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Prehistoric Settlement in Eastern Micronesia: Archaeology on Bikini Atoll, Republic of the Marshall Islands

CHARLES F. STRECK, JR.

U.S. Army Engineer Division, Pacific Ocean,
CEPOD-ED-MI. Bldg. 230,
Fort Shafter, Hawaii 96858-5440

Abstract—Recent archaeological research on coral atolls in Micronesia suggest that they may have been settled contemporaneous or prior to the high volcanic islands of the region. Research on Bikini Atoll in the northern Marshall Islands has resulted in the identification of extensive prehistoric cultural deposits despite massive modern disturbance from nuclear weapon testing and construction of support facilities. These cultural desposits have been radiocarbon dated to perhaps greater than 3,000 years B.P., despite Bikini's perceived environmental marginality. The cultural remains also exhibited distinct functional specificity and illustrated the geomorphic dynamism of island landforms on coral atolls. The results of this research indicate that cultural adaptation to coral atoll environments may be of great antiquity in Micronesia.

Introduction

Relatively little archaeological research has been performed on the coral atolls of Micronesia, particularly those in the eastern archipelagoes of the Marshalls and Kiribati. The distribution of archaeological research has been patterned by general culture historical and processual models of human settlement in the Pacific emphasizing the overwhelming ecological significance of the high islands and the environmental marginality of coral atolls (e.g. Alkire, 1977, Bellwood 1979, Kirch 1984).

Chief among many factors which have been perceived as inhibiting long-term habitation and cultural adaptation on Micronesian atolls are: 1) limited fresh water resources, 2) lack of varied raw materials for the development of sophisticated tool assemblages, (3) lack of arable land and severely limited cultigen species, 4) susceptibility to environmental stress, sometimes catastrophic, particularly tropical storms and drought, 5) inability of atoll populations to consistently ensure surplus resources, 6) inability of small isolated populations to overcome periods of social stress such as disease and warfare, and 7) difficulty in establishing and maintaining communication and exchange networks. Although seldom explicitly stated, an underlying assumption in many of the archaeological investigations of coral atolls has been that they are recently formed geomorphic features, essentially static in shape and size (barring catastrophic events).

Although these factors cannot be discounted as having constrained human residence on some coral atolls, they do not appear to be so restrictive as to have prevented atolls from being components of the initial settlement and subsequent evolution of Micronesian cultures. Recent archaeological research in the Marshall Islands and other Micronesia atolls corroborates this new view.

Previous Atoll Research

Modern archaeology on Micronesian atolls was initially oriented towards Polynesian outliers, guided by investigations into the origins of the Polynesian populations. Investigations at Nukuoro in the eastern Caroline Islands[1] established the presence of extensive stratified cultural deposits suggesting long periods of occupation (Davidson 1967, 1968, 1974). Environmental variables affecting the cultural stratigraphy, such as sea level change and storm surge encroachment, were also described. Subsequent research on Faraulep and Woleai in the western Carolines substantiated the probability for long human habitation dating from around A.D. 1000 (Fujimura & Alkire 1979). Similar deposits were identified and sampled at Ulithi (Craib 1980) and Ngulu (Takayama 1982) radiocarbon dated about A.D. 400 and 55, respectively. These investigations in western and central Micronesia suggest that habitation continued unabated from the lowest excavation levels through historic contact periods (generally most intensive in the early 19th Century). Therefore long term habitation and cultural evolution was possible on atolls despite apparent environmental limiting factors.

Relatively few archaeological studies have been performed in eastern Micronesia despite the pioneering efforts of Davidson. The most intensive of these studies was at the Polynesian outlier of Kapingamarangi, south of Nukuoro (Leach & Ward 1981). Deep stratified cultural deposits were identified on the small island of Touhou dating from about A.D. 1200. One result of this research was the identification of numerous coral rubble walls and sand-entrapment systems which appeared to have been used to accentuate island relief and increase available land area. A possible secondary effect of this prehistoric landform modification may have been to increase the availability of potable subsurface water (the Ghyben-Herzberg lens). This may be an example of traditional cultural attempts to mitigate some of the factors thought to have inhibited longterm cultural adaptation in atolls. Such practices may have been common in the atolls of Mirconesia, particularly in areas with pronounced dry seasons and/or frequent cyclonic storms.

