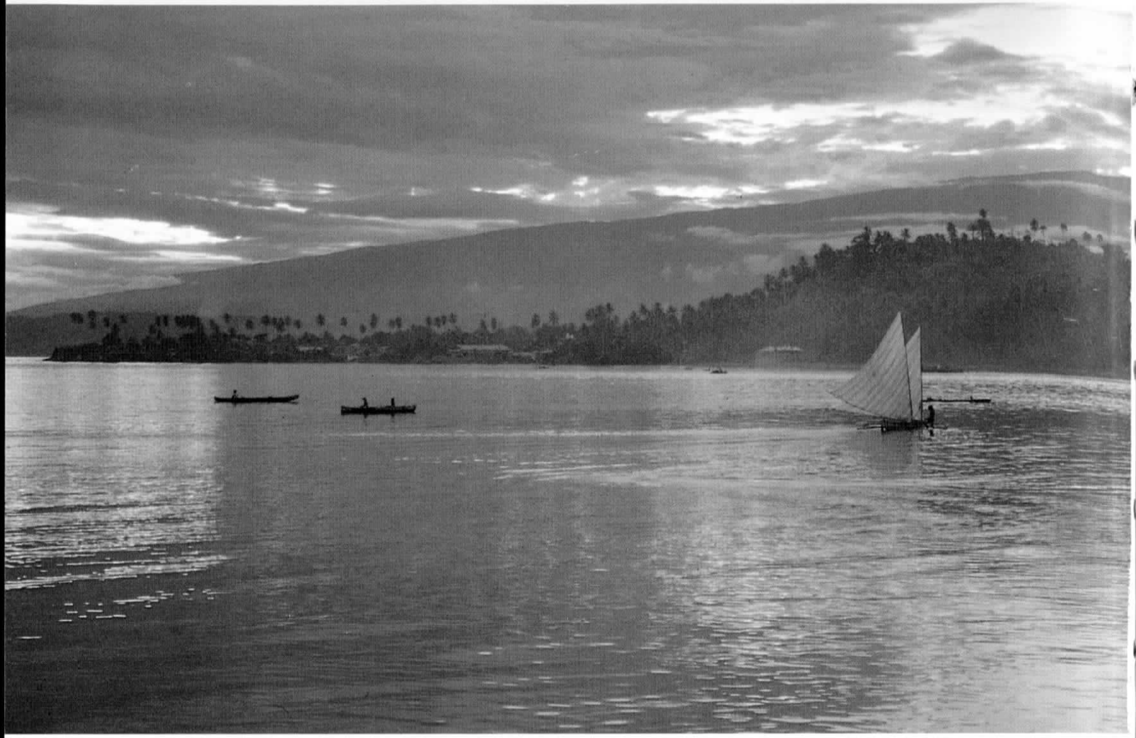

... The light is grey and the dawn wind cool. Low clouds, glistening like snow, drift in front of the mountains. We sail close to the shore on a calm sea, passing palm groves and gardens where maize is laid out to dry. Houses are hidden behind a lattice of clustered coconut trees, and everywhere we smell the smoke of early morning fires...

BIRD'S HEAD APPROACHES

Irian Jaya Studies – A Programme for Interdisciplinary Research

Edited by

GERT-JAN BARTSTRA

A.A. BALKEMA / ROTTERDAM / BROOKFIELD / 1998

29. I.C. Glover 1976. Ulu Leang cave, Maros: a preliminary sequence of post-Pleistocene cultural development in South Sulawesi. *Archipel* 11: 113-154; and I.C. Glover 1981. Leang Burung 2: an Upper Palaeolithic rock shelter in South Sulawesi, Indonesia. *Modern Quat. Research in Southeast Asia* 6: 1-38. Van Heekeren had found a few hand stencils in this latter cave in 1950.
30. In Van Heekeren's *The Stone Age of Indonesia (= Verhandelingen van het Kon.Inst. voor Taal-, Land- en Volkenkunde*, 21) from 1957, but also in the second edition (= *Verhandelingen*, 61) from 1972, the Toalean is classified in a so-called Mesolithic or Sub-Neolithic stage. Notions on an (Epi-)Palaeolithic rock art or tool assemblage have then vanished.
31. For example, P. Veth et al.; J. Lilley; J.M. Pasveer; and P. Bellwood et al, all in this volume. See also M.A. Smith & N.D. Sharp 1993. Pleistocene sites in Australia, New Guinea and Island Melanesia: geographic and temporal structure of the archaeological record. In M.A. Smith, M. Spriggs & b. Frankhauser (eds), *Sahul in review*, etc.: 37-59. Canberra: Australian national University. A critical evaluation of some early dates may also be found in R. Shutler 1991. Colonization, expansion, and successful adaptation in Southeast Asia, New Guinea and Australia 40,000-10,000 BP. *Asian Profile* 19(2): 151-157; and in S. Bowdler 1992. The earliest Australian stone tools and implications for Southeast Asia. *IPPA Bulletin* (Indo-Pacific Prehistory Association), 12: 10-22.
32. As in P. Bellwood 1985. *Prehistory of the Indo-Malaysian archipelago*. Sydney: Academic Press; and to a certain extent also in the next paper in this volume, by Pasqua & Bulbeck.
33. See Note 28.
34. See Note 29.
35. For example G.-J. Bartstra 1978. Note on new data concerning the fossil vertebrates and stone tools in the Walanae valley in South Sulawesi (Celebes). *Modern Quat. Research in southeast Asia* 4: 71-72. It is stated that 'at high spots alongside the river are to be found in distinct concentrations very small flakes and cores, neither rounded nor patinated, and associated with arrow-heads (denticulated and with hollow base)'.
36. Reported upon in, for example B. Kallupa 1992. The 4-days Ralla trip. A survey report for the Biologisch-Archaeologisch Instituut (BAI), Groningen, Holland. Unpubl. report from the Suaka Peninggalan Sejarah dan Purbakala, Sulselra (Archaeological Service, Ujung Pandang); and A.M. Ramli 1993. Laporan pendahuluan survai situs prasejarah Panincong dan Padang Lampe di desa Lompo Ri Aja, Dec. Tanete Riaja, Kab. Barru, Sulsel. Unpubl. report from the Suaka Peninggalan Sejarah, etc.; and: M. Fadhlan S.I and H. Sukendar, 1994. Keadaan geologi dan peninggalan arkeologi situs Ralla, Kab. Baru, Sulawesi selatan. Unpubl. report from the Suaka Peninggalan Sejarah, etc. From this same area come fossil remains of marine vertebrates (see Note 5).

MONIQUE PASQUA & DAVID BULBECK
Centre for Archaeology, University of Western Australia, Australia

A technological interpretation of the Toalean, South Sulawesi

1 INTRODUCTION

This article is a slightly revised summary of Pasqua's (1995) Honours research on Toalean lithics carried out at the University of Western Australia under Bulbeck's supervision. In broad terms, the research re-interprets the Toalean from a technological perspective rather than the traditional typological approach. In particular, comparative statistical analysis of the debitage categories in the studied assemblages correlates with the available typological and chronological information to suggest systematic variation within the Toalean. The possible explanations for this apparent variation are discussed at the end of the paper.

The Toalean is apparently confined to the southwest peninsula of Sulawesi (see Fig. 1) where it spanned the Middle to Late Holocene. Early investigations by the Sarasin cousins (1905), Van Stein Callenfels (1938) and Van Heekeren (e.g. 1939) recognized a Toalean 'culture' through a number of sparsely documented excavations in rockshelters. Van Heekeren (1972: 113-115) proposed a three-stage chronology with a Lower Toalean, made up of large crude flakes and frequently tanged tools, a Middle Toalean characterized by projectile points with rounded bases and abundant geometric microliths, and an Upper Toalean when hollow-based points, bone points and pottery appeared (for details see preceding paper in this volume: Bartstra on Maros).

