NEW ZEALAND JOURNAL OF ARCHAEOLOGY

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Surface Artefact Distributions at the Nan Madol Site: a Preliminary Assessment of Spatial Patterning

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ABSTRACT

Detailed instrument mapping and systematic surface collection of artefacts were undertaken on four of about 90 islets at the Nan Madol site in Ponape, Micronesia. Surface artefact distributions are analysed to distinguish non-random clusterings and associations. Results generally indicate limited patterning. A test excavation on Dapahu, a Nan Madol islet, demonstrates that the location of pottery sherds on the surface is due to the incorporation of early archaeological deposits into islet fill. A submerged pottery-bearing archaeological deposit below islet fill dates to between the first and fifth century A.D., at present the earliest known on Ponape. The non-isomorphic distribution of surface shell artefacts with respect to pottery suggests that the majority may be contemporaneous with islet use. It is concluded that Nan Madol's settlement dynamics do not involve productive specialisation, but rather are influenced primarily by ceremonial and ritual considerations.

Keywords: MICRONESIA, PONAPE, NAN MADOL, SURFACE ARTEFACTS, SPATIAL PATTERNING, POTTERY, CHRONOLOGY.

INTRODUCTION

Surface artefacts have long been important to archaeological research. They assist in the location of sites and provide readily obtainable inventories of portable material remains useful for site classification and chronological ordering. It is only in the past decade or two, however, that surface artefacts have been used for more anthropologically oriented purposes such as settlement pattern analyses. Examples include studies of community patterns, site formation, and population size. In addition, surface artefacts have proven highly useful for dealing with questions of site structure and location of subsurface features. In the words of Lewarch and O'Brien (1981:297), ". . . surface artefacts are useful in more situations and for more kinds of research problems than might commonly be appreciated". Attention to natural and cultural formation processes involved in surface artefact distributions has increased in recent years (see Lewarch and O'Brien 1981), which should provide a basis for greater reliability of inferences. Thus, it is clear that archaeologists cannot afford to give short shrift to the surface remains of their sites. Surface artefacts can often provide the greatest amount of data for the time and money invested in field investigations.

In this article I wish to make a preliminary evaluation of surface artefacts for the study of intra-site settlement patterns at the Nan Madol site in Ponape, Micronesia. The focus will be on the determination and documentation of artefact patterning and differential spatial distributions. Possible inferences about settlement dynamics will be considered, and pertinent information concerning oral history will also be briefly reviewed.

This study is termed "preliminary" because of the very limited sample size of the data set and the corresponding inappropriateness of using some of the more sophisticated pattern recognition techniques. Furthermore, information on chronology and subsurface characteristics is still very incomplete. Nevertheless, enough data are available from recent investigations to provide a reasonable basis for opening the discussion on surface patterning. Importantly, a preliminary study such as this will

serve the purpose of focusing future research at what must be one of the most spectacular archaeological sites in the Pacific.

The primary motivation for this study derives from the fact that Nan Madol is a well-preserved elite centre for a highly developed prehistoric complex society. With few exceptions (e.g. Cordy's [n.d.1] study at Lelu on Kosrae), intra-site settlement studies based on artefact distributions are not available from the political centres of other complex societies in the Pacific. As such, Nan Madol provides a special opportunity for archaeological study.

NAN MADOL: THE SETTING AND THE SITE

Nan Madol is located on Ponape, a high volcanic island of 334 km² in the Eastern Caroline Islands of Micronesia. Apart from several small atolls, the nearest neighbouring islands are Truk, 705 kilometres west, and Kosrae, 558 kilometres east-southeast. The climate of Ponape is tropical. The almost daily rains permit extremely luxuriant vegetation growth with no apparent windward-leeward distinction. The coast is generally covered by mangrove forest, which is quite extensive in some areas. Offshore 2 to 4 km is a barrier reef, which almost completely encircles Ponape. The intervening lagoon contains a number of small islands, and Nan Madol is situated on the fringing reef adjacent to one of these on Ponape's east side.

Ethnographic descriptions indicate that traditional Ponapean society was highly stratified (Bascom 1965; Riesenberg 1968). Cordy (n.d.2) has characterised it as the 4-strata type, which places it among the most complex societies in Oceania. At the time of initial western contact in the late 1820s, Ponape was divided into five autonomous chiefdoms. These in turn were divided into much smaller territorial units headed by subchiefs. The subchiefs were appointed by the paramount chiefs (*Nahnmwarki*) or their ranking counterparts (*Nahnken*) in the dual system of titles. The highest ranking subclans of two different clans inherited the chiefly and noble titles, and ideally their members intermarried to maintain genealogical position and solidify as well as integrate their authority. Warfare and feuding between chiefdoms were common, and settlement was dispersed.

The most important traditional Ponapean food cultigen is breadfruit. Bananas, taro, and yams, while also cultivated, provide relatively minor contributions to the diet. Intensive methods of agricultural production do not seem to have been employed. Pigs were absent before western contact, though dogs were present. Reef fish from the lagoon is a mainstay of the Ponapean diet. Almost no effort is made to exploit the ocean beyond the barrier reef.

The site of Nan Madol is architecturally impressive and has attracted the attention of numerous visitors and investigators (see Athens 1981). It consists of approximately 90 man-made islets occupying a roughly rectangular area of about 80 hectares (1.3 x 0.6 km) on the reef (Figs. 1-3). The islets vary considerably in size, shape, and surface features. Tiny Dekehtik[1] is only 20 x 27 metres, while Pahnkadira and Dorong are both almost 100 metres on a side. The distinctive architecture of Nan Madol is largely the result of the extensive use of naturally formed prismatic basalt columns. They are stacked horizontally on the periphery of each islet, where they form retaining walls to stabilise the islet's unconsolidated interior fill. On some of the islets, wall construction is very elaborate and extends above the surface of the fill to form true walls. The most impressive example of this kind of construction is at the islet Nandauwas (see Fig. 2), which has a massive outer wall enclosure 5.5 to 7.5 metres high (above the islet surface). This same islet also has an interior enclosure wall 3 to 4.2 metres high. The Nan Madol columns, weighing several tons or more, were brought from different quarry locations on the main island of Ponape[2]. Islet

construction, therefore, was obviously a very labour intensive endeavour.

Islet fill consists mostly of large (greater than 10 cm) chunks of coral rubble mixed with some smaller rubble and gravel and a small amount of soil. Some islets near the outer edges of Nan Madol, however, apparently consist primarily of large coral rubble, perhaps because the stronger tidal action in these areas promotes erosion