Other research in the eastern Carolines has been performed on And Atoll, near Pohnpei (Ayres *et al.* 1981). Traditional Pohnpeian basaltic structures (*pehi*) as well as deep, stratified cultural deposits radiocarbon-dated well before the A.D./B.C. boundary have been identified. Although not yet systematically investigated, cultural deposits similar to those found on Nukuoro, Kapingamarangi, and And have been noted on Ngetik (Leach & Ward 1981, Streck unpublished observation).

Archaeological research in the eastern Micronesian atoll archipelagoes of the Marshalls and Kiribati has been extremely limited. An extensive reconnaissance survey of 12 atolls and one island was performed in 1977 (Dye 1987). This investigation included the collection of a large traditional artifact assemblage (in excess of 1,500 items), identification of probable cultural deposits, and limited test excavation. Research in the Laura area of Majuro Atoll, for example, suggested that the area may have been continuously inhabited from the A.D. 600's through modern times. Other potential longterm habi-

[1] For locations of islands see foldout map in this volume.

tational cultural deposits were identified on a number of atolls, mostly in the central and southern Marshall Islands.

More intensive archaeological survey was performed on Majuro, where 133 sites were found throughout the atoll (Dye 1987). A range of site types including domestic homesteads, fishtraps, possible religious sites, and resource procurement areas were identified. A series of radiocarbon dates from cultural strata indicates that the atoll was initially settled as early as the 100's B.C. This was the first indication that human settlement on eastern Micronesian atolls was contemporaneous with, or had preceded, that on the high islands of Kosrae, Pohnpei, and Truk.

Archaeological site distribution on Majuro suggested that habitation on the eastern (windward) side of the atoll was inhibited by cyclonic and storm wave exposure. This area also lacked fish traps on the coral reef. Perhaps a more significant mitigating factor may be that this portion of Majuro contains the atolls' deep water passages and a much more restricted protecting fringing reef. These characteristics would allow greater adverse impact to the eastern islands and islets through tropical storm surge than elsewhere in the atoll.

Archaeological survey and test excavation have also been performed on Arno (Dye 1987). A total of 164 surface and subsurface archaeological sites were identified. Radiocarbon dates from test excavations indicate that the atoll was occupied from at least the A.D. 800's. Dye used the results of this investigation to formulate an atoll-wide prehistoric settlement model. Generally, the densest prehistoric habitation was posited to have occurred on the more sheltered western islands (as on Majuro) and been concentrated along the lagoon strand. Isolated homesteads and/or "worker's" residences would be found within the interior of the larger islands and on the smaller islets. Exceptions to this pattern appeared to occur when wide ocean-facing reefs were present forming sheltered micro-lagoonal environments.

Several other archaeological historic preservation compliance projects have been performed in the Marshalls, including a survey of six small islets northeast of Ebeye on Kwajalein Atoll (Athens 1984) and a proposed dock site on Majuro (Rosendahl 1977). Neither investigation was conclusive. Recent archaeological investigations on Kwajalein Atoll have been performed accompanying U.S. Army activities. Intact, though truncated, prehistoric cultural deposits have been identified beneath the present airfield runway on Kwajalein Island radiocarbon-dated to 300–400 B.C. (Shun & Athens, this volume). Possible coral pebble structural pavements, a large, diversified artifact assemblage, and possible sediments from taro cultivation were associated with this deposit. Archaeological reconnaissance and intensive survey on all the islands of Kwajalein Atoll under U.S. Army control identified extensive cultural remains on the small islets of Legan and Enewetak (Schilz 1989). These surveys identified probable surface structural remains, deep, stratified cultural deposits containing dense midden and functional features (mostly earth ovens), and several indigenous artifacts (mostly *Tridacna* spp. adzes). Radiocarbon dates suggest these small islets were inhabited from around A.D. 600.

Several descriptions of "typical" atoll settlement pattern, particularly applicable to the Marshall islands, have been presented in the archaeological literature. Many of these have emphasized island size and availability of ground water resources while attempting to standardize the settlement pattern of the entire archipelago (e.g. Alkire 1977, Athens

1984, Bryan 1972, Cordy 1979). Most of these schemata differ only slightly from those formulated for Majuro and Arno atolls (Dye 1987).

