SETTLEMENTS ASSOCIATED WITH THE INLAND SEPIK-RAMU SEA

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INTRODUCTION

This paper reports on the discovery and our current knowledge of some marine-shell middens in the lower Ramu area of Papua New Guinea. The fieldwork was carried out in association with John Chappell of the Australian National University (cf. Swadling *et al.* 1989). When these sites were occupied, they were located along the shore of a former inland sea. Our work in determining the extent and history of this inland sea has generated a series of models which have been discarded or updated as new data come to hand.

A short summary of our current understanding of the history of the inland sea is as follows. During the early Pleistocene, uplift of the northern ranges transformed a former continental-margin sea into a barred-basin inland sea. Sediment from these newly uplifted ranges then began to infill the inland sea, while fluctuating sea levels, associated with the advances and retreats of Pleistocene ice sheets, produced a migratory coastline. The rapid post-glacial sea-level rise began the last phase of this inland sea. Large rivers such as the Sepik and Ramu probably had elongated "birdsfoot" deltas where they entered the inland sea. When sea level stabilised around 6,000 years ago the inland sea rapidly reduced in size. During the mid-Holocene the Bosmun Plateau would have been an island, but by the late Holocene the inland sea had become a shallow freshwater lake fed by the large rivers flowing into its inland reaches. The coastal entrance to this lake was probably restricted. From the entrance a wedge of salt water penetrated into the lake and this would have been extended by wind- and wave mixing. Marine taxa did not extend far inside the lake, but estuarine taxa were present well beyond the coastal entrance.

THE DONGAN SITE (JMB)

Discovery and Location

A Papua New Guinea National Museum archaeological team went to the Bosmun Plateau in 1986, as it was predicted that sites associated with the proposed former inland

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Sepik-Ramu sea would be found there (Swadling 1990, a conference paper presented in 1984). According to Swadling's model, the Pleistocene-aged Bosmun Plateau would have been an island 6000 years ago. It was hoped that by talking to villagers and making field surveys coastal sites dating to 6000 years ago would be located. The Bosmun village complex was targeted as a good location to start, as the Bur River gave ready access to this village and the eastern part of the plateau (Figure 1).

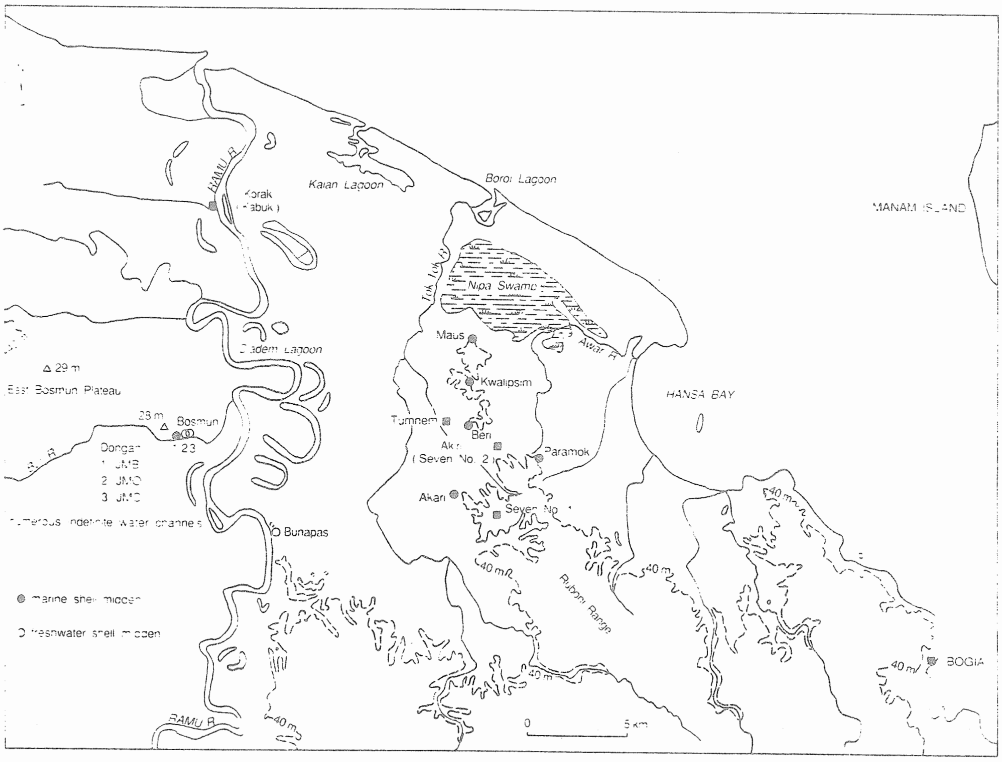

FIGURE 1: LOCALITY MAP OF THE LOWER RAMU

When Swadling and Araho arrived at Dongan village, one of the Bosmun settlements, they found marine shells eroding out of the Bur River bank. The width of the midden as exposed in the river bank is 50 m. The test excavation revealed that it was some 2.5 m thick and covered by 3 m of river alluvium. If the site had not been exposed by the river, it would not have been found (see photographs in Swadling *et al.* 1988:14-17).

The Test Excavation

In order to gain an understanding of the stratigraphic relationship of the midden and riverine deposits, a test excavation trench was dug which exposed the deposits from the top of the bank to the river (Figure 2). Steps were dug in the brown riverine sediment overlying the midden to try and expose any volcanic ash deposits from offshore volcanoes,

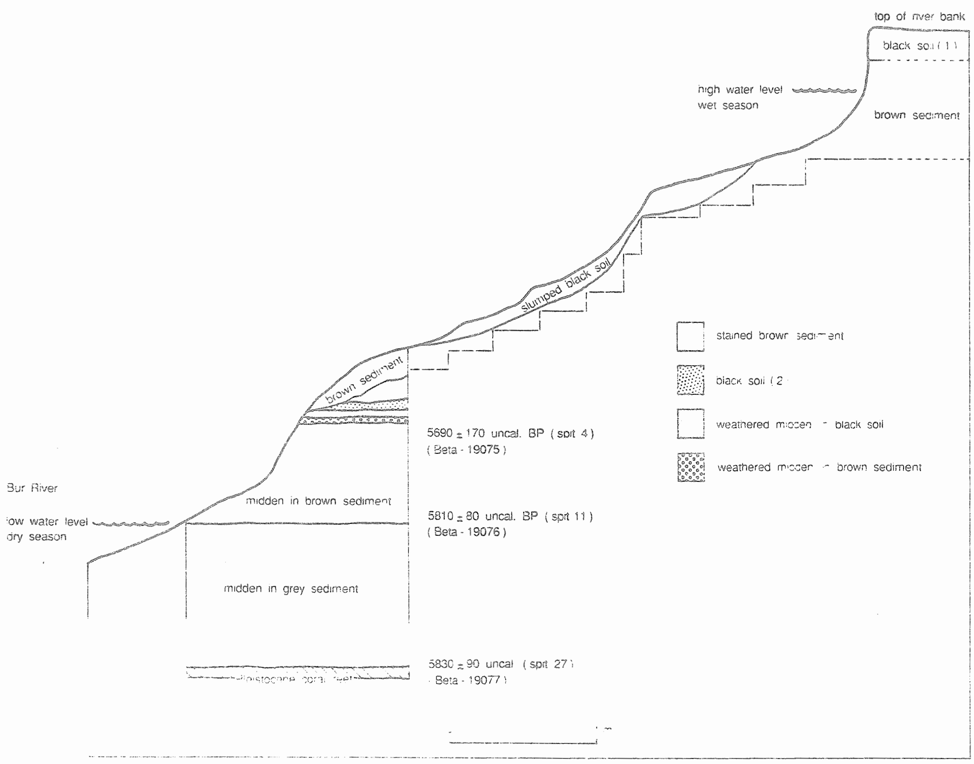

FIGURE 2: WEST FACE OF EXCAVATION TRENCH, DONGAN MIDDEN (JMB)

