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BALOF SHELTER, NEW IRELAND — REPORT ON A SMALL EXCAVATION

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SUMMARY

The excavation of 6 m^2 from a rock shelter in New Ireland is described. The maximum depth of deposit was 80 cm, with no clear strata being visible. A radiocarbon date of 6-7,000 years b.p. was obtained from the lowest levels, and one of 2,500 years b.p. from the middle. Faunal materials recovered include mammals (all except one still extant), lagoon fishes, reptiles and shellfish, the last being primarily from reef and lagoon environments. Artefacts from earlier levels include bone bi-points, flaked stone tools patterned similarly to those from the New Guinea Highlands and made from stone from a variety of resources, and obsidian imported from Talasea, New Britain. Obsidian from the Lou (Admiralty Is.) source, and pottery date from about 2,500 years ago. The site is the oldest so far excavated in Melanesia, and data from it provide insights into the development of trade patterns in the area over the last 7,000 years.

1. SITE, STRATA AND DATING

SITE AND EXCAVATION

Balof shelter is situated about 1.5 km inland from Medina village, on the east coast of New Ireland, some 90 km from the northern end (Fig. 1).

The coastal strip around Medina is only a few hundred metres wide and the country then rises in a series of irregular terraces, each of which is a few hundred metres across and possesses a steep and sometimes partially cliffed front. Balof shelter is located in the face of one such front, the third above the current coastal strip. It is estimated to be some 60-75 m above sea level.

The cliff at the point where the site is formed has been eroded and dissolved (possibly post-elevation) into an almost circular cavity some 50 m across at the base, which itself has been somewhat undercut to form a series of shelters. The largest and driest of these cavities is on the northeastern side, where the protected area is some 25 x 6 m. This is known locally as Balof (Fig. 2). The other shelters around the cavity are damp, while the cavity centre is filled with lianas hanging from the surrounding bush and a few trees. On the eastern side one scrambles over a pile of boulders to reach the main terrace surface from which it is a fairly easy walk to the beach.

Records of The Australian Museum, 1978, **Vol. 31 No. 19,** 000-000, Figures 1-13

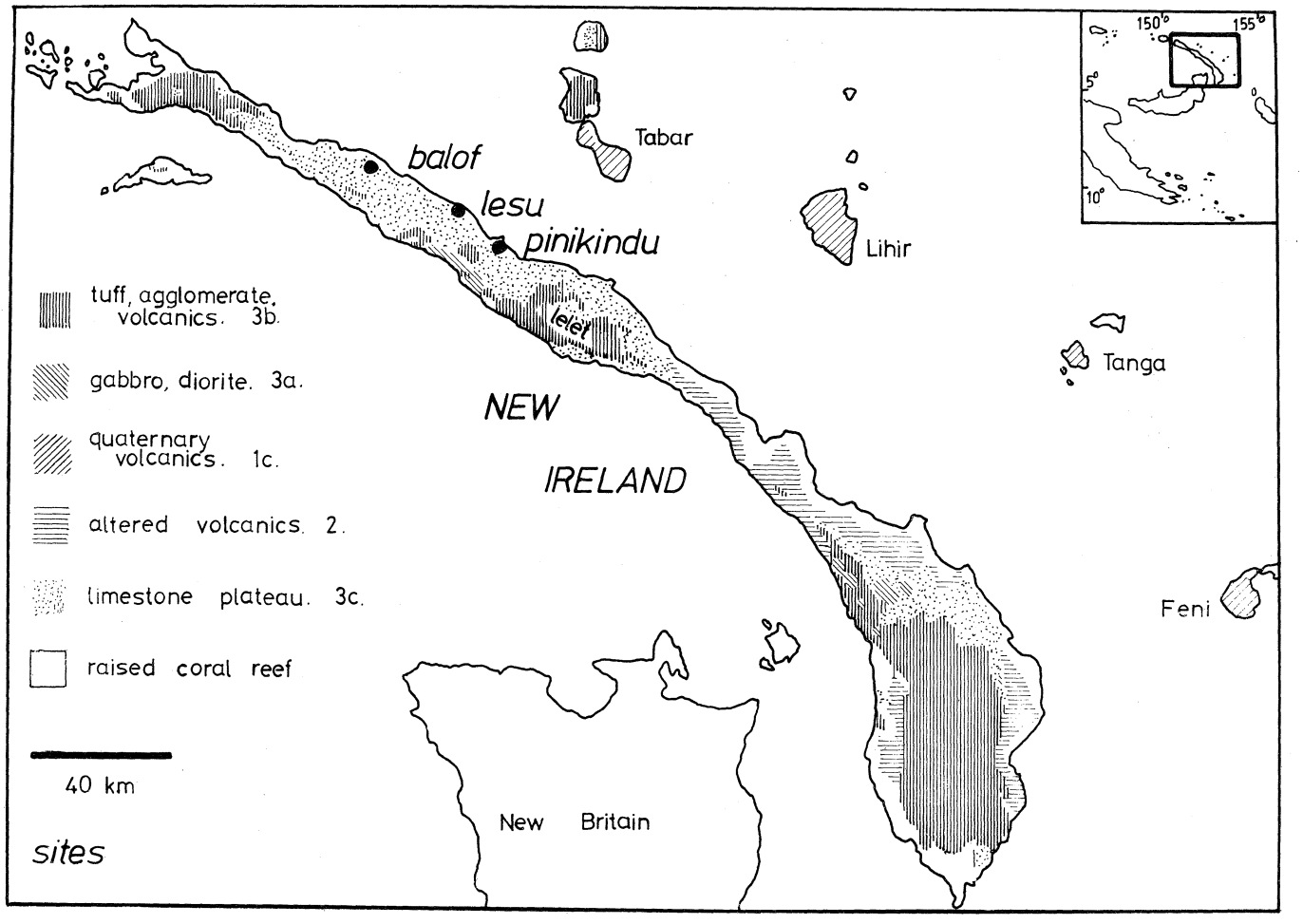


Fig. 1. Map of New Ireland showing sites mentioned in the text and geological features.

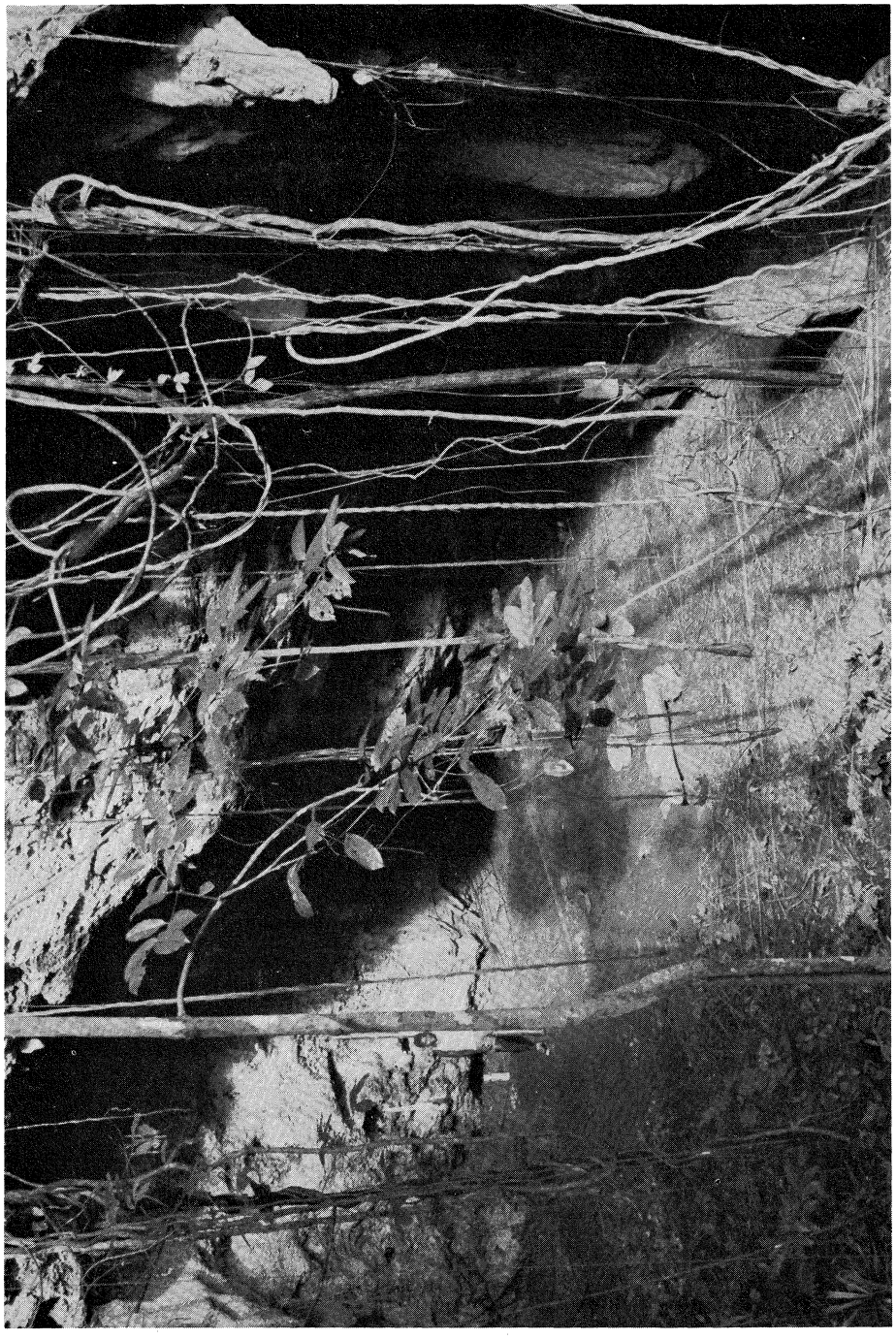


Fig. 2. Balof site from the east. Human figures give scale.

Evidence of human use of Balof came from material lying on the surface. Broken gramophone records, clearly 78 r.p.m., but of unidentifiable titles, confirmed local statements concerning its use in the 1939-45 war, while snake and rat bones, fire hearths and limestone slabs used in pit cooking also suggested use within the same period.

Local informants, especially Sanaila, whose gardens were on the terrace in front of the site, believed it had been occupied in pre-European times by people whose more permanent residence was further inland. This belief conforms with population history of the area in that the interior was inhabited in the late nineteenth century, whereas today it is not. Sanaila's belief has not been checked archaeologically.

To commence the excavation a base line was laid out and a datum point fixed on the cave wall. The site was gridded into one metre squares, lettered east-west and numbered north-south. Six square metres were excavated, with squares C3 and D3 being set 50 cm north of their true position to avoid rockfalls (Fig. 3). Surface levels were between 20 and 37 cm below datum.

As there were no well-defined strata apart from a large pit near the surface (see below) the deposit was removed in arbitrary spits some 10 cm in depth. In the absence of visible zonation, we have assumed that there is a direct correlation between depth below surface and age of the deposit, so that spits the same depth below the surface have been correlated for analysis. In all, eight spits were excavated, clayey red-brown cave earth being reached some 107-112 cm below datum. This clay appreared to be completely sterile, and the removal of 60 cm confirmed this.

All excavations were carried out by JPW, the excavated material being sieved by local labour through 6 mm mesh. Sieves were checked before material retained by them was disposed of. In the following analyses spits are designated (1) — (8) following a square code, and sets of correlated spits are labelled levels I-VIII.

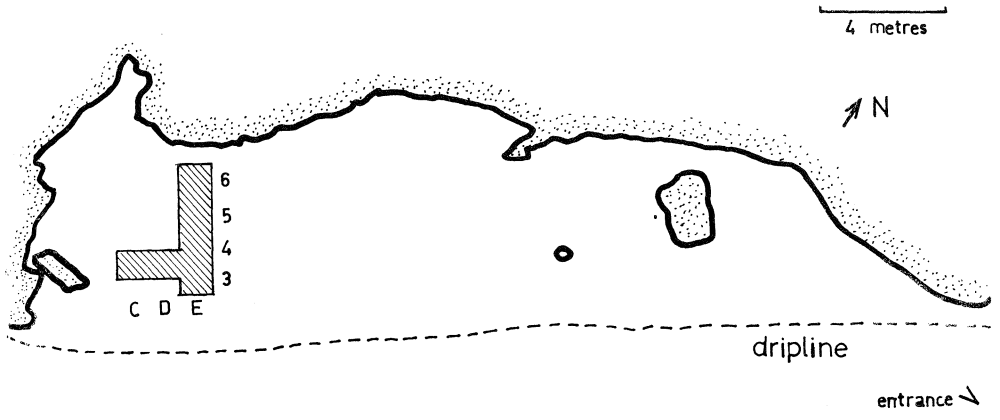
STRATIGRAPHY

The top 3-5 cm consisted of hard-packed, damp, grey ashy soil, with patches of lighter ashy material. It contained recent artefacts. Below this level there was soft grey soil with some limestone grits and rubble. Apart from a few thin lenses of darker or lighter soils, with ash in the first 3 spits (26 cm below surface) in E3, no soil changes were seen in the deposit until the clayey red-brown cave earth was reached (Figs. 4, 5, 6).