A brief archaeological reconnaissance survey of seven northern Marshall Island atolls was completed in 1988 (Thomas 1989). This resulted in the identification of prehistoric cultural deposits and the collection of indigenous artifacts on the atolls/islands of Jemo, Rongerik, Erikub, Taka, and Wotho. Limited archaeological test excavation established human residence on these environmentally "marginal" atolls from at least around A.D. 1000. The first intensive archaeological investigations to be performed in the northern Marshalls have been at Bikini Atoll (Streck 1986, 1987). Surface and subsurface reconnaissance survey and controlled test excavation have been performed in most portions of the atoll.

Bikini Atoll: Background

The Marshall Islands are composed of two north-south trending chains of atolls and islets (the Ralik and Ratak chains) containing a degree of habitat diversity dependent upon the size of the atoll and the amount of annual rainfall (Alkire 1978). Bikini is situated in the drier northern portion of the Marshall Islands. It receives an average of only 53 inches of rainfall a year while, for example, Arno averages 160 inches yearly.

Bikini Atoll (Fig. 1) is situated 4,000 kilometers (ca. 2,500 miles) southwest of Hawaii at 11° 35′ N, 165° 25′ E. It comprises a ring of 23 islands with a total land area of 8.8 km² (3.4 square miles), including the intertidal zone. The oval-shaped lagoon mea-

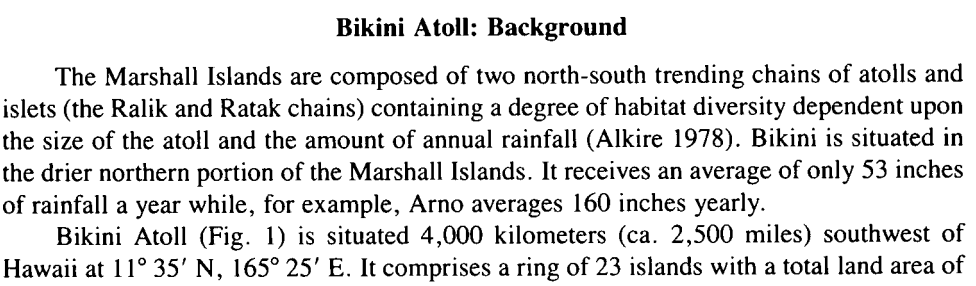

Figure 1. Map of Bikini Atoll.

sures approximately 42 km east/west, 24 km north-south, encompassing about 630 km^2. The lagoon environment exhibits a varied and abundant marine biota.

Partly as a consequence of low annual rainfall, northern atoll populations such as at Bikini engaged in gardening activities emphasizing non-labor intensive species that were tolerant to frequent droughts (Wiens 1963). They depended on the hardier crops of coconuts, pandanus, and arrowroot for subsistence, while breadfruit and taro were more important on the southern atolls (Kiste 1974). Although the incidence of cyclonic storms is slightly higher in the northern Marshall Islands, they are relatively rare and may actually be of some benefit by replenishing and maintaining the ground water supply of the larger islands (Maragos *et al.* 1973).

Contrary to the general settlement pattern noted and inferred for the southern atolls in the Marshall Islands, Bikini appears to have been more densely populated along the eastern, windward portions of the atoll (Streck 1986, 1987). Rainfall patterns and island substrate composition may be sufficiently different in the northern Marshalls, so that fresh water cannot be tapped for cultural use on the smaller islets as is common on the more southerly atolls.

Bikini Island, the largest in the atoll (227 ha or 560 acres), was the only permanently occupied area when the community was evacuated in 1946. It appears to have hosted the most extensive habitation during prehistory. The second largest island, Eneu (123 ha), possesses a larger and higher quality groundwater resource, however (Peterson 1986). Eneu, as well as the islands of Nam (53 ha), Enidrik (97 ha), and Eneman (20 ha) also may have had small permanent settlements during the premodern (pre-20th Century) era. Nam was the only island, beside Bikini and Eneu, on which definite evidence for probable prehistoric cultural deposits or indigenous Marshallese artifacts were identified.