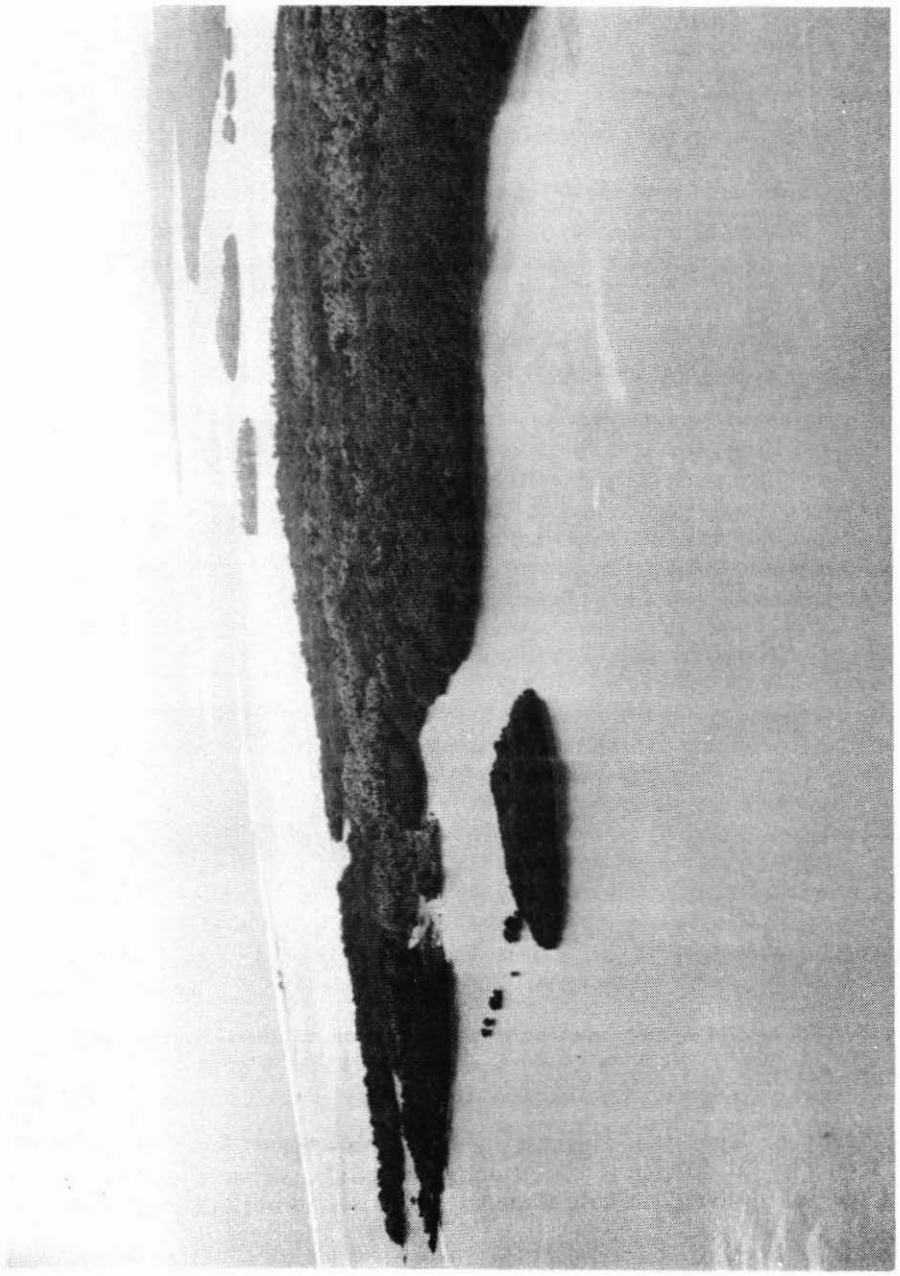

Figure 1: Aerial view of Nan Madol; view due south. Nan Madol stretches from the forested mass of the extreme left all the way to the extreme right. The slightly higher elevation area of the centre-right is Temwen Island, a natural volcanic island in Ponape's lagoon. The island in the foreground and the nearest island in the background are man-made and pertain to Nan Madol.

Figure 2: Aerial view of Nan Madol; view to northwest. The high-walled islet, Nandauwas, is in the foreground, with low-walled Dau to the left rear and Kohnderek to the right of Dau. In the background are Temwen Island, Madolenihmw Harbour, and the mainland of Ponape.

and limits sediment deposition. Thickness of the fill varies from less than a metre to several metres on the different islets. At present high tide, sea water inundates the surface of many of the lower islets, suggesting sea level rise and/or tectonic subsidence

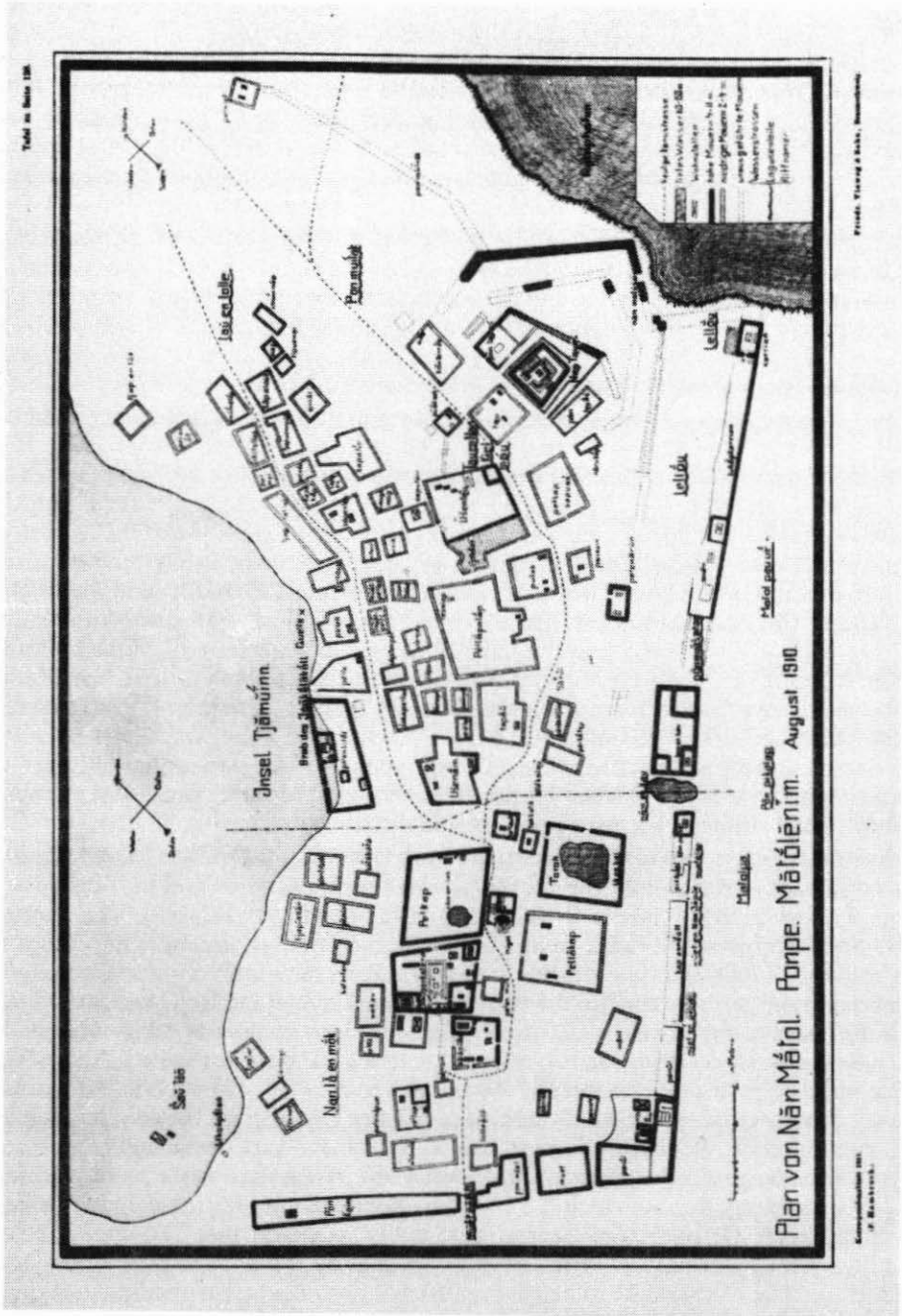

Figure 3: Map of Nan Madol prepared by Paul Hambruch (1911). This is Hambruch's original map (see Athens 1981).

have been active processes since the time these islets were constructed (additional information is presented below). The surfaces of the islets are almost entirely coral, though basalt cobbles and column fragments can be relatively dense on some islets. House platforms, tombs, walls, and other features were built on the islet surfaces or in the fill. The water channels between the islets are not deep, and may be traversed on foot at low tide, or by canoe or motor boat at high tide.

According to oral accounts (Bernart 1977; Hambruch 1932-36), Nan Madol was the centre of a polity ruled by paramount chiefs bearing the title of *Saudeleur*. With the exception of the Palikir region on the northwest side, all of Ponape was encompassed by the Nan Madol polity and *Saudeleur* authority was absolute. Palikir reputedly remained semi-autonomous because the *Saudeleur* feared its chief's magical power.

It is perhaps worth emphasising that numerous oral history sources indicate Nan Madol to have been a political and religious centre for a highly stratified society having hegemony over Ponape[3]. Recent archaeological studies on Ponape's main island, furthermore, confirm the absence of any other site having the size or architectural elaborateness of Nan Madol[4]. Thus, there can be no doubt about Nan Madol's top position in the settlement hierarchy of prehistoric Ponapean society.