In squares E4-5 there was a large pit approx. 1 m across with a maximum depth of 25 cm. This contained much carbon and ash, along with burned soil and limestone cobbles. This is probably a cooking pit, although present day custom does not require the digging of such a large pit. It appeared to be dug from the base of the surface layer.

Several postholes were found in the surface level and four in level III. Three of the latter contained remains of wooden stakes, two of which had been burned.

The other major feature was a large rock-fall in E3 which first appeared in spit (3) and gradually enlarged to occupy most of the square by the time spit (6) was reached. Considerable quantities of shell and bone were found beside this rock, suggesting that its sides may have been used as a convenient rubbish-dumping location. Another large rock, which may be bedrock, occurred in the northeast corner of E6.



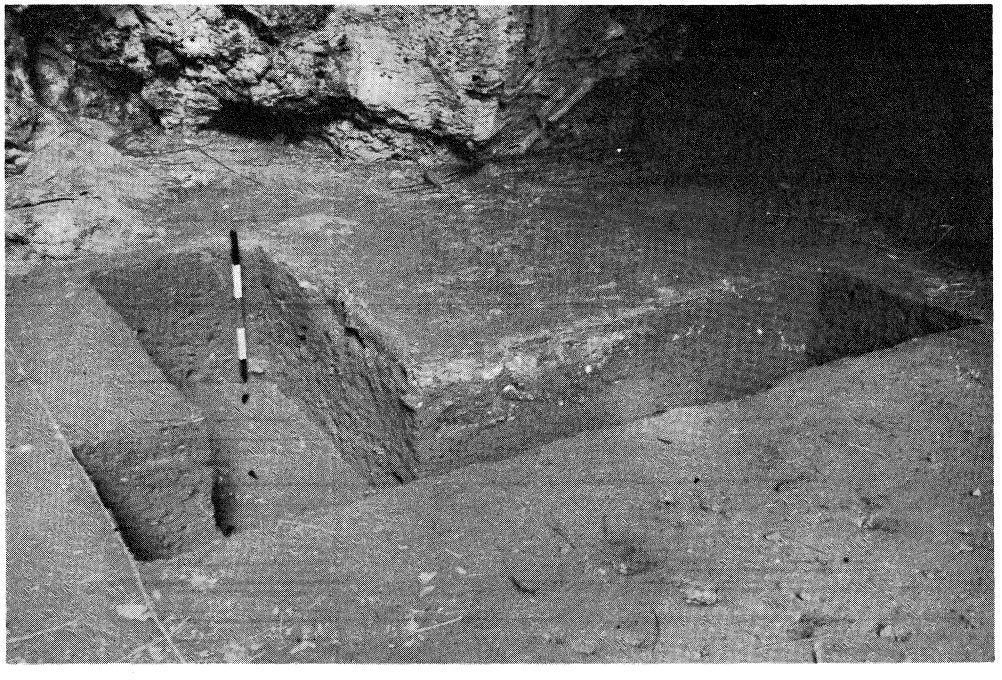


Fig. 3. Plan of Balof, showing location of excavation. Fig. 4. Excavation, showing stratigraphy.

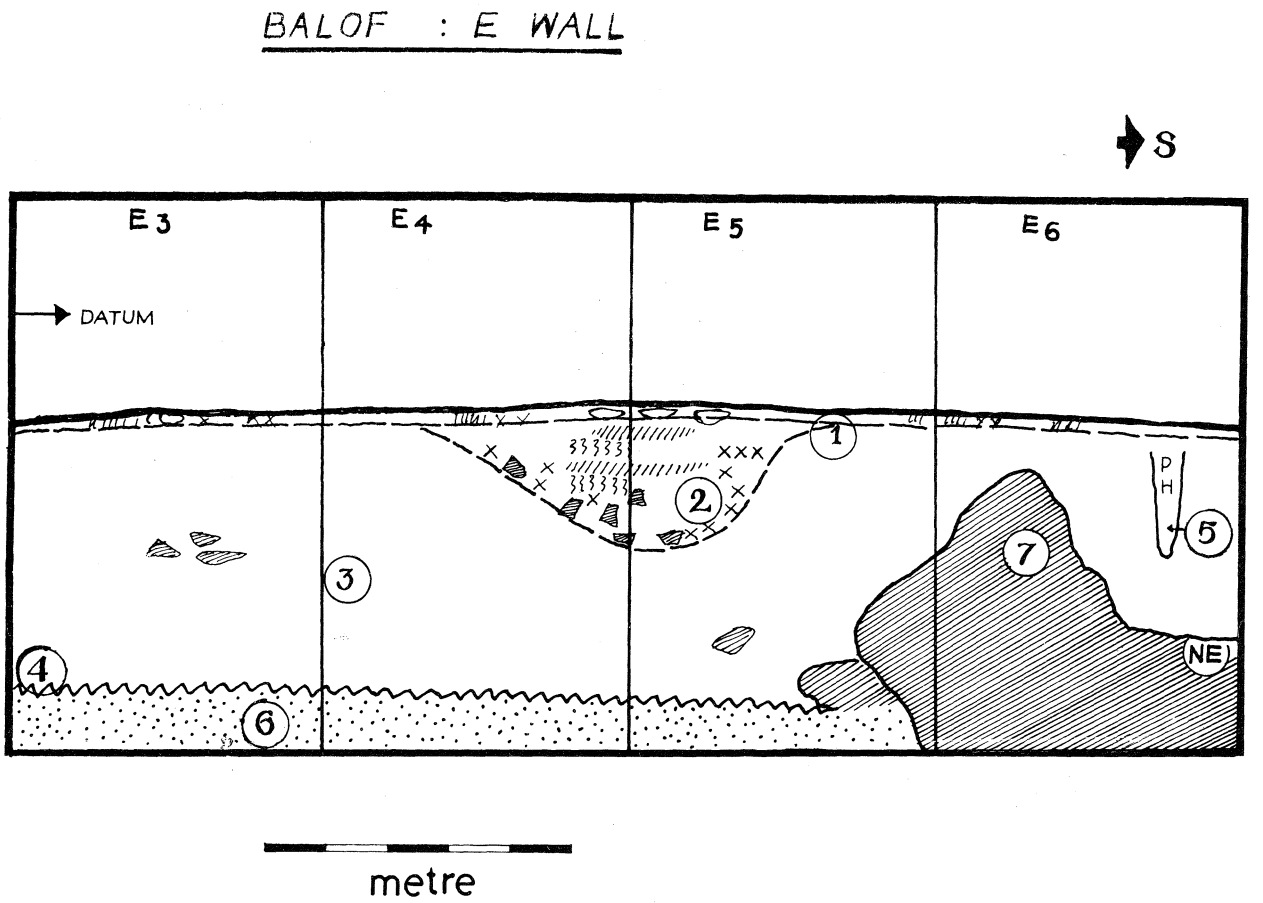


Fig. 5. Balof: section along east wall of squares E3-E6. (1) Hard packed surface, with traces of white ash and carbon; (2) pit, with stones (shaded), carbon (xx), white ash (//) and lighter, burned soil; (3) undifferentiated dark brown soil; (4) mixed transitional zone between (3) and (6); (5) post-hole; (6) red-brown sterile cave earth; (7) rock; (NE) not excavated.

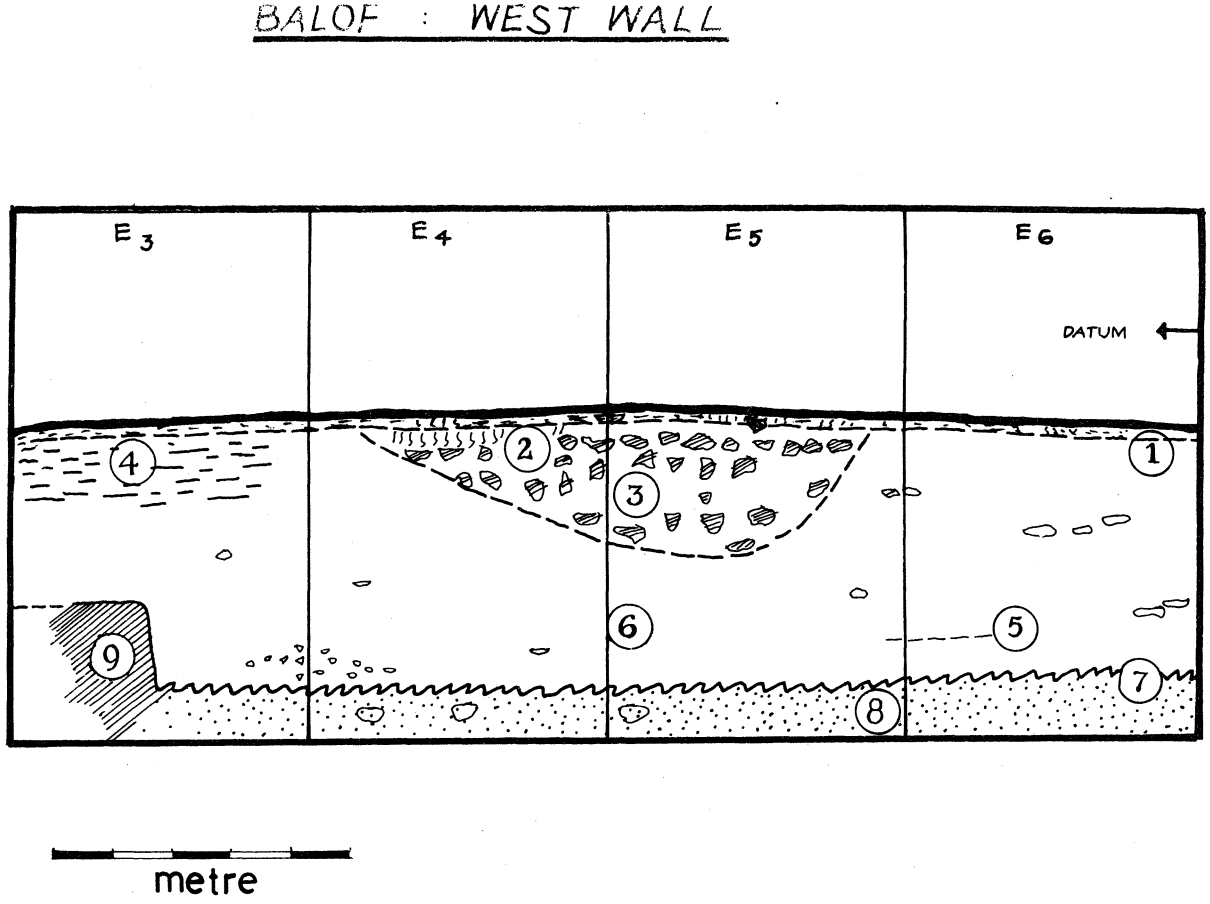


Fig. 6. Balof: section along west wall of squares E3-E6. (1) Hard packed ashy surface; (2) light brown ash; (3) pit, consisting of soft blackish soil with many burned limestones and much carbon; (4) thin layers of darker and lighter soil with some ash; (5) irregular concreted flowstone; (6) undifferentiated soft dark brown to grey soil with occasional limestones; (7) mixed transitional zone between (6) and (8); (8) red-brown sterile cave earth; (9) rock.

Although shell and other occupational debris occurred throughout the deposit, along with some burned limestone cobbles, there was little evidence of hearths or carbon below level III. It seems likely that human treadage and scuffage of the surface of a slowly accumulating deposit (see Dating) has rendered such evidence undetectable.

The sequence of events at Balof was probably as follows: the cave was initially an underground dissolution cavity, in which the clayey red-brown earth was deposited. Subsequent collapse opened it at the top and sides, making human use possible. Deposits accumulated from further disintegration of the cave, some washed or blown-in material, and humanly-derived debris, with the latter always accounting for a high proportion of the total.

DATING

Two radiocarbon dates were obtained.

GaK2437 1540 ± 270 b.p. (half-life 5730).

This date comes from scattered lumps of charcoal 17-23 cm below surface in spit (3), and found over two-thirds of square D3. The sample consisted of fingernail-sized lumps which were collected on a knife point and stored in new plastic bags.

Both the scattered nature of the sample and the problems of surficial deposit re-working suggest that this determination should not be taken as more than a general indication of age, although probably one of minimum age. Nonetheless, it was this determination which originally enabled the prediction that the earliest use of the site should have occurred some 6000 years ago, assuming a reasonably constant rate of deposit accumulation (White 1972b). Since such an age would be older than for any other well-dated site east of the main island of New Guinea, further testing seemed essential, but the absence of charcoal in the lower part of the site made this difficult.

NSW95 ≥ 6600 ± 400 b.p. (half-life 5568). Corrected to a half-life of 5730, this date becomes ≥ 6800 ± 410 b.p.