Radiometric dates first became available from the excavations directed by Mulvaney and Soejono (1970) and Ian Glover (1976, 1978). Glover's sequence at Ulu Leang 1 showed the broad chronological transition that would be expected from Van Heekeren's scheme, and dated the first microliths to between 7000 and 6000 BP, whilst the hollow-based (or Maros) points appeared by 5500 BP and were most popular at 4000-3500 BP (Presland 1980: 36-39). However, in Mulvaney and Soe-

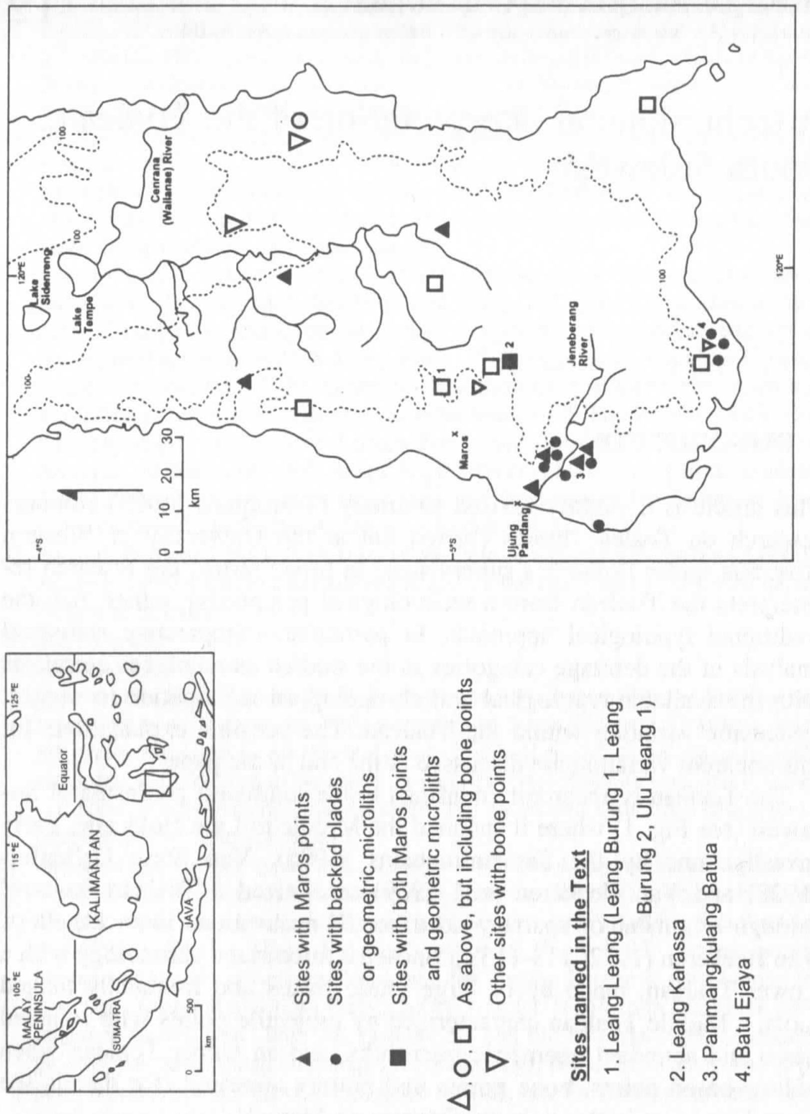

Figure 1. Distribution of sites with Toalean tool types (after Bulbeck & Pasqua, in prep.).

jono's sequence at Leang Burung 1, Maros points tend to be older than the microliths, suggesting to Chapman (1986: 81) that no single typological sequence applied universally (but see below).

As well as attempting to produce a radiometrically dated culture history of the Toalean, these studies also initiated a technological approach. Presland (1980) looked at flake dimensions and choice of stone material to compare Leang Burung 2, which has an Upper Pleistocene sequence (Glover 1981), and Ulu Leang 1. From the lack of significant differences, he inferred that the technology of flaking remained unchanged despite the Middle Holocene appearance of microliths. Chapman (1981) considered such technological variables as the prevalence of bipolar flaking, the dimensions of cores and complete flakes, and the size grades of broken debitage. However, both Presland and Chapman were descriptive rather than analytical in their technological comparisons and remained essentially committed to a typological analysis. In contrast, the present study focuses on the debitage from three assemblages, in order to reconstruct the reduction sequences represented and to identify the manufacturing technology employed at each site.

2 MATERIALS

The studied lithics come from two excavated rockshelters and one open-air site (see Fig. 1). The two rockshelters, Leang Karassa and Leang Burung 1, were excavated in 1969 by the 'Australian-Indonesian Archaeological Expedition to South Sulawesi' (Mulvaney & Soejono 1970). The third assemblage, from Pammangkulang Batua, was collected in 1987 by Bulbeck during his 'South Sulawesi Prehistoric and Historical Archaeology Project' (Bulbeck 1992). A summary of the unpublished details discussed in Pasqua (1995) is necessary as background to these assemblages.

2.1 *Leang Karassa*

Leang Karassa is located within a karst valley adjacent to the Taddaiang River approximately 20 km from Maros town. The site was originally excavated by Van Heekeren in 1936. He found a high frequency of bladelets, scrapers, knives, and points with serrated edges, but few bone tools and no Maros points. The dominance of his Lower to Middle Toalean markers suggested it was one of the oldest Toalean sites, although still of Holocene age as indicated by the modern faunal associations (Van Heekeren 1972: 111; cf. Glover 1978: 69).

In 1969 Campbell Macknight excavated 2 m^2 to a maximum depth of approximately 80 cm, to the point where bedrock or cemented deposits were encountered (see Fig. 2). As at Leang Burung 1, the deposits were sieved through a 6 mm mesh, which implies that the smallest debitage pieces would not have been retained. Chapman (1981, Appendix), after cursorily examining the lithics, concluded that they broadly matched those described by Van Heekeren. Strangely, however, sherdage occurred throughout Macknight's excavation, whereas Van Heekeren had reported that pottery was restricted to the uppermost layers. Chapman accordingly inferred that either the squares excavated by Macknight had suffered substantial disturbance, moving sherds throughout the profile, or the age Van Heekeren attributed to Leang Karassa is too old. Our new data indicate that there has been disturbance, but only in the form of one redeposited layer, and that the rest of the deposits excavated by Macknight are Late Holocene.

The four stratigraphic layers are, top to bottom, a brown sediment, a black greasy layer, a brown clayey sediment which constitutes most of the deposits in square A at the south, and a shelly deposit at the base (see Fig. 2). A charcoal sample from 10 cm below the surface in square A returned a date of 370 ± 50 BP (Wk-3824), which calibrates to

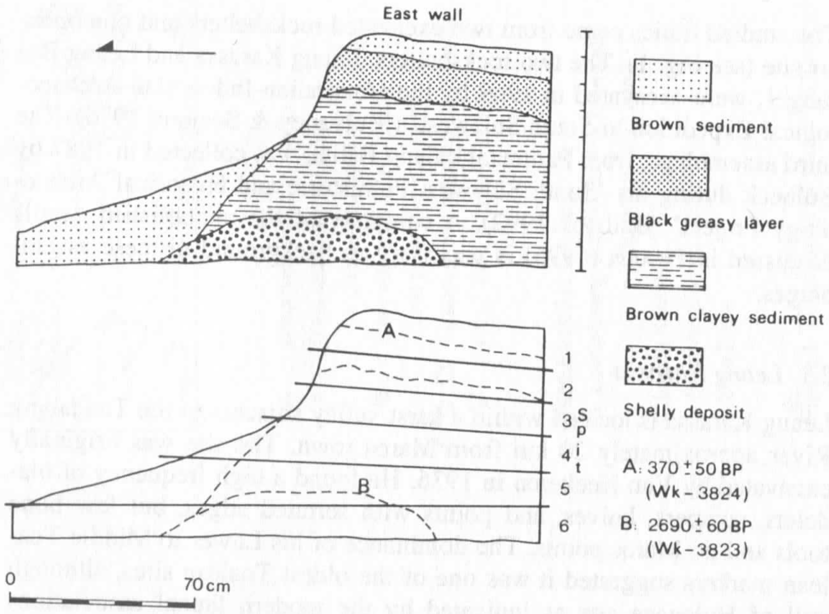

Figure 2. Stratigraphy and approximate provenance of the dates from Macknight's 1969 excavation of Leang Karassa (after Pasqua 1995: Figs 5.2 and 5.3).

