

STONE TECHNOLOGY AND THE CHRONOLOGY OF HUMAN OCCUPATION ON ROTE, SAWU AND TIMOR, NUSA TENGGARA TIMUR, INDONESIA

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Keywords: Nusa Tenggara, Timor, archaeology, Pleistocene, Holocene, lithic technology

ABSTRACT

Some characteristics of stone technology in the three outer arc islands of Nusa Tenggara during several phases of human occupation are examined. The data derive mainly from the results of my excavations on Rote and Sawu, that are compared with the results of earlier excavations in East Timor by Ian Glover. There is an indication that stone technology in the region changed entering the last glacial maximum, as indicated by the disappearance of large tools with Hoabinhian-like technologies. But the sample is very minimal for statistical testing. There are also lithic technological changes after the Mid-Holocene.

INTRODUCTION

Any correlations between environment and stone technology will vary by region. For instance, Cornelissen (2002:230) argues that stone technology in central Africa was not "tightly environmentally determined". Were there correlations between environmental phase and prehistoric stone technology in Nusa Tenggara Timur (NTT)? To examine this possibility, stone assemblages from different phases of human occupation from the three islands of Rote, Sawu and Timor (Fig. 1) are examined. The phases of human occupation are determined from excavated sites, and C14 dates for Rote and Sawu sites are presented in Table 1.

The data derive mainly from excavations at Lie Madira on Sawu, the only cave site excavated so far on Sawu Island, and the Pia Hudale and Lua Meko complexes of rock shelters on Rote (Fig. 1). All were excavated as part of my PhD research (Mahirta 2004). For Timor, the data derive from Glover's 1966 excavations in several caves in East Timor: Lie Siri, Uai Bobo 1 and Uai Bobo 2 (Glover 1986). I have examined personally both core and flake technological characteristics from Lie Siri, Uai Bobo 1 and 2, the material being stored in the Australian Museum in Sydney and sent on loan to ANU.

For flakes, the variables compared are length, breadth, and the length/breadth ratio. Types of secondary working examined include retouching and any hafting modification. Core variables examined by Glover were the same as

those chosen by me, in particular number of platforms and direction of reduction. Comparison with material recently excavated by O'Connor in several caves in East Timor, especially Lene Hara (O'Connor et al. 2002), could not be carried out due to the earlier timing of my research, but the new discoveries at Lene Hara have resulted in new insight into human occupation in Nusa Tenggara, commencing from at least 30,000 – 35,000 years ago.

Firstly, some evidence for prehistoric environmental change in the region is presented. This is followed by presenting the characteristics of stone technology on Sawu, Rote and Timor, structured according to the phases of identified environmental change. The purpose is to see whether technological changes can be considered to match environmental phases. Accordingly, the phases identified are the Late Pleistocene (c. 30,000 - to c. 19,000 years BP), Last Glacial Maximum (c. 19,000 to 15,000 BP), Terminal Pleistocene to Mid-Holocene (c.15,000 – 6000 BP) and Late Holocene (after 6000 BP).

THE REGIONAL PALAEOENVIRONMENTAL BACKGROUND DURING THE PLEISTOCENE AND HOLOCENE

Climatic change

The general trend of climatic change from the Late Pleistocene into the Holocene in Nusa Tenggara can be inferred from records taken from Timor Trench core (Kaars 1990) and from the Lombok Ridge core (Kaars 1990; Wang et al. 1999). The data from these marine cores can be interpreted largely as a reflection of the vegetation histories and associated changes of climate in Nusa Tenggara and northwestern Australia.

During the last glacial period, there was a combination of drier and cooler climates in the region, as indicated by extremely low values for mangrove pollen. The pollen record from the Timor Trench indicates that grassland vegetation advanced from 38,000 to 12,000 BP, and coastal tropical lowland forest and eucalyptus woodlands contracted. The greatest expansion of grassland took place between 19,000 and 17,000 BP when sea level was at its lowest. After that period, sea level rose again (Kaars 1990). During warmer interglacial periods, including the Holocene, as inferred from the Lombok Ridge and Timor Trench cores, higher pollen values occurred for lowland