such as Manam, or evident layering in the river sediments. Neither was observed during the 1986 field season, but when Chappell, Swadling and Ivuyo visited the site in 1987 some variation in the sediment build-up was noted. This was best demonstrated by a small freshwater midden that occurs as a lens in the brown river sediments. This midden (JMO) is some 100 m downstream from the large mid-Holocene midden (JMB). It is 170 cm from the top of the river bank and rests on coarse sand. This poorly preserved lens of shell is 55 cm wide by 12 cm deep. No cultural material was found. The shells gave an uncalibrated radiocarbon date of 1430±70 BP (ANU-6076).

A different strategy had to be adopted to investigate the underlying midden deposits at JMB as it was evident that a large part of the midden was below the current river level. In order to obtain controlled stratigraphic samples from the midden, a pit 130 by 150 cm was dug. Within this pit a bench 130 by 50 cm was excavated by trowel on the landward side. When no stratigraphic changes were evident, the midden was excavated in 10 cm spits. This allowed the controlled excavation of the midden deposits below the river level. Frequent bailing was required to remove the water constantly seeping into the pit.

Each night seepage flooded the pit. In the morning this water was clearer and cooler than the river water. Village women came to the hole at dawn to fill up lengths of bamboo with water for village use. This clean water was a delight to the villagers as they had been informed by water-resource specialists that they could never expect a clean groundwater source in their area. Our excavation demonstrated that the deposits overlying the Pleistocene reef were acting as an aquifer even in an extremely dry year like 1986. A brief on this discovery in our field report pointed out that any future drilling should avoid the midden (Swadling and Araho 1986).

The base of the midden rests on recrystallised Pleistocene reef (J. Chappell pers. comm. 1987). At the time people were dumping their refuse on the midden heap, this reef would have provided an area of hard shore on the eastern tip of the island. The sheltered shore along the southern side of Bosmun Island would have been lined by mangroves. The northern coastline would have been a black-sand beach with pandanus growing along the strand, and possibly coconuts.[1]

After its abandonment the midden was infilled by encroaching grey marine mud to half its height. By the time this level was reached the coastline must have prograded north of the site, as the upper half of the midden is infilled with brown riverine sediments. The cap of the midden consists of weathered shells overlain by a black soil. The black soil continues into the top of the weathered shells and they continue into the brown riverine sediments. This suggests that the top of the midden was exposed for some time after the site was abandoned. The time that it took for the underlying grey marine mud and subsequently the riverine sediments to encroach on and blanket the midden was sufficient for this weathering and soil formation to take place. The small shell midden (JMO) indicates that the brown sediments were being deposited by 1430±70 BP (ANU-6076) while a charcoal date of 970±80 BP (Beta-19078) for the ancestral Bosmun village middens near the top of the river bank provides an indication of when the current floodplain was established in the Bur River area (these dates are uncalibrated).

The top three layers of the mid-Holocene midden were dug stratigraphically (see Figure 2). They are the black soil, the weathered shell in black soil and the weathered shell in brown riverine sediment. The rest of the site was dug in 10 cm spits. Spits 4-11 consisted of marine shell in brown riverine sediment and spits 12-27 of marine shell in grey marine mud.

Three radiocarbon dates from charcoal excavated from the 130 by 50 cm bench are available. These were taken from near the top (spit 4), middle (spit 11) and bottom (spit 27) of the midden deposits (Figure 2). The top sample was the first surviving charcoal found and was in poor condition compared to the middle and bottom samples. The first identifiable plant remains were not recovered until spit 6.

The uncalibrated radiocarbon dates are as follows: spit 4, 5690±170 BP (Beta-19075) spit 11, 5810±80 BP (Beta-19076); spit 27, 5830±90 BP (Beta-19077).

Only once in living memory has the Bur River overflowed its bank during the wet season (Bill Morong pers. comm.). In an extreme dry season the top of the midden is exposed as the river level drops, but the mid- to basal deposits remain waterlogged preserving the organic materials present.

The base of the midden is 0.5 m below mean sea level. We observed that at high tide the flow of the Bur River reverses and the water level noticeably rises.

The Shell Deposits

The bulk of the midden consists of mudflat- and mangrove- associated shellfish. The main species present are as follows: *Terebralia palustris, Saccostrea echinata, Polymesoda (Geloina) coaxans, Telescopium telescopium* and *Anadara granosa*. Mangrove bark is still attached to many of the *Saccostrea* shells.

Of the other shell species present, apart from a *Neritina* species (mostly occurring from spit 9 upwards) and a *Barbatia* species (found only below spit 14), all had frequencies of less than ten specimens each. They include the bivalves *Anadara antiquata, Anodontia* sp., *Isognomon ephippium, Periglypta* sp. and the gastropods *Balanus glanolula, Cerithidea cingulata, Neritina crepidularia, Peristernia ustulata, Turbo petholatus* and *Vemacumantus australis.*

The range of species found, their frequencies and size, were examined to see whether any changes could be attributed to human exploitation or coastal progradation. In the field a plastic bag 25.5 by 47 cm was filled with what was considered to be a representative sample of the shells present. When the range of species seemed higher, two bags were filled. This is clearly not an ideal sampling technique, but without any means of processing large numbers of shells in the field or funds to ship large quantities back to Port Moresby it was the most efficient procedure available to us. For the first three spits insufficient *Terebralia palustris* were bagged (Figure 3), but this problem was recognised in the field and more of the most common species were bagged. The increase in *Saccostrea echinata* and *Polymesoda (Geloina) coaxans* at the base of the midden reflects their dominance in this part of the site.

Apart from archaeological sampling considerations, the composition of the midden also reflects the industrial use of the shell by the occupants of the site. Our observations suggest that the *Polymesoda* in the midden will probably be less than the actual number of shells gathered. Many *Polymesoda* were broken, indicating that these shells had been used as cutting implements before being dumped. Some *Polymesoda* and *Anadara* had been holed in the way characteristic of fishnet weights. *Polymesoda* are also the most favoured shellfish in Papua New Guinea for making lime to be consumed with betel nut. This nut was recovered from the midden, but we cannot demonstrate whether lime was or was not being used. It certainly is today. Dongan villagers quickly carried away all the large *Polymesoda* shells recovered from the base of the excavation which were not included in our sample. (Curiously, the Akiri villagers were only interested in the *Terebralia* and, to a lesser extent, the *Telescopium* shells from the Akari and Beri excavations and discarded *Polymesoda*).