1438-1651 AD at two sigma (cf. Stuiver & Reimer 1993). Thus the deposition of the extant black greasy layer ceased at some point between the 15th and the 17th century. The second charcoal sample, collected from 65 cm below the surface in square A, is dated to 2690 ± 60 BP (Wk-3823), i.e. a calibrated age of 2740-2880 BP at two sigma. It dates the approximate age at which the clayey sediment began building up. Square A thus appears to have an intact stratigraphy with two late Holocene dates in correct order. However, along the face which slopes steeply into square B, most of these deposits have subsided or otherwise been removed (see Fig. 2).

In square A Macknight excavated six spits, each 15 cm deep, which slant across the layers, so any attempt to relate the recovered artifacts to stratigraphy will be inexact (see Fig. 2). For instance the basal spit has the lowest ratio of sherds to lithics (1:3) which could be either because the shelly layer is aceramic or because sherds are comparatively rare at the base of the clayey sediment too. Similarly, the geometric microlith Pasqua identified among the lithics in spit 6 could, without further information, have come from either an aceramic (preceramic) or an early ceramic context. In spits 5 to 2, sherds consistently outnumber lithics, reaching a ratio of 3:1 in spit 4. Immediately above, among the spit 3 lithics, Pasqua identified a second geometric microlith. From the available sections it must have been excavated in either the upper levels of the clayey sediment or the greasy layer, and so dates somewhere between 2700 and 500 BP, and has an unquestionable association with pottery. One would guess that it was deposited closer to 2700 than to 500 yrs ago.

The top spit in square A shows a peculiar reversal: the sherdage count again falls behind the lithics (a ratio of 1:2), and indeed this spit has the highest lithics count within the excavated deposits. Even more strangely, the lithics include a Maros point with the classical serrated edge and a hollowed base or, more precisely, the basal two thirds of it (Pasqua 1995: Fig. 5.4). The re-emphasis on lithics, and the inclusion of a type whose popularity peaked over 3500 yrs ago, are totally out of keeping with the recent date for this spit. Accordingly, we infer that the uppermost brown layer consists of sediments and artefacts redeposited from elsewhere in the rockshelter. This redeposition event, which can be no more than 500 yrs old, can probably be identified with known instances of recent disturbance, either during the construction of the paved highway which runs along the front of the rockshelter, or at around 1957 when organic-rich sediments were removed from the site to be used as fertiliser. Having lost their original depositional context, all the materials in spit 1 are essentially undated.

It might seem unlikely that Van Heekeren would have excavated Maros points or microliths at Leang Karassa and then failed to have observed them. However, Van der Hoop's (1941) catalogue notes one denticulated and winged arrowhead from Leang Karassa (Acc. No. 3411) and even a geometric knife (Acc. No. 3424), so apparently Van Heekeren had indeed excavated a Maros point and possibly a geometric microlith too. On the other hand, where his brief notes (1972: 110-111) mention shell-rich layers with sherdage only at the top, these layers would appear to correspond to the shelly deposit at the base of Macknight's excavations. In support of the idea that most of the deposits consist (or anyway consisted) of an aceramic shell midden, Bulbeck (1995) observed only lithics, and no sherds, attached to the cemented deposits along the rear wall of the site. Accordingly, any general difference between Van Heekeren's and Macknight's assemblages would be understandable in terms of the greater age of the former assemblage.

This issue however does not affect the quite straightforward interpretation of Macknight's square A. Spits 2 to 6 contain an in situ lithics assemblage which is mostly or entirely ceramic in its associations and dates between approximately 3000 and 500 BP. Spit 1 in square A, and both spits in square B, are dominated by disturbed, redeposited materials which could be of any age. Accordingly, the technological analysis focuses on the in situ layers as an assemblage representing the ceramic or 'Neolithic' Toalean.

2.2 *Leang Burung 1, Trench B*

Leang Burung 1 is a large rockshelter, with a steeply sloping floor, within the Leang-Leang limestone karst where they abut the Maros coastal plain. The excavated areas comprise Trench A within the shelter, Trench B outside the entrance, and Trench C which connects them. The stratigraphic integrity of the site has always been under a cloud as the excavating team noted numerous sand-filled depressions piercing the surface, and as preliminary study recovered several cases of matching but widely separated sherds of decorated pottery (Chapman 1981). More recently Bulbeck (1992) has extracted human bone from Trench A. These not only exhibit numerous cases of fragmentation and widespread dispersion of originally whole items, as previously found with the pottery, but also suggest that prehistoric burials may have been one cause of the disturbance.

The outlook for Trench B, however, is more promising. A mere eight earthenware sherds were excavated, indicating that the deposits are preceramic in their virtual entirety. Sorting through the faunal remains, Bulbeck found 15 fragments of semi-fossilized human bone which cover the

whole skeleton without overlapping on any portion of it. Hence they appear to represent a primary burial whose extent of post-depositional disturbance is charted by the five separate provenances of the fragments (labelled B in Fig. 3). The radiocarbon date obtained on this bone, 4610 ± 220 BP (ANU-6175), calibrates to 5855-4650 BP at two sigma. It falls between the original charcoal dates of 4880 ± 480 BP, i.e. 6670-4360 BP (ANU-1264), and 3420 ± 400 BP (ANU-390), i.e. 4830-2750 BP (see Fig. 3). The promise of a relatively tight chronology prompted Pasqua to select the Trench B lithics for study.

Closer inspection of the stratigraphy, however, reveals the problem that the younger charcoal date (A in Fig. 3) appears to be provenanced beneath most or all of the dated bone fragments. If this charcoal date is to be accepted, then the simplest scenario would interpret it as dating the event which disturbed the burial. In this scenario, at a time when the area of Trench B was covered with brown sand, human or natural disturbance deposited the 4830-2750 year old charcoal at A, and brought some of the burial to the surface. These upwardly displaced bone fragments became incorporated within the grey unit which was subsequently deposited. In

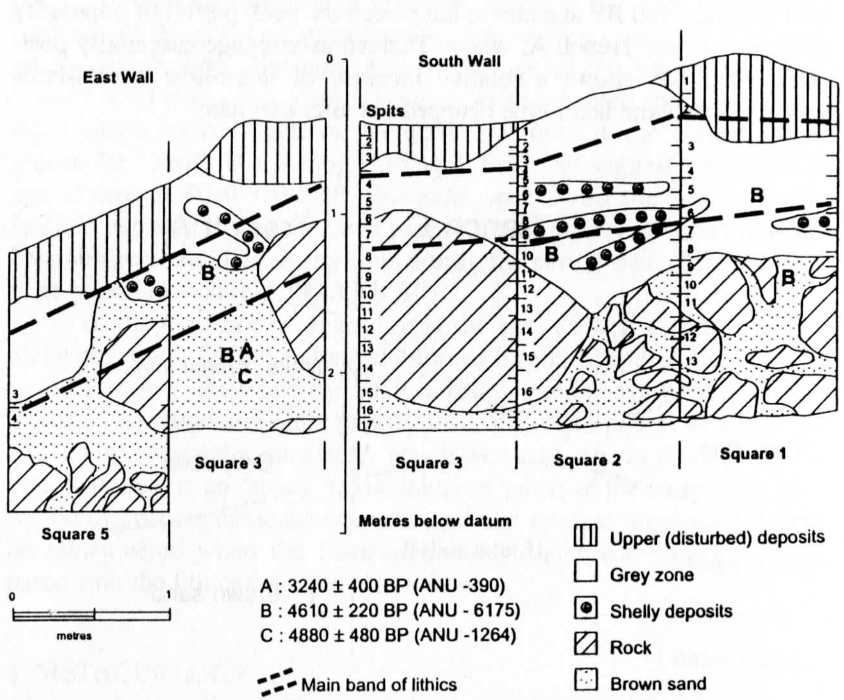

Figure 3. Stratigraphy and approximate provenance of the dates from the excavation of Leang Burung 1 Trench B (after Pasqua 1995: Figs 4.3 and 4.4).

support of this scenario, we can refer to Trench A which has both the grey zone and the underlying brown sand found in Trench B (see Fig. 4). The only charcoal date from Trench A, apparently located at the base of the grey zone directly above the brown sand (Chapman 1981: 20A), clocks in at 2820 ± 210 BP (ANU-391), i.e. 3460-2360 BP when calibrated at two sigma. If we let this determination also apply to the base of the grey zone in Trench B, the changeover from brown to grey sands would be dated to around 3500 BP.