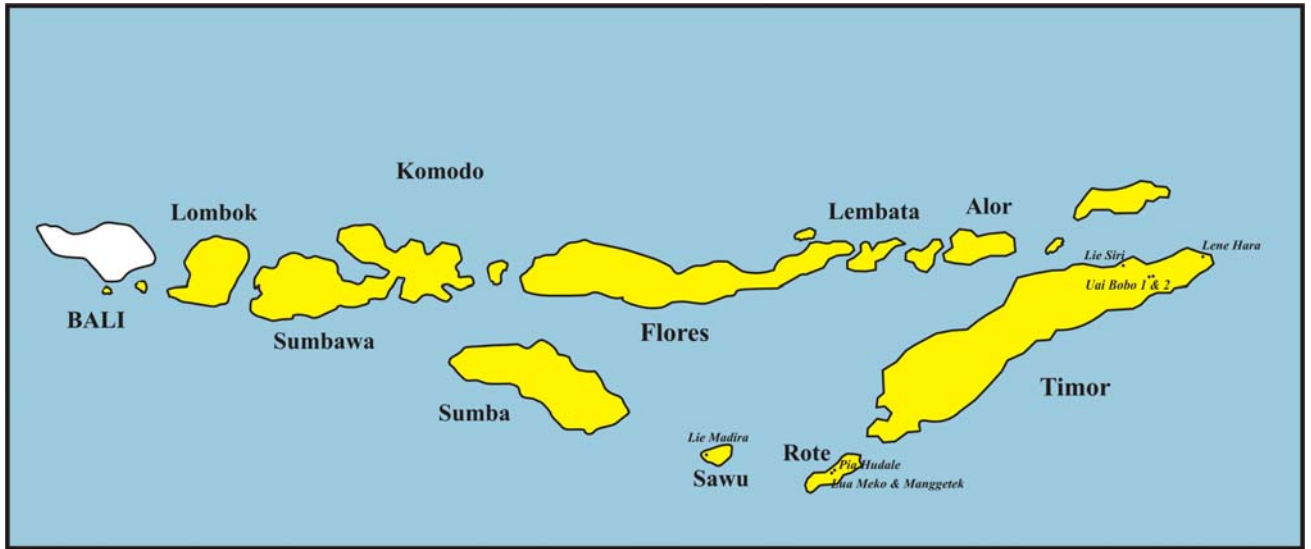


Figure 1. Sites on Sawu, Rote and Timor discussed in the text.

Table 1. Radiocarbon dates from Pia Hudale, Lua Meko and Lie Madira.

Lab. No	Spit	Depth	Layer	Square	Sample	Uncal. BP	Cal. BP
Pia Hudale, Rote							
ANU-11102	2	10 cm	1	D3	<i>Turbo opercula</i>	10,440±500	12,912 (12,410) 11,474
ANU-10912	4	20 cm	2	B2	<i>Turbo opercula</i>	11,290±150	13,427 (13,250) 13,087
ANU-11270	5	25 cm	2	C3	<i>Gafrarium sp.</i>	10580±80	11,085 (10,990) 10939
ANU-11000	11	55 cm	3	D3	<i>Melanoides feniculus</i>	11,160±220	13,355 (13,120) 12,900
Lua Meko, Rote							
ANU-10911	1	5 cm	1	EX	<i>Turbo opercula</i>	5590±110	6,602 (6,440) 6,311
ANU-10910	2	10 cm	2	TP	<i>Turbo opercula</i>	4720±100	5623 (5550) 5429
ANU-10909	3	15 cm	3	TP	<i>Turbo opercula</i>	5420±60	6,333 (6280) 6,209
ANU-11103	7	35 cm	4	TP	<i>Turbo opercula</i>	10,030±120	12,005 (11,680) 11,407
ANU-10908	12	60 cm	5	EX	<i>Strombus sp</i>	24,420±250	beyond Calib range
Lie Madira, Sawu							
ANU-11008	4	20 cm	3	TP	<i>Angaria sp.</i>	4750±90	5643 (5570) 5456
ANU-10916	11	55 cm	5	TP	<i>Trochus</i>	5800±90	6791 (6700) 6596
ANU-10917	15	75 cm	5	TP	<i>Terebra</i>	5960±70	6870 (6774) 6561
OZD-764	22	110 cm	7	TP	Charcoal (AMS)	680±40	666 (656) 564

rainforest taxa, pteridophytes and mangroves (Wang et al. 1999). At these times, sea levels rose, resulting in the coastal spread of mangroves to peak values.

Indication of climatic change in the Mid-Holocene is not clear from the Timor and Lombok pollen record. However, the Digul River in lowland New Guinea was inundated by sea at 6 ka, indicating that sea level increased about 3-4 m (Chappell 2005).

Pleistocene to Holocene faunas in Nusa Tenggara

Monk et al. (1997) argue that the major factors that have affected vegetation and faunal communities in the recent past have been sea-level changes, human migrations, and agriculture. Considering that agriculture was not a major activity in the Pleistocene to Early Holocene, climate and sea level produced greater impacts on the vegetational and faunal communities at these times.