The islands of atolls in the Marshall islands tend to have higher relief and greater average elevation than in many other Micronesian atolls. Bikini Island has an average interior elevation of 1.8–2.7 m above sea level with a maximum of 4–5 m despite massive modern land alteration. Eneu averages 1.5–3.0 m elevation.

Foreign influences, while profound in much of the Marshall Islands, appear to have had minimal social effect until 1946 on Bikini (Hezel 1979, 1983, Kiste 1974). Following defeat of the Japanese in the Pacific during World War II, the U.S. Government removed the 167 residents of Bikini in 1946 so that the atoll could be used for the testing of nuclear weapons. Considerable hardship was inflicted on the Bikinian community until they were finally settled on Kili island in 1948.

Most of the nuclear test blasts were concentrated in the western portion of the atoll, although radioactive fallout was severe on the northeastern islands following wind abnormalities during thermonuclear blast BRAVO in 1954. In 1968 the main islands of the atoll were deemed safe for settlement. Debris cleanup, replanting, and establishment of new community facilities resulted in the alteration of the land surface of most of the larger islands. In 1978, Brookhaven National Laboratory performed whole body radiation-burden examinations of some of the Bikinian resettlers which revealed unacceptable radiation levels. The resettled community was subsequently evacuated from the atoll.

The Bikini Atoll Rehabilitation Committee (BARC) was established by the U.S. Congress in 1982 to support research and advise on methods for rendering Bikini Atoll

safe for human habitation. In addition to primary research dealing with radiological conditions and means to reduce or ameliorate conditions to within federal dosage standards, BARC has supported a wide range of environmental investigations.

Bikini Atoll: Archaeological Resources

Archaeological reconnaissance was initially performed on 11 of the 23 islands on Bikini Atoll in 1985. Potentially significant cultural deposits and/or indigenous artifacts from ground surface contexts were noted on Nam, Bikini, and Eneu. Subsequent test excavation was performed on these islets (Streck 1986, 1987, in prep.). Archaeological excavations covered over 30 m^2 and included a systematically sampled volume exceeding 18 m^3. An artifact assemblage composed of over 300 items (70% from subsurface context) was recovered. The assemblage includes over 200 indigenous Marshallese artifacts including shell ornaments, shell and coral tools, pearlshell fishhooks, and various other utensils. Thirty-five radiocarbon age determinations have been obtained from 25 locations on Eneu and Bikini Islands (Table 1; Figures 2 and 3). In addition, initial analysis of over 24 kg of excavated midden has been completed including copious amounts of marine mollusc shell, possible marine mammal bone, sea turtle bone, and crustacean and echinoderm remains. These data allow for the preliminary determination of chronology of human settlement, use of particular island areas, function of subsurface features, and reconstruction of probable settlement pattern during the prehistoric period on Bikini Atoll.

Several constraints governed the way the archaeological survey was performed, and recovered data were interpreted on Bikini. Among these were the physical effects of the nuclear testing and the construction of support facilities for the testing between 1946 and 1958. Direct effects of the testing included the complete destruction of several small is-