This date comes from the acid insoluble fraction of 553 gm of bone from spits (7) and (8) in squares C3 and D3. These spits range from 58 to 84.5 cm below surface. The sample consisted of long-bone shafts and vertebrae of small mammals and reptiles.

We believe that this age is approximately correct, since it is in reasonable accord with the earlier prediction, and there are, as will be seen, good reasons in terms of the archaeological materials for believing in its approximate accuracy. But, because of the sample size, the area over which it was collected, and the problems of dating bone fractions, this date cannot be relied on for more than a general indication of the age of the deposit.

2. **FAUNAL MATERIAL**

SHELL

About 12.75 kg of shells and fragments were recovered from the excavation. This material was found in every level, although amounts in I and II were low, while nearly 30% occurred in VII. There was also some variation in the areal distribution (Tables 1-3). This material has not been fully analysed in scientific taxonomic terms, both because of the considerable difficulties involved and also because its primary interest for this study is in terms of the record of environmental exploitation it gives. Thus, following initial sorting

of the shell into clear morphological categories, Dr. W. Ponder (Curator of Molluscs, The Australian Museum) was asked to suggest from which local environments the shellfish were originally gathered.

Table 2 shows the weight of shells obtained from each environment, and Table 3 expresses these figures as a percentage of the total after the removal of shells occupied by hermit crabs and unidentifiable opercula.

Table 1. Distribution of Shell (%)

C3	D3	E3	E4	E5	E6
21.0	15.5	11.6	32.0	9.0	10.0

It should be noted that up to one third of all the material cannot be related to environmental categories. As well as a number of *Nerita* shells which had been inhabited by hermit crabs and opercula which are difficult to relate to particular gastropods, there is a quantity of very broken shell. We suspect that lagoon environments provide much of this remnant material since this is where small mussel and oyster varieties, with thin, light shells, are found.

Land snails occur in all levels. There is no ethnographic evidence of their having been eaten in New Ireland and they may be an indicator of site disuse (Clay 1974:7). The shells were, however, mixed in with other occupational debris and were most common in levels which contained large numbers of other shells, which suggests that some use was made of them.

Some littoral environments show a regular but very low level of exploitation throughout the site's use. These are semi-exposed dead coral (chitons only) and reef top areas (limpets only): it is likely that these shellfish were gathered in passing, in the course of other reef and lagoonal collecting.

Table 3 shows some variation in environmental exploitation over time. In the lower levels (V-VIII) shells from hightide splash levels, especially *Nerites,* predominate. The only other common varieties of shells in these levels are bivalves from the mangrove environment. These however, increase in level IV and above, as do shells from fringe mangrove, lagoon and reef. There is some areal variation in the distribution of this material within the excavation and it may be that both this and the variation between levels indicate the chances of refuse disposal in this corner of the site rather than larger-scale causes such as local environmental change or economic reorientation of the collectors. But we note also that the change in shellfish environments comes at a time when other changes occur in the site, so that some degree of cultural preference may also be involved. A larger sample of material might solve this problem.

BONE

About 4 kg of bone were recovered from the excavation. All bone material was fragmentary and some of it was burned.

Initial sorting and indentification of mammalian material was done by JPW and further preliminary work on cranial material only was carried out by P. Thompson (then of

the Archaeological Service Section, Australian Museum). In 1975 Dr. J. Hope (Dept. of Prehistory, A.N.U.) identified some of the post-cranial material. Assistance with reptile identification was given by the Dept. of Herpetology, Australian Museum.

Minimum estimated numbers of animals are listed in Table 4. For all mammal, reptile and fish remains numbers of animals are taken as equivalent to the largest number of identifiable body parts (jaws, particular teeth, etc.) within each square and spit. Crab numbers are based on claws (pincers) (actually half-claws), four or less in any square and spit indicating one animal. Sea urchins were identified by spines, any number within any square and spit being counted as one: there were never more than a few spines within any one unit.

Table. 2. Weight of Shell by Level, Sorted According to Environments of Origin (gm)

LEVEL	S.E.D.C.R.	Lagoon	Outer Lagoon Reef	R.H.T.S.L.	Outer Lagoon	Reef	Reef Top	B.E.I.B.	Fringe Mangrove	B.F.W.	Mangrove	Land Snails	Semi Terrestrial	Hermit Crab Inhabited Nerita Shells	Remnant	Operculies	TOTAL WEIGHT OF SHELL PER LEVEL	%
I	4.2	41.4	11.8	26.2	1.8	69.3	1.4	71.4	36.7	.2	125.8	7.9	.4	11.3	37.8	21.6	469.2	3.7
II	11.5	100.4	19.5	77.8	4.8	100.5	3.9	71.2	68.3	1.3	220.2	6.2	3.8	16.2	197.4	36.7	939.7	7.3
III	10.1	201.2	23.7	213.9	32.7	205.7	10.9	101.8	179.4	2.8	428.5	38.4	4.1	30.7	498.2	131.9	2114.0	15.6
IV	27.4	93.2	9.6	296.7	8.9	335.8	19.4	44.6	168.5	8.4	378.5	23.0	2.5	23.7	209.2	77.0	1726.4	13.4
V	13.8	39.8	4.5	532.6	—	42.0	30.3	94.0	28.7	3.3	275.6	29.3	2.3	44.1	106.2	72.8	1319.3	10.3
VI	26.8	15.2	3.6	1170.8	—	12.4	20.2	195.8	18.4	.2	336.7	59.5	17.2	38.0	98.7	21.7	2035.2	15.9
VII	61.3	30.5	4.8	2526.5	3.6	63.1	5.4	367.1	33.0	.7	193.1	78.0	13.2	193.7	121.5	56.1	3751.6	29.2
VIII	7.3	10.4	.2	312.5	—	10.0	2.0	19.0	5.8	—	66.1	7.9	7.9	5.9	32.1	—	486.9	3.8
Total from each environment	162.4	532.1	77.7	5157.0	51.8	838.8	93.5	964.0	538.8	16.9	2024.5	250.0	51.4	363.6	1301.1	417.8	12842.3	

ABBREVIATIONS

S.E.D.C.R. = Semiexposed dead coral rock (chitons)
R.H.T.S.L. = Rocks at high tide splash level (Nerita)
B.E.I.B. = Back end inside beach
B.F.W. = Brackish fresh water.

Table 3. Shell Weight Per Level Gathered From Various Environments (%)

LEVEL	semi-exposed dead coral rock	Lagoon	Outer Lagoon reef	Rocks at high tide splash level	Outer Lagoon	Reef	Reef Top	Back end inside beach	Fringe Mangrove	Brackish fresh water	Mangrove	Land Snails	Semi-Terrestrial	Remnant	Weight in gms: Totals for Levels	Level Totals as % whole
I	1	9.5	2.7	6.0	0.4	15.9	0.3	16.4	8.4	0.5	28.8	1.8	0.1	8.7	436.3	3.6
II	1.3	11.3	2.2	8.8	0.5	11.3	0.4	8.0	7.9	0.1	24.8	0.9	0.4	22.3	886.8	7.4
III	0.5	10.3	1.2	11.0	1.9	10.5	0.6	5.2	9.2	0.1	22.0	2.0	0.2	25.5	1951.4	16.2
IV	1.7	5.7	0.6	18.2	0.5	20.6	1.2	2.7	10.4	0.5	23.3	1.4	0.1	12.9	1625.7	13.5
V	1.2	3.3	0.4	44.3	—	3.5	2.5	7.7	2.4	0.3	23.0	2.4	0.2	8.8	1202.4	10.0
VI	1.4	0.8	0.2	59.3	—	0.6	1.0	9.9	0.9	—	17.0	3.0	0.8	5.1	1975.5	16.4
VII	1.6	0.9	0.1	72.1	—	1.8	0.1	10.4	0.9	—	5.5	2.2	0.4	3.4	3501.8	29.0
VIII	1.5	2.2	—	65.0	—	2.1	0.4	4.0	1.2	—	13.7	1.6	1.6	6.7	481.0	4.0
															12060.0	

Table 4. Estimated Minimum Number Of Animals based on individual squares and spits

	LEVELS								TOTALS
	I	II	III	IV	V	VI	VII	VIII	
Mammals									
Homo sapiens		1	1	1	1		1	1	6
Sus scrofa — pig	1	1	1	1					4
Thylogale brunii — pademelon	2	4	6	4	6	5	1	1	29
Macropus agilis or *Dendrolagus* sp. — wallaby			1*	1*					1
Phalanger orientalis ducatoris sp. — cuscus	6	6	7	9	7	8	8	3	54
Megachiroptera (genera not identified) — flying foxes	3		14	19	17	33	18	11	115
Microchiroptera (genera not identified) — insectivorus bats	2				3	5			10
Rattus exulans or *Melomys rufescens*? — rats	1	3	1		2	3			10
Reptiles									
Scincidae — skinks	2	4	2	3	8	13	16	4	52
Varanidae — monitors		1			1	3	2	2	9
Unidentified Lizards			2	1	1		1		5
Ophidae — ? python	3	3	3	3	7	7	8	7	41
Fish									
Scaridae (identified jaws) — parrot fish			1	1					2
Other fish (spines & vertebrae only; ?parrot or other lagoon type)	2	3		3	2				10
Other									
Elasmobranchii — sharks		1		1	1		1	1	5
Crabs — not identified	4	6	8	9	6	5	6	3	47
Echinoderms — sea urchins	5	6	6	6	2	5	1	1	32

*These bones were found in adjacent levels of the same square and may therefore belong to the same animal.

Homo sapiens. The distribution of these bones is given in Table 5. It is notable that six specimens are teeth and two of the other bones are charred. A number of explanations for the occurrence of these bones may be derived from the ethnographic record and these are listed here, although no testing of any of these explanations can be undertaken.

1. Food remains (Parkinson 1907 [n.d.]:227, 236, 256; Groves 1933:342). The occurrence of charred bones might support this view.

2. Trophy collections, bones being carried around in the hope that powers possessed by the dead person could thus be accrued by the living. (Parkinson 1907 [n.d.] :230).

3. Relicts from compound mortuary practices such as those described by Billings (1971:533-8). For example, bones are retrieved form buried corpses and carried round in a leaf parcel.

4. *Memento mori* (Parkinson 1907 [n.d.] :230). The drilled lunate described below may well have served this purpose.

5. The detritus from tooth evulsion.

Sus scrofa. A list of individual fragments is given in Table 6. The absence of pig remains below level IV is interesting and may be associated with the appearance of pottery at the site (below). However, the excavation is too small to be confident that the oldest pig remains at the site have been found, and other explanations involving changing patterns of site use are also possible (cf. Bulmer 1976). Pigs are nowadays eaten at feasts (Billings 1971:482; Powdermaker 1933:183) and the remains here may result from portions of animals carried from elsewhere.

Other mammals. The rangeof mammalian material identified is wide. If the list is compared with that of New Ireland species given by Laurie and Hill (1954), then representation of all families,other than *Peramelidae* (bandicoots) and *Mus* are present. Laurie and Hill list nine species of megachiroptera for New Ireland,and although it was not possible to identify our specimens below sub-order level,the presence of a number of different species is reflected in the evidence (J. Hope, pers. comm).

Two post-cranial fragments have been identified as *Macropus agilis* or *Dendrolagus* sp. by P. Thompson. These occur in spits (4) and (5) of square D3, and may therefore come from the same animal. Either of these identifications poses a problem since the nearest known locality for either animal occurring in the wild is mainland New Guinea. It may be that these remains indicate the former presence of one or other species on New Ireland, the animal now being extinct through some cause such as hunting pressure. Alternatively, we may remember that it is a common Melanesian practice to catch and tame young animals and also to transport various kinds of animals from place to place. The direct journey of a live macropod from New Guinea to New Ireland is, perhaps, difficult to envisage, though certainly not impossible, while the association of these specimens with other changes in the site is interesting. However, no explanation can be preferred until we know more about the pre-human fauna of New Ireland.

Fish and other marine creatures. Very few fish bones were recovered, and all, apart from the shark's teeth, were of small, probably lagoon, fishes. A possible explanation for this scarcity is that Balof was used when men were hunting rather than fishing, both of which are male occupations on New Ireland today (Powdermaker 1933:183).

Six shark teeth were found, including three in levels VII and VIII. It is tempting to see in these teeth evidence of the dramatic New Ireland method of lassoing sharks (Parkinson 1907 [n.d.] 258-9; Powdermaker 1933: 172-7) which has been recorded by Powdermaker in this area. The lassoing method is at least four centuries old, judging from an illustration

Table 5. Distribution Of Human Remains

	C3	D3	E3	E4	E5	E6	TOTAL HUMANS
I							
II	Mandibular condyle						1
III			molar	Incisor molar			1
IV		Incisor				distal end R Fibula (charred)	1
V		Metacarpal					1
VI							
VII	Incisor	Patella Incisor Lunate*				Phalange (slightly charred)	1
VIII	1st & 4th cervical vertebrae						1

*Lunate at D3 (7) drilled.