Chapman (1981) noted that the main concentration of lithics in Trench B at Leang Burung 1 occurred in the shelly deposits which, as shown in Figure 3, were intercalated with the basal levels of the grey sands. From the available information, it is impossible to be sure that the main band of lithics also dipped into the top of the brown sand. However, the dated samples in Trench B all underlie this main band, suggesting a maximum age of 4000 BP for its accumulation. The lack of ceramics suggests a minimum age of 3000 BP (cf. Leang Karassa) or, more likely, 3500 BP (Bulbeck 1992: 13, 1995: 5-6). Finally, note that the lithics from this trench include 24 Maros points but only ten microliths (Chapman 1986). Hence at Leang Burung 1, as at Ulu Leang 1 (Presland 1980), 4000-3500 BP appears to have been the peak period of popularity of Maros points. Trench A, whose Toalean assemblage essentially postdates 3000 BP, shows a relative increase of microliths over Maros points, because the latter type dropped out after that date.

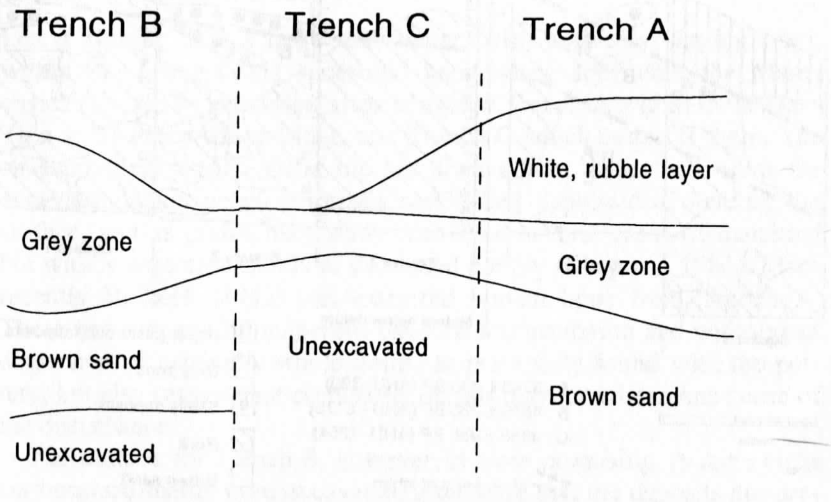

Figure 4. Schematization of the relation between the grey zone and the brown sand in trenches A and B at Leang Burung 1 (after Pasqua 1995: Fig. 4.2).

In summary, the assemblage which Pasqua studied from Leang Burung 1 consists of an essentially preceramic Toalean industry which includes more Maros points than microliths. The composition of the assemblage and the available radiocarbon dates suggest a main dating of approximately 4000-3500 BP, although this estimate could possibly be too young.

2.3 *Pammangkulang Batua*

Pammangkulang Batua is located on the west bank of the Jeneberang River where it enters the coastal plain before running towards the modern capital city of Ujung Pandang (see Fig. 1). Not only is it an open site, it also lies well away from the Maros sites, approximately 50 km south of Leang Karassa. Bulbeck's team surveyed a 300 m long footpath and its associated fields, where they recorded 422 lithics, 57 earthenware sherds, and 39 fragments of Chinese and European ceramics dating between the 18th and 20th centuries. The site also retains quarrying scars from the 17th century when conglomerate blocks were hewn at Pammangkulang Batua for use in the Somba Opu fortress near Ujung Pandang. The earthenware sherds probably relate to the 17th century and later use of the site, but unfortunately they were not collected for laboratory examination. The only hint of the age of the lithics is the frequency of Maros points, seven complete or fragmented specimens, without a single backed blade or geometric microlith in the collection. As argued for Trench B at Leang Burung 1, this may suggest a most likely age of around 4000-3500 BP. However, specialized site use is another feasible explanation for the large proportion of points, in which case the assemblage could date to any time during the period when Maros points were manufactured (c. 5500-3000 BP).

Given the evidence of quarrying at the site, as well as traffic of humans and water buffalos along the footpath, and tillage of the adjacent fields, it is very likely that the Toalean lithics would have been subject to treadage, scuffage and other post-depositional disturbance. Much of the site is also seasonally inundated, which would appear to account for the soft, hydrated, even 'soapy' consistency of much of the stone. The likelihood of post-depositional edge damage and artefact breakage needs to be remembered when the Pammangkulang Batua assemblage is compared with the lithics from the Maros sites.

3 METHODOLOGY

Having discussed the main lithic types at the three sites, to order them in a culture-historical perspective, we can move to the technological analysis. This was undertaken with a slightly elaborated version of Sullivan and Rozen's (1985, 1989) hierarchical key where debitage categories are identified on the basis of the presence or absence of specific attributes. The first attribute, positive percussion features, separates cores (which lack this feature) from other artifacts. The latter are classified into debitage and retouched pieces. Debitage is then classified into debris (no single interior surface discernible), flake fragments (which have a single interior surface, but lack a point of applied force), broken flakes (having both a single interior surface and a point of applied force, but with their margins incomplete), and complete flakes. Broken flakes were further divided into longitudially and transversely broken flakes, depending on which margin is lacking (O'Connor 1990). Among the flakes, blades were recognized by their length, parallel lateral margins, and longitudial arrises on the dorsal surface. Bending flakes, attributed to pressure rather than percussion flaking, were identified by the absence of a bulb of percussion and their typically diffuse platform (Cotterell & Kamminga 1990: 142). Finally, bipolar flaking was recognized on cores from the presence of crushing or grinding of the raw material at opposing ends, and on flakes from crushing of the striking platform and/or crushing at the distal end.

To interpret the proportions of debitage categories and realize which further observations are required, we require a theoretical model of the reduction sequence that was followed in knapping a stone nodule through the stages of core preparation and manufacture of useful flakes. The most appropriate model would seem to be the reduction sequence proposed by Flenniken and White (1985) for Australian flaked-stone assemblages, with which the Toalean is often compared (e.g. Van Heekeren 1972: 124; Glover & Presland 1985: 194; Chapman 1986). This model identifies seven stages:

– Stage 1. The conscious selection of raw materials which will be most suited to tool manufacture, and the procurement of such resources;

– Stage 2. Preliminary treatment of a stone nodule to produce a workable core;

– Stage 3. The further refinement and treatment of these cores and the manufacture of blades and linear flakes;

– Stage 4. Continuation of blade manufacture and the manufacture of medium-sized flakes (points may be made at this stage by retouching the flake blanks);

– Stage 5. The manufacture of smaller artifacts, either in the form of implements (especially microliths) or micro-debitage;

– Stage 6. Exhaustion of the core with the production of debris;

– Stage 7. Discard of debitage into the archaeological record.