Oral accounts describe many details regarding use of the islets, legends, magical events, and personalities (see Bernart 1977; Hambruch 1932-36; Hadley n.d.). It is known, for example, that the *Saudeleurs* resided on Pahnkadira and were buried at Nandauwas[5], and that priests conducted an important ritual feeding of turtle entrails to a sacred eel kept on Idehd islet. The accounts also tell of the demise of the *Saudeleur* reign, which is said to have been instigated by the arrival of Isokelekel and his army of 333 men from Kosrae. The *Saudeleur* was defeated in battle and Isokelekel established the *Nahnmwarki* system of titles. The political unification of Ponape disintegrated into the three separate chiefdoms of Kiti, Sokehs, and Madolenihmw, the latter including the Nan Madol site (five chiefdoms eventually formed). Nan Madol continued to be occupied for a time, though after the sixth *Nahnmwarki* the residence of the Madolenihmw chief shifted out of Nan Madol to neighbouring Temwen Island and nearby locations[6]. Whether this shift in residence of the paramount chief led to rapid abandonment of Nan Madol is not clear, though it certainly suggests a dramatic change in the site's stature as a political and ritual centre.

Historical sources provide further insight into the functioning of Nan Madol, though it is important to realise that the site is described as unoccupied and in ruins by one of its earliest western visitors in 1828-1833 (O'Connell 1972:182-188). The journal writings of Sturges and Gulick, both American missionaries, are most important in this respect, though the time of their observations in 1859 and 1854, respectively, is well beyond the period when the site was used as a residential location (see Chronology section). Despite this caveat, their descriptions are nevertheless of great interest. In one passage, Sturges (1859, Jan. 3), refers ". . . to a great occasion called 'Aponalap', which means a great canoe swapping." As Gulick's journal, along with Sturges' journal, suggests, the "swapping" is actually a form of prestige competition between individuals and communities. Redistribution of canoes by chiefs had considerable political importance. According to Gulick (1854, April 18), Aponalap was a 17 day annual religious ceremony during which ". . . various political and politico-religious affairs are transacted". Of particular interest here is his statement that "Four of the five localities visited during this series of days are among those celebrated ruins [Nan Madol]. . ., a fact I regard as somewhat significant as to the origin and intent of those curious structures" (1854, April 18). Gulick (1854, April 18) provides the following description of events that take place at Nan Madol:

> On the fourteenth day, which is the great day of a feast, a large number of canoes are lashed together so as to form a raft before one of the sacred localities, and a number of songs are sung by a selected choir of young men, dressed in the extreme of heathen fashion, who have been rehearsing for several weeks, and who keep time with small fancifully made paddles, some of which shall in due time be sent to the . . . [word not legible] house. On the fifteenth day of the feast the Ishipau [*Nahnmwarki*]

> and Wasai [2nd highest title holder in the Nahnmwarki title line], each in separate canoes, are towed by other canoes from the region of the ruins to a place near the Sugarloaf [Mt. Takaiuh] in Matalanim bay. Songs are sung by the little fleet as it passes along, accompanied as these voices are by the deep monotonous sound of the conch shells which are blown. They echo sadly over the still waters of the harbor. Such singings are practiced during the whole of the ensuing night by pleasure parties, the canoes enjoying the brilliant full moon. We were several times that night waked by these melancholy monotones—most emphatically melancholy in all their moral associations. On the 16th day the Ishipau and Wasai are towed back to the ruins, and the entrails of a turtle, which have been kept some time for this purpose, are carried to one of the artificial islands [islet of Idehd] and given to a sacred eel, which is said lives in a pond in the centre of the structure. The entrails are taken to the spot from the canoe by a priest, who walks in backwards, that he may not look on the sacred fish. I have examined this place, and find that there is not a drop of water there, much less an eel, nor is there a possibility of there ever having been water there. No natives as yet dare to visit the spot to examine for themselves.

CHRONOLOGY

Oral history and several radiocarbon dates provide a rough framework for the chronology of occupation at Nan Madol. From oral history it is possible to derive an estimate for the date of the *Saudeleur* overthrow and consequent dissolution of a centralised polity on Ponape. This information also provides a date for the final period of residence by a *Nahnmwarki* at Nan Madol and the presumed abandonment of the site. The available radiocarbon dates serve to establish the time of the *Saudeleur* reign and megalithic construction at Nan Madol, as well as the age of an earlier non-megalithic occupation at the site. Further refinements in the chronology will almost certainly be forthcoming as on-going research at Nan Madol proceeds[7].

Beginning with Isokelekel, oral history records 22 *Nahnmwarki* of Madolenihmw (Jenks 1970; Hadley n.d.; Whiting [1954], however, lists only 17). As historical sources document 9 *Nahnmwarki* since 1836 (see Athens 1981; Hadley n.d.), the average length of reign would be 16 years. Because there were 13 *Nahnmwarki* prior to 1836, the date for the *Saudeleur* demise (which would also be the beginning of the *Nahnmwarki* system with Isokelekel) can be estimated at A.D. 1628. The 16 year average also suggests that the residence of the first six *Nahnmwarki* at Nan Madol would have comprised almost a century.

Abandonment of Nan Madol by the paramount chiefs, therefore, would have begun about A.D. 1724. This date may be compared to the statement by L. H. Gulick, one of the earliest missionaries to reach Ponape in 1852, that "Till within the memory of some [Ponapeans] living in 1852, the whole of this locality [Nan Madol] was densely populated, with the exception of the most sacred spots, and no mangroves were allowed to intrude" (1857:58). There is an apparent discrepancy between the 1724 date and Gulick's statement, in that people living in 1852 would have been too young or not yet born to remember anything prior to about 1790. However, this problem may only be the result of an earlier abandonment by the paramount chiefs and a later abandonment by other residents of the site.

Excavations in 1963 by the Smithsonian Institution on the islet Idehd produced three radiocarbon dates. They are from a 3-metre-high rubble mound, which presumably resulted from the accumulation of residue from stone ovens used in the periodic cooking of turtle for the eel ceremony. The dates have ranges from A.D. 1200-1320 near the mound base, to A.D. 1240-1350 and 1330-1430 for the mid to upper-mid sections of the mound (calibrated dates, 95% confidence interval, see Table 1). The beginning date for the accumulation of mound residue would be somewhat earlier, since the lowest Smithsonian date is approximately 55-75 cm above the mound base. This means that ritual activities at Idehd probably began at least by A.D. 1100 or 1200. Also, since the mound base rests on islet fill that is contained by basalt columns

(personal observations), megalithic construction was clearly under way by this time.

TABLE 1
SMITHSONIAN RADIOCARBON DATES, IDEHD RUBBLE MOUND (AFTER SMITHSONIAN 1965:253)

Sample No.	Location		Radiocarbon Years B.P.	Calibrated Dates Calendar Years*
	Metres in from base of mound	Metres from surface		
SI-90	3.50	1.20	520±65	A.D. 1330-1430
SI-91	8.50	1.47	690±50	A.D. 1240-1350
SI-92	8.00-8.50	2.25-2.45	770±60	A.D. 1200-1320

* Klein *et al.* 1982. Dates are given as 95% confidence interval.

Though not easy to prove, it is likely that the beginning date for ritual at Idehd (A.D. 1100-1200) is closely tied to the establishment of the *Saudeleur* polity. It is difficult to conceive of one without the other, considering the prominence of both in the religious, social, and political configuration of Ponapean society. Furthermore, megalithic construction, as documented at Idehd, would almost certainly be related to a strong polity. By extension, therefore, if the beginning date for the *Saudeleur* is A.D. 1100-1200, then megalithic construction for the rest of Nan Madol may be contemporaneous or subsequent to that date.

Recent excavations by Ayres (1983) and his students on the islets of Pahnkadira and Usendau indicate rather complex building sequences. Details on this work are not yet available, though Ayres (1983:140) has indicated that basal radiocarbon dates go back to the late A.D. 700s (Usendau) and the late A.D. 900s (Pahnkadira). The latest building sequence at Pahnkadira is dated after A.D. 1400 (Ayres 1983:140). Megalithic construction does not appear to be associated with the earlier dates on these islets.

Athens has also conducted recent excavations. These were on the islet Dapahu, located in the centre of the Nan Madol complex. An underwater archaeological deposit in a coralline sand and pebble matrix was observed beneath the islet's coral rubble fill. This earlier occupation, apparently documenting previously suspected coastal submergence on Ponape during the period of human habitation (see Athens n.d.), produced a calibrated radiocarbon date of A.D. 20-445 in association with pottery (further information is provided in section on Pottery Distributions). Dates for Dapahu's construction and occupation (stratigraphically above the underwater occupation) were not forthcoming, though it was determined that pottery use (Athens 1980a) had probably been discontinued by that time.