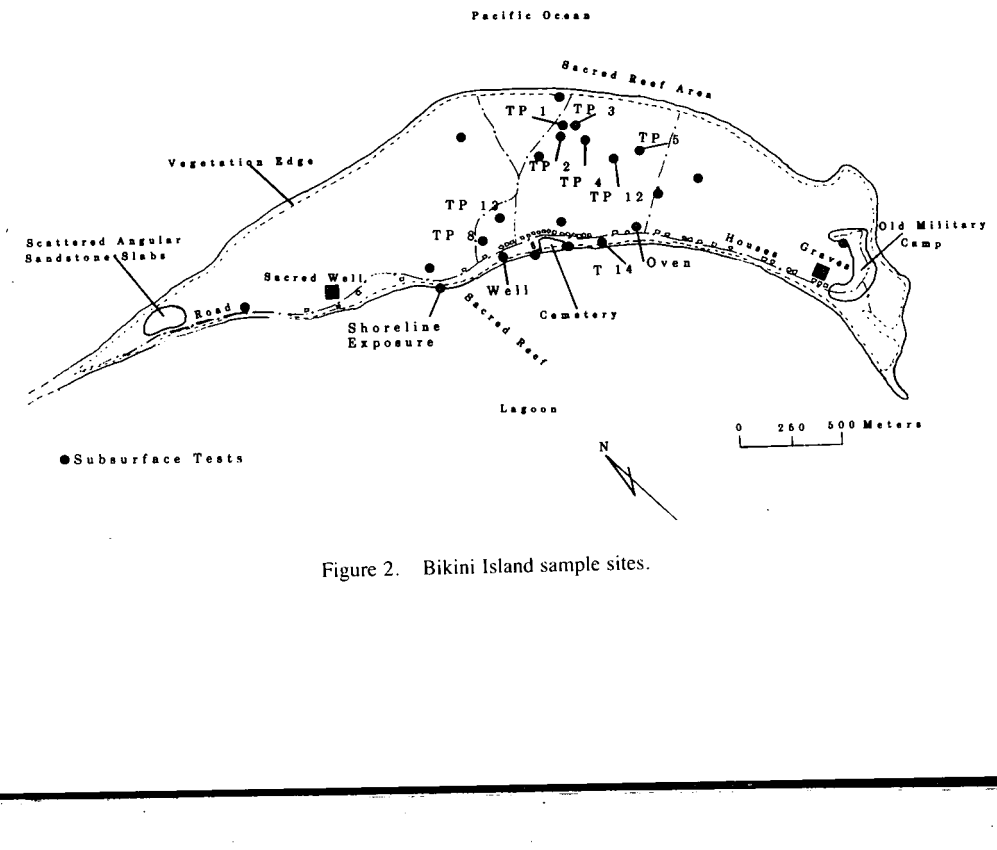

Figure 2. Bikini Island sample sites.

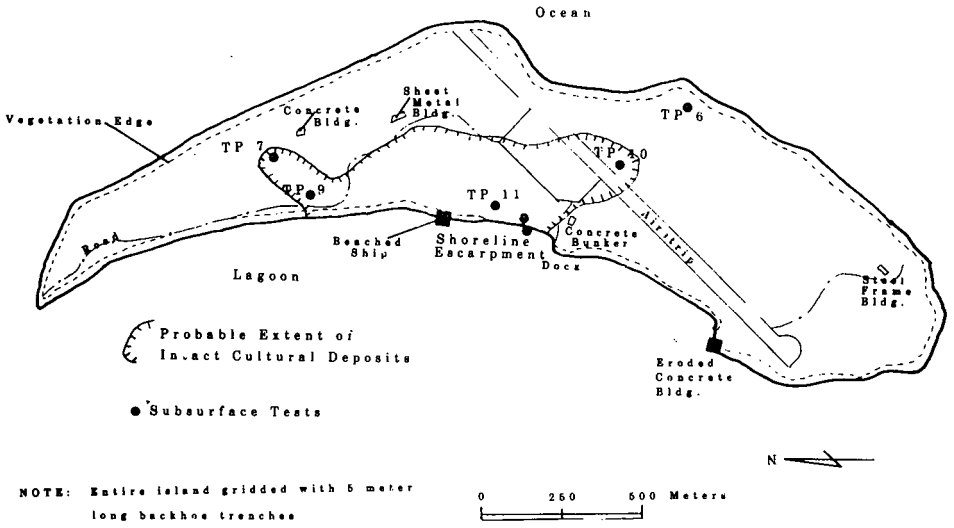

Figure 3. Eneu Island sample sites.

lands at the northwestern end of the lagoon and significant portions of Nam and Eneman Islands. Both of these larger islands probably supported small permanent settlements during the premodern or prehistoric period. The only identified remains from such probable use were from one restricted area of Nam, where a remnant of the original island surface is preserved. This area supported a lush, mixed vegetative cover (in contrast to the remaining portions of the island) on a low hummock. Archaeological test excavations in the area confirmed the presence of a thick (ca. 70 cm in depth), intact cultural deposit containing earth and coral pebble-lined firepits.