A concentration on Stage 2 in the reduction sequence should be correlated with large flakes and cores, the frequent presence of cortex on cores and debitage, and a low proportion of prepared as opposed to opportunistic striking platforms. As the reduction sequence proceeds through Stages 3 and 4, cores and flakes should reduce in size, flakes should elongate and blades should appear, a higher proportion of artifacts lacking cortex should be apparent, and preparation of striking platforms should be more evident. Retouched points, including miscellaneous points which lack a hollowed base, may also be among the artifacts associated with Stage 4 reduction. Stages 5 and 6 should be associated with even smaller flakes and debitage pieces, the absence of cortex and a higher occurrence of bipolar working.

The following definitions were employed to gauge these tendencies. Cores were subdivided into those with a single platform, multi-platform cores, and broken cores. Single-plane cores, also called broken pebbles, were not observed in any assemblage. Core length is the maximum length of the stone nodule parallel to the direction of the longest flake scar; core breadth is the maximum measurement perpendicular to core length across the same face; and core thickness is the maximum measurement perpendicular to this face. Flake length is the distance from the point of percussion to the termination; flake breadth is the maximum distance perpendicular to flake length across the ventral surface; and flake thickness is the distance, from ventral to dorsal surface, at the intersection of flake length and breadth. Preparation of the striking platform was associated with the flat and faceted types, the latter containing at least two flake scars, while platforms with a crushed or a cortex-covered surface were considered unprepared. Further evidence of platform preparation was recognized from overhang removal in the form of tiny flake scars on the dorsal surface touching the striking platform. The terminations of the complete flakes were divided into feathers, hinges, steps and snap (cf. Cotterell & Kamminga 1987). The representation of cortex on an artifact was estimated visually as >50%, 25-50%, under 25%, and none.

Further observations were taken to monitor factors which may have affected the reduction sequences. Stone material was classified as cryptocrystalline, medium-grained siliceous, coarse-grained siliceous, volcanic, and limestone (found only at Leang Burung 1). Cortex was classified as geological (thick and unsmoothed), secondary (thin and unsmoothed), and riverine (smoothed through water rolling). On specimens where more than one cortex type was observed the cortex was classified by the major type present. Evidence of heat treatment of the stone, to improve its knapping qualities, was noted in terms of potlid fractures, negative potlid scars, crazing of the surface, and colour alterations.

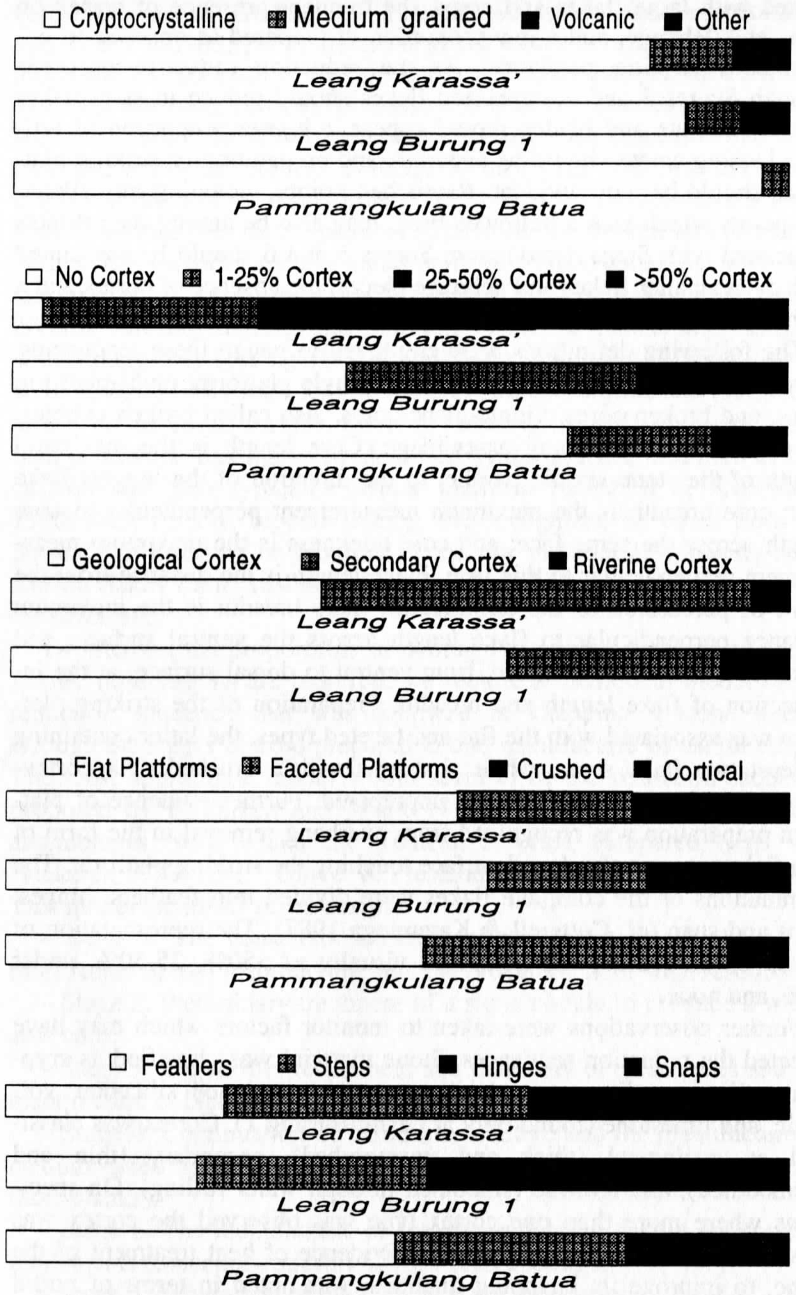

Figure 5. Raw material, cortex characters and major technological attributes of the three compared Toalean assemblages.

4 RESULTS

Basic statistical data on core and flake dimensions expressed to a single decimal place are given in Table 1, along with a summary of the statistically significant differences identified by two-tailed t-tests (calculated from the data as expressed to two decimal places). Comparative analysis of the three assemblages found that quality of raw material, percentage of cortex coverage, striking platform types and flake termination types are the main non-metrical features that distinguish between the three compared Toalean assemblages. The proportions of these features, as well as cortex class (for Leang Karassa and Leang Burung 1 Trench B), are depicted in Figure 5, to which the reader is referred as she/he reads the following presentation of the study's results.

4.1 *Leang Karassa*

81% of the 667 studied Leang Karassa lithics were of cryptocrystalline stone, with small proportions of medium-grained (11%) and volcanic stone (7%). Cortex was ubiquitous, covering more than 50% of 33% of the artifacts, 25-50% in 36% of cases, under 25% in 27% of cases, and absent from only the remaining 4%. This prevalence equally character-

Table 1. Means, standard deviations and t-test results from the three Toalean sites.

	Number	Length	Breadth	Thickness
Single-platform cores				
Leang Karassa	16	32.7 ± 11.6[1]	29.9 ± 10.0[2,3]	11.0 ± 3.5[4]
Leang Burung	151	30.7 ± 9.3[2]	20.5 ± 7.7[1]	9.1 ± 4.6
Pammangkulang Batua	15	23.3 ± 7.3	15.7 ± 6.8	10.9 ± 3.5
Multi-platform cores				
Leang Karassa	40	31.8 ± 13.2[5,6]	29.5 ± 9.2[1,2]	15.0 ± 6.9[1]
Leang Burung 1	175	26.4 ± 8.1	20.9 ± 6.1[2]	10.7 ± 4.9
Pammangkulang Batua	17	24.5 ± 7.2	16.8 ± 3.7	12.3 ± 4.6
Complete flakes				
Leang Karassa	111	26.5 ± 11.3[1,2]	22.0 ± 8.4[1,2]	5.5 ± 3.2[4]
Leang Burung 1	789	22.0 ± 9.5[2]	19.0 ± 7.4[2]	4.9 ± 2.7[7]
Pammangkulang Batua	85	18.5 ± 6.1	15.9 ± 5.1	5.7 ± 3.0

[1]Larger than Pammangkulang Batua at $p(H_O) < 0.02$. [2]Larger than Pammangkulang Batua at $p(H_O) < 0.001$. [3]Larger than Leang Burung 1 at $p(H_O) < 0.001$. [4]Larger than Leang Burung 1 at $p(H_O) < 0.05$. [5]Larger than Leang Burung 1 at $p(H_O) < 0.02$. [6]Larger than Pammangkulang Batua at $p(H_O) < 0.01$. [7]Smaller than Pammangkulang Batua at $p(H_O) < 0.02$.

izes the cores and core fragments, debitage categories, the two geometric microliths, and the ten miscellaneous points, indicating that veins of cortex typically permeated right through the nodules worked at Leang Karassa. Its interdigitation with cortex-free zones allowed the knappers to select suitable surfaces to strike, with the result that 58% of platforms are flat, 22% are faceted, 12% are crushed, and only 8% are cortical.