The Nusa Tenggara islands have highly endemic, impoverished vertebrate faunas as a result of permanent isolation from both the Sunda and Sahul continental shelves; i.e: no land bridges have existed to permit terrestrial vertebrate faunas to cross to the islands. Some taxa more adept at crossing water than others. Proboscideans, murids and reptiles, including varanids and tortoises, are among the taxa that have been able to cross water gaps. By the time anatomically modern human arrived on many Wallacean islands, the large archaic fauna with species such as *Stegodon* were extinct (Morwood 2007). Aplin's identification of the bones from the Rote Pleistocene fauna shows a presence of murids, pteropodids and reptiles (Mahirta et. al. 2004) before the arrival of humanly introduced animals. Such a fauna also existed on East Timor (Veth et Al. 2004). The recent faunas of these islands are dominated by birds, reptiles an giant endemic murids (Morwood 2007).

Animal translocations have occurred throughout the middle and late Holocene. The introduction of the Sulawesi pig (*Sus celebensis*) to Flores and presumably Timor occurred around 7000 years ago, followed by long-tailed macaque, common palm civet and domesticated pigs c. 3500 years ago (Larson et al. 2005). Glover (1986) notes that macaque monkeys (*Macaca fascicularis*), rusa deer (*Cervus timorensis*), and the palm civet (*Paradoxurus hermaphroditus*) all came from the west, whereas the cuscus *Phalanger orientalis* was brought from the east to as far west as Timor. Recent analysis of Liang Bua deposits confirms that *Phalanger orientalis* was brought westwards as far as Flores (Morwood 2002). Thus, Nusa Tenggara Timur seems to have become a meeting place for faunal movements from both east and west.

Stone technology c. 30,000 to 19,000 years BP

The data for this period come mainly from Lua Meko on Rote and Lene Hara in East Timor. The deepest level reached in the 1997 excavation at Lua Meko was 70 cm below the present surface, and the deepest sample submitted for radio carbon dating (24,420±250 BP) came from 60 cm below the present surface. Based on a calculation of the rate of deposition, which would average 479 years per cm if constant in rate, the date of the 70 cm level (spit 14) would be about 30,000 BP. Recent tentative OSL dating of a sand sample collected 20-25 cm deeper than the location of previous sample (by Chawalit Kaokhiew at Chulalongkorn University lab), resulting in a date of 29,417±70.

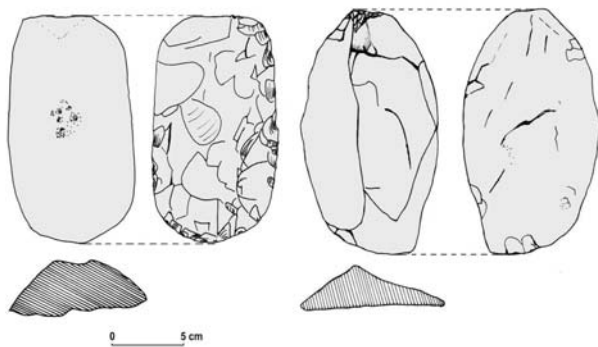


Figure 2. Two large stone artefacts from Late Pleistocene spit 14 (70 cm below the surface), Lua Meko.

On Rote, the Late Pleistocene assemblage contained two large flaked stone artefacts, both of silicified material. One is a macro-flake with minimal secondary working at its distal end, but the other, made by splitting a flat cobble, was further retouched unifaceally from its ventral side. The dorsal side is not worked or retouched. In the middle of the dorsal surface is an indentation, indicating that that the artefact also functioned as an anvil. It is interesting that the same type of technology was found in the Lene Hara Pleistocene layer, although applied to smaller sized material (O'Connor et al., in preparation).

The pitted surface on the dorsal side of the large flaked stone artefact might suggest that a bipolar reduction strategy was applied. But this pit could also be from crushing seeds or nuts. Definite bipolar cores were not found in Lua Meko, but some likely by-products of bipolar reduction were. No prepared prismatic cores were found from this period, but one of the large flakes has a blade-like proportion (3:2), and the dorsal scars indicate that blade-proportioned flakes were produced during this period of occupation. The two scars on the dorsal surface of a large flake (Fig. 2) indicate that the core reduction strategy applied during this period was parallel not centripetal (following Andrefsky's 1998: 141 core reduction classification). Two core fragments of igneous material were recovered also with signs of parallel reduction.

c. 19,000 – 15,000 BP

This was the driest period, when savanna vegetation dominated the landscape. The number of stone artefacts discarded in Lua Meko was reduced (see Fig. 3), and consisted mostly of debris. This may signify that the site was abandoned or visited only occasionally. Such an abandonment at this time is also recognized at Widgin-garri shelters 1 and 2 and Koolan shelter 2 in northwest Australia. (O'Connor 1996, 1999: 32). The variety of artefacts found consisted of unspecialised flakes and flake debitage, with no macro-flake tools as produced in the earlier period and no cores, blades or retouched tools. The situation at Lene Hara at this time is uncertain owing to disturbance.