Table 6. Pig Remains

LEVELS	
I	1 premolar
II	3 canines
	1 molar
	1 fragment of jaw
III	1 unerupted molar
	2 incisors
	1 intervertebral disc
	1 fragment of an intervertebral disc
	1 metatarsal
	2 phalanges
IV	2 molars

in Abel Tasman's journal (A.D. 1643) showing a canoe with two of the propellor-shaped floats resting on the gunwales, and it would not be surprising if earlier inhabitants of New Ireland were also skilled exploiters of marine resources. Unfortunately all identifiable parts of the gear used in shark catching are made of wood and other perishable organic materials so that direct archaeological documentation of this technology seems unlikely.[1]

While the preparation and cooking of fish, like its capture, is generally a male task, the collecting and cooking of crabs and shellfish is done by women (Powdermaker 1933:168-70, 183), so that women's presence at the site is clearly documented by such remains.

3. ARTEFACTS

SHELL

(i) Arm-rings (Fig. 7a). Two fragments of arm-rings made from *Trochus niloticus* were recovered, from E4 (2) and (3). *Trochus* arm-ring fragments are common in other New Ireland sites (White 1972b:309; Clay 1974:12), and their method of manufacture has been described by Parkinson (1907 [n.d.] :254) and more recently by Clay (1974:12). Arm-rings were frequently used in various kinds of exchanges.

(ii) Tools (Fig. 7b-f). Twenty seven pieces of shell, all from mangrove-dwelling bivalves, showed traces of use as tools (Table 7). One of these was a triangular piece with ochre on the inner side (?a palette), the other twenty six all show signs of sharpening and/or wear. Two formally distinct groups occur: in one the original lip of the shell forms a functional edge (n = 22), while in the other a cut or broken edge of shell has been sharpened for use (n = 4). Two of the latter cases are made from a piece of shell which includes the hinge, which would give it added strength.

[1] It has also been suggested that the remains could come from beached sharks. JED's great uncle, Mr. C. Britter, a professional shark fisherman in Mauritius, has never observed beached sharks, since dead ones are quickly eaten by their voracious and cannibalistic fellows. " . . . this I know about the shark. His bite is worser than his bark" (O. Nash)

It seems likely that these tools are 'unmodified shell scrapers' (Poulsen 1970:41) which can only be detected by the presence of sharpening or wear. The use of shell tools as vegetable scrapers is widely recorded in New Ireland (Powdermaker 1933:179; Billings 1971:230) but the scrapers themselves are not described. Parkinson mentions the use of sharpened shells in scraping the skull and in trepanning (1907 [n.d.] :104-8), and also records the use of a sharply ground shell in finishing off carvings (1907 [n.d.] :251).

Table 7. Distribution Of Shell Tools

LEVELS	C3	D3	E3	E4	E5	E6	TOTALS
I	2	0	0	0	1	0	3
II	0	0	1	0	0	0	1
III	2	0	0	1	0	1	4
IV	0	1	2	1	0	3	7
V	0	1	1	0	1	0	3
VI	1	5	1	0	0	0	7
VII	1	1	0	0	0	0	2
VIII	0	0	0	0	0	0	0
TOTALS	6	8	5	2	2	4	27

BONE

(i) Points. Five whole and twenty broken points were found in levels IV to VIII. All the whole points and five almost whole points were clearly bipoints, while eight of the remainder bore a general resemblance to bipoints (Fig. 8a-q). One clear uni-point was found, in E5 (4) (Fig. 8t). This was made of the broken-off spinous process of a vertebra. One other bone fragment may have been the mid-section of a point. All points, with the exception mentined above, were made of mammalian long bone sectioned along the medullary cavity.

Actual and estimated measurements of all points,along with their location and description are given in Table 8. A rough estimate of the original length of broken points was made by outlining the remaining fragment on graph paper and completing a symmetrical outline for it, making the assumption that all were bipoints. Examination of the mean lengths from each level shows a slight tendency for this to increase through time, but the variation appears insignificant. There is no variation in cross-section with time.

Two points appear to be unfinished, having been cut to shape but with the tips remaining unground (Fig. 8 r-s). As well as indicating the process of manufacture, the presence of these unfinished pieces indicates that the site may have been used for making or repairing artefacts. No waste material was noted, but this would be difficult to distinguish from other bone debris.

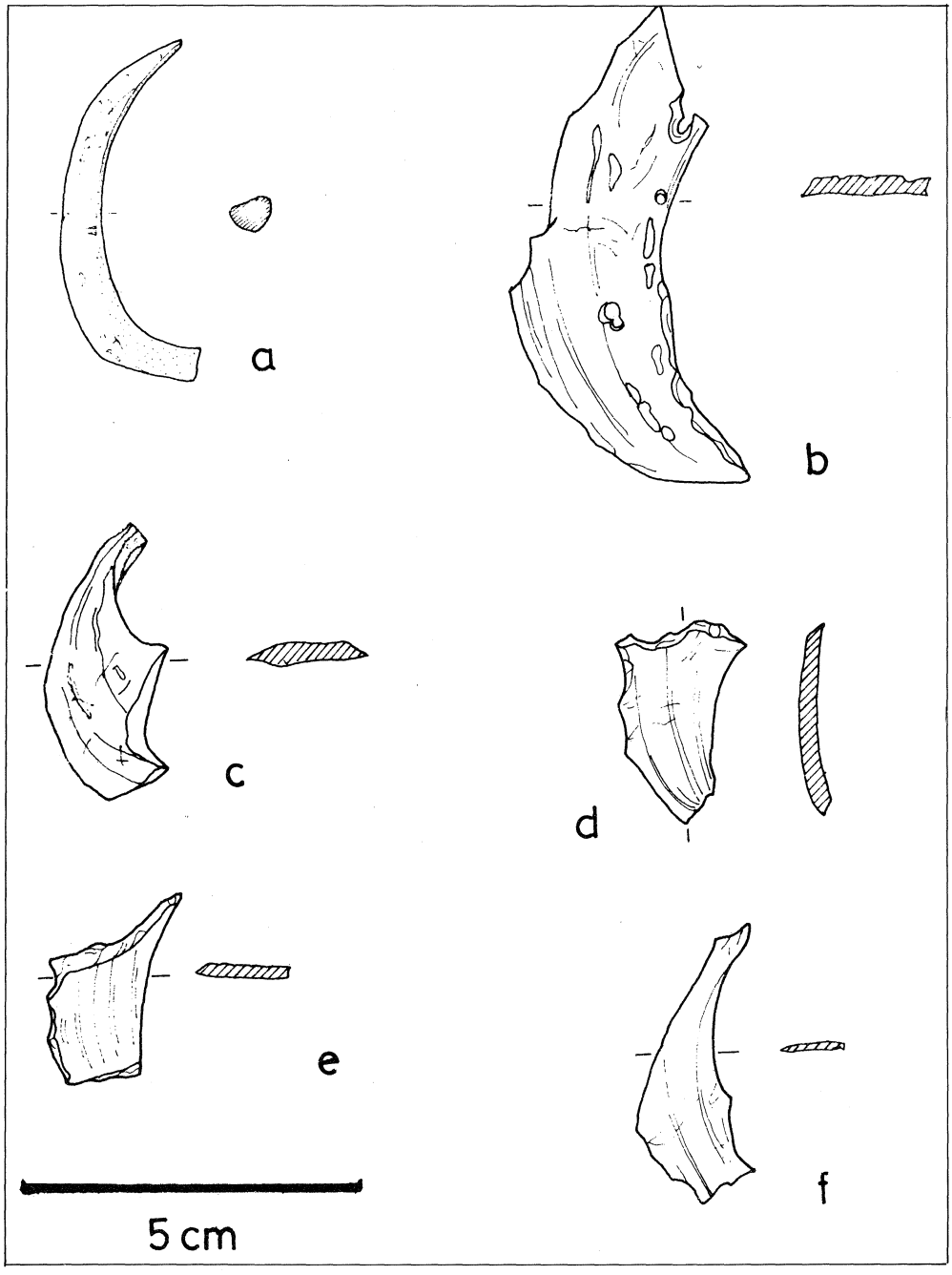


Fig. 7. Shell artefacts. a; arm ring, E6(4); b-f: shell scrapers, D3(6), E4(4), E5(4), E4(6), E6(4).

It is likely that the points were spear or arrow barbs. Comparison with material held in The Australian Museum shows that these points are similar in size to those on a spear from the Bismarcks (E 52765) and on arrows from Bougainville (E 27570, E 60305, E 60306). In the former case however, whole sections of bone were used, and no examples of points made of split pieces of long bone were located among the collections from this area.

The points are too small to have been spear or arrow heads, and the use of fish gorges is not known in New Ireland in the contact period (Anell 1955, 1960). Parkinson (1907 [n.d.] :251) refers to the use of a bone awl in carving, but no further description is given and these points seem too small for this purpose.

Further confirmation of their association with hunting may be seen in the lack of similar points and the rarity of wild animal bones at New Ireland coastal sites (White 1972b:309; Clay 1974:7).

(ii) Pendant? (Fig. 8u). A human left lunate[1] with a hole drilled from both sides was found in D3 (7). The bone comes from an adult of small stature. The hole has apparently been made by cutting into bone from both sides with a sharp instrument, with the centre being finally reamed or drilled out. One side has now been broken out of the hole. Similar artefacts have not been recorded from the region, though Specht (1969:262) found two drilled human pre-molars on Buka. It may be a *memento mori*.

POTTERY

Fifty nine sherds were found in levels I-V. Six of them were broken laterally, so that either the inner or outer surface was missing, and these have not been included in any analyses. The fifty three whole sherds have a total weight of 70 gm and a surface area of 900 mm^2. Table 9 shows the distribution of this material, about two-thirds of which comes from levels III and IV, and nearly 50% of which comes from square E4. Table 9 also indicates that there is no great variation in sherd size throughout the sample.

Two groups of sherds were distinguished on the basis of their temper. A. Fifty-one sherds have a plentiful inclusion of coarse white grains which seem too abundant to be a natural inclusion in the clay. The grains are flat in section and irregularly shaped with rounded edges, suggesting crushed and rolled shell, possibly from a beach. These sherds are soft and crumbly in character. B. Two sherds, one from each of levels II and III, are firm and brittle, with fewer non-plastic inclusions. The grains are fine and rounded, and white in colour. They are probably water-worn sand. It is not clear whether this is natural or added temper.

Sherd colours range from red through brown and grey to black. Many sherds have patchy colouration and some have sides of different colours, a normal characteristic of pottery fired on an open fire. Group A Sherds have grey or black cores which may result from incomplete oxidation.

Four sherds (2 group A and 2 group B) show evidence of wiping while still damp.

Sherds were too small to identify vessel formation technique(s) or to allow vessel form to be reconstructed. However, decoration on the concave side of a level III sherd suggests it may be part of an unrestricted vessel.

[1] For an exact identification we are indebted to Mr. A. B. Bailey, Dept. of Anatomy, University of Sydney.

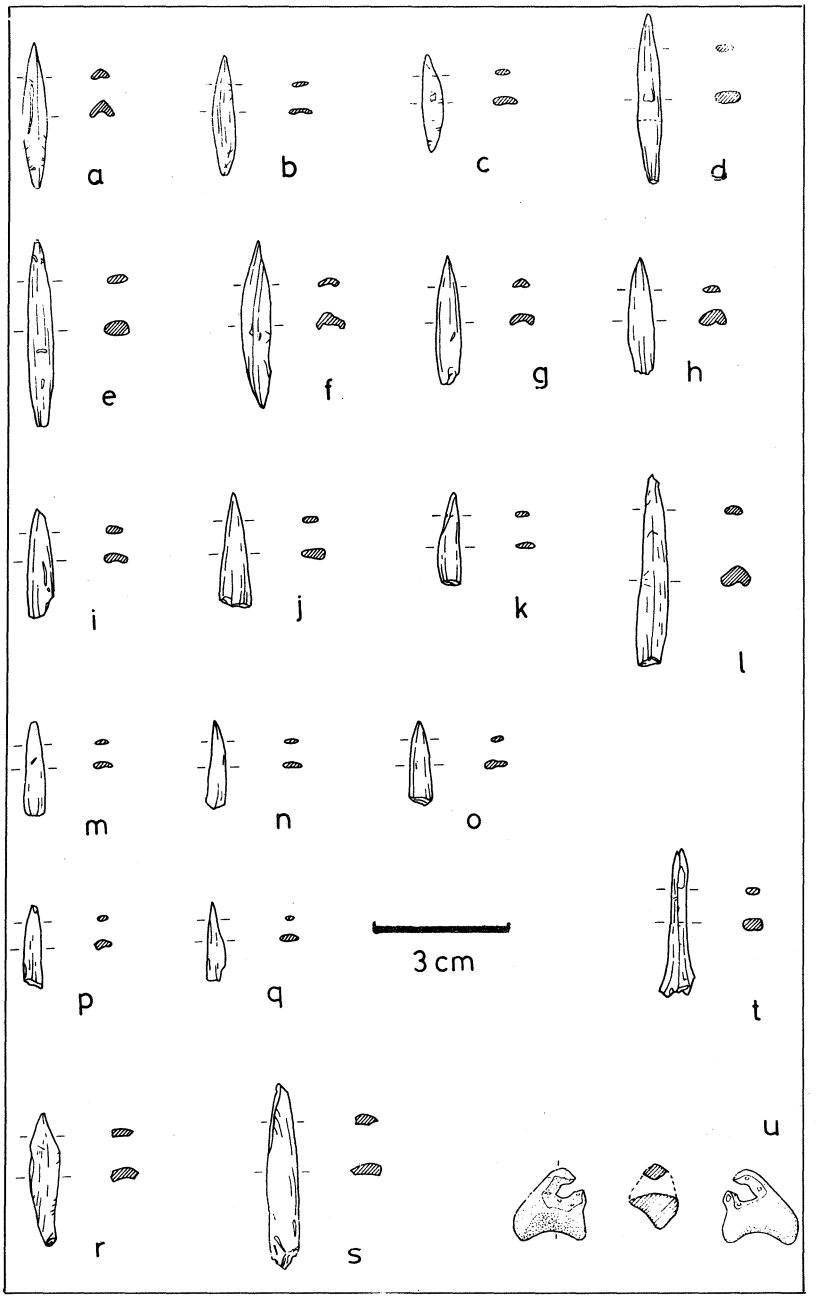


Fig. 8. Bone artefacts. a-q: bi-points; r-s: apparently unfinished bi-points; t: unipoint; u: pendant? See Table 8 for locations.