When present, cortex was almost always secondary (56%) or geological (40%). Only complete cores show a higher frequency of geological (82 cases) over secondary cortex (56 cases), suggesting that nodules with geological cortex were more readily available but that the knappers preferred to focus on portions of the nodules with secondary cortex. All nodules of siliceous stone had presumably been found among the lumps of chalcedony embedded in the limestone along the Taddaiang River bed where Leang Karassa looks over it (Van Heekeren 1972: 111). The difference between geological and secondary cortex presumably reflects localized variation in the extent of exposure to the elements.

Apparently, the knappers at Leang Karassa accepted using the local stone despite the drawback that they could rarely produce cores free of flaws. Step fractures are common among the flakes, characterizing 38% of terminations, which can be attributed to the density of significant flaws (cf. Cotterell & Kamminga 1987: 700). Feather terminations (28.5%) and hinges (30%) are also common. 43% of platforms show evidence of overhang removal; this high proportion may reflect the care with which the knappers had to select and then prepare the limited areas suitable for striking. Pressure flaking or percussion with a soft hammer was very occasionally undertaken, as suggested by the two bending flakes (compared with 216 typical flakes). Evidence of bipolar traits on 5% of the complete flakes, yet on none of the cores, suggests that bipolar flaking was occasionally carried out, but at fairly early stages in the reduction sequence before the cores neared the end of their use life. A casual attempt to improve the flaking quality of the stone is suggested by evidence of heat treatment on 7% of the cores and core fragments, although strangely this evidence was proportionately far more common on medium-grained and volcanic cores than on cores of cryptocrystalline stone.

Several observations indicate that the assemblage reflects a focus on Stages 3 and 4 of Flenniken and White's reduction sequence, i.e. a lower intensity of core reduction than at the other two sites. T-tests show that the single-platform cores, multi-platform cores, and complete flakes are significantly longer, broader and thicker than their counterparts at Leang Burung and Pammangkulang Batua in 14 of the 18 available comparisons (see Table 1). Only 30% of the Leang Karassa cores are broken, compared to over 50% at the two other sites. The ratio of blades to flakes

(including broken flakes), 1:55, is higher than in the other assemblages. Points also reach their highest proportion of the total lithics count at Leang Karassa (2.6%), even if none of them are Maros points. Van Heekeren (1972: 111) also drew attention to the high frequency of primary bladelets and points in the Leang Karassa assemblage which he excavated. The two geometric microliths may suggest occasional core reduction to Flenniken and White's Stage 5.

In summary, both the deeply flawed nature of the cryptocrystalline stone used at Leang Karassa and its ready availability seem to have encouraged the site occupants to focus on the intermediate stages of Flenniken and White's reduction sequence.

4.2 *Leang Burung 1, Trench B*

A high proportion of the lithics at Leang Burung are cryptocrystalline, 86%, well in excess of the 7% which are medium-grained, and the approximately 3% contributions each of volcanic stone and limestone. Cortex coverage occurs fairly commonly in low amounts, with 18% of artifacts having 25-50% coverage, 33% under 25% coverage, and 43% exhibiting no cortex at all. Geological cortex (66%) dominates over secondary cortex (25%) and riverine cortex (8.5%). Thus the major source of flaking stone would appear to have been nodules of cryptocrystalline rock located among the Leang-Leang karsts, even if river pebbles of medium-grained and volcanic stone were often brought to the site to function as hammers, anvils and hearth stones (cf. Chapman 1986: 77).

The low proportion of lithics with over 50% cortex coverage, 6%, suggests that the preliminary treatment of the stone nodules, involving the removal of the exterior cortex with decortification flakes, occurred away from the site. Heat treatment of the stone also apparently occurred elsewhere, as negative potlid scars were occasionally observed on the cores, but no potlid fractures were found among the debitage. However, only 3% of cores and core fragments exhibited any signs of heat treatment, so it would not seem to have been a common practice. The treated cores were percussed at Leang Burung, with very occasional pressure flaking or percussion with a soft hammer (three bending flakes compared to 1189 other flakes). The high quality of the stone may have obviated the need for much platform preparation, as only 19% of the flakes show overhang removal. The proportions of platform types are very similar to those at Leang Karassa (61% flat, 20% faceted, 10% crushed and 10% cortical).

Core reduction seems to have been carried further at Leang Burung than at Leang Karassa, with a focus on Stages 4 and 5. The cores and flakes are significantly smaller on every measurement, except the lengths of single-platform cores which are equal across the sites. Far more of the cores are broken. Small size of the cores may also be associated with the need to knap along flattish surfaces which, according to Cotterell and Kamminga (1987: 701), would explain the high proportion of Leang Burung flake terminations which are hinges (44%). (The other common terminations are steps, 29%, and feathers, 25%.) The blade to flake ratio is very low at 1:149, while the proportion of points to all stone artifacts is also slightly lower at Leang Burung (1.9%). However, bipolar working seems to have been as rare at Leang Burung (2% of cores, 0.5% of flakes) as at Leang Karassa, so the cores were not reduced to the point of total exhaustion. Indeed there is little evidence that the cores with bipolar working are smaller than the other cores, suggesting that bipolar flaking was used as an occasional optional strategy at various steps along the reduction sequence.

The technological differences between the two rockshelters boil down to less cortex, smaller cores and flakes, more broken cores, and a greater emphasis on Stage 5 at Leang Burung. These differences probably reflect an overall better quality of stone (including a higher proportion of cryptocrystalline stone), more curation of the stone, and the absence of preliminary core preparation at the site.

4.3 *Pammangkulang Batua*

The surface collection from Pammangkulang Batua merits an interpretation similar to that provided for Leang Burung, and any attempt at a more precise interpretation may be premature for two reasons. First, as a surface assemblage it has been exposed to different site-formation processes, and as a surface collection its composition depends on the skill of the survey team to pick out the lithics from the background earth and grass. Second, most of the assemblage was studied and drawn by Bulbeck in Ujung Pandang in 1987, so Pasqua had only a small 'control sample', 90 of the total assemblage of 422 lithics, to observe directly in terms of her modified Sullivan and Rozen scheme. The main value of our observations on Pammangkulang Batua may thus lie in demonstrating that our understanding of the Toalean, as developed on assemblages in rockshelters, can also be applied to open sites.

There is little doubt that cryptocrystalline stone dominates the assemblage, accounting for an estimated 96% of pieces, while the remainder consists of medium-grained stone. The cryptocrystalline stone includes a bewildering variety of red, brown, pink, grey, white, and banded varieties. Fully 11.9% of the cores and core fragments show evidence of heat treatment, but because only negative potlid scars (and no potlid flakes) were identified, any heat treatment occurred elsewhere rather than at Pammangkulang Batua itself.