The lengths of the *Saccostrea* shells were measured, as shown in Figure 4a. As most of the spires of *Terebralia* and *Telescopium* had been smashed to extract the meat it was not possible to measure shell length from the tip of the spire to the base of the aperature for each shell, so the width of the base was measured, as shown for *Terebralia* in Figure 4b.

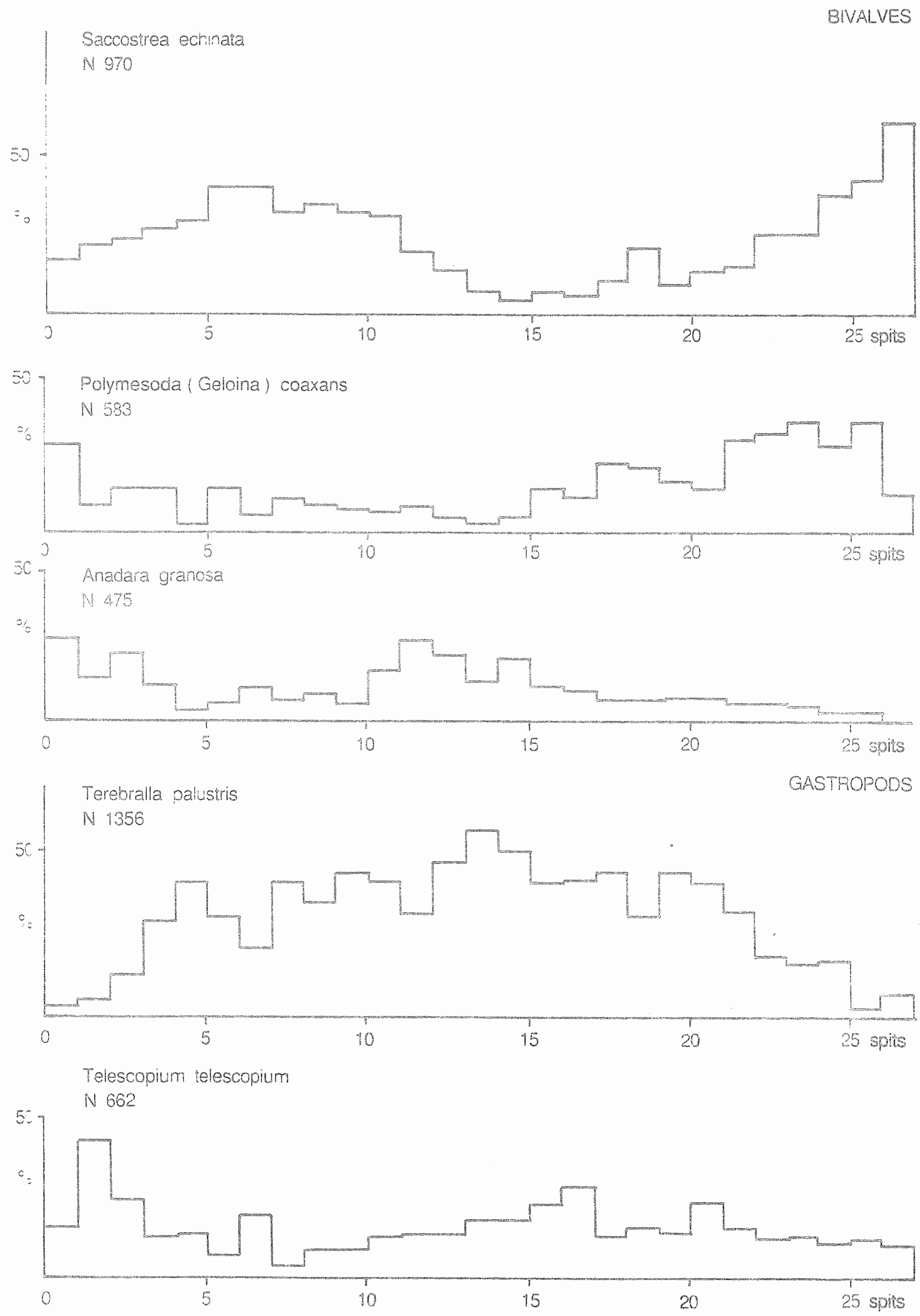

FIGURE 3: FREQUENCY OF THE FIVE MAIN SHELLFISH SPECIES, DONGAN MIDDEN (JMB), AS PERCENTAGE OF ALL SHELLFISH FROM EACH SPIT

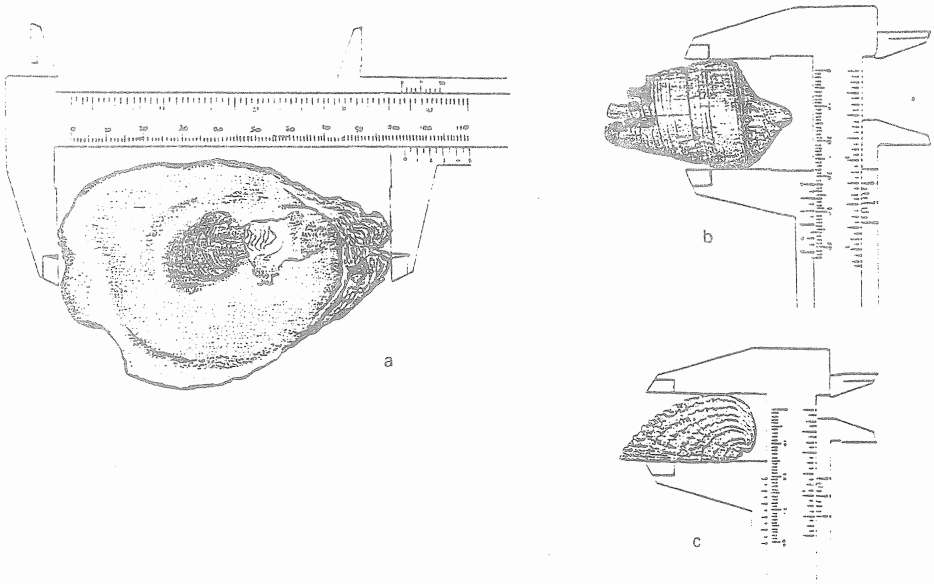

FIGURE 4: MEASUREMENTS TAKEN ON *SACCOSTREA ECHINATA* (a), *TEREBRALIA PALUSTRIS* (b) AND *ANADARA GRANOSA* (c) SHELLS.
Drawings by Anton Gideon.

Many of the anterior and posterior sides of *Anadara* and *Polymesoda* were damaged so these two species were measured by valve depth, as shown for *Anadara* in Figure 4c.

Most coastal communities rate bivalves such as oysters higher than muddy-shore gastropods. Given this preference, it is perhaps not surprising that the overall size of the bivalves decreases before that of the muddy-shore gastropods. By midway in the build-up of the midden there is a marked decrease in the overall size of the populations of *Saccostrea echinata, Polymesoda (Geloina) coaxans* and *Anadara granosa* (Figure 5). By spit 7 there is also a decrease in the overall size of the gastropods *Terebralia palustris* and *Telescopium telescopium*.