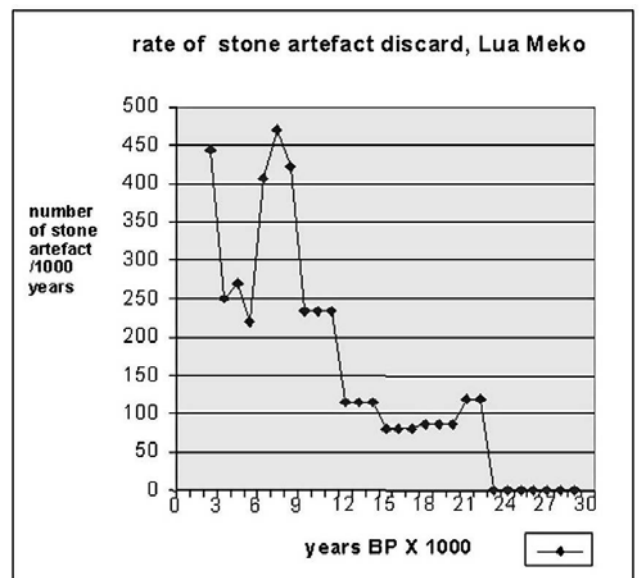


Figure 3. Changes in flaked stone artefact discard rates at Lua Meko.

c14, 000 BP – 5000 BP.

Most flaked lithic finds recovered from Rote and East Timor fall within this period. Both in the East Timor sites excavated by Glover and in the Rote sites, short flakes

and multiplatform cores were predominant, compared with blades and prepared prismatic cores. The percentage of flakes with blade proportions (length:breadth >2:1) was only 14.28 (33 out of 231 complete flakes measured) in this period at Lua Meko. However, not all of these blade-proportioned flakes have parallel margins. True blade/bladelets with parallel margins were only 24 of the total complete flakes measured.

Unfortunately, the assemblage sequence at Lua Manggetek (next to Lua Meko) was severely disturbed, as shown by the occurrence of pottery down to spit 9. This spit is not dated, but see Table 1 for data on site disturbance). From the overall assemblage in Lua Manggetek, it is also apparent that flakes with blade proportions were rare. Occupation at Pia Hudale (4 km from Lua Manggetek and Lua Meko) started $11,160 \pm 220$, around 2000 years later than at Lua Manggetek ($13,390 \pm 430$). The dates from Pia Hudale indicate that either the site was occupied briefly but intensively in the Terminal Pleistocene to early Holocene then was abandoned, or there is unrecognized disturbance. Thus, it is difficult to separate the occupation phases, even though no pottery or shell beads were found below 15 cm. At Pia Hudale the percentage of blade-proportioned flakes was even lower than the other sites; only 199 out of 1500 flakes measured (13.26%). The number of flakes with parallel margins and length/breadth ratios >2 was only 7 of the total sample measured.

It is obvious from another survey and excavation I carried recently (Mahirta and Indriati 2006) that the distances of raw material sources from sites, and the sizes and quality of the raw materials, were not the reasons for the low percentages of blade-proportioned flakes on Rote. Most raw materials came from close to the sites and good quality materials were available in the river bed approximately 1 km from the site.

Some bipolar cores were found during this phase, but the numbers are always low. Cores with multi-platforms are predominant, and the centripetal or radial reduction strategies that occur rarely in East not occur in Rote or Sawu assemblages at all. No bipolar cores were found in Lua Meko Terminal Pleistocene to Holocene layer (N=67), but one was found in Lua Manggetek (N= 63) and there are 5 very small rounded cores with maximum dimensions between 20 and 29 mm from Pia Hudale (N= 82). The latter were probably bipolar cores based on their small sizes, although definitive signs of bipolar crushing cannot be identified. It can therefore be inferred that a bipolar reduction strategy continued to be applied from 25,000 BP, but the application of the bipolar reduction technique was always rare.