Cortex was rarer than at either rockshelter assemblage, being detected on only 76, or 29%, of complete, broken or fragmented flakes. As at Leang Burung 1, the most frequent category of cortex coverage is under 25% (17%), followed by 25-50% (8%), while decortification pieces with over 50% cortex are rare (4%). The cortex classes which Pasqua observed were either geological (79% of cases) or secondary (21% of cases), and Bulbeck positively identified only a few cases of riverine cortex in the sample he observed in South Sulawesi (almost all other cases being unspecified). As regards platform morphology 54% are flat, 39% are faceted, 6.5% are crushed, and 1% is cortical. This negligible number of cortical platforms supports the inference that preliminary core preparation did not take place at Pammangkulang Batua. In short, Pammangkulang Batua appears to have been either a home base or a special-purpose site to which the occupants carried their prepared cores (and other curated stone) collected predominantly from a wide sweep of outcrops in the adjacent hills and monadnocks.

There are two aspects of technological observations where Pasqua's data from the control sample produced a different perspective from Bulbeck's observations made in South Sulawesi. Pasqua recorded more step than feather terminations on complete flakes whereas Bulbeck recorded more feathers than steps (with hinges and especially snap terminations rare in both samples). The combined observations (50% feather terminations, 29% steps, 19% hinges, and 2% snaps) make sense in terms of the other attributes of Pammangkulang Batua discussed below, but need confirmation from re-observation of the collection retained in South Sulawesi. A more serious discrepancy relates to the frequency of bipolar working, as Pasqua found no evidence of this on her control sample, whereas Bulbeck's notes mention bipolar traits on 40% of cores and core fragments, and classify 9% of flakes as bipolar. Probably, Bulbeck confused post-depositional damage (see below) with bipolar working, which was actually as rare at Pammangkulang Batua as at the rockshelter sites.

Several lines of evidence indicate that treadage, scuffage and other disturbances have substantially influenced the Pammangkulang Batua assemblage. First, it has a low proportion of complete flakes as a total of flakes and flake fragments, 33% compared to 40-50% at the rockshelter sites, and a high ratio (in this case equalled at Leang Burung) of core fragments to complete cores. Second, while core and flake lengths and breadths are smaller than at either rockshelter site, significantly smaller than at Leang Burung on five of the six comparisons (see Table 1), core and flake thicknesses always exceed those at Leang Burung. Longer, broader cores and flakes are more likely to be broken through postdepositonal disturbance, and hence may be under-represented among the complete examples at Pammangkulang Batua, whilst thicker items may be over-represented as they are more likely to have remained intact. Third, 38% of the observed striking platforms exhibit signs of overhang removal, i.e. a higher proportion than at Leang Burung. This may reflect a technological strategy involving more fidgety work, related to the smaller size of the Pammangkulang Batua cores and flakes, just as the high incidence of feather terminations may reflect the knapping of thickish flakes from very high-quality stone. However, post-depositional damage could also account for these observations, as it could have produced flake scars behind the striking platform which mimic platform preparation, and had the effect of selectively culling flakes weakened by their preparation on flawed stone (associated more frequently with step and hinge terminations) from the sample of complete flakes.

If we allow for the likely post-depositional effects at Pammangkulang Batua, the available observations suggest a focus on Stages 4 and 5 of the reduction sequence. This conclusion is supported by the absence of geometric microliths, the low ratio of blades to flakes (1:133), and the moderate ratio of points compared to all lithics (2.4%). Finally, the absence of bending flakes at Pammangkulang Batua agrees with the interpretation, suggested by the rockshelter assemblages, that the Toalean involving controlled knapping with a hard hammer to produce flakes, often as blanks for points, with only the most sporadic production of blades.

5 DISCUSSION

Discussion of the technological analysis boils down to a comparison between the rockshelter assembages at Leang Karassa and Leang Burung 1, as both occur in the similar context of the limestone karsts of South Sulawesi, in deposits which were built up through similar site-formation processes. The Pammangkulang Batua assemblage, by contrast, was apparently exposed to very different post-depositional processes, in a context lacking any evidence of ecofacts, and where usewear analysis would be hard to distinguish from the mimicking effects of trampling (cf. Shea & Klenck 1993). Further, as the available profile of technological characteristics suggests a basic similarity with the Leang Burung 1 assemblage, and as the assemblages could well be of the same age, any discussion of Pammangkulang Batua can be subsumed under a discussion of Leang Burung 1.

The Leang Burung assemblage differs from the Leang Karassa lithics by exhibiting less cores, smaller cores and flakes, more broken cores, more hinge terminations, and an emphasis on Stages 4 and 5 of Flenniken and White's reduction sequence (compared to Stages 3 and 4 at Leang Karassa). These differences can be accounted for in terms of raw-material quality and curation methods. The local stone utilized by the knappers at Leang Karassa appears to have contained frequent flaws and deeply inlaid cortex which decreased core productivity and increased the difficulty in manufacturing suitable flakes. The knappers at Leang Burung 1, however, apparently imported raw materials which contained less flaws and were therefore easier to work.

These technological differences do not seem to explain the typological contrasts which distinguish the aceramic assemblages from the ceramic assemblage at Leang Karassa. For instance points constitute 2-3% of total lithics in all cases, but round- and straight-based varieties appear to have persisted into the Late Toalean after the hollow-based Maros points dropped out. Geometric microliths also apparently persisted, even though the weak expression of Stage 5 at Leang Karassa would have provided a sound explanation for their absence. Additional evidence of a decline in the knapping of standardized tools in South Sulawesi's late prehistory comes from Batu Ejaya 1, which is currently dated to around 1000 BP. The excavated assemblage retains the 'magic' 2% frequency of points as a proportion of all lithics, but geometric microliths are reportedly absent (Chapman 1986: 82). Possibly, then, the Leang Karassa late Toalean occupants were prepared to tolerate the poorer quality of stone available near the site as part of a temporal decline in the production of formal tools. Excavation and technological analysis of a preceramic assemblage from Leang Karassa could test whether this aspect of the assemblage excavated by Macknight reflects a temporal Toalean trend or rather the site's immediate access to flakeable stone of inferior quality.

Any wider attempt to systematize our understanding of the Toalean would need to investigate the economic activities undertaken at the sites. Faunal assemblages were recovered during the 1969 excavations at Leang Burung 1 and Leang Karassa, as well as at Batu Ejaya, but these had not been documented or analyzed by the time this paper was written. Chapman (1981, 1986) identified and described the flakes with phytolith gloss from Leang Burung 1 and Batu Ejaya, but not from Leang Karassa. In addition to this data shortfall, there is some disagreement over the interpretation of glossed flakes, as Sinha and Glover (1983/1984) argued that gloss morphology can be used as a guide to the sort of plants that were processed, whereas Chapman (1986: 81) objected that gloss characteristics may only reflect the sort of activity that was performed. Microscopic identification of the phytoliths themselves should reveal what sort of plant had been processed, but this avenue of investigation has not been started on any Toalean assemblage. Equally important in future investigations, and yet untried, would be the study of residues (besides phytolith gloss) on Toalean tools.

6 CONCLUSION

On the basis of the definitions of the terms 'tradition' and 'industry' given by Bahn (1992), the Toalean is best regarded as a tradition. The required 'long-term continuity in either individual technologies or attributes' (Bahn 1992: 513) is at least partly satisfied by Pasqua's successful application of Flenniken and White's core-reduction sequence to explain the technological differences between the c. 4000 and c. 2500 year old assemblages at Leang Burung 1 and Leang Karassa. The knappers appear to have followed the same core-reduction strategy despite the typological differences comparing Leang Burung 1 (and Pammangkulang Batua) with Leang Karassa.

These typological differences are precisely why the Toalean cannot be considered an industry, as it does not measure up to 'a frequently repeated assemblage of restricted content' (Bahn 1992: 227). Indeed, as Figure 1 suggests, Maros points do not appear to have been found northeast of the upper Walanae drainage, whilst bone points are absent from some Late Holocene assemblages such as those excavated in 1969 at Leang Karassa and Batu Ejaya. The question therefore arises whether older South Sulawesi assemblages, such as the Upper Pleistocene lithics from Leang Burung 2, and younger assemblages such as the Batu Ejaya lithics, should be included in the Toalean. These assemblages would certainly be excluded if Flenniken and White's reduction sequence were found to be inapplicable; however, their model is quite general and may well apply to numerous traditions. Unless 'Toalean' is simply to become a synonym for 'South Sulawesi flaked artifacts', it is probably wisest to restrict usage of the term to assemblages including a 'Mesolithic' component, especially points with serrated edges, backed blades, geometric microliths and bone points. At the same time, location within South Sulawesi (or a nearby Indonesian region) should be considered a necessary attribute of a Toalean assemblage, so as to distinguish the Toalean from similar traditions in Australia, South Asia and elsewhere.