SURFACE ARTEFACTS AND FEATURES – FIELD INVESTIGATIONS

During 1979 and 1980 Athens (1980b) conducted field investigations at Nan Madol for a period of 2½ months. The primary goal of this work was to produce detailed instrument maps of islets that had been cleared of dense vegetation by an on-going C.E.T.A. project. Of the 15 islets that had been cleared, only four could be mapped in the available time. These were Dorong, Dapahu, Dau, and Kohnderek. Selection of these particular islets was based primarily upon their differences from one another and their spatial separation. They do not necessarily constitute a representative sample of islets. Indeed, one of the impressive characteristics of the Nan Madol islets is their variability; no two seem to have the same configuration of features, spatial patterns, shape, and construction technique, and oral accounts of their uses tend to be distinct[8].

Systematic surface collection of artefacts was employed as part of the investigative strategy. The procedure is described in Athens (1980b). Generally, there was good visibility on the islet surfaces, which mostly consisted of exposed coral rubble. Point provenience data were obtained for 359 shell artefacts, 37 stone artefacts, 518 prehistoric pottery sherds, 24 historic artefacts, and 31 specimens of subsistence and organic remains (Athens 1980b)[9]. They have been classified by islet into descriptive types and subtypes (Athens 1980b: Table 7, pp. 99-103).

All islet features were also mapped and described. These include house platforms, tunnel orifices, alignments, canoe landings, pavings, and others. In all, 94 features were recorded for the four islets (Table 2).

TABLE 2
LIST OF NAN MADOL ISLET FEATURES AND LAND AREA

Features+ and Land Area	Dorong	Dapahu	Dau	Kohnderek
Islet land area, m²	5,807*	4,208	3,621	3,080
Platforms	5	3	5	8
Historic platform/foundation	–	–	1	1(?)
Meeting house (*nahs*)	1	–	–	1**
Tomb	1	–	–	–
Rectangular alignment	2	1	2	3
Linear alignment	3	1	3	1
Wall, columnar basalt	1	–	–	–
Wall or structure, stacked coral	–	2	1	1
Large tunnel orifice	1	–	1	–
Small tunnel orifice	11	–	–	–
Canoe landing	–	2	1	2
Paving (basalt and coral)	2	2	2	10
Other and unidentified features	3	4	4	2

\+ Count is higher than original tabulation (Athens 1980b) as some of the features have been subdivided into their separate components.
* Total area of enclosure is 9,089 m². Dorong is built around a natural reef pool.
** Structure has been recently destroyed.

SURFACE PATTERNS AT NAN MADOL—ARTEFACTS AND FEATURES

Discussion of surface patterns will proceed according to the following four topics: 1) patterns between artefacts and features, 2) between-islet patterning in which artefacts of the different islets are compared to one another, 3) within-islet patterning, in which artefact associations are considered on single islets, and 4) the analysis of pottery distributions. The goal of these studies will be to document, describe, and where possible, to understand artefact and feature distributions as they exist on the islets Dorong, Dapahu, Dau, and Kohnderek.

PATTERNS BETWEEN ARTEFACTS AND FEATURES

Artefacts were plotted on the four islet maps (originally prepared at a 1:200 metric scale) with idealised representations of features for clarity. Kohnderek, for example, is shown in Fig. 4. Copies of these maps were made, and the different artefact types and subtypes were colour coded for ease of visual recognition of clusterings that could be suggestive of associations with features. Some of the subtypes were lumped into single type categories to provide higher numerical counts, while a few types had such low counts that they were eliminated from the analysis altogether. Table 3 lists the relevant data used in this study. This analysis is primarily designed to test for activity complexes and possibly aid in the determination of feature function.

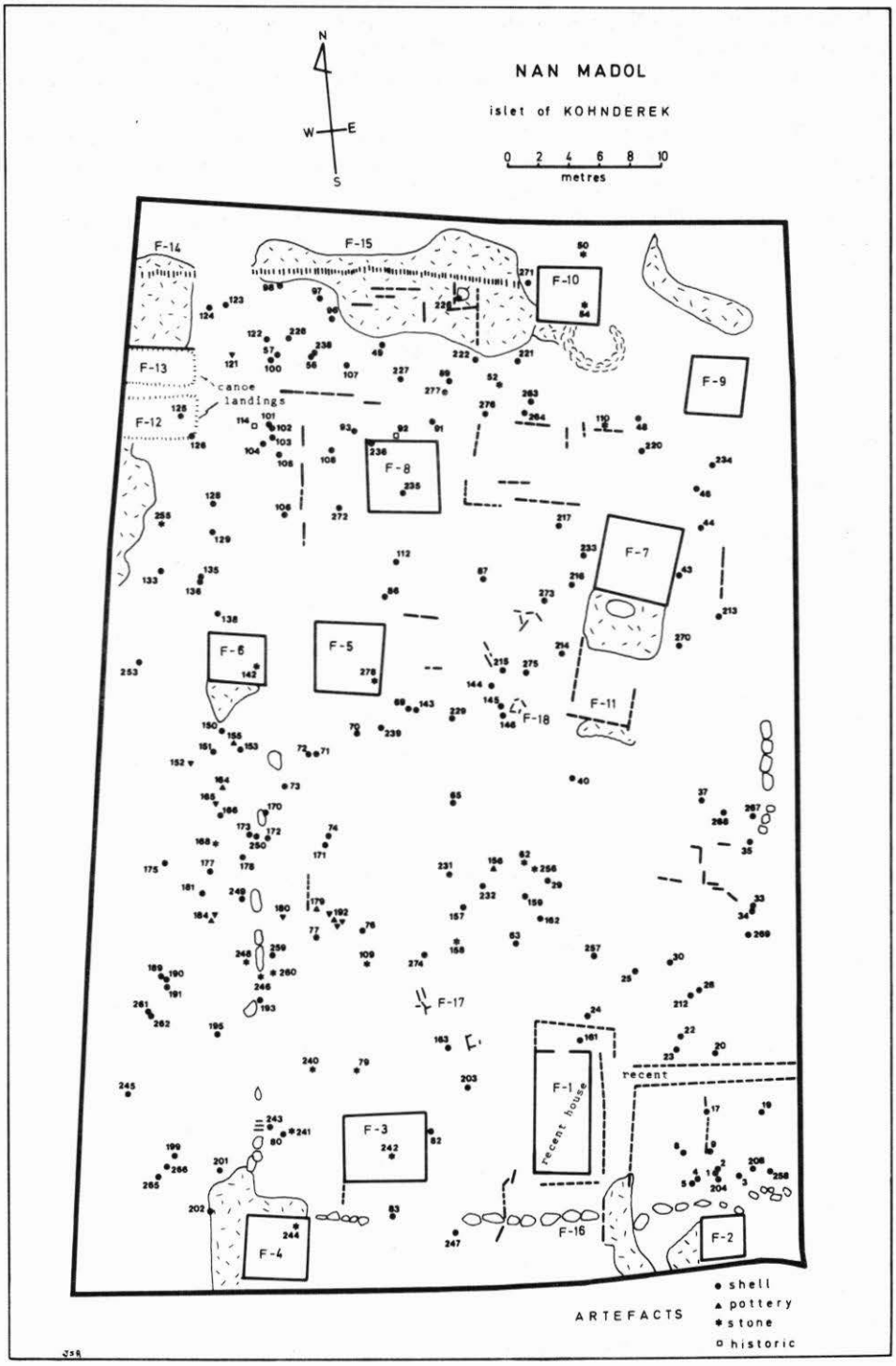

Figure 4: Schematic plan of Kohnderek islet showing artefact distributions. Large squares indicate platforms; thick lines indicate columnar basalt alignments (except on platforms); stippled areas are pavings.

TABLE 3
LIST OF NAN MADOL SURFACE ARTEFACTS USED IN SPATIAL PATTERNING ANALYSES

Artefacts	Types and Subtypes*	Dorong	Dapahu	Dau	Kohnderek	Total
Tridacna lip adzes						
adzes with cutting edge	I.a.1,2,3	11	12	10	36	69
blanks	I.a.4	2	6	1	2	11
fragmentary or missing edge	I.a.5	3	27	7	16	53
Tridacna rim or hinge adzes						
large adzes	I.b.1	3	5	7	9	24
adzes with curved, straight, triangular or transverse edges	I.b.2,3,4; I.c.	7	6	5	9	27
fragmentary or missing edge	I.b.6	2	6	3	3	14
Terebra adzes	I.d.1,2,3	1	5	4	17	27
Cassis adzes						
rim adzes	I.f.1,2	2	3	1	6	12
lip adzes	I.g.	3	2	–	1	6
Conus artefacts (no adzes)	I.h.1,2,3,4,5,6	15	10	2	11	38
Adornments	I.j.1,2,3	1	4	4	6	15
Pounding Stones	II.a.	7	1	4	3	15
Grinding Stones	II.d.e.	1	–	2	6	9
Historic Artefacts	V.a.b.c.d	–	14	8	2	24

* from Athens (1980b). Counts include adzes recently found on Dapahu and 2 *Conus* rings on Dorong (see note 9).