Construction of support facilities for nuclear testing included massive mechanical grading and transport of surface sediments on all the larger islands, particularly Bikini, Eneu, Aerokojlol, and Enidrik. Subsequent construction activities associated with the abortive resettlement of Bikini Atoll in 1968 included the grading of the surfaces of Eneu and Bikini Islands as well as the removal of radioactive sediments from Bikini (disposed of in the BRAVO coral reef crater). The net result of these activities has been to create an archaeological testing environment much more akin to American urban archaeology than to that normally encountered on Pacific islands. Most of the original topographic variability of the islands has been lost.

Archaeological subsurface testing identified extensive areas of intact cultural deposits. These have been uniformly truncated at the top, however. In many areas little more than the lower portions of prehistoric pit and/or earth oven features were preserved. The remains from intact cultural deposits were identified on approximately 40% of the land area of Eneu Island (concentrated near the lagoon shoreline) and on 70% of Bikini Island. The most impressive exposure of prehistoric cultural stratigraphy is along the southwest shoreline of Eneu. This area contains the "Shoreline Escarpment" site wherein three distinct cultural deposits are visible on a 2–3 m high erosional scarp. The lowest cultural

deposit, containing numerous features indicative of domestic habitation, has been radiocarbon-dated to as early as 1200 B.C. Elsewhere on Eneu the intact deposits are much thinner (generally 20–40 cm thick) and contain less dense cultural remains. All of the *in situ* cultural deposits on Bikini Island were identified in subsurface context except in isolated areas where mechanical grading had exposed the oval boundaries (in plan view) of earth ovens. Thickness of the deposits at any particular location on the island varies greatly, probably as a function of the original island topography (original high spots flattened and low spots filled).

Indigenous artifacts (generally collected from surface context) were denser on Bikini than on Eneu. They were most dense near the houses occupied during the abortive resettlement of the island where ground disturbances had occurred. There is no apparent difference in excavated artifact assemblage composition on either island. The functional and decorative artifact tradition on Bikini Atoll appears to have been extremely conservative through time.

Initial attention was also directed toward the results from radiocarbon and carbon isotopic analysis of charcoal and shell samples derived from prehistoric cultural contexts because of anticipated effects from nuclear weapon testing. Discussions with scientists and specialists at Beta Analytic, Inc, Lawrence Livermore National Laboratory, and Oak Ridge National Laboratory dispelled any uncertainty about radioactive element contamination of charcoal dating samples from Bikini and Eneu islands. Carbon isotopes formed through the nuclear testing at Bikini Atoll had a short halflife and would not have readily permeated the soil matrix outside the blast zone. In addition, the size of the biomass converted during the testing would have been slight. The most likely effect from nuclear testing, if any, on the age determinations would be to skew them towards the present, making them younger.

Bikini Atoll Archaeological Research: Results

The results of radiocarbon age calibration of cultural samples from Bikini and Eneu are presented in Table 1. Unfortunately, a single bulk dating sample from Nam was too small for reliable calibration. The apparent continuity and antiquity of human habitation on Bikini Atoll was unanticipated for the northern Marshall Islands, which were expected to have been settled late in prehistory. Existing Bikinian oral traditions suggested that the community was founded only within the past few hundred years.

The earliest date (1965–1665 B.C.) was from Test Pit 2 near the geographic center of Bikini Island. The sample was retrieved from a remnant portion of a wide, bowl-shaped earth oven (*um*) situated at 60–72 cm below present ground surface. The 1 × 1 m test excavation unit contained the remains of the bases of at least 6 ovens, some of which were associated with faint traces of cultural deposit. The sample was separated, vertically, from the overlying cultural features by an approximately 7–10 cm thick band of culturally sterile, aeolian sand. At the time of archaeological sampling, this area of Bikini Island was being utilized for agricultural experiments and had been highly altered through grading and bulldozing. At least three cultural strata are present in most archaeological test units in this interior portion of Bikini Island, while a simpler, two-strata depositional pattern appears to predominate near the lagoon shoreline.

Beta #	Sa
−15042	T
−15043	T
−15044	T
−16389	B
−16863	T
−16864	F
−16865	L
−16866	L
−16897	T
−16898	T
−16900	W
−17391	T
−17392	H
−17393	T
−17394	F
−17762	T
−17763	T
−17826	L
−21237	F
−21238	F
−21239	T
−21240	T
−21241	T
−21242	T
−22133	T
−22135	T
−22136	S
−22137	T
−22316	T
−22317	T
−22322	A
−22323	T
−22324	T
−22325	T
−22326	T

F = Archaeolog
Cult. Dep. = Cultural
Shrl. Exp. = Shoreli
TP = Test Pit; T = Te

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would have been

Table 1. Radiocarbon dating sample from Bikini Atoll.