In the absence of any means of ageing the shells it is difficult to determine whether the general decrease in the size of the five main species at Dongan reflects the impact of human exploitation and/or a deteriorating environment following coastal progradation. With a deteriorating environment individual shellfish could be expected to reach a smaller size than previously for a given age, whereas human exploitation would produce the opposite effect by thinning out the populations and encouraging rapid growth (Swadling 1976). Until more is known about the rate and nature of coastal progradation in the Sepik-Ramu and the age structure of the shells themselves, it is not possible to attribute the decreases in shell size solely to either human impact or a deteriorating environment following coastal progradation.

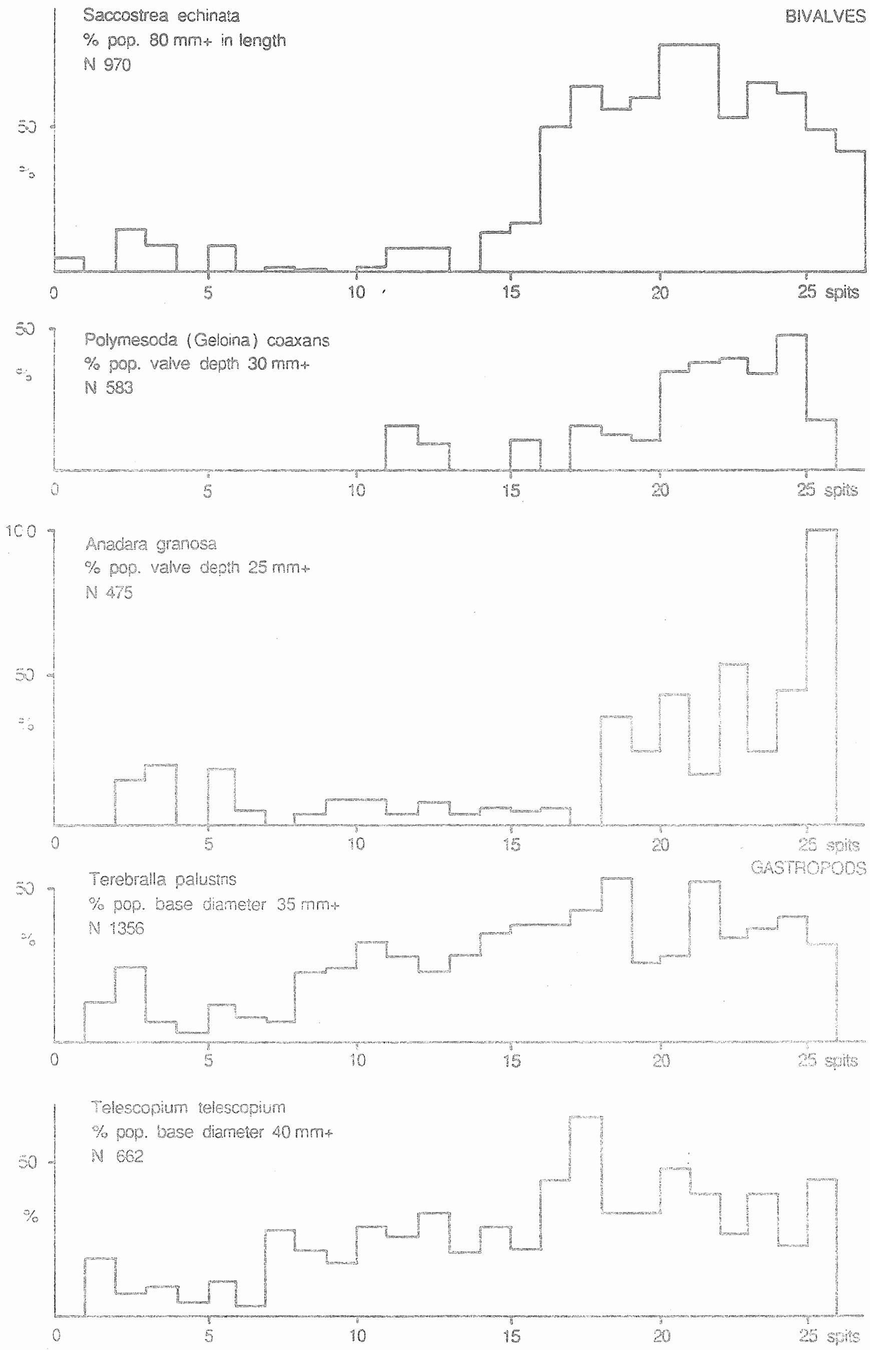

FIGURE 5: SIZE REDUCTION IN FIVE MAIN SHELLFISH SPECIES OVER TIME, DONGAN MIDDEN (JMB), SHOWN AS PERCENTAGES PER SPIT OF A GIVEN SIZE

It is likely that both factors were having an impact on the shellfish populations. Human exploitation probably played a major role in the decrease in size of the most popular food species by midway up the midden. The general absence of *Neritina* in the lower part of the midden, together with its increasing but still low frequency from spit 9 upwards, is a possible indication that coastal progradation was changing the shoreline environment under exploitation prior to the abandonment of the site. At the Akari site *Neritina* is the most common species present and the overall size of *Saccostrea echinata, Polymesoda (Geloina) coaxans, Andara granosa, Terebralia palustris* and *Telescopium telescopium* is much smaller than in the Dongan site.

Fish Bones

The fish bones recovered from the Dongan excavation have been identified by B. Foss Leach at the National Museum of New Zealand. The minimum numbers he has determined for each spit are given in Table 1. Also present but not shown in this table is the mangrove crab *Scylla serrata*.

This small sample allows some preliminary statements to be made about the range of species found and the extent to which they reflect the reconstructed marine environment of 5800 years ago. The recovery in the Dongan site of bivalve shells with their umbos punctured in the traditional way for net sinkers implies the use of nets to catch some of the fish. When a study of the size ranges of the species recovered is completed, more can be said about other likely fishing practices, which in turn has interesting implications for the type of sea craft being used.

Curiously, not all the fish recovered are generally considered edible. Toadfish (*Arothron* sp.), which make up 10.8% of the identified fish, contain poisonous toxins in their liver and roe, and to a lesser extent in their flesh, which are not destroyed by cooking (Munro 1967:552; Grant 1982:702). Ostraciidae (boxfish/coffinfish/cowfish), which are 3.6% of the identified bone, are also reputed to have toxic flesh, but Munro (1967:571) reports that some Pacific Islanders roast and eat these fish. Boxfish/coffinfish live in shallow water, often around coral reefs, whereas toadfish inhabit shallow coastal water and estuaries. It seems unlikely that fishermen would bring back unwanted fish from two different habitats, rather than discard them soon after being caught. This suggests that the inhabitants of the site knew how to prepare these fish for consumption.

Of the fish generally considered edible, about half usually inhabit soft-shore bays and estuaries, whereas the remainder are usually associated with rocks and coral. The presence of coral-dwelling fish is not unexpected in view of the date of 5770±100 uncal. BP (ANU-6081) for coral pieces recovered from beach sand 2 m below the floodplain muds at Marienberg (Swadling *et al.* 1989).