Table 8. Bone Points

Ref. to Fig. 8	Level	Square	Actual Measurements (mm) L B Th	Actual or Estimated Full Length of Whole Points (mm)	Mean actual or estimated length per level (mm)	Cross Section	Condition
		C3	24x6x1	—		Concave	Mid portion?
m		E4	20x5x2	35		Flat	Broken
d*		E5	36x5x2	36		Oval	Complete — found in two fragments
	IV				35		
t		E5	32x5x2	?		Oval	? Complete — Uni-point on spinous process
		E6	17x3x2	30		Oval	Broken. Knife marks both surfaces
i		E6	24x5x2	38		Flat	Broken
s		C3	40x6x2	50		Flat	Broken. Unfinished?
o	V	D3	18x5x2	30		Concave	Broken
b		E3	26x5x2	27		Flat	Almost whole, tip off
c		E3	22x5x1	22	35	Flat	Complete
l		E4	41x6x2	50		Concave	Broken
		E6	24x5x1	35		Flat	Broken
		E3	16x4x2	32		Slight Concavity	Broken
r		C3	29x5x2	30		Flat	Almost whole, tip off, unfinished
g		C3	30x5x2	35		Concave	Broken — end off
n		C3	19x3x1	30		Flat	Broken
f	VI	D3	37x5x3	37	33	Concave	Complete
h		D3	27x5x2	32		Concave	Broken
j		D3	24x6x2	37		Flat	Broken
q		D3	18x4x1	29		Flat	Broken
e		D3	42x5x2	44		Oval	Tip off
k		D3	20x5x2	25		Concave	
	VII				29.7		
		D3	18x5x2	25		Flat	One end and one tip off
p		D3	18x4x2	25		Concave	
a	VIII	C3	33x5x2	33	33	Concave	Complete

*Found with both tips intact — Damage to tip shown in Fig. 9d occurred subsequently.

Table 9. Distribution Of Sherds — Numbers; Weight And Area (% only)

Levels	C3	D3	E3	E4	E5	E6	Totals	Percentages		
								Nos.	Weight	Area
I	—	—	1	—	1	1	3	5.7	8.0	7.7
II	1	—	1	3*	1	2	8	15.1	18.4	17.1
III	2	2	3*	9	2	1	19	35.9	29.7	33.3
IV	2	3	4	8	—	—	17	32.1	28.7	27.6
V	—	—	—	6	—	—	6	11.3	15.1	15.4
TOTALS	5	5	9	26	4	4	53			
Percentages: Nos.	9.4	9.4	17.0	49.1	7.5	7.5				
Percentages: Weight	16.9	12.0	14.7	40.4	7.4	8.6				
Percentages: Area	13.3	9.8	16.1	44.9	8.3	7.7				

(* = Presence of 1 Group B sherd.)

Two rim sherds were found in level IV (Fig. 9a-b). Both fragments are very small, but appear to be from vessels with direct rims. Both sherds have indented lips, the indentations having been made with a thin stick or some similar implement being pressed down into the damp clay.

Four sherds are decorated with incised lines (Fig. 9c-f). Three have one to three fairly deep, U-sectioned incisions which could have been made with a stick, and one has two shallow, slightly wavy and non-parallel lines, clearly incised sequentially. The incisions are irregular in depth and thickness. Table 10 gives data on the decorated sherds. Note that the aspect of the decoration is deduced from the curvature of the sherd.

There is some correlation between decoration and sherd thickness. While half the sherds are only 2 mm thick and only 9 are 4 mm or more thick, three of the four decorated sherds come from the latter group. This may simply indicate that pots were of variable thickness and the thicker part was selected for decoration.

These sherds may be compared with those recovered by Clay from a test excavation in rubbish mounds at Pinikindu, 50 km to the south of Balof (Clay 1974). He divides the sherds into three temper groups—

I. Heavily tempered with crushed shell, possibly some fossil shell and coral. Sherds appear over-tempered and are very crumbly.

II. Temper of rolled white sand and other local constituents. These are the "best made" ceramics.

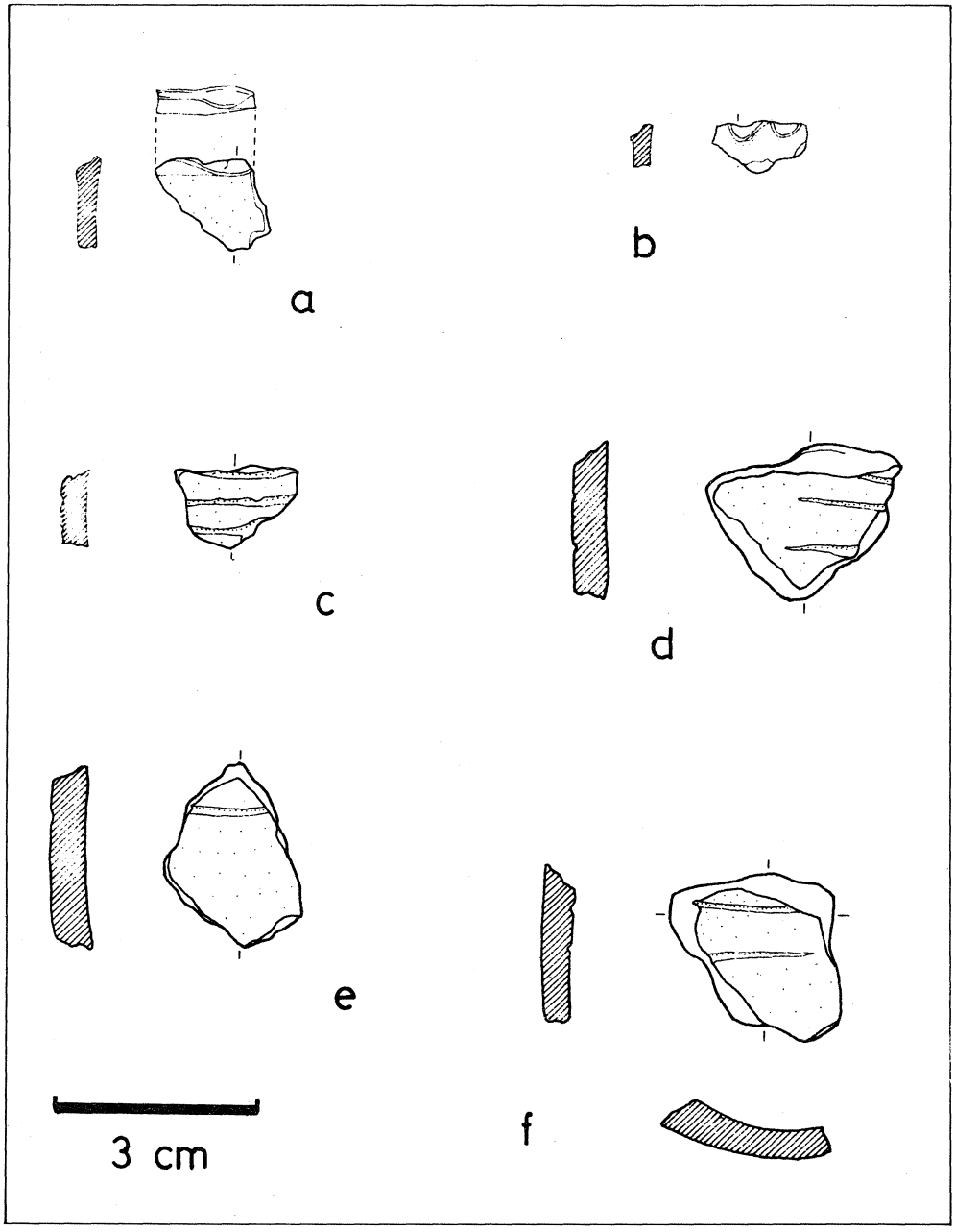


Fig. 9. Potsherds. a-b: rims; c-f: incised bodies.

Table 10. Decorated Potsherds

Ref. to Fig. 11	Location	Number of incised lines	Distance apart (mm)	Aspect	Thickness of sherd (mm)
f	D3 (3)	2	6	Interior	6
c	E5 (3)	2	3	Exterior	3
e	E5 (3)	1	—	Exterior	4
d	E4 (5)	3	4–7	? Exterior	6

III. Temper largely of black, freshly facetted volcanic sands, along with some white sand. Black sand is not present in the area and the sherds or temper may derive from elsewhere.

Clay's groups I and II are similar to the Balof A and B sherd groups. Pottery of similar appearance to the Balof A group is also common among the sherds excavated at Lesu (White 1972b:309), but a detailed analysis of that material has not yet been made.

As regards decoration, linear incisions are not reported from Pinikindu and are rare at Lesu. At both these sites applied relief is the most common decorative mode, but in both cases the majority of sherds are undecorated. Crenellated rims occur at all three sites.

STONE

(i) Sources. An initial division of the non-local stones into obsidian and other stone was made. The obsidian was sent to W. R. Ambrose (Dept. of Prehistory, Australian National University) for sourcing as part of his project on obsidian sources within Melanesia. Samples of all other rocks from the site were idenified by D. McColl, Curator of the Bureau of Mineral Resources Museum, Canberra. The probable sources of rocks thus identified were distinguished by P. D. Hohnen, who has carried out geological surveys of New Ireland for the Bureau of Mineral Resources. The results of these identifications are given in Table 11.

Group 1. Rocks in this group have not been found in New Ireland. They form 9.0% of the total non-local rock weight recovered.

(a) Obsidian (2.8%). Forty six pieces of obsidian have been subjected to the technique of prompt nuclear analysis by W. R. Ambrose (Ambrose 1977; Bird and Russell 1977). Preliminary attributions as to provenance have been made on the basis of results for Na440, Al 1013 and F, and we are most grateful to Mr. Ambrose for the early release of these attributions. Table 12 shows that obsidian from levels VI and VII is all from Talasea, and that this source continues to supply stone throughout the site's history, but is supplanted in importance by Lou Is. (in the Admiralty Is. group) in levels IV-II.

(b) Coloured and black cherts and chalcedonies (6%). Hohnen found only grey and white chalcedonies on New Ireland and considers that these coloured varieties are unlikely to be from the island. Probably they are from New Britain. However, since these rocks are vein-or cavity-filling deposits a precise sourcing is impossible without minerological analyses like those done by Ward and Smith (1974).

