheim, W. G. 1994. Comments on recent conferences: the Hoabinhian 60 years after Madeleine Colani. *Southeast Asian International Newsletter*, 4: 9–12.

Sørensen, P. and Hatting, T. 1967. *Archaeological Excavations in Thailand*. Copenhagen: Mungaard.

Srisuchat, A. 1987. Prehistoric caves and some important prehistoric sites in southern Thailand. In *Final Report of the Seminar in Prehistory of Southeast Asia*. Bangkok: SPAFA, pp. 103–17.

Stuiver, M. and Reimer, P. 1993. *CALIB User's Guide Rev 3.0.3A for Macintosh Computer*. Seattle: Quaternary Research Center AK-60, University of Washington.

Suchitta, P. 1980. *Past and Present Use of Khok Phanom Di Mound, Thailand: An Anthropological Assessment.* Bangkok: Thammasat University Press.

Suvarnasuddhi et al. 1976. *Preliminary Environmental Study of the Upper Khwae Noi Basin*. Bangkok: The Applied Scientific Research Corporation of Thailand Press.

Tamers, M. A. 1970. Validity of radiocarbon dates on terrestrial. *American Antiquity*, 35: 94–100.

Tauber, H. 1973. Copenhagen radiocarbon dates X. *Radiocarbon*, 15: 109–11.

Taylor, R. E. 1987. *Radiocarbon Dating: An Archaeological Perspective.* Orlando, FL: Academic Press.

Thompson, G. B. 1996. *The Excavation of Khok Phanom Di: A Prehistoric Site in Central Thailand*, Vol. IV. *Subsistence and Environment: the Botanical Evidence (The Biological Remains Part II)*. London: Society of Antiquaries of London Research Report LIII.

van Heekeren, H. R. 1962. A brief survey of the Sai-Yok Excavations, 1961–62 season of the Thai-Danish prehistoric expedition. *Journal of the Siam Society*, 5: 15–18.

van Heekeren, H. R. 1963. Thai-Danish expedition. *Journal of the Siam Society*, 51: 79–84.

van Heekeren, H. E. and Knuth, C. E. 1967. *Archaeological Excavations in Thailand I: Sai Yok*. Copenhagen: Munkgaard.

van Stein Callenfels, P. V. and Evans, I. H. N. 1928. Report on cave excavations in Perak. *Journal of the Federated Malay States Museums*, 12: 145–60.

Whitmore, T. C. 1984. *Tropical Rainforests of the Far East.* Oxford: Clarendon Press.

Whittaker, R. H. 1975. *Communities and Ecosystems.* New York: Macmillan.

Wiessner, P. 1982. Risk, reciprocity and social influences on !King San economics. In *Politics and History in Band Societies* (eds E. Leacock and R. B. Lee). Cambridge: Cambridge University Press, pp. 61–84.

Winterhalder, B. and Smith, E. A. (eds) 1981. *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses.* Chicago: University of Chicago Press.

Yellen, J. E. 1977. *Archaeological Approaches to the Present.* New York: Academic Press.

You-Di, C. 1969. *Prehistoric People in Thailand*. Bangkok: Fine Arts Department. In Thai.

You-Di, C. 1970. *Prehistory of Thailand*. Bangkok: Fine Arts Department. In Thai.

You-Di, C. 1986. *Collective Papers of Chin You-Di*. Bangkok: Pikanesa. In Thai.

Zhisheng, N. et al. 1993. Episode of strengthened summer monsoon climate of Younger Dryas age on the Loess plateau of Central China. *Quaternary Research*, 39: 45–54.