The soft-shore species include sharks and rays (14.4%), snapper/perch (16.2%), trevally (4.5%), small barracuda (2.7%) (the larger fish live in shoal and reef areas) and remora (0.9%) (Table 1). The rocky-shore and coral species include sea bream/snapper (22.5%), rock cod (10.8%), emperor/bream (1.8%), unicornfish/surgeonfish (1.8%) and moray eel (1.8%).

Taxon name	Family name	Common name	MNI	%	spit 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Elasmobranchii	Elasmobranchii	(sharks/rays)	16	14.4	1	1	1	1		1	1	1	1			1							1	1	1	1	1	1	1		
Dasyatidae	Dasyatidae	stingrays	2	1.8								1								1											
Myliobatidae	Myliobatidae	eagle/cow nosed rays	4	3.6		1	1	1	1																						
Teleostomi, sp. B	Teleostomi	(bony fish)	3	2.7								3																			
Muraenidae	Muraenidae	moray eels	2	1.8		1																		1							
Epinephelus/ Cephalopholis sp.	Epinephelidae	rock cod	12	10.8		1	1	1	1	1	1	1	2	1											1			1			
Caranx sp.	Carangidae	trevally	5	4.5		1	1	1			1	1																			
Lethrinidae	Lethrinidae	emperor/bream	2	1.8					1									1													
Lutjanus sp.	Lutjanidae	snapper, perch	18	16.2		1		2		2	3	2	3	1		1			1		1				1						
Nemipteridae	Nemipteridae	sea-bream/snapper	25	22.5		3	3	3	1	1	2	3	2		3	1							1		1			1			
Remora sp.	Echeneidae	remora	1	0.9									1																		
Sphyraenidae	Sphyraenidae	barracuda, sea-pike	3	2.7						1	1			1																	
Acanthurus sp.	Acanthuridae	unicornfish, surgeonfish	2	1.8		1					1																				
Ostraciidae	Ostraciidae	boxfish, coffinfish, cowfish	4	3.6						1		1		1		1															
Arothron sp.	Tetrodontidae	toadfish	12	10.8				4				2	3		1												1		1		
		TOTAL MINIMUM NUMBER	111																												
		Total each spit			1	10	7	13	4	7	10	15	12	4	4	4	0	1	1	1	1	0	2	2	4	1	2	3	2	0	0

TABLE 1: DONGAN FISH-BONE IDENTIFICATIONS BY B. FOSS LEACH

David Coates of the Food and Agriculture Organization Sepik River Fish Stock Enhancement Project (pers. comm. 1990) comments that the fish recovered from the Dongan site are quite different from those caught in the area now. Only *Caranx*, *Lutjanus* and shark occur in the freshwater, and these are possibly different species from those recovered from the site (cf. Allen and Coates 1990).

Finally, apart from observing the trend, little can be said about the lower frequency of identified fish from spit 10 and below until the study of the size ranges of the species recovered is completed.

Plant Remains

Many important Melanesian tree crops were recovered in the Dongan excavation. Doug Yen and Holly McEldowney, when both were with the Department of Prehistory, Research School of Pacific Studies, at the Australian National University, identified the following edible nuts and fruits: *Areca catechu* (betelnut, Neo-Melanesian *buai*), *Aleurites* sp. (candlenut), *Canarium* spp. (canarium almonds, *galip*) and *Cocos* sp. (coconut, *kulau*), *Cordia* sp., *Pandanus* spp., *Pangium* sp., *Parinarium* sp., *Pometia pinnata* (Oceanic lichee, *taun*) and *Sterculia* sp.. In addition, Natalie W. Uhl of the L.H. Bailey Herbarium at Cornell University is running anatomical tests to confirm whether a leaf fragment recovered from the Dongan excavation came from a sago palm. Details of the discoveries are set out in the Appendix.

These finds include some of the most important tree crops of Papua New Guinea. Betelnut and coconuts are widespread lowland crops. Sharing betel nuts and chewing the shared nuts constitute a popular social activity in Papua New Guinea. The Dongan finds suggest that this practice has a history of at least 5500 years. Likewise, the coconut finds, along with those recovered at the Aitape skull site (Hossfeld 1965; Gill 1967) give a similar antiquity for the use of coconuts on the north coast.

The offshore islands, especially Manam, Koil and Wogeo, are renowned for their supply of *Canarium* spp. nuts to the mainland (Hogbin 1938-9; Tiesler 1969-70). This trade still continues. When Akiri villagers were asked why they imported these nuts from Manam, they replied that the Manam nuts were much sweeter than those that grew on their land. The recovery of *Canarium* nuts from the Dongan site again indicates a long interest in this crop.

Today *Pometia* and *Pandanus* are important crops in certain areas of the Sepik-Ramu. The former is harvested between November and March in the Prince Alexander and Torricelli Mountains. There are many stories about fights over *Pometia* harvests (e.g. Stubbs *et al.* 1977:54). *Pandanus* is harvested at the Murik Lakes in December (David Lipset pers. comm. 1988). The fleshy proximal base of most of the *Pandanus* fruit keys recovered from the Dongan excavation had been eaten and sucked, leaving an almost brush-like end. This practice is also found in other parts of Papua New Guinea. In West New Britain the fleshy base and possibly the kernels of the coastal *Pandanus odoratissima* are occasionally eaten or used as a source of drinking water (Arentz *et al.* 1989:90).

The other edible fruits and nuts - *Aleurites, Cordia, Pangium, Parinarium* and *Sterculia* - have not maintained the same regional prominence in the Sepik-Ramu as those listed above. It would be interesting to learn more about their local consumption today and in traditional times in this region. *Pangium* is known to be popular on the Rai Coast of Madang (Powell 1976:111) and is important in the lower Jimi Valley and Yuat Gorge (Gorecki 1989:71-72).

Apart from edible fruits and nuts, the bark of *Pisonia grandis* and wood from *Calophyllum* trees were recovered in the Dongan excavation. Both of these continue to be important sources of string and timber respectively.

The time range for arboriculture in Melanesia must now be extended beyond the 1600 BC date demonstrated by Kirch (1989) for the Talepakemalai site on Eloaua Island in northern New Ireland Province. The Dongan finds also refute the proposal based on lexical reconstructions that the Lapita dispersal was responsible for the initial introduction of arboriculture into Melanesia (Kirch 1989:228).