Table 11. Rock Materials And Probable Sources

SOURCE		ROCK	Weight in grams: LEVEL I	II	III	IV	V	VI	VII	VIII	TOTAL EACH ROCK	% EACH ROCK
1. Not found on New Ireland	(a) Lou Is. and Talasea	Obsidian	3.1	2.6	6.3	1.6	2.1	8.4	20.1	—	44.2	2.8
	(b) Source not located	Black chert with a chalcedony vein	—	—	—	—	—	17.6	4.0	—	21.6	1.4
		Coloured cherts & chalcedonies	—	—	—	—	—	15.0	31.5	25.0	71.5	4.6
	(c) Islands to the northeast	Pumice	—	0.7	1.0	—	—	—	—	—	1.7	0.1
		Flow Basalt	—	—	0.2	0.9	—	—	—	—	1.1	0.1
2. New Ireland	Altered volcanics — not character-istic of any particular location	Grey & White cherts & chalcedonies	—	—	1.9	—	4.4	1.9	28.7	9.5	46.4	3.0
		Lightly altered Lava	—	—	20.3	3.7	—	—	13.7	2.6	40.3	2.6
		Agate	—	—	—	—	—	5.6	—	6.9	12.5	0.8
		Jasper & Jasperized Volcanics	—	—	—	1.2	—	7.4	15.3	34.3	58.2	3.7
		Altered Andesite	31.7	—	1.5	9.3	7.3	49.9	66.6	19.0	185.3	11.9
		Flow Rhyolite	0.3	—	—	—	—	—	3.9	12.3	16.5	1.1
		Basalt or Dolerite	—	—	4.1	—	—	—	7.6	—	11.7	0.7
		Volcanic Agglomerate	—	—	—	—	—	29.1	—	—	29.1	1.9
		Acid Volcanic Rhyolite	—	—	4.1	—	—	—	—	25.7	29.8	1.9
		Silicified Chloritised Volcanics	—	—	20.7	1.1	14.7	42.5	74.1	20.2	173.3	11.1

Table 11. Rock Materials And Probable Sources

SOURCE		ROCK	Weight in grams — LEVEL I	II	III	IV	V	VI	VII	VIII	TOTAL EACH ROCK	% EACH ROCK
3. Specific locations within New Ireland	(a) West or South	Microgabbro dolerite	8.6	—	—	56.9	—	31.2	92.9	6.6	196.2	12.6
		Microdiorite	—	—	2.9	8.1	10.0	3.3	4.6	97.5	126.4	8.1
	(b) Central Lelet Plateau	Lithic Tuff	2.3	—	—	—	3.4	5.2	10.3	26.2	47.4	3.0
		Scoria	—	—	—	—	—	0.5	—	—	0.5	0.1
		Laterite	—	—	0.7	0.7	2.0	11.4	17.6	—	32.4	2.1
		Ochre	—	—	—	—	—	—	9.8	—	9.8	0.6
		Ochreous Claystone	—	—	—	—	—	1.2	—	—	1.2	0.1
	(c) Limestone plateau	Fine-grained Sedimentary	—	2.6	—	8.4	1.2	31.3	42.1	4.8	90.4	5.8
		Travertine	—	—	—	—	—	—	—	30.2	30.2	1.9
		Limestone mail	6.5	—	11.5	1.7	0.6	7.1	—	17.8	45.2	2.9
		Fossilized material Calcite	—	—	—	—	55.8	69.1	3.4	—	128.3	8.2
4. Unidentified			—	—	—	—	105.0	—	6.4	—	111.4	7.1
TOTAL WEIGHT — Rocks in each level in gms			53.0	4.8	74.9	93.6	206.7	337.7	452.6	338.6	1561.9	
% of rocks/level			3.4	0.3	4.8	6.0	13.2	21.6	29.0	21.7		

(c) Pumice and flow basalt (0.2%). These rocks originate from areas of recent volcanism, and are likely to have been brought to the site along with obsidian. Alternatively, the pumice, at least, may have floated to the New Ireland coast from islands to the northeast, and been collected on the shore.

The presence of exotic raw materials in all levels suggests that exchange networks are of some antiquity in the area. It is interesting to note that the probably exotic cherts and chalcedonies occur exclusively in the lower levels, perhaps implying that that the earlier exchange networks were less source-exclusive than the later ones, which seem to have been based entirely on obsidian. Further there is at least twice the weight of exotic rocks in the lower 3 levels as compared with the upper 5, implying that the more recent exchange was on no greater scale than that which occurred earlier, prior to the introduction of pottery.

Group 2. Rocks of New Ireland origin, but which are vein-or cavity-filling deposits and hence not referrable to a particular area at present. These form 38.7% of the total weight of rock from the excavation.

Group 3. Rocks from specific areas of New Ireland (45.3%).

(a) West or South coast (20.7%). The nearest source for these materials is on the west coast, a little to the south of Balof, but a precise location cannot be determined.

(b) Central Lelet plateau (5.8%). Material from this area includes ochres and similar materials.

(c) Limestone plateau (18.8%). This area is nearest to the site but does not provide good materials for flaking.

Some idea of possible rock sources is given in Figure 1, based on data from the B.M.R. map of Papua New Guinea geology. According to Mr. J. Casey (B.M.R., Canberra) (pers. comm.) the nearest source of any rock material suitable for flaking is probably a 'window' exposing Oligocene volcanic rocks, (2 above) in the younger Lelet limestone some 10 km south of the excavation. However, this likely source has not been identified. It is sometimes the case that small-scale rock sources are below the level of 'geological visibility,' but were exploited by prehistoric peoples. Recent failure to identify such a source would be particularly understandable in New Ireland with its history of inland depopulation in the last two generations.

(ii) Ochre. Apart from two lumps of ochre in C3(7), a small piece of retouched stone from the same location is coloured red on both sides. A piece of shell from level I is coloured red on one side and may have been used for mixing powder with liquid.

(iii) Anvil (Fig. 10a). A pebble weighing 105 gm was found in E6 (5). On one of its faces a rounded concavity had been battered while the other face was bruised and pitted. Anvils are not reported from New Ireland sites but Specht (1969:264) reports them from Buka.

(iv) Ground stone. Two fragments of stone with grinding on two surfaces were recovered (Fig. 10b-c). One piece of basalt from C3 (3) weighs 4.1 gm and a piece of microdiorite from E3 (4) weighs 2.9 gm. These are the only pieces of axes recovered in the excavation. It should be noted that *Tridacna* shell adzes are common in coastal sites but none were found at Balof.

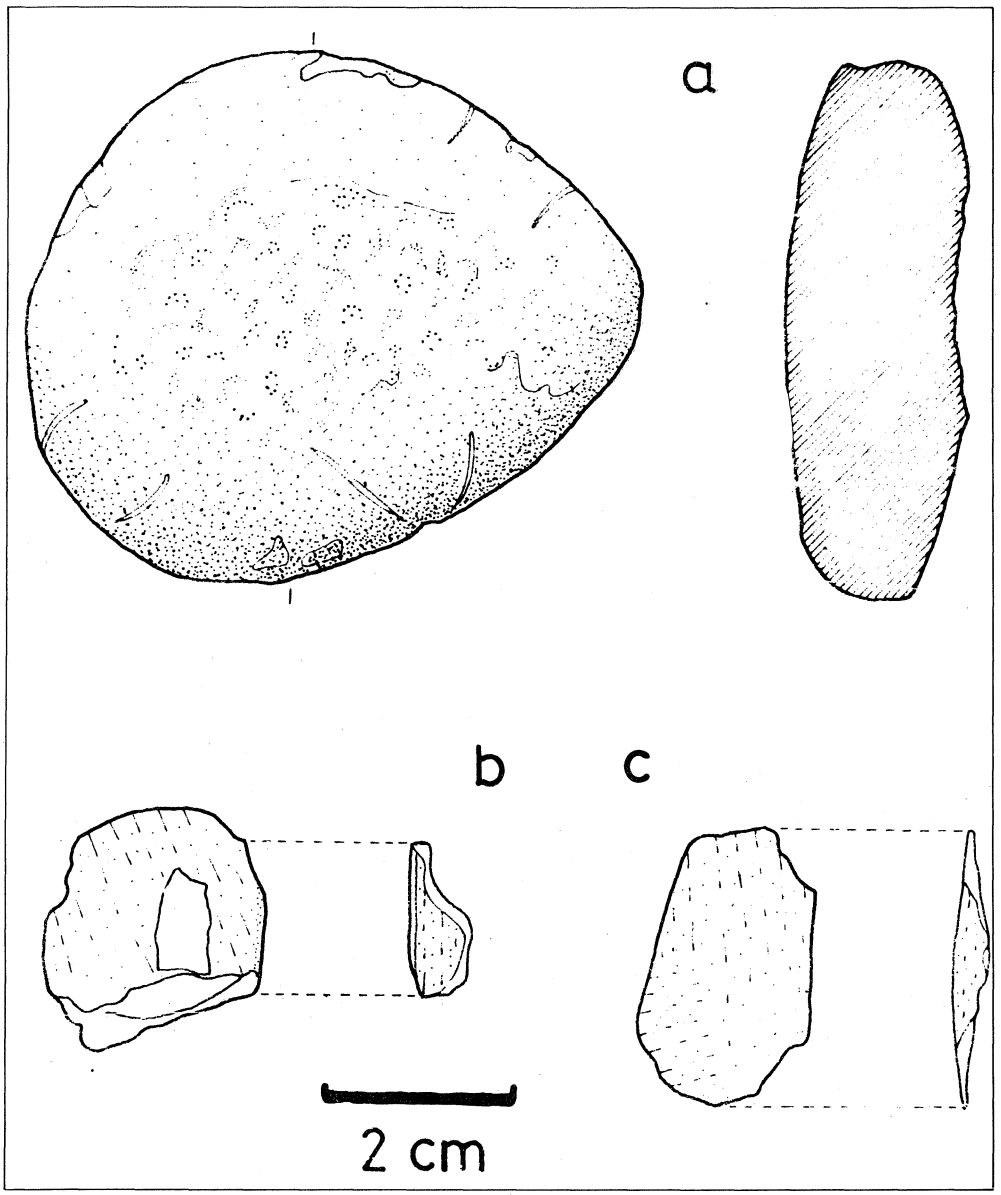


Fig. 10. Stone artefacts. a: anvil, E6(5); b-c: ground axe-adze fragments.

. (v) Flaked stone. A total of 403 pieces of stone that could be confidently identified as resulting in some way from knapping processes were excavated. Of these 46 were made of obsidian which was worked using a bipolar technique. Twenty-eight pieces, including 4 of obsidian, showed some retouch (4) or apparent use wear (24) and the remaining 331 were flakes and other knapping debris. Much of the obsidian occurred in the upper levels of the excavation but most of the other stone was found in levels VI-VIII.

Debris. The distribution of this material is given in Table 13. Over 80% of the debris occurs in levels VI-VIII. It was noted that all the coloured and grey and white cherts and chalcedonies, as well as the altered andesite (second most common variety of rock recovered) occurs among this material. No particular knapping technology could be determined from this debris.

Implements (Figs. 11, 12). Twenty-eight pieces of stone with altered edges were excavated. Step-flaked retouch occurred on only 4 stones, the rest exhibiting simply the removal of some small flakes along one or more sharp edges in a manner characteristically made by use. All the tools would normally be called 'scrapers,' but no attempt to make them in set and regular patterns could be observed. They appear to be *ad hoc* tools consisting of usable edges on pieces of stone which could be conveniently held in the hand. Their closest parallels are among the New Guinea Highlands tools described by White (1969). Many of the stones from Balof show alteration on several different edges (defined according to White 1969:24), and it is notable that all those with more than two altered edges are made on fine-grained stone.

Table 14 describes each piece of stone with one or more altered edges. The location of the alteration is given with reference to an axis drawn at right angles to the striking platform in the case of flakes, or to the longest dimension of the stone where no platform could be determined. Some indication of the size of stones is given by a surface area measurement which consists of length (defined above) times breadth, the greatest distance at right angles to this.

For the purposes of comparison, tools were grouped into two units — levels III-V and levels VI-VIII. Tables 15-17 compare weights and edges of these two groups and show no apparent differences.

Obsidian (Fig. 13). Apart from the four artefacts included in the previous section, 42 pieces of obsidian were excavated. Numbers and weights of all pieces are given in Table 18, which makes it clear that most obsidian occurred in very small pieces. About 60% of these pieces were flat flakes and exhibited battering and crushing at one or both ends (Fig. 13a). The remainder were also small flat or splinter shaped pieces, but without visible traces of working. In addition, a clearly defined bipolar or scalar core was found in E3 (7) (Fig. 13b). Both this core and the flakes are evidence for the continued use of a bipolar technique for flaking obsidian throughout the period of the site's use.

It should also be noted here that three larger flakes of obsidian were found (Fig. 13c-e). All have been used as tools and are described in Table 14, but they do not appear to have been flaked with a bipolar technique. Their occurrence in levels VI and VII, along with the absence of similar tools in higher levels, may be significant, and will be discussed further below.

In the nineteenth century obsidian was widely traded and used. Parkinson refers to trepanning, scarification and circumcision as well as wood-carving (1907 [n.d.] :104-8, 164, 166, 215), with the last use of course being likely to produce more debris. As Parkinson says, "As soon as an obsidian knife is useless, without any attempt to repair the edge, a new one is broken off. In the places where carving is done, splinters lie around in great numbers" (1907 [n.d.] :215).