In their aggregate, the artefacts show little obvious tendency to cluster around islet features. However, when the distributions of the artefact types are considered separately, several clusterings become apparent. For the islet of Dorong the strongest cluster is with nine *Conus* artefacts (bevelled rings) around the orifice of a large tunnel structure (Feature 11). Another four *Conus* rings form a nearby secondary cluster. The tunnel structure is said to have been used for keeping a sacred eel. Whether the artefact association is fortuitous must be considered. Since a similar large tunnel structure is found on Dau, and there are no *Conus* artefacts in the vicinity, it would appear that the Dorong association is not valid. However, the possibility that the two features had different functions must be considered as a source of artefact variability. But whether this was in fact the case cannot be determined at present; the lack of patterning provides no basis for interpretation.

Other clusterings of possible significance concern historic artefacts, which are found in greatest quantity on Dapahu and Dau. The Dapahu cluster is around a house platform that seems to have been documented by Hambruch's fieldwork in 1910. The artefacts (porcelain and glass), however, do not appear to pre-date the Japanese period, suggesting their association with the platform is fortuitous (unless it was re-used at a later date)[10].

On Dau there are eight historic artefacts in the vicinity of three features. One of the features is a house foundation (Feature 4), thought to be historic because of its upright columns at the four corners, which would have been used as frame supports. There is an associated paving around the foundation. The third feature, adjacent to the foundation, is a small circular enclosure constructed of piled coral rubble. The presence of two kaolin pipe stems near these features suggests the possibility of nineteenth century construction and use. However, there are also painted porcelain sherds of probable more recent manufacture, suggesting the possibility of later construction and/or perhaps re-use of the features. It may be notable that on Kohnderek there is a platform with upright columns on two corners (Feature 10). A

gun flint was found nearby (on top of another platform). The gun flint and pipe stems are the only definite nineteenth century surface artefacts found at Nan Madol[11]. It is also of interest that, like the Dau feature, the Kohnderek platform has an adjacent circular enclosure made of piled coral, though it is much smaller. And both the Dau and Kohnderek features have extensive areas of basalt pavings next to them. Thus, it would appear that these probable habitation features on different islets share several distinctive traits. The surface artefacts, though extremely limited, indicate the possibility of post-contact nineteenth century construction of the platforms. The important factor here is the suggestion of architectural change during the early historic period.

BETWEEN-ISLET PATTERNING

Between-islet patterning may be examined along several dimensions. One of these concerns the relationship of total numbers of artefacts to selected variables. In this respect a scatterplot of shell tools versus islet land area revealed something of an inverse trend (Fig. 5); artefact numbers decreased as islet size increased (correlation coefficient $r = -0.67$). Though the appearance of a trend could be in part due to small sample size—just four cases—it is quite clear that any positive correlation can be ruled out. Another analysis concerned the possible relationship between shell tools and platforms on the four islets. Here the correlation coefficient $r = 0.49$, though positive, is nevertheless quite weak for the small sample. In undertaking both the scatterplot and correlation analyses it was believed that shell tool numbers could conceivably be a function of number of people living on an islet, and that islet size and/or number of platforms could be used as an indirect indicator of population size. Clearly, however, the results do not support such an assumption.

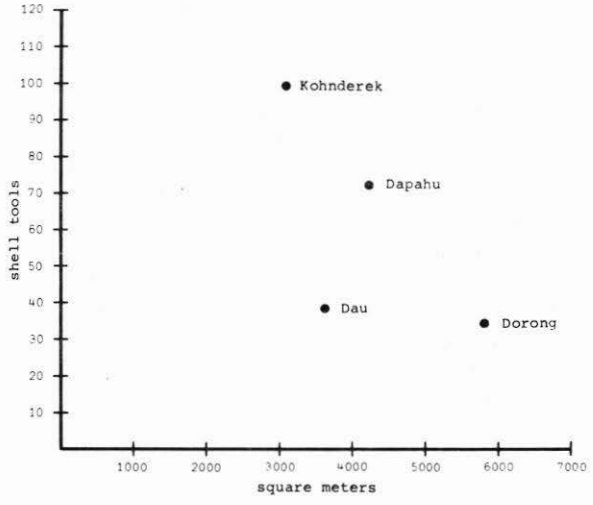

Figure 5: Scatterplot of number of shell tools *versus* islet size (m^2).

Another dimension of between-islet patterning concerns the relationship of artefacts to one another; that is, are there any patterned associations among the different artefact types when the islets are considered as a group? Correlation coefficients, which measure the strength of associations, have been calculated for five pairs of artefact variables (Table 4). Though the question of statistical significance is a problem when dealing

with such a small number of cases, there does appear to be an interesting pattern in the results. This concerns the fact that all the shell tool combinations have relatively high correlation coefficients (example a has r = 0.92 and is the only example that is statistically significant at the 0.1 level), while the single adornment variable (*Conus* rings) shows virtually no association with *Tridacna* hinge adzes (r = 0.04). This result suggests that shell tools may comprise "tool kits" in which the use of any one for a project involves the use of others. Alternatively, it could mean that while the different tools may have been used to perform different projects or tasks, the same projects or tasks were consistently performed on all the islets and in roughly the same proportion. Analysis of within-islet patterning (see below) seems more consistent with this latter interpretation.

TABLE 4
CORRELATION COEFFICIENTS* FOR SELECTED VARIABLES PERTAINING TO DORONG, DAPAHU, DAU, AND KOHNDEREK ISLETS

Example	Variables	r
a	*Tridacna* lip adzes *v.* *Tridacna* hinge adzes	0.92
b	*Tridacna* lip adzes *v.* *Terebra* adzes	0.82
c	*Tridacna* hinge adzes *v.* *Conus* artefacts	0.04
d	*Terebra* adzes *v.* *Cassis* rim and lip adzes	0.59
e	*Tridacna* lip adzes *v.* *Cassis* rim and lip adzes	0.71

* Except for example a, critical values for r at commonly accepted levels for statistical significance (df = 2) are not attained (see Thomas 1976:508, Table A.11). Example a is significant at the 0.1 level.

Regarding the *Conus* rings, the lack of association with *Tridacna* hinge adzes implies a usage unrelated to whatever was happening with the adzes. This is not surprising and may be an indication that certain islets were more important for certain kinds of activities, such as religious or ritual functions, or the residences of only certain classes of personages. Dorong islet, which has the greater number of *Conus* rings, is a case in point. The large number of tunnel features and a tomb distinguish it from the other islets.

One final point that should be made on between-islet patterning concerns the fact that no discrete artefact types have been recognised on any of the islets. With very minor exceptions, all classes of shell artefacts are found on all the islets. Thus, it would appear that there is considerable overlap in the kinds of activities that are represented on the islets.

WITHIN-ISLET PATTERNING

Within-islet patterning concerns the spatial association of artefacts on individual islets. Do certain types of artefacts tend to be found together more than might be expected from chance? The approach that will be used here follows the contingency table analysis of distance distributions with respect to nearest neighbour as described in Hodder and Orton (1976:204-207). The frequency of nearest neighbour associations are tabulated for artefact types and a chi-square computation tests for independent association. The four tests performed for this study only concern shell artefacts on Dapahu and Kohnderek (two tests each), where the counts are highest and the possibility of obtaining meaningful results is therefore greatest.

Tables 5, 6, 7, and 8 show that the null hypothesis was accepted in all four cases. The variables tested are independent and there is no evidence for associations other than might be produced by chance. It would seem, therefore, that the shell tools tested do not comprise "tool kits" for the performance of particular tasks or activities.