In sum, the Toalean can best be considered a tradition based on a chronologically variable expression of a limited range of formal 'Mesolithic' tools, of which points are a consistent constituent, mediated through application of a general flaking technology similar to that proposed for Australia. This conclusion is, however, only the starting point for an attempt to explain variability within the Toalean through economic and technological factors, as well as the typological indicators.

We still do not have answers to such basic questions as whether the introduction of ceramics and horticulture to South Sulawesi were associated with each other, whether ironworking displaced stone knapping (cf. Chapman 1986: 84), or whether rockshelter sequences (as opposed to open sites) might bias the archaeological record towards the apparition of cultural continuity reaching across what were really junctures of major economic and cultural change.

REFERENCES

Bahn, P. (ed.) 1992. *Collins dictionary of archaeology*. Glasgow: Harper Collins.

Bulbeck, F.D. 1992. A Tale of two kingdoms: The historical archaeology of Gowa and Tallok, South Sulawesi, Indonesia. Unpubl. Ph.D. Thesis. Canberra: Australian National University.

Bulbeck, F.D. 1995. Fieldwork in South Sulawesi, 27 December 1994 to 10 January 1995. Report by David Bulbeck to interested parties 15 May 1995. Unpubl. ms.

Bulbeck, D. & M. Pasqua (in prep.). Old and new data on the Toalean of South Sulawesi, Indonesia.

Chapman, V.C. 1981. An analysis of the artefact collections excavated by the Australian-Indonesian Archaeological Expedition to Sulawesi, 1969. Unpubl. M.A. Thesis. Canberra: Australian National University.

Chapman, V. 1986. Inter-site variability in South Sulawesi: The results of the 1969 Australian-Indonesian Archaeological Expedition. *Archaeol. Oceania* 21: 76-84.

Cotterell, B. & J. Kamminga 1987. The formation of flakes. *Am. Antiq.* 52: 675-708.

Cotterell, B. & J. Kamminga 1990. *Mechanics of pre-industrial technology*. Cambridge: Cambridge University Press.

Flenniken, J.J. & J.P. White 1985. Australian flaked stone tools: A technological perspective. *Rec. Aust. Mus.* 36: 131-151.

Glover, I.C. 1976. Ulu Leang cave, Maros: A preliminary sequence of post-Pleistocene cultural developments in South Sulawesi. *Archipel* 11: 113-154.

Glover, I.C. 1978. Survey and excavation in the Maros district, South Sulawesi, Indonesia: The 1975 field season. *Bull. Indo-Pacific Prehistory Ass.* 1: 60-103.

Glover, I.C. & G. Presland 1985. Microliths in Indonesian flaked stone industries. In V. Misra & P. Bellwood (eds), *Recent Advances in Indo-Pacific Prehistory*: 185-195. Leiden: E.J. Brill.

Mulvaney, D.J. & R.P. Soejono 1970. The Australian-Indonesian archaeological expedition to Sulawesi. *Asian Persp.* 13: 163-177.

O'Connor, S. 1990. 30,000 years in the Kimberley. Unpubl. Ph.D. Thesis. Perth: University of Western Australia.

Pasqua, M. 1995. Mid-late Holocene Toalean sites in South Sulawesi: a technological analysis. Unpubl. B.Sc. Hons. Thesis. Perth: University of Western Australia.

Presland, G. 1980. Continuity in Indonesian lithic traditions. *The Artefact* 5: 19-46.

Sarasin, P. & F. Sarasin 1905. *Die Toála-Höhlen von Lamontjong*. Wiesbaden: C.W. Kreidel's Verlag.

Shea, J.J. & J.D. Klenck 1993. An experimental investigation of the effects of trampling on the results of lithic microwear analysis. *J. Archaeol. Sci.* 20: 175-194.

Sinha, P. & I.C. Glover 1983/1984. Changes in stone tool use in Southeast Asia 10,000 years ago: a microwear analysis of flakes with use gloss from Leang Burung 2 and Ulu Leang 1 caves, Sulawesi, Indonesia. *Modern Quaternary Research in Southeast Asia* 8: 137-164.

Stuiver, M. & P.J. Reimer 1993. Extended ^{14}C database and revised CALIB radiocarbon dating program. *Radiocarbon* 35: 215-230.

Sullivan, K. & K. Rozen 1985. Debitage analysis and archaeological interpretation. *Am. Antiq.* 50: 775-779.

Sullivan, K. & K. Rozen 1989. The nature of lithic reduction and lithic analysis: stage typologies revisited. *Am. Antiq.* 54: 179-184.

Van Heekeren, H.R. 1939. De Liang Saripa, een neolithisch station nabij Maros (Zuid-Celebes). *Tijdschr. indische Taal-, Land- en Volkenk.* 79: 108-118.

Van Heekeren, H.R. 1972. *The Stone Age of Indonesia.* (2nd rev. ed.). The Hague: Martinus Nijhoff.

Van der Hoop, A.N.J.Th. 1941. *Catalogus der Praehistorische Verzameling.* Bandung: A.C. Nix & Co.

Van Stein Callenfels, P.V. 1938. The Proto-Toalian. *Tijdschr. indische Taal-, Land- en Volkenk.* 68: 579-84.

PETER BELLWOOD[1], GOENADI NITIHAMINOTO[2], GEOFFREY IRWIN[3], GUNADI[4], AGUS WALUYO[5] & DAUD TANUDIRJO[6]

[1]*Australian National University, Canberra, Australia*
[2]*National Research Centre of Archaeology, Yogyakarta, Indonesia*
[3]*University of Auckland, New Zealand*
[4]*Office of Historical and Archaeological Heritage, Ujung Pandang, Indonesia*
[5]*Office of Historical and Archaeological Heritage, Yogyakarta, Indonesia*
[6]*Gadjah Mada University, Yogyakarta, Indonesia*

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35,000 years of prehistory in the northern Moluccas[1]

1 INTRODUCTION

The northern Moluccan islands, comprising Halmahera, Morotai, Bacan, Obi and the various small satellite islands of the region, occupy an obviously strategic geographical location between the major islands of Sulawesi, the southern Philippines and New Guinea. Given current understanding of the archaeological and linguistic prehistories of Indonesia and Oceania, it can be suggested that the northern Moluccas could have played important roles in the following periods of prehistory:

1. During the period of initial human migration through eastern Indonesia towards Australia and New Guinea. Currently, it is not clear whether the first Australians reached Australia by crossing from Timor and Nusa Tenggara, or whether they reached New Guinea first via the close-set islands which run from eastern Sulawesi and Sula, via Obi, to Halmahera, Gebe and west New Guinea. We may never know the exact route, indeed there could have been crossings of both, and the chronology of this dispersal is also under debate. Radiocarbon dating in Australia suggests earliest dates of c. 40,000 BP, whereas luminescence dating suggests dates greatly in excess of this, perhaps as much as 60,000 years.

2. During the period of Austronesian (AN) population dispersal into the Pacific, dated in the case of western Oceania by archaeological and linguistic means to c. 3300 BP. Linguistic evidence suggests that the AN languages of southern Halmahera relate, more closely than any other AN languages in Indonesia, to the Oceanic AN languages of Melanesia, Micronesia and Polynesia. If this is so, then the Halmahera region could have been the immediate homeland for the languages of the Oceanic subgroup and their speakers. The archaeology of this dispersal in western Melanesia is related directly to the Lapita cultural complex, which apparently commenced c. 3300 BP in the Bismarck Archipelago.