Spit	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Fruit																						
Cordia																				x		
Pangium						x																
Parinarium			x						x		x											
Pometia				x																		
Sterculia									x													
Spit	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Fruit keys																						
Pandanus					x	x	x	x	x	x					x	x	x	x	x	x	x	x
Spit	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Nuts																						
Aleurites			x																			
Areca catechu											x											
Canarium	x	x	x	x					x								x					
Cocos	x		x													x						
Spit	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Wood and bark																						
Calophyllum							x	x	x		x	x		x	x		x	x	x	x	x	
Pisonia											x	x			x	x	x	x	x			

TABLE 2: SUMMARY OF PLANT IDENTIFICATIONS AT DONGAN, BY SPIT

Table 2 summarises the plant identifications at Dongan by spit, based on the detailed schedule in the Appendix. Note that no identifiable plant material was recovered from the top five spits. Below spit 20 there is a smaller range of products than at the top of the site. Those found grow on or near the coast, viz. *Pandanus*, coconuts, *Canarium* and *Cordia*. Curiously, spits 17-19 were devoid of any edible fruits or nuts, wood and bark being the only finds made. From spit 16 upwards there is a wider range of edible fruits and nuts, suggesting that a larger hinterland was being visited by the occupants of the site. This implies that the site was more than a camp for collecting shellfish, fishing and gathering other coastal products, such as coconuts and pandanus. If this view is accepted, the absence of pottery from the Dongan site becomes all the more tantalising, as there seems no good reason why it should be absent from the site if pottery was being used in the Sepik-Ramu at this time.

Human Remains

Christy Turner II of Arizona State University has examined the human tooth recovered from spit 1. It is a human permanent lower left lateral incisor of a three to four year old child. The tooth never erupted and ceased development at that time, due to death. The crown has a hypoplasia restriction groove near the anatomical neck, which could be due to the effect of weaning or other stress. The hypoplastic disruption of the ameloblasts was current at the time of death.

Unfortunately the lower incisors have almost no anatomical variation useful for population characterization. Similarly, these teeth are about the same size in men and women, so the specimen could be anyone of either sex.

THE AKARI SITE (JMF)

Akari is a midden located on a low but prominent knoll at the northwestern tip of the Ruboni Range (Figure 1). The site is now covered in forest. Along with the Maus and Kwalipsim middens, Akari was found by Seven No. 1 village people when they moved north before World War II. In post-war years the site was extensively quarried for shell to burn for lime for consumption with betel nut. This was such an active industry at this time that one European government officer is reputed to have considered the possibility of developing it into a local business venture. As a consequence of this activity, the surface of Akari is covered with abandoned quarry pits some 1-2 m in diameter (Figure 6). There are so many that it was difficult to find undisturbed areas suitable for excavation. Akari ceased to be the main source of shell for the people at Akiri (Seven No. 2) when Paramok midden was discovered, as this site is closer to both their village and the road.

Two excavation squares and two test pits were dug in 10 cm spits at Akari. Every effort was made to find stratigraphic layering and this resulted in some 10-15 cm spits in the upper part of the site. Up to 20 cm was removed in the first spit to get rid of localised spill from quarry pits. Both large squares had an upper deposit rich in artifacts, shells, bones and organic matter but with no clear stratigraphy, overlying shell midden lacking artifacts. The only indication of any features in the upper deposit was an ash dump in spit 4 of square A. The artifacts found include incised and appliqué-decorated potsherds, trimmed cowrie (*Cypraea moneta*) and dog whelk (*Nassa*) shells, an uncompleted *Trochus* armband fragment, obsidian flakes, stone axe/adze fragments, *Tridacna* adze roughouts and shell net weights. None of the shells valued for lime by groups in the lower Ramu (namely *Polymesoda*, *Terebralia* and *Telescopium*) were absent from the squares we excavated, indicating that we were digging non-quarried parts of the site.

In square B, unlike in square A, the basal midden shells were crushed, as if part of a frequently trodden area. Test pit C confirmed that this surface could be traced across the back part of the site, but test pit D indicates that it does not extend beyond the perimeter

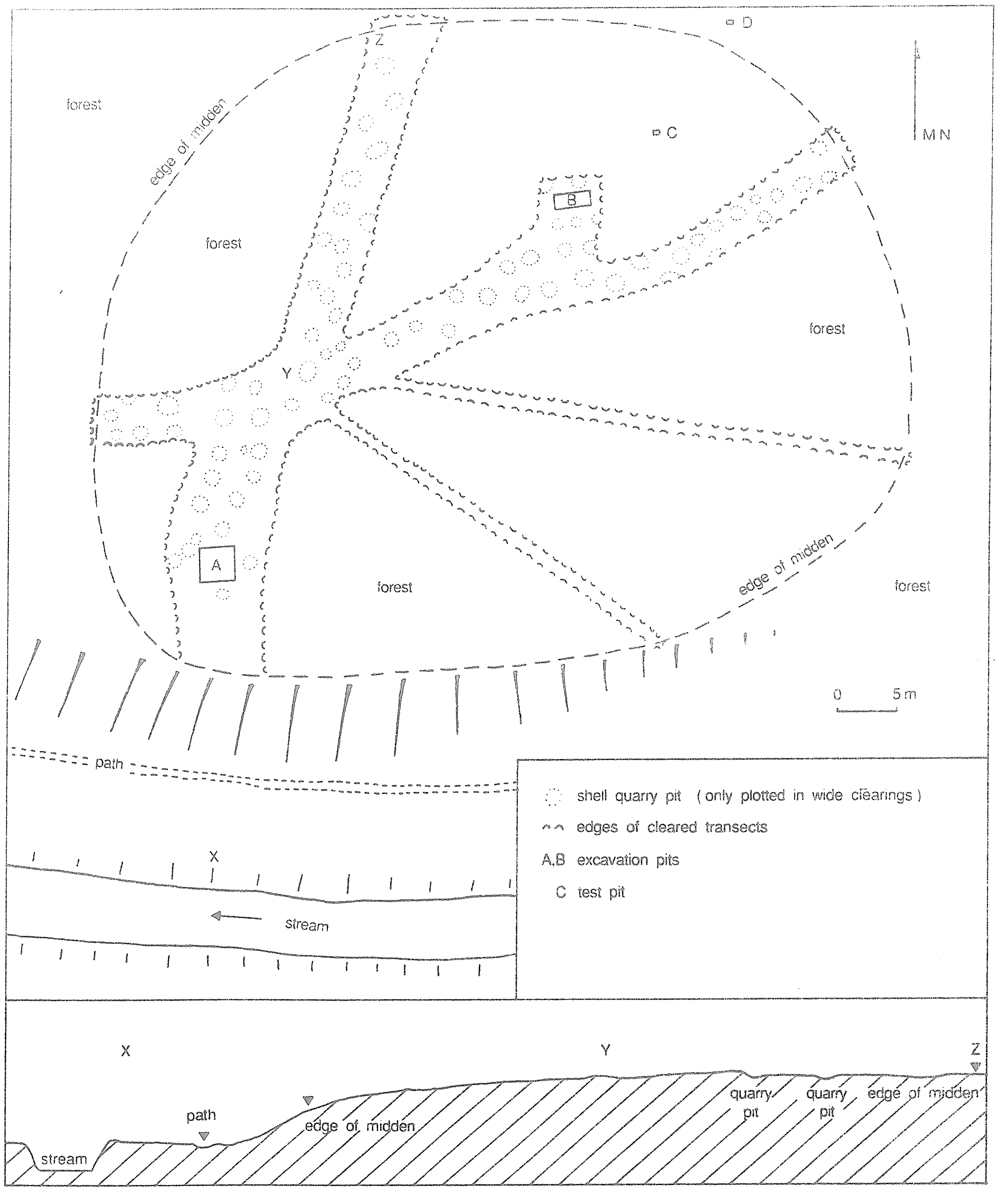

FIGURE 6: PLAN AND PROFILE OF AKARI MIDDEN (JMF)

of the midden. Some potsherds and charcoal flecks were found in test pit D, but no indication of a living surface was evident on the basal grey-clay surface. As a generalisation, there seemed to be little pottery beyond the area of the midden.