TABLE 5
CHI-SQUARE TEST OF ASSOCIATION BETWEEN *TRIDACNA* LIP ADZES (WHOLE OR BLADE PORTION) AND *TRIDACNA* LIP ADZE FRAGMENTS (BUTT OR MID-SECTION), DAPAHU ISLET

		Base Point A lip adzes	B lip adze fragments	Total
Nearest Neighbour	Type A	7	13	20
	Type B	11	14	25
		18	27	45

Chi-square with Yates' correction for continuity = 0.8437
Chi-square at 0.05 significance level (df = 1) = 3.84146
Null hypothesis accepted

TABLE 6
CHI-SQUARE TEST OF ASSOCIATION BETWEEN *TRIDACNA* LIP ADZES (ALL SUBTYPES*) AND *TRIDACNA* HINGE ADZES (ALL SUBTYPES), DAPAHU ISLET

		Base Point A lip adzes	B hinge adzes	Total
Nearest Neighbour	Type A	38	16	54
	Type B	10	4	14
		48	20	68

Chi-square with Yates' correction for continuity = 0.1684
Chi-square at 0.05 significance level (df = 1) = 3.84146
Null hypothesis accepted

* Counts from original list (Athens 1980b:99-103, Table 7), which includes unclassifiable worked fragments.

TABLE 7
CHI-SQUARE TEST OF ASSOCIATION BETWEEN *TRIDACNA* LIP ADZES AND *TRIDACNA* HINGE ADZES, KOHNDEREK ISLET

		Base Point A lip adzes	B hinge adzes	Total
Nearest Neighbour	Type A	40	14	54
	Type B	14	7	21
		54	21	75

Chi-square with Yates' correction for continuity = 0.12899
Chi-square at 0.05 significance level (df = 1) = 3.84146
Null hypothesis accepted

POTTERY DISTRIBUTIONS

From the time that Nan Madol pottery was first noted (Athens 1980a), its distribution was considered quite curious. Dapahu had well over 400 sherds on its surface, while the other islets had scarcely a dozen or two, if that. A wide distribution of pottery at Nan Madol was suggested by initial observations (Athens 1980a), and this was confirmed by investigations conducted in 1984 (see note 7).

TABLE 8
CHI-SQUARE TEST OF ASSOCIATION BETWEEN *TRIDACNA* HINGE ADZES AND *TEREBRA* ADZES, KOHNDEREK ISLET

		Base Point A hinge adzes	B Terebra adzes	Total
Nearest Neighbour	Type A	14	8	22
	Type B	7	9	16
		21	17	38

Chi-square with Yates' correction for continuity = 1.2714
Chi-square at 0.05 significance level (df = 1) = 3.84146
Null hypothesis accepted

A preliminary description of Nan Madol pottery is provided in Athens (1980a). Vessel shape appears to be limited primarily to globular pots with vertical or everted rims, though some jars are also present. Carination has not been noted. Decoration is usually confined to simple parallel notches along the interior and exterior rim edges. However, a recently recovered rim sherd has, in addition to the notches, three parallel rows of punctation on the inner rim lip and one row between the notches on the rim top. Dickinson (n.d.) undertook petrographic studies, discovering that most of the pottery contains crushed sherd temper. Only 5.8 percent of the surface body sherds on Dapahu contained calcareous temper. Dickinson indicated that the volcanic mineral inclusions of this pottery, apparently occurring naturally in the clay, were not inconsistent with an origin on Ponape. Further studies of the pottery's physical properties are described by Intoh and Leach (n.d.). The decorated Nan Madol pottery has no obvious parallels with other Micronesian or Pacific pottery.

Originally, the Nan Madol pottery was thought to be contemporaneous with the Nan Madol occupation[12]. However, several observations began to make this seem unlikely. For example, its surface distribution on Dapahu appeared random and not as if it had been part of an organised activity. Also, oral accounts were completely mute on the subject of pottery, suggesting that so much time has elapsed since its manufacture that it is no longer remembered. Another factor was Ayres and Haun's (n.d.1) subsequent report of finding pottery at a site near the Ponape coast at Awak, though they later considered it to be different from the Nan Madol pottery (Ayres, Haun, and Mauricio 1981:11). A 1500 B.P. radiocarbon date for this pottery seemed to confirm an early period of pottery use on Ponape (Ayres 1983:140). This compares to dates in the early part of the first millennium A.D. for recently discovered pottery on Truk (Shutler, Sinoto, and Takayama 1977). Both the Ponape and Truk data, therefore, seemed to fall in line with a common Pacific pattern of generally early pottery use and later discontinuance.

The last bit of evidence indicating that the Nan Madol pottery may date to an early period is rather indirect. There is a possibility that archaeological sites on Ponape's east coastal margin may have been submerged (Athens n.d.). This, however, was not well documented, the only evidence being a few artefacts recovered from dredged lagoonal coral rubble and sand (Athens n.d.; Saxe *et al.* 1980:119). But this indication of submergence also appeared to tie in with the observation that Dapahu had deposits of coralline sand eroding from between the rocks of its basalt column retaining wall and into the adjacent waterway. Could it be that Dapahu was built on a now submerged sand islet previously occupied by a pottery producing people? The idea seemed plausible and would go a long way towards explaining the curious distribution of Nan Madol pottery.

During a brief period of fieldwork in 1982 it was possible to test this idea with the excavation of two test pits on Dapahu. Only Grid 1 could be completed. In this unit there were two layers of archaeological deposits. The upper Layer I consists of coral rubble fill mixed with black silt loam[13] and a small amount of coral gravel. The lower Layer II, completely submerged at low tide, consists of coral sand mixed with coral gravel and generally small bits of coral rubble. The lowest level of Layer II (level 9) produced 438 grams of charcoal and wood fragments. A 47 gram charcoal sample, extracted from the larger sample, yielded a date of 1770 ± 90 radiocarbon years (Beta-6107; calibrated calendar range of A.D. 20-445 at 95% confidence interval according to Klein *et al.* 1982)[14]. Regrettably, lack of a water pump precluded excavation deep enough to reach culturally sterile deposits. In any case, the association of pottery with the radiocarbon date demonstrates occupation at Nan Madol beginning at least by the early first millennium A.D.

Table 9 summarises the distribution of pottery in the Grid 1 levels. Both absolute counts and sherd density figures are given. Of interest here is that the density figures show a rather homogeneous distribution of sherds throughout Layer I. This strongly suggests that pottery was already in the fill material gathered for islet construction, and that its presence on Dapahu's surface has nothing to do with post-construction pottery use. Since the Idehd radiocarbon dates suggest that major construction at Nan Madol may not have begun until after A.D. 1100 or so, it would appear that pottery use had terminated some time earlier.

Another interesting point brought out by Table 9 is that pottery density significantly increases in Layer II, which further substantiates the view that this layer constitutes a depositional episode distinct from Layer I. Presumably Layer II is not an earlier stage of islet fill, but represents a natural islet used for human occupation.

Mention should be made of the fact that in the lowest level of Layer II fully 51 percent of the pottery sherds contain calcareous sand temper[15]. This is a very substantial departure from the extremely low percentages of calcareous temper in sherds from the Layer I islet fill and on the surface. Kirch (1981:137) has brought attention to the temporal priority of the use of calcareous temper in Lapita pottery of the West Polynesian-Fiji region, and it now appears that the same may be true for the Ponape pottery (derivation of Ponape pottery from Lapita pottery is not implied; Lapita pottery is up to 1500 years older). The same pattern is also followed by the pottery in Guam (Reinman 1977) and Yap (Takayama 1982). The pottery from Truk was made virtually exclusively with calcareous temper (Shutler, Sinoto, and Takayama 1977). Thus, for whatever reason, calcareous temper seems to have been initially the favoured temper among pottery producers in at least several major areas of the Pacific.

This consideration of sherd temper suggests that the pottery in Dapahu's fill and on the surface, having as it does so little calcareous temper, must be later in time than the A.D. 20-445 radiocarbon date. More dating will be necessary before a reliable time frame can be established for the sherd tempered (non-calcareous) pottery, though about A.D. 400-800 is expected, with the end date marking the termination of all pottery manufacture[16]. Of interest is that the fill pottery apparently was derived from an underwater or tidal location, presumably in conjunction with the coral rubble fill. In Grid 2 a large (9 x 14 cm) chunk of well-cemented calcareous conglomerate with at least 10 visible sherds in it (non-calcareous temper) was recovered 34 cm below the surface. A marine origin for this specimen is definitely indicated[17].