It is interesting to note that non-chert core fragments, such as those found in the Late Pleistocene layer of Lua Meko, were also found in Lua Manggetek. Considering that the same raw materials were used and the same techniques applied, it seems that the technology continued from at least 25,000 BP to the Terminal Pleistocene. A pebble tool of flat non-chert material with partly bifacial retouch was also recovered from Lua Manggetek spit 6,

similar to bifacially flaked Hoabinhian pebble tools. Such flaked flat non-chert pebbles were not reported from the East Timor sites excavated by Glover (1986).

My impression, examining the stone artefacts of this occupation phase from East Timor excavated by Glover, is that generally flakes with signs of use-wear and retouch are longer and bigger than at Pia Hudale and Lua Meko. Nevertheless, the proportion of true blades with length/breadth ratios >2 is still low, indeed absent in the Terminal Pleistocene to Mid-Holocene layers in Uai Bobo 2 (Horizons I – VI) (Glover 1986:Table 105). Neither did they occur in Uai Bobo I. In Lie Siri, there were 8 true blades (19%) out of 44 utilised flakes in Horizons V – I (Holocene).

Lie Madira on Sawu was characterised by an abundance of blade-like flake proportions in the assemblage, with a median length/bread ratio for all complete flakes (N=348) being 1.83. The means of the length/breadth ratios are 1.58 and 1.59 mm respectively in the lower and upper levels, but in the middle level, dating from 5960 ± 70 and 4750 ± 90 BP, the mean is 2.02. Most true blades with elongation indices >2 and parallel margins occur in this level, but again they are not many, only 26 out of 348 complete flakes measured (0.07%). Some retouched artefacts from Lie Madira can be seen in Fig. 4.

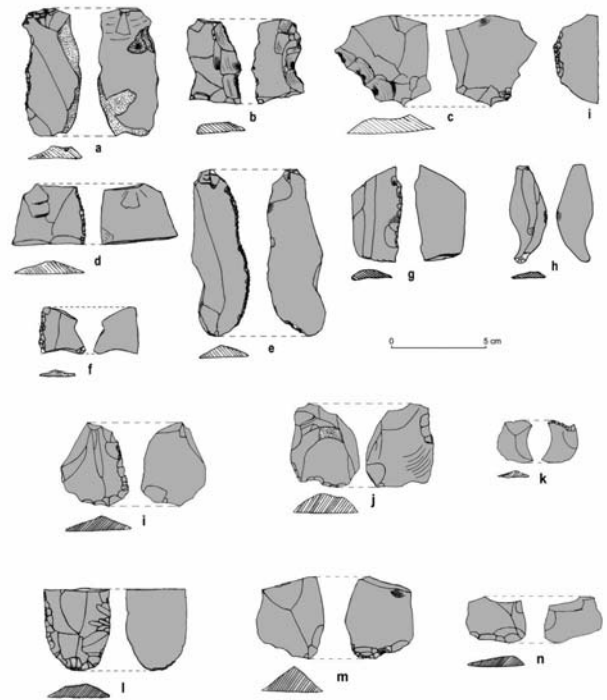


Figure 4. Retouched pieces from mid-Holocene spits, Lie Madira. Stippling on the edges of e – h indicates gloss. Provenances: a, spit 13; b, spit 16; c, spit 7; d, spit 13; e, spit 16; f, spit 8; g, spit 4; h, spit 9. i, spit 14; j-m, spit 8; n, spit 9.

Generally, secondarily worked flakes with retouching, backing or hafting form only a small percentage of the total stone assemblage, suggesting that either people rarely resharpened flakes for reuse or that formal shaped

tools were not produced. The first appearance of tools with secondary working in Uai Bobo 1 and 2 was at 7000-8000 BP, and in Lie Siri retouched tools first appeared in Horizon Ia and continued up to Horizon VII (c.9000 to 2000 years ago). In Uai Bobo 1 they formed only 0.45%, or 36 out of 7856 flaked artefacts, and in Uai Bobo 2 they formed only 0.70% (42 out of 5969 total flaked artefacts). In Lie Siri they formed 0.75%, or 120 out of 15,898 flaked artefacts. This figure is calculated by data from Tables 68, 97 and 98 in the East Timor excavation report (Glover1986).

In the Rote sites (Lua Meko, and Pia Hudale), secondary modification with retouching occurred again after c.8000 years BP, although rarely, following its earlier disappearance around 19,000 to 15,000 BP. In Lua Meko, retouched artefact from this period are only 14 out of 4222 flaked artefacts (0.03%), in Pia Hudale only 59 out of 18,938 flaked artefact (also 0.03%; Figs 5 and 6), while in Lie Madira only 1 retouched piece came from this phase (out of 1295 flaked stone artefacts).