The problem with the site is in its dating. The following radiocarbon results, all uncalibrated, have been obtained:

1 A large piece of charcoal removed from a charcoal-rich feature in a midden lens of Akari A (sample C in Figure 7) gave a date of 5980±130 BP (ANU-7079) and the surrounding shell gave a date (uncorrected for oceanic reservoir effect, see Gillespie and Polach 1979) of 6170±90 BP (ANU-7080).

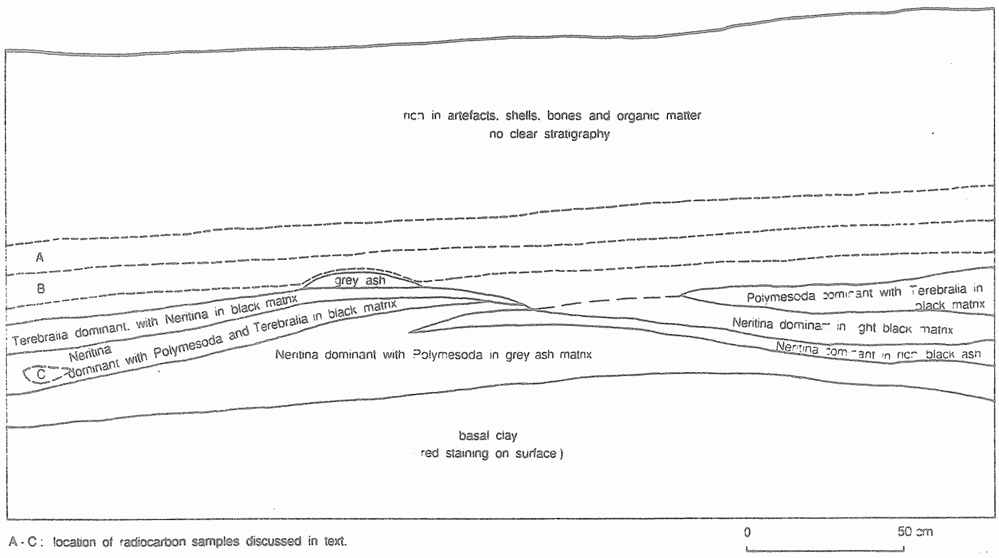

FIGURE 7: NORTH FACE, EXCAVATION UNIT A, AKARI MIDDEN (JMF)

2 Composite charcoal collected from spit 6 (sample B in Figure 7), the last spit before clear stratigraphy is evident, where pottery is rare and does not occur below, gave a date of 5580±130 BP (ANU-7083) and the surrounding shell an uncorrected date of 6400±90 BP (ANU-7084).

There are no real problems with the above, particularly as the shell dates may be up to 400 years too old as they have not been corrected for oceanic reservoir effect. It is the other dates which give cause for concern.

3 A composite charcoal sample collected from the basal crushed shell of square B gave a date of 3280±200 BP (ANU-7085) and the surrounding shell an uncorrected date of 6360±90 BP (ANU-7086). As is evident from the south wall of Akari B (Figure 8), this crushed shell is clearly associated with the build-up of the shell dump and these midden layers in both square A and B lack artifacts. In this respect an earlier date was expected.

4 Further problems arise with spit 5 at Akari A, which gave a charcoal date of 1630±120 BP (ANU-7081) and a shell date of 6320±90 BP (ANU-7082) (sample A in Figure 7). This raises serious problems about the antiquity of the pottery and other artifacts, as well as pig and dog remains, recovered in spit 6 upwards.

The general lack of stratigraphy in the upper deposits was interpreted during excavation to be the product of leaching, root activity and tree uprooting over 5000 years. The shell quarrying and the burning of leaves and logs on the site during its shell-quarry

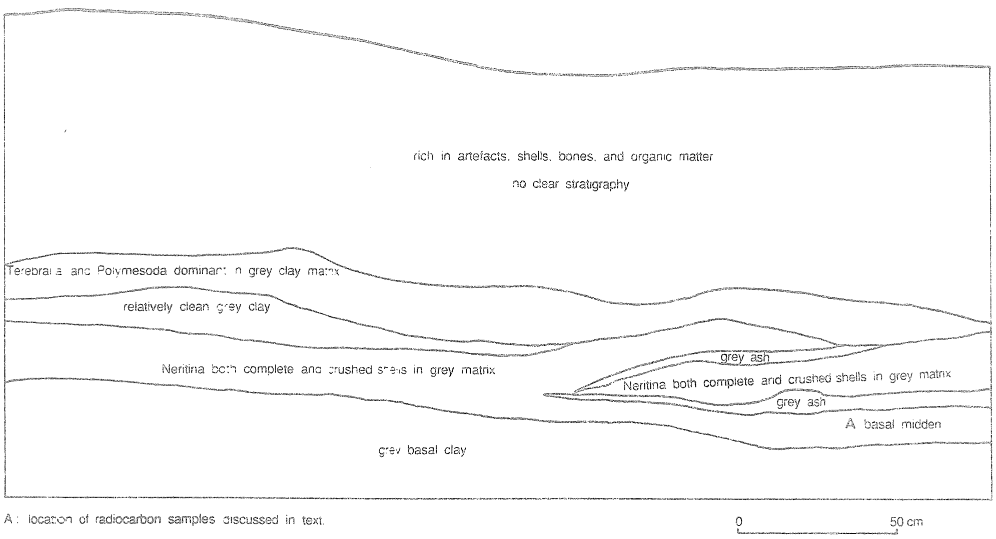

FIGURE 8: SOUTH FACE, EXCAVATION UNIT B, AKARI MIDDEN (JMF)

phase have not only disturbed a large part the deposits but could have introduced modern carbon deep into the site, and lateral migration of this cannot be ruled out.

In view of the significance for Melanesian prehistory of determining the antiquity of the pottery recovered, sherds from Akari and Paramok are now being subjected to thermoluminescence dating. Paramok is the youngest of all the marine-shell middens located in the lower Ramu and has an uncorrected shell date of 2140±70 uncal. BP (ANU-6086). Preliminary tests by David Price of the University of Wollongong have confirmed that the potsherds have a thermoluminesence signal and we now await the results to see whether the Akari sherds consistently give an older signal than those from Paramok.

Once this information is to hand, we will consider whether dates should be run on some of the shell artifacts and pig bones recovered. Only then will we be certain whether we have a mid-Holocene site with a Melanesian artifactual and faunal assemblage. If this is the case, the Lapita cultural complex will cease to be the sole catalyst for many of the significant introductions and changes in the Pacific. However, the arboricultural finds at the Dongan site clearly demonstrate that this aspect of Melanesian life has an antiquity of at least 5800 years.