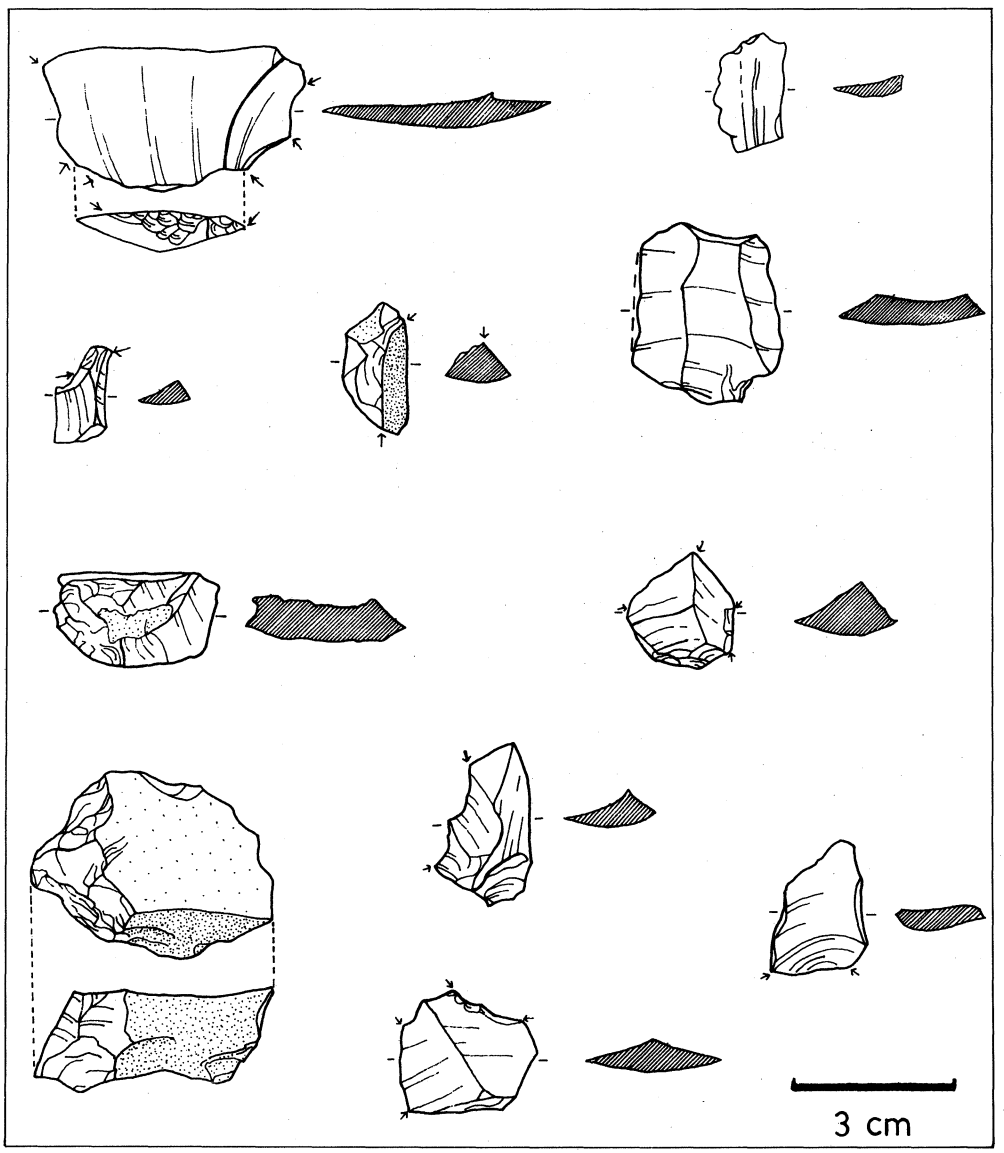


Fig. 11. Stone tools from levels VII-VIII.

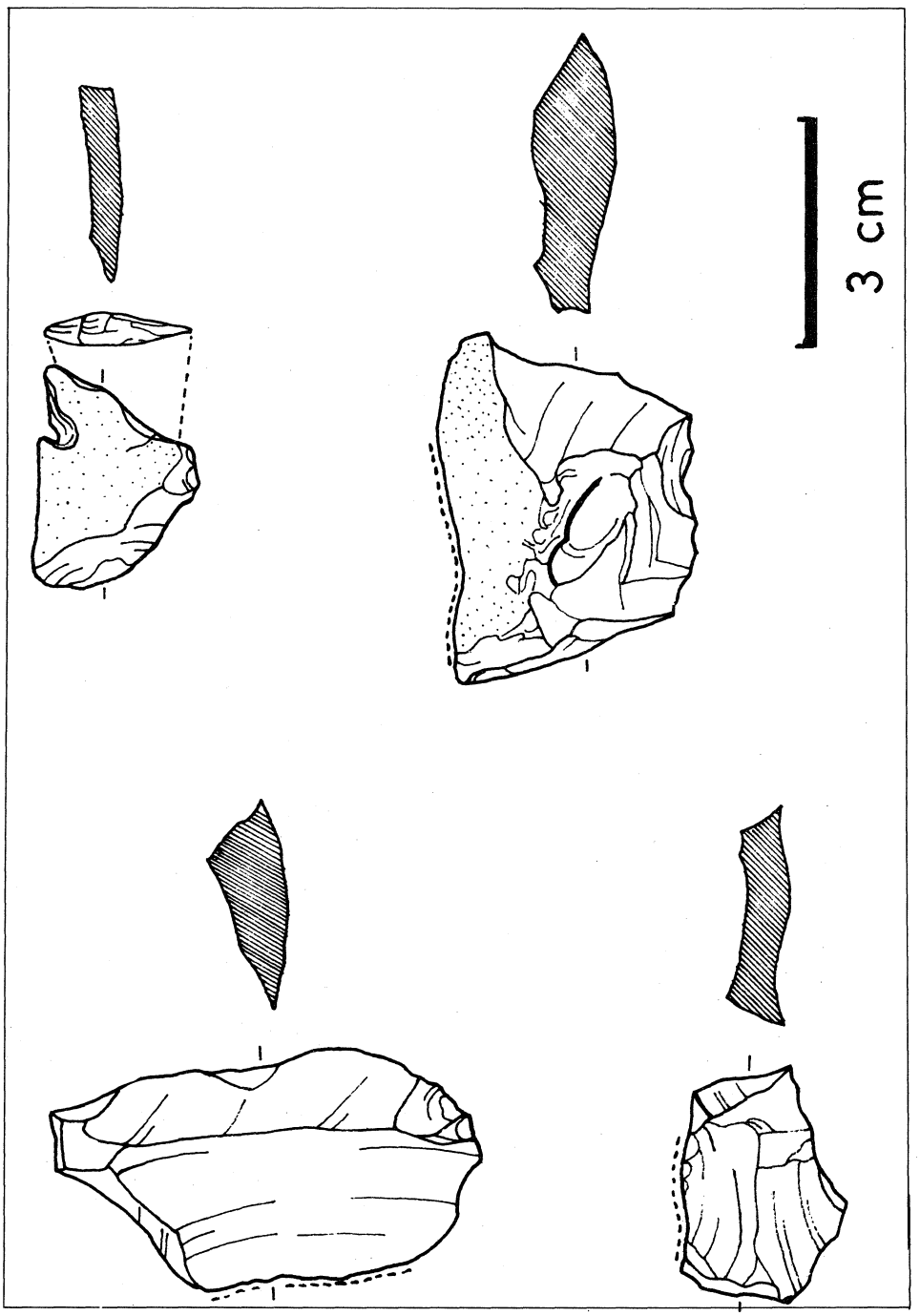


Fig. 12. Stone tools from levels III-V.

Table 12. Sources Of Obsidian (No. of pieces)

Level	Talasea	Lou Is.
I	2	1
II	1	4
III	4	11
IV	2	3
V	4	1
VI	4	—
VII	8	—
VIII	—	—

Table 13. Distribution Of Flakes Showing No Use Wear Or Retouch: Numbers And Weight (gm)

LEVELS	C3	D3	E3	E4	E5	E6	TOTALS	WEIGHT (gm)
I	1	1	2	—	—	1	5	42.9
II	—	—	—	—	—	1	1	2.6
III	—	2	—	2	—	1	5	4.7
IV	1	1	1	2	3	5	13	5.3
V	4	—	—	4	9	7	24	26.7
VI	8	7	—	10	6	13	44	155.6
VII	35	43	17	43	2	13	153	333.0
VIII	17	16	—	43	—	10	86	200.0
TOTALS	66	70	20	104	20	51	331	850.8

Table 14. Stones With Altered Edges

Level	Square	Weight (gm)	Area (sq. mm.)	Retouch	Location of Alteration	Lengths of Altered Edge (mm.)	Material
III	E3	20.3	1300		Both sides and end	27, 10, 24	Lightly altered lava or chert
	E4	20.7	1100		All edges altered	77, 20, 15, 5, 22, 18	Silicified chloritised volcanic
IV	E5	3.7	500		Side	10	Lightly altered lava
V	E3	2.6	450		Both sides and end	20, 11, 15	Calcite
	E5	7.7	500		End	15	Silicified chloritised volcanic
	E5	0.8	200		Both sides and end	10, 15, 5	Calcite
VI	C3	10.7	1050	✓	Both sides and end	30, 15, 15	Silicified chloritised volcanic
	E3	6.3	650		Multiplane	10, 15, 12, 7, 20, internal 20, 12, 4	Obsidian (Fig. 13b)
	D3	1.0	400		Both sides and end	30, 5, 20	Obsidian blade (Fig. 13c)
VII	C3	7.6	700		Both sides and end	10, 20, 6, 22, 10	Basalt or dolerite
	C3	3.7	250		Side	25	Obsidian
	C3	14.5	100		Side	20, 9	Microgabbro dolerite
	C3	2.3	400		End	5	Lithic tuff
	D3	3.1	300		Both sides and end	10, 11, 8, 30	Silicified chloritised volcanic
	C3	4.5	500		Both sides	18, 15	Fine-grained sedimentary chert
	D3	3.4	300	✓	Multiplane	15, 10, 9, 7, 10	Calcite, Fos. shell
	E3	26.8	1000	✓	Multiplane	5, 5, 20, 20, 5, 5	Fine-grained sedimentary chert
	E3	1.0	100		Side and end	3, 2	Silicified chloritised volcanic
	E4	2.4	250		Multiplane	9, 10, 10	Altered lava
	E4	7.0	450		End	13. Prob. Whole	? Flow rhyolite
	E6	2.1	250		Multiplane	12, 6, 6, 6	Tuff
	E4	11.6	700		Both sides and end	8, 17, 7, 20, 7	Obsidian (Fig. 13e)
	E6	1.0	200		Broken	10-edge not whole	Jasperized volcanic
VIII	C3	19.3	1100		Side, probably not whole	19	Microdiorite pebble
	D3	17.0	800		Multiplane	20, 21, 12	Silicified chloritised volcanic
	D3	5.6	500		Both sides	25, 20	Microdiorite pebble
	D3	.5	200		Broken	Edge not whole	Jasper
	E4	2.6	300		Side	20	Lightly altered lava

Table 15. Stones with Altered Edges: Weight (gm)

Levels	<4	4-9.9	10-19.9	>20	Total
III-V	3	1	0	2	6
VI-VIII	10	5	5	1	21

Table 16. No. of Altered Edges/Stone (%)

Levels	No. of edges								No. of Tools	Mean No.
	1	2	3	4	5	6	7	8		
III-V	33.3	—	50.0	—	—	16.7	—	—	6	2.8
VI-VIII	23.8	23.8	19.0	9.5	14.3	4.8	—	4.8	21	3.0

Table 17. Shapes of Altered Edges (%)

Levels	Straight	Concave	Convex	Wavy	No. of Edges
III-V	35.2	35.2	17.7	11.8	17
VI-VIII	50.0	29.7	10.9	9.4	64