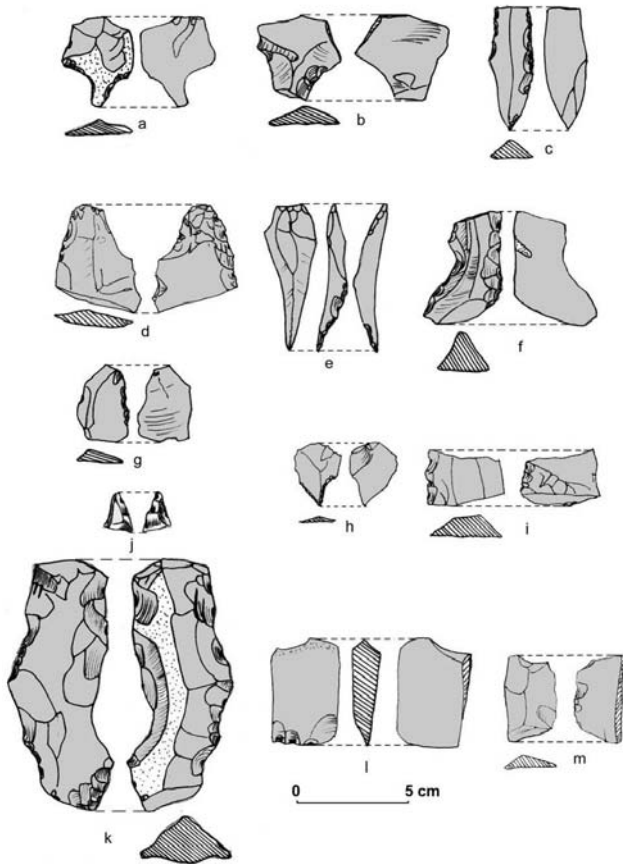


Figure 5. Retouched flakes from Terminal Pleistocene to mid-Holocene spits, Lua Meko, Rote. Provenances: a, spit 2; b, spit 1; c, spit 10; d, surface; e, spit 10; f, spit 9; g, spit 1; h, spit 10; i, spit 7; j, spit 1; k surface; l, spit 10; m, spit 7.

After the Mid-Holocene

After the Mid-Holocene there was an increase in blade production. In Lie Siri, the number of blade-proportioned flakes in the horizon dating c. 3000 to 1000 BP is 6 (17 %

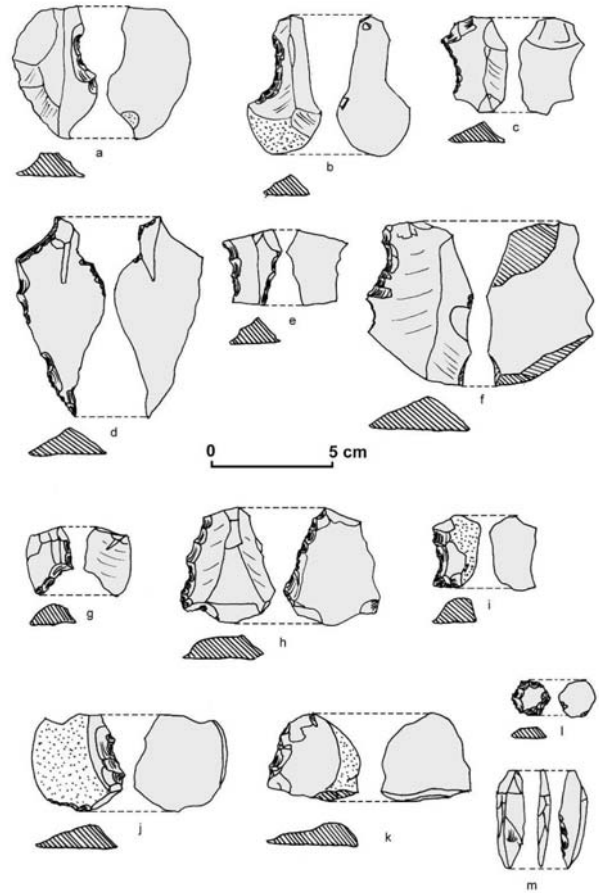


Figure 6. Retouched flakes from Terminal Pleistocene spits, Pia Hudale. Provenances: a, spit 3; b, spit 1; c, spit 2; d, surface; e, spit 1; f, spit 6; g, spit 6; h, spit 1; i, spit 6; j, spit 3; k, spit 4; l, spit 2; m, spit 1.