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NOTE

1 Despite the antiquity of coconuts on this coast, only a small number of coconuts were growing in villages at the time of contact. So little trade copra was available in comparison to areas such as the New Guinea islands that German plantations on the north coast were largely established on the proceeds from bird-of-paradise hunting (Swadling ms.).

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APPENDIX: DONGAN PLANT IDENTIFICATIONS

By D.E. Yen with the assistance of P.H. McEldowney

Spit	Description	Identification	Confidence1	Notes
5	small carbonised lumps	none		
6	thick carbonised lumps	none		
6	1 carbonised piece 2.5 x 1 cm	*Cocos*	±	external concave surface, striations, raised strip like coconut
6	1 piece basal plate of endocarp with thick plate. Like *Canarium salomonense*	*Canarium*	+	resembles P. Gorecki's upper Arafundi collection, *galip*
7	5 carbonised fragments suggestive of *Canarium*	*Canarium*	0	
8	8 pieces of nut shell 1 large 2.5 x 1.5 cm, part side & basal plate	*Canarium indicum*	+	thick-shelled form, has part of one of the two sterile locules

8	1 small piece carbonised fruit shell	*Aleurites*	0	too small a fragment for any confidence
8	1 small piece carbonised	*Parinarium*	0	has characteristic coarse-grained aril, but too small
8	sundry pieces of carbonised wood	*Cocos*	0	small
9	1 piece thick carbonised nut	*Canarium indicum*	+	thick-shelled, small-sized
9	1 piece thick carbonised nut shell, 3.3 x 1.6 cm	*Canarium indicum*	+	thick-shelled, showing distinct pistillate channel
9	1 piece identified as fruit skin approx. 1 cm2, compared with control *Pometia*	*Pometia pinnata*	-	internal & external features, 'netting', pity no seed
10	carbonised wood and bark	none		breaking off like *Calophyllum* when fired, but too thin
10	2 carbonised fibrous fragments with seed cavities showing	*Pandanus* sp.	±	like *P. odoratissimus* keys (fragmented)
11	3 pieces uncarbonised, fibrous with cavities	*Pandanus* sp.	+	like *P. odoratissimus* keys (fragmented)
11	carbonised lumps	none		
11	thin-walled skin/fruit shell	*Pangium*	0	no distinctive features
12	fragments of wood bark, some very thin	*Calophyllum*	0	effect of burning, shattering thick bark of *Calophyllum*?
12	carbonised lumps	none		
12	small uncarbonised fragments of fruit keys	*Pandanus* sp.	+	smaller fragments than those represented later
13	thin tree bark, not *Calophyllum*	none		
13	1 small piece *Pandanus* sp.	*Pandanus* sp.	-	
13	2 carbonised lumps	Calophylluym sp.	0	like P. Gorecki's 14,000 year old specimens from Kowekau rock-shelter, Middle Sepik (see Plate 41 in Swadling *et al.* 1988
14	5 pieces, including one distal end of nut shell, 2 parts of basal plates	*Canarium indicum*	+	thick-shelled variety
14	1 piece of partial fruit key, one larger lump	*Pandanus* sp.	±	part of fibrous end, too small for further identification
14	3 pieces of bark	*Calophyllum*	0	has layered character of *C. inophyllum* bark
14	1 thin fragment of fruit shell, rimmed, striated surface	*Sterculia*	-	thinner than fresh, but inner/ outer surfaces similar to fresh
14	1 thick fruit section 2.5 x 2 x 0.5 cm with *Parinarium* surface features	*Parinarium*	0	but separation of outer 'skin' from 'flesh' not in fresh material

15	mostly smooth-surfaced bark	none		
15	1 small fragment	*Pandanus*	0	small
16	fibrous 'bunch' shape and formation like betel fruit husk	*Areca catechu*	+	see Plate 38 in Swadling *et al.* 1988
16	many bark fragments	*Pisonia grandis*	0	coastal tree
16	many bark fragments	*Calophyllum inophyllum*	0	coastal tree
16	1 fragment fruit-like	*Parinarium'*	0	only basis is internal feature
17	thick rough carbonised bark	*Calophyllum*	±	
17	thin smooth carbonised bark, vertical cracking	*Pisonia*	±	
17	fibrous carbonised bits	none		too small without other distinguishing features for identification
18	bark, rather variable in size and character, some is possibly *Pisonia*	none		
18	some fibrous bodies, but insufficient size	none		
19	some carbonised chunky pieces, with layered character	*Calophyllum*	-	
20	1 chunk of bark	*Calophyllum*	0	
20	several pieces of thin bark	*Pisonia*	0	
20	chunks of fruit keys, some with fibres attached	*Pandanus*	±	
21	good chunks of fruit keys	*Pandanus*	+	
21	1 piece fruit shell	*Cocos*	0	small, but external character consistent with identification
21	1 piece carbonised bark	*Pisonia*	-	
22	carbonised lumps	*Calophyllum*	±	layering characteristic of *Calophyllum*
22	2 carbonised fragments	*Pisonia*	-	
22	good specimens, one large specimen could be *P. dubius*	*Pandanus*	+	some indication of different sizes and species?
22	one basal plate(?) of nut, thick but cf. small *C. indicum*	*Canarium indicum*	±	doubt is based on assigning species names to old material, always a hazard
23	large carbonised lumps, really do look like *Calophyllum*	*Calophyllum inophyllum*	+	

23	thin fragments	*Pisonia*	0̲	
23	unmistakeable, but with some indication again of variation in species	*Pandanus*	+	e.g. some of the proximal ends could not be matched to large distals
23	leaf fragment	*Metroxylon*	?	identification by Dr Natalie Uhl (to be confirmed)
23b	large carbonised lumps	*Calophyllum*	+	
23b	most of thinner bark not like *Pisonia*	none		
23b	fruit keys, fibrous	*Pandanus*	+	more uniform in size
24	carbonised lumps	*Calophyllum*	±	
24	thin carbonised fragments, at least some *Pisonia*	*Pisonia*	-	
24	partially carbonised lumps	*Pandanus*	+	again uniform, small, *P. odoratissimus*?
25	1 piece carbonised with clear 'skin', layering	*Cordia*	0	I am not familiar with this species when pressed in this way
25	small carbonised lumps	*Calophyllum*	-	
25	thinner carbonised fragments than above	none		
25	*Pandanus* keys	*Pandanus*	+	again uneven sizes, see comments spits 22, 23 for *Pandanus*
26	large carbonised lumps	*Calophyllum*	-	layering not as clear
26	fruit keys, including very large individual	*Pandanus*	+	variable species
27	fruit keys	*Pandanus*	+	some variability
-	found in grey clay when bailing out	*Pandanus*	+	no doubt, smaller species?

Notes

1 Identification confidence
+ = confident
± = some doubt
- = lowest usable identification
0̲ = little confidence
0 = no confidence

General comments

1 *Canarium* seems to fade out with depth (but see spit 22)
2 Presence of *Pandanus* in deeper spits consistent enough, appears first in spit 10
3 Coastal trees, *Calophyllum* especially, consistent in lower spits, noticeable with increasing frequency from spit 13
4 Mangrove could be among unidentified wood and bark.