SHELL ARTEFACTS: EARLY OR LATE?

The foregoing pottery discussion suggests the necessity of carefully scrutinising the data on shell artefacts to determine their origin. As is widely recognised, a severe

drawback in using many surface assemblages is the problem of establishing contemporaneity (see Lewarch and O'Brien 1981:316-317). Obviously, if the Nan Madol shell artefacts have the same origin and depositional history as the pottery, then the whole question of inferring settlement dynamics from surface assemblages

TABLE 9
NAN MADOL POTTERY, DAPAHU ISLET, GRID 1

Level	Depth Below Surface cm	Soil/Sediment Matrix	Rim Sherds: Decorated CST[a]	Rim Sherds: Decorated no CST	Rim Sherds: Plain CST	Rim Sherds: Plain no CST	Body Sherds CST	Body Sherds no CST	Sherd Fragments[b] CST	Sherd Fragments[b] no CST	Total	Screened Sediments[c] m^3	Sherd Density per m^3
surface	0	Layer I[d]	–	2	–	2	2	24	–	17	47	–	–
1	0-4	Layer I	–	1	–	1	–	69	–	10	81	0.0314	2,580
2	4-11	Layer I	–	–	–	–	1	62	–	7	70	0.0503	1,392
3	11-21	Layer I	–	1	–	1	2	167	–	13	184	0.0730	2,520
4	21-31	Layer I	–	–	–	2	1	171	–	18	192	0.0693	2,770
5	31-43	Layer I	–	–	–	7	10	184	–	9	210	0.0852	2,465
6	43-57	Layer I	–	–	–	1	7	108	–	5	121	0.0681	1,777
7	57-73	Layer II[e]	–	–	–	2	9	85	–	5	101	0.0303	3,333
8[f]	73-93	Layer II	–	–	–	–	9	44	11	42	106	0.0303	3,498
9[f]	88-98	Layer II	–	–	1	–	38	35	17	17	108	0.0200	5,400

(a) CST = Calcareous Sand Temper. Much (or perhaps all) of the pottery without CST contains crushed sherd temper.
(b) Sherd fragments are less than 1 cm in maximum dimension and/or they lack the inner or outer surface.
(c) Cobbles and boulders were removed before measuring the volume of sediments to be water-screened in ¼ and ⅛ inch wire mesh screens.
(d) Layer I consists of large coral rubble chunks mixed with black silt loam and coral sand, gravel, and small bits of rubble. Layer I is the islet fill out of which Dapahu was constructed.
(e) Layer II consists of very fine to very coarse coral sand mixed with coral gravel and rubble. A very small amount of silt is also present. All of Layer II remains underwater at low tide.
(f) Levels 8 and 9 were only partially excavated. The overlap of level 9 with level 8 is the result of efforts to obtain finer vertical control in the lower deposits after completion of level 8 in a separate part of the grid unit.

is unwarranted. There are several reasons, however, for believing that many, if not most, of the shell artefacts are unrelated to the early "pottery period" of occupation at Nan Madol.

Probably the most forceful reason arguing against an early time period for the shell artefacts is that their distribution bears absolutely no relation to the distribution of pottery. As shown in Table 10, for example, Kohnderek has by far the greatest number of shell artefacts, yet it has only 14 pottery sherds. Dapahu, which has the overwhelming majority of sherds, has only a middle range figure for shell artefacts (correlation coefficient r = 0.14).

The Dapahu excavation data likewise do not indicate a relationship between pottery sherds and shell artefacts. In fact, very few shell artefacts were found in either of the two excavation units (1 m^2 each). However, because these excavations were so limited and the surface density of shell artefacts is quite low, these results must be regarded as more suggestive than conclusive. Once systematic excavations can be undertaken, it should be possible to develop some fairly reliable estimates for the contribution of shell artefacts from disturbed islet fill to the surface assemblage. The fill must certainly be contributing some shell artefacts, but present evidence indicates that the number is probably fairly low.

TABLE 10
COMPARISON OF THE DISTRIBUTION OF SURFACE POTTERY SHERDS WITH SURFACE SHELL ARTEFACTS*

	Total Sherds	Total Shell Artefacts
Dorong	24	56
Dapahu	472	102
Dau	8	49
Kohnderek	14	154

* Counts from Athens (1980:Table 7, pp. 99-103), with the addition of two shell artefacts from Dapahu and two from Dorong (see note #9). Correlation coefficient r = 0.14.

Two other points may be made in favour of a late period for most of the shell artefacts. One of these, previously mentioned in the section on between-islet patterning, is that there is no positive relationship between islet size and number of shell artefacts. Thus, if fill were responsible for the artefacts, the islets with the greatest surface area would be expected to have the largest number of artefacts. Virtually the opposite seems to be the case. The other point is that the islet with the most house platforms, Kohnderek, also has the greatest number of shell artefacts. Despite the previously noted lack of relationship between platforms and artefacts, it is this author's opinion that there is a connection between the two variables. The problem is that statistics do not take into account intervening variables. In this respect, it seems likely that the islets at Nan Madol can be separated into one of three broad functional categories: residential islets, religious and ritual islets, and mortuary islets. This is the pattern Cordy (1982) has documented at the similar Lelu ruins in Kosrae. When more islet mapping and surface collecting can be undertaken at Nan Madol and islets segregated according to such categories, it is probable that more patterning between artefacts and features will emerge. For example, residential islets may begin to show a closer correspondence between platforms and utilitarian artefacts. Islets that have special religious significance or other features that set them apart—Dorong and Idehd are examples—will probably not have such a close correspondence.

ORAL ACCOUNTS AND ARCHAEOLOGY

Much of the information on Ponapean oral history derives from accounts by Bernart (1977) and Hambruch (1932-36). Other information is also scattered through many sources dealing with Ponape, and much can still be learned from Ponapean informants today (e.g., Hadley n.d.). This is not the place to provide an extensive treatment of oral accounts relating to Nan Madol. But in view of the archaeological data just presented, it would be of interest to mention briefly the most important points concerning Dorong, Dapahu, Dau and Kohnderek.

Dorong, which surrounds a large natural reef pool, is said to have been used for keeping and raising clams, which were collected at appointed times. Archaeologically, *Anadara* sp. clam remains appear to be relatively common on the surface. There is a special kind of square paving, which has a wall of stacked basalt columns around its edges (Feature 3), and a huge kava (*sakau*) pounding stone nearby. This feature has only recently (1984 field investigations) been determined to be a tomb structure. Similar features of this type at other islets were found to contain multiple secondary burials. There are also 11 tunnel-like channels that run underground, and a single very large one. The latter was said to have been used for keeping a sacred eel (*saleng iaia*). Platforms and a meeting house (*nahs*) foundation are also present on Dorong.

Dapahu is said to have been used for canoe making as well as the distribution of food to participants of a ceremony honouring the deceased *Saudeleur* at Nandauwas (see note 12). The greater number of fragmented *Tridacna* lip adzes on Dapahu compared to the other islets could possibly indicate greater attention given to canoe making on this islet.

Dau was the place where the guards of Nan Madol resided, and Kohnderek is said to have been used for mourning the deceased with a kind of dance. Neither islet has archaeological data that might reflect such functions.

CONCLUSION

It might now be justifiably asked whether surface artefacts are of any utility in trying to understand intra-site settlement dynamics at Nan Madol. What, indeed, has been accomplished? Dividing this question into two levels of significance, the value of surface artefact studies becomes quite apparent. On one level they improve the understanding of archaeological formation processes. The second level, on the other hand, provides insight into the actual settlement dynamics of Nan Madol.

As should be clear, without an understanding of the archaeological factors that condition the distribution of surface artefacts, it is impossible to know with certainty whether surface distributions are referrable to settlement dynamics. Surface artefacts, however, can play a key role in assessing formation processes. For example, reliable figures for total artefact counts were instrumental in bringing attention to the odd distribution of pottery, and subsequently for supporting the contention that shell artefacts are by and large contemporaneous with islet construction and use. At the same time, these surface data very clearly suggested on which islet test excavations would be most profitable.

Excavation data, of course, are very important, and the artefact density figures and vertical distribution information obtained from the Dapahu test pits provided substantial insight into the question of artefact surface distributions. Had excavation been undertaken without careful surface artefact collection, the evaluation of surface artefact data would have been much more difficult. In sum, excavation and surface collection go hand in hand in the study of archaeological formation processes. But the priority of careful and systematic surface collection in any investigative programme would seem essential in view of the Nan Madol experience.