of the total of 36 utilised flakes recovered from this level), an increase on the previous horizons dating from c. 8000 – 3500 BP. In Uai Bobo 1 there are 72 blade-proportioned flakes from this period, compared with only 21 from earlier horizons. Before 6000 BP, blade-proportioned flakes were absent from the Uai Bobo 2 assemblage, but after this time they reached 26% (44 out of 132 utilised flakes from horizons VII to X). This indicates that a preference to produce blades increased during the Mid-Holocene, but short flakes tools still remained more common than blade-proportioned flakes. A small percentage of blades has also been identified in Lene Hara, where O'Connor et al. (in preparation) infer a flake-based assemblage with little secondary modification.

Secondary working also increased during this phase. In Lie Siri, retouched artifacts formed 2.16% (339 out of 15,898 flaked artefacts), in Uai Bobo 1 3.02% (238 out of 7856 flaked artefacts), and in Uai Bobo 2 3.3% (197 out of 5969 flaked artefacts). In Lua Meko, the percentage of artefacts with secondary remained as in the previous period, that is 14 out of 4222 flaked artefacts, or 0.03%.

In Lie Madira, on Sawu Island, the percentage increased to 1.85% (24 out of 1295 flaked artefacts).

Among those artefacts with secondary working, a distinctive stone technology developed during this period. In Uai Bobo 1 a more advanced technology of tanged points appeared (Fig. 7). In Uai Bobo 1, these occur above horizon IIIC (2190±80 BP), together with pottery. In Niki-Niki cave, West Timor, tanged points also occur in the pottery layer, but no dating is available for this site. Hafting modification also occurs in the Pia Hudale and in Lua Meko pottery-bearing layers, as well as in Lie Madira on Sawu (Fig. 8) although the results are not as distinctive as in Timor.

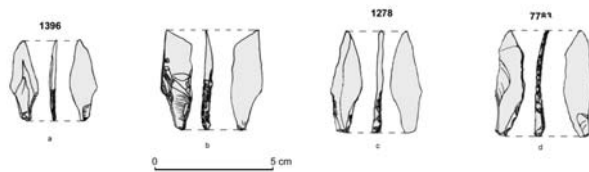


Figure 7. Tanged points from Uai Bobo 1.

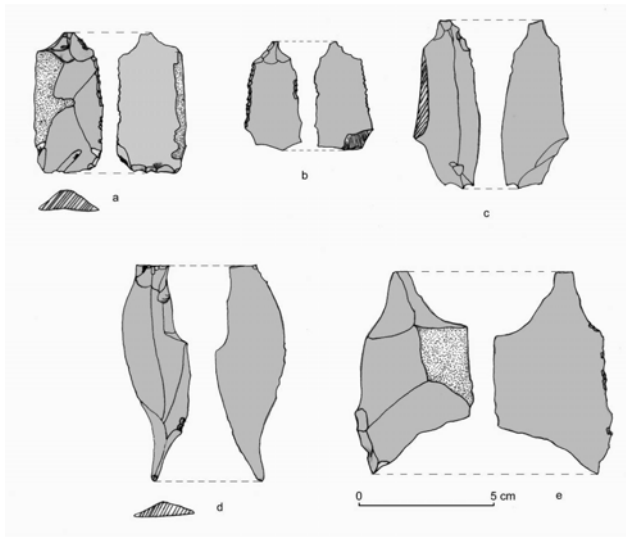


Figure 8. Stone artefacts with hafting modification from Lie Madira, Sawu.

Apart from the tanged points mentioned above, artefacts prepared by vertical retouching (backing technique) also occur in East Timor. Such backed artefacts occurred in Horizons IIIC and IVa in Uai Bobo 1 and in Horizon IX in Uai Bobo 2 (Glover 1986: 139 and 174). The backing technique applied at Uai Bobo is close to the backing technique applied to Bondi points from Australia (Flenniken and White 1985: Fig. 22; Fig. 24).

Geometric microliths (produced by retouching vertically the edges of the middle sections of blades or flakes) are not found in East Timor, Rote or Sawu. Both microliths and backed blades were found in South Sulawesi sites, as in Australia. Anggraeni (1989: appendix figures) has examined microliths from Toalian sites in South

Sulawesi and has found a bipolar technique was applied in the backing process. Thus, the basic principle of the backing technology was vertical bipolar retouch. Retouching and the use of bipolar technique already occurred in the earlier period of human occupation in the region, but the combination of both techniques only occurred after the Mid-Holocene.