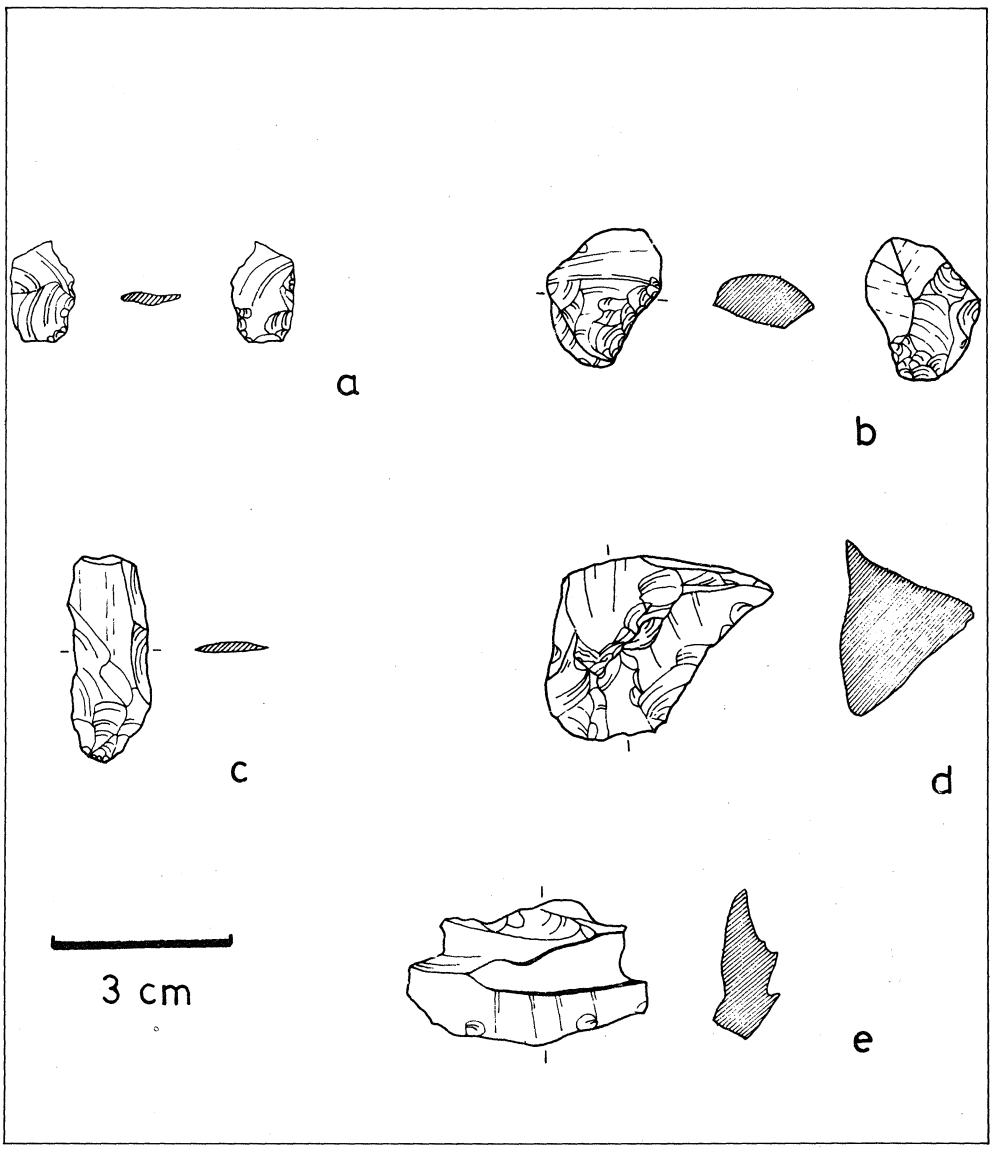


Fig. 13. Obsidian artefacts. a: typical small flat flake, C3(3); b: scalar core, E3(7); c: blade flake, D3(6); d-e: chunky flakes, E4(7), E3(6).

Table 18. Distribution of Obsidian (gm)

Each figure denotes the weight of a single piece

Levels	C3	D3	E3	E4	E5	E6	Total wgts (gm) and %	Total nos of flakes and %
I	—	2.5	0.4	0.2	—	—	3.1 / 7.0	3 / 6.5
II	0.5 0.7	—	0.3	—	0.6	0.5	2.6 / 5.9	5 / 10.9
III	0.6 0.4 0.4 0.3 0.2	0.1	0.4 0.3 0.3	1.0 0.8 0.3 0.3 0.2	0.6	0.1	6.3 / 14.3	16 / 34.8
IV	0.3	0.5 0.3 0.2	—	—	—	0.3	1.6 / 3.6	5 / 10.9
V	—	0.6 0.2	—	—	—	1.0 0.2 0.1	2.1 / 4.8	5 / 10.9
VI	—	1.0* 0.5	6.3*	0.6	—	—	8.4 / 19.0	4 / 8.7
VII	3.7* 0.2 0.2 0.1 0.1	1.2	3.0	11.6*	—	—	20.1 / 45.5	8 / 17.4
VIII	—	—	—	—	—	—	— / —	— / —
Totals	13	10	7	8	2	6	44.2 / 100	46 / 100

* Marks a piece with altered edges or a core

4. DISCUSSION

STRATIGRAPHY AND THE SAMPLE

In the preliminary report on Balof, it was suggested that there were two main levels, an upper marked by bone points, pottery and obsidian, and a lower with a wider range of retouched tools made of stone other than obsidian (White 1972b). This report shows that a simple division into two stages cannot be maintained, although as Table 19 shows there are clear changes through time in the artefactual content. Within levels IV-V, several items were added to the inventory, one at least was dropped and there was a change in the nature and quantity of worked stone.

It is possible that the changes at Balof all occurred at a particular time, but various taphonomic processes have combined to obscure this. For example we might expect that not every kind of new item brought into the area would be carried to the site and immediately deposited there. Then, too, it is also clear that the accumulation of deposit at Balof was slow(*c*.15mm/100 yrs.), and there must have been some re-working of it by both casual and deliberate human activities. The absence of visible hearths and pits other than near the surface, along with the uniform texture of the soil is adequate witness to this. It must therefore be considered whether we should regard levels IV and V, and perhaps even III and VI, as "mixed." As Stockton (1973) has shown in other conditions, small objects tend to move downward in some kinds of deposit while larger ones move upward. Should these processes be used to explain the obsidian chips and bone points in the lower level, and the larger pieces of altered local stone in the upper? If we took the interface of levels V and VI as the transition point, this would imply the downward displacement of some 13 pieces of obsidian (25% of the total), including the five *largest* pieces, and 12 bone points (45% of the total), as well as the upward displacement of six stone tools (20%). This would have occurred in a deposit which was not dry, fine sand but a slightly damp, fairly fine soil, reasonably well packed and containing large quantities of shell and bone. In the light of Stockton's (1973) data and Matthews' earlier discussion (1963) we are reluctant to believe in such large-scale resorting of artefacts in this deposit, while recognising that some has certainly occurred. In particular we suggest that much of the lower obsidian and most of the upper stone tools are in a relatively correct stratigraphic and thus chronological relationship. The implications of this will be discussed below.

Further, we draw attention to the fact that only 6 square metres have been excavated from a site which, if it stretches over the entire sheltered area, will be some 100 m^2 in extent. Given that different parts of a site are likely to be differently used, and that rubbish deposition areas in odd corners may be less disturbed by subsequent activities, we see further excavations as having some potential not only for finally resolving the displacement problem just discussed but also, perhaps, for isolating different areas of site use.

In conclusion, we note that the common occurrence of shells and land animal bone throughout the deposit suggests the presence of both females and males, but that most of the artefacts, the uses of which are inferred from ethnographic data, were probably used by men (bone points, stone axes) or are not sex-linked, at least in the form in which we find them (obsidian flakes, shell tools, arm-rings).

FAUNA

The sample of faunal material from the site is too small for any major conclusions to be drawn. It is interesting to note that fish remains occur only in level V and above, while it is in level IV and above that shellfish derive from a wider range of environments, including the reef and lagoon. These changes hint at some economic re-orientation,

Table 19. Summary of Excavated Material

Levels	Arm-ring	Pig bones	Fish bones	Ground Stone	Pottery	Shell tools	Obsidian	Shark teeth	Bone points	Prob. imported chalcedony	Bone pendant
I	—	✓	✓	—	✓	✓	✓	—	—	—	—
II	✓	✓	✓	—	✓	✓	✓	✓	—	—	—
III	✓	✓	✓	✓	✓	✓	✓	—	—	—	—
IV	—	✓	✓	✓	✓	✓	✓	✓	✓	—	—
V	—	—	✓	—	✓	✓	✓	✓	✓	—	—
VI	—	—	—	—	—	✓	✓	—	✓	✓	—
VII	—	—	—	—	—	✓	✓	✓	✓	✓	✓
VIII	—	—	—	—	—	—	—	✓	✓	✓	—

possibly associated with the observable artefactual changes, but we cannot be more definite. There is no diminution in the numbers or range of land-based animals, and remains of the only animal not now present on the island (*Macropus agilis* or *Dendrolagus* sp.) occur in upper levels, so that the site must have been a base for cooking hunted animals throughout its history. The occurrence of pig in levels IV and above only may be significant. Pig is commonly associated with first millennium B.C. settlements in island Melanesia (Green 1976) and was, of course, introduced to mainland New Guinea long before this (White 1972a; Bulmer 1975). It is possible that pigs were brought into island Melanesia only by the widespread exchange network associated with dentate-stamped 'Lapita' pottery and obsidian (Green 1976), but more data from sites older than the second millennium B.C. are required to determine this.

POTTERY

Although some general similarities can be seen between the sherds found at Balof and those from other New Ireland sites, the amount of material is too small for detailed comparative analyses. This also affects any discussion of the relation between the pottery at Balof and either the Lapita pottery complex (Green 1974) or the 'Sohano style' of pottery found on Buka and Sohano Islands (Specht 1972). Given that pottery appears at Balof probably around 2000-2500 years ago and similar ceramics occur at other sites in the same area (Clay 1974; White 1972b), and remembering that in this region classic 'Lapita style' pottery has been found only on small islands to the north and south of New Ireland (Egloff 1975; White and Specht 1971), we are inclined to think that New Ireland pottery is a local development, perhaps by some kind of "stimulus diffusion" from Lapita-style pottery makers. It is already clear that there is a complex relationship between 'classic' Lapita and more local pottery traditions in the New Hebrides (Garanger 1971) and the Solomons (Specht 1972): we suggest a similar situation occurred in New Ireland, though without yet being able precisely to define the nature of the relationship.

STONE

The stone artefacts from Balof are interesting for two reasons — technological and material. Technologically two different flaking processes occur concurrently. While most of the obsidian is flaked with a bipolar technique, other stone is knapped in a more *ad hoc* fashion. The latter seems to be common to New Guinea, Melanesia and beyond (White 1969) and probably represents the original form of stone tool use in the area.

Bipolar flaking will produce a larger number of small sharp-edged pieces from a small piece of stone than will other techniques, particularly if the core is wrapped so that the force of the hammer below is cushioned and directed downwards (White 1968). The flakes at Balof may appear too small for use, but JPW has observed flakes of similar size, held between thumb and forefinger, used frequently for carving in the New Guinea Highlands (see Lampert 1971 also).

Bipolar techniques have been noted by JPW in the obsidian exchanged throughout Melanesia in the first millennium B.C., but no thorough examination has been made of the technologies used on this material at any location. The multitude of small flat flakes found at Balof are paralleled at Lesu (New Ireland), Ambitle Is., and the Reef Islands sites and we suggest that the use of this flaking technique is linked to the rarity of obsidian and the consequent need for economy in its use.

Overall, the changing pattern of stone resources drawn on at Balof is an important one. First, we note that in the earlier levels all obsidian came from the Talasea source on New Britain, some 600 km of coastal travel distance. This early obsidian was not always flaked in the most economical way, as a few larger, non-bipolar pieces show. In the

earlier levels too, the presence of a range of other rock types whose sources probably lie at some distance away, on or off the island, points to a wider network of resource exploitation than occurs later. It seems likely that this network of stone exchange, which existed from some 6000 years ago formed the structural basis upon which the better-known exchange systems of the first millennium B.C. were erected.

By about the first millennium B.C. — Balof data does not allow us to be very precise in dating — it is notable that stone other than obsidian has become much scarcer and the obsidian itself comes mostly from Lou Island, in the Admiralty Islands group. This source, although closer to Balof (480 km), lies on the other side of a 175 km direct sea crossing, and it is not surprising to find its exploitation developed later in time. Other sites in the region (e.g., Watom) show that the Talasea source continued to be exploited in this period, and a few pieces were traded as far as Balof. All obsidian in these levels is flaked with a bipolar technique.

We also draw attention to the fact that stone other than obsidian was almost completely absent from the Lesu site, dated probably to 1500-2500 B.P., and most (all?) obsidian there was flaked with bipolar technique. The consistent data from these two sites encourages us to think that exchange networks were more highly integrated and specialised in the first millennium B.C. than they had been earlier. We predict, on the basis of this reconstruction, that the majority of obsidian at Lesu will be found to be of Lou Is. origin.

CONCLUSION

The 6 m^2 excavation at Balof has demonstrated the human settlement of New Ireland probably some time in the fifth millennium B.C. The presence of humans in island Melanesia at this time has previously been predicted on the basis of the occurrence of Non-Austronesian languages, and surface finds of apparently "old" stone tools (Shutler and Marck 1975; Shutler and Kess 1969), but no dated archaeological site had been located. Balof is such a site.

The material excavated demonstrates, to a limited degree, that whereas early inhabitants drew on a wide range of stone sources (including Talasea obsidian), hunted land animals (one to extinction?), and collected most shellfish from a particular environment, later users were in possession of pottery and also made use of a wider variety of marine resources, but drew on a narrower range of stone resources, particularly Lou Is. obsidian. Small bone bipoints may be linked to hunting or to some activity no longer current, but whether arm-rings, ground stone axes and the possession of pigs are all restricted to the later users remains to be determined by research on a larger scale.

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