What can now be said about settlement dynamics at Nan Madol? Probably the most significant conclusion has to do with the structure of economic organisation at the site. The shell artefacts fail to provide definite evidence of artefact distributions or associations that would suggest different activities, special functions, or the segregation of space on the different islets for the purpose of economic management. From this it may be inferred that specialised production—that is the highly structured organisation of people and materials for the efficient manufacture or processing of goods—was not a characteristic of Nan Madol. Such a result is in direct opposition to the often cited view that chiefdoms function to facilitate economic specialisation and redistribution (see Service 1962). At Nan Madol chiefly administrators do not seem to have been administering the flow of goods and services, a conclusion which supports the position taken by Earle (1977) in his review of Pacific chiefdoms based on ethnographic and ethnohistoric data. Importantly, the Nan Madol data are archaeological and represent a time period prior to western contact.

Although research at Nan Madol has been limited, available archaeological data, historic documents, and oral accounts point to a very substantial concern with ceremonial and ritual activities by the site's occupants. In addition, the most recent archaeological investigations of 1984 (report in preparation) have documented a much greater use of the islets for mortuary purposes than previously suspected. This information, however, does not diminish the over-riding importance of Nan Madol as an administrative centre for the very complex social and political organisation of Ponape. It was above all the residence of paramount chiefs. But it is nevertheless inescapable that religion must have been a very important integrating force in prehistoric Ponapean society. Political expansion and island unification by the *Saudeleur* probably could not have been accomplished without it. In this respect, surface artefact distributions provide a significant contribution to the understanding of Nan Madol, by suggesting that economic management must have been minimal and therefore could not be the key to the development of chiefdom level society on Ponape.

ACKNOWLEDGEMENTS

The original draft of this paper was presented at the XVth Pacific Science Congress, symposium on "Settlement Pattern Archaeology in the Pacific", organised by Dr Roger C. Green, and held in Dunedin, New Zealand, February 1-11, 1983. My thanks to Rosalind Hunter-Anderson, who read the paper when I was unable to make the trip. Table 9 has been revised to include new sherds found during final midden sorting, and the text has been modified in places as well.

Field investigations in 1979 and 1980 were conducted under the auspices of the Pacific Studies Institute of Guam for the Office of Historic Preservation, Trust Territory of the Pacific Islands. The Ponape Historic Preservation Committee greatly facilitated this work, with Masao Hadley, Pensile Lawrence, and Narsi Kostka being particularly helpful. During the field investigations of December 1982, Pensile Lawrence provided assistance and made necessary arrangements for conducting fieldwork. Accommodations were generously provided by Masao Silbanuz and his family. Peter Reichert of Pacific Missionary Aviation very kindly provided the opportunity to take aerial photographs of Nan Madol on a return flight from Kosrae. John Athens printed the photographs. Debra Tillar volunteered her time for sorting the 1982 midden remains, and David Welch helped with the soil descriptions. David Hanlon provided leads on several important historical documents. I am very grateful to all for their assistance.

NOTES

1. Islet names are spelled according to modern Ponapean orthography as presented in the list compiled by Rufino Mauricio (Ayres, Haun, and Mauricio 1981:4-6). Mauricio's list is derived from Hambruch (1936), who recorded names given to him by informants in 1910.

2. Oral history accounts identify at least six quarries for the Nan Madol basalt columns (Christian 1899; Hambruch 1936). Trace element analyses are at present being undertaken of Nan Madol column samples for comparison with these quarries and other outcrops of columnar basalt to identify their sources. Measurement of the huge boulder at the base of the southeast corner of Nandauwas' outer enclosure wall indicates that it weighs *ca.* 52 tons.

3. Although political unification is described or implied by oral history accounts, a considerable amount of caution should be exercised in interpreting its meaning in the Ponapean situation. Our notion of political unification may be strongly biased by western political traditions. It is possible that such expressions as "political unification" and "absolute power of the *Saudeleur*" overstate the reality of the situation.

4. Intensive surveys have been conducted on Ponape by Athens (1980c), Ayres and Haun (n.d.1, n.d.3, 1980), Ayres, Haun, and Severance (1981), Bath (1984), Saxe *et al.* (1980), and Streck (1980, 1983).

5. The paramount chiefs (*Nahnmwarki*) who followed the collapse of the *Saudeleur* rule, are also said to be buried at Nandauwas.

6. The early *Nahnmwarki* residence was also on the islet Pahnkadira in Nan Madol. According to Hadley (n.d.), the 7th *Nahnmwarki* lived on Peidoh Island, which is attached to Temwen Island. The 8th *Nahnmwarki* returned to Nan Madol, residing on Usendau islet. The residence of the 9th *Nahnmwarki* is not mentioned by Hadley (n.d.), though the 10th lived on Na Island. Most of the subsequent *Nahnmwarki* apparently lived on Temwen Island, though Hadley (n.d.) specifically names this location for only a few.

7. Athens conducted a four month field project at Nan Madol in early 1984. Maps were produced of 25 islets, and 21 test pits were excavated on 14 islets. A field project at Nan Madol is also being conducted by W. Ayres in 1984.

8. The mapped islets might be considered part of a broad class of "low islets" as opposed to "walled islets", which have retaining walls that rise above the islet surface.

9. There was also an unclassified elongated ceramic bead. Field investigations in 1982 produced three additional surface artefacts from the islet Dapahu. These were *Tridacna* hinge and lip adzes (one each), and a small clear-glass bottle fragment. In 1984 two *Conus* rings were found on Dorong.

10. The Japanese period dates from 1914 to 1945. A Japanese WW II gun emplacement is located on Temwen Island and other installations are at nearby Nahpali Island. It is not unlikely that Japanese military activity could account for some of the Japanese period remains at Nan Madol (e.g. porcelain and glass fragments).

11. Excavations in the south crypt of Nandauwas by the American trading ship captain, Dudoit, in either 1834 or 1836, and then in the central crypt by two British whaleship captains in 1840, produced Spanish style artefacts (Athens 1981). There is the implication that unrecorded Spanish vessels could have landed at Ponape before the time of documented western contact in the late 1820s, which is also suggested by Ponapean oral accounts. Spanish galleons conducted considerable trade between Manila and Mexico from 1565 to 1815 and one or more of these ships may have been sufficiently off course to pass by Ponape.

12. This was primarly because of the association of food distribution activities on Dapahu and nearby Usennamw. Hambruch (1936:32) mentions that Usennamw ". . . was the kitchen for the king and later the Nanamariki. He appeared here and distributed the finished dishes to his following". Hambruch (1936:37-38) also notes that after depositing gifts at the grave of the deceased *Saudeleur* at Nandauwas for the *epenlap* [Aponalap?] festival, the participants went to Dapahu ". . . where the prepared food was taken and there distributed. . ."

13. It is believed that the black silt loam is the result of *in situ* soil development.

14. Dr M. Tamers, Beta Analytic Inc., stated (pers. comm.) that in his opinion immersion in salt water has absolutely no effect on radiocarbon dates, and that the Dapahu sample (large chunks of wood charcoal) was a good one. Given the validity of this date, therefore, Dapahu has the earliest archaeological deposits at present known on Ponape. By way of comparison, a swamp core from Ponape's Awak valley produced a date of A.D. 227 for the earliest definite evidence of human cultural activity (charcoal flecking and wood; Ayres and Haun n.d. 2:14). The closeness of this date to the Dapahu date, especially given the distinct environmental settings of the two locations from which the dates were derived, is impressive.

15. Excavation of Grid 2 on Dapahu was completed in 1984. Field observations indicate that basal levels in Layer II contained exclusively or nearly exclusively calcareous tempered pottery. Approximately 1 metre of sand deposits were excavated below the low tide water level. Laboratory analysis of this material is at present underway.

16. The end date is based on the fact that the lowest deposits on Pahnkadira (late A.D. 900s) did not have pottery, and the lowest deposits on Usendau (late A.D. 700s) did contain a small number of sherds (see Ayres 1983; Ayres, Haun and Mauricio 1981).

17. It now seems likely that the very thin white laminar deposits observed in the Nan Madol pottery (Athens 1980a:98) resulted from precipitation of salts accumulated during deposition in a tidal environment.

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Received 19 April 1983