Examining Toalian artefacts from the Mulvaney excavation at the Australian National University, I found that Toalian sites have the most varieties of backed artefacts, including geometric microliths, either shaped from symmetrical or asymmetrical flake preforms. In the Toalian industry, the earlier backed artefacts occur before pottery appeared, while in Uai Bobo and Lie Siri they occur in the form of tanged points with pottery and pig bones. This animal is not native to Nusa Tenggara (Glover, 1986; Veth et al. 2004). Commonly, these traits were associated with Austronesian-speaking people who hunted animals using bows and arrows as suggested by linguistic reconstruction. However, to relate directly any technological innovation with the arrival of these people in the Mid-Holocene is not easy. In the Aru Islands, bone points were recovered from early to Mid-Holocene layers, and from the Niah caves, bone points with breakage patterns consistent with use as projectile points, with residue on their hafted ends, were recovered from the Terminal Pleistocene deposit (Piper et al. 2008). Thus, people in some islands of southeast Asia were already familiar with projectile points before Austronesian-speaking people arrived, although the materials and techniques for producing projectile points were not the same. The Aru and Niah projectile points were made of bone and were ground.

Analysing the non-hafted stone artefact assemblages from several sites on Sawu and Rote, one gets an impression that generally retouch was applied to resharpen flake or blade edges, and not to shape fresh flakes detached from nodules. A strong indication of this is that there are many low angle working edges on blades with signs of use wear without retouch, whereas retouch is commonly found on the steeper or high angled working edges of flakes and blades. Only after c. 3000 BP was retouch applied to create formal tool types. As in the Rote and Sawu sites, retouching became more common during this period in East Timor, sometimes both from ventral and dorsal sides. One bifacial tool was found on the surface at Gassi Issi (East Timor), and signs of bifacial trimming do occur in the Rote sites (Figs 6d and k), although very rarely.

Having examining the characteristics of stone artefact technology from different phase of human occupation in Nusa Tenggara Timur, we get an overview that different techniques appeared after the Mid-Holocene. There was no evident climatic change at this time from the Timor and Lombok pollen records. However, New Guinea lowland inundation at 6 ka indicates that sea level increased by about 3-4 m (Chappell 2005), indicating that at this time the climate was very warm.

Qualitatively, there are no clear differences in debris morphology from the earlier period of occupation (19,000 – 15,000 BP) to the following one (15,000 – 5000 BP) at Lua Meko. Comparing mean measurements using the Mann-Whitney U Test and t-tests between flakes from the middle occupation (after the glacial maximum to the Mid-Holocene) and the upper occupation period (after the Mid-Holocene) indicate that there were no significant differences in flake size that could reflect the application of different technologies.

CONCLUSIONS

Three types of technological tradition have generally been recognised in Island Southeast Asia: a) Hoabinhian-like technology plus unspecialized flake technology, b) unspecialized flake technology with few retouched artefacts, and c) specialized flake technology. The Hoabinhian-like technology that belonged to the Late Pleistocene human occupation phase continued into the Terminal Pleistocene and probably early Holocene. The unspecialised flake technology which also appeared in the Late Pleistocene at c. 25,000 BP continued until after the Mid-Holocene, throughout all periods of occupancy. This tradition continued to develop until, after the Mid-Holocene, new technological ideas in the forms of tanged points and backed blades appeared. Therefore, it can be inferred that there were changes in stone technology from c. 30,000 BP into the Mid-Holocene, but these changes did not take place in correlation with episodes of environmental change.

There is a tendency towards contemporaneity of developments in flaked stone artefact technology in Timor, Rote and Sawu, in which secondary modification by retouching of flakes and blades became more common in the Mid-Holocene. During this time, Timor witnessed a more advanced stone technology in the form of tanged points. Prehistoric Rote and Sawu also received tanged points, but in simpler forms.

ACKNOWLEDGEMENTS

This paper has been improved from critical comments from Prof Mike Morwood and referees arranged by the convenor of session 2B at the 18th IPPA conference. I thank them. Some part of this paper are from my PhD thesis at ANU. Grants for carbon dating for Rote and Sawu were sponsored by the School of Archaeology and Anthropology and the Centre for Archaeology Research (CAR) at ANU. Leanne Brass made it possible for me to access the East Timor collection from In a Glover's research at the Australian Museum in Sydney. Thanks are also due to Doreen Bowdery and Peter Hiscock. I would like express my gratitude to IPPA for making it possible for me to present this paper in Manila.

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