Beta #	Sample	Provenience	^{13}C Adjusted Age	Calendric Age
−15042	TP2	Dep.; F4 (shell)	2070 ± 80 BP (^{14}C)	650–490 BC
−15043	TP2	BOE; (Char)	3450 ± 60 BP	1960–1665 BC
−15044	TP2	F2;(Char)	980 ± 70 BP	AD 900–1210
−16389	B-57	F1;(Char)	760 ± 90 BP	AD 1055–1350
−16863	TP7	F1;(Char)	300 ± 80 BP	AD 1415–1675
−16864	FS2	Shrl.Escpt.;Char	1020 ± 80 BP	AD 860–1225
−16865	LS2	Shrl.Escpt.;Char	700 ± 80 BP	AD 1200–1405
−16866	LS3	Shrl.Escpt.;Char	1360 ± 80 BP	AD 465–870
−16897	TP4	F1;(Char)	890 ± 50 BP	AD 1030–1250
−16898	TP3	L5;(Char)	840 ± 60 BP	AD 1050–1265
−16900	Well	F1;(Char);Bulk	820 ± 80 BP	AD 1030–1325
−17391	TP5	Cul.Dep.;(Shell)	950 ± 70 BP (^{14}C)	AD 930–1070
−17392	H-16	Oven;(Char)	610 ± 80 BP	AD 1245–1425
−17393	TP2	F6;(Char)	1020 ± 70 BP	AD 890–1170
−17394	FS3	Shrl.Escpt.;Char	2380 ± 290 BP	1095 BC–AD 200
−17762	TP2	F1/2;(Char)	760 ± 50 BP	AD 1190–1315
−17763	TP4	F3;(Char)	850 ± 90 BP	AD 925–970 (1305)
−17826	L4	Shrl.Escpt.;Char.	2575 ± 210 BP	1210–275 BC
−21237	FS6	Shrl.Escpt.;Char	1300 ± 70 BP	AD 600–870
−21238	FS7	Shrl.Escpt.;Char	2000 ± 100 BP	365 BC–AD 220
−21239	T14	F1;(Char)	320 ± 70 BP	AD 1425–1655
−21240	T14	F2;(Char)	420 ± 60 BP	AD 1400–1525
−21241	T14	F14;(Char)	420 ± 60 BP	AD 1400–1525
−21242	TP9	F1;(Char)	430 ± 60 BP	AD 1400–1515
−22133	TP8	L2;(Char)	60 ± 80 BP	AD 1650–1950
−22135	TP13	L5;(Char)	790 ± 100 BP	AD 1040–1335
−22136	Shrl.Exp.L.	Gray Sand;Char	0 ± 80 BP	AD 1665–1950
−22137	TP10	L2;(Char)	290 ± 110 BP	AD 1415–1680 (1950)
−22316	TP12	L5;(Char)	580 ± 80 BP	AD 1255–1435
−22317	TP11	L8;(Char)	1210 ± 70 BP	AD 630–905
−22322	AT-4	38-52cmbs;Char	130 ± 60 BP	AD 1650–1950
−22323	TP13	L4,SE F;(Char)	920 ± 50 BP	AD 930–965 (1235)
−22324	TP12	L4;(Char)	920 ± 60 BP	AD 930–965 (1235)
−22325	TP11	L7;(Char)	1450 ± 80 BP	AD 410–765
−22326	TP8	L3;(Char)	70 ± 90 BP	AD 1650–1950

F = Archaeological Feature; L = Excavation Level/Layer; LS = Layer Sample; FS = Feature Sample; Cult. Dep. = Cultural Deposit; BOE = Base of Excavation; Shrl. Escpt. = Shoreline Escarpment Sample Area; Shrl. Exp. = Shoreline Exposure Sample Area; Char. = Wood Charcoal; Dep. = Deposit; AT = Auger Test; TP = Test Pit; T = Test

While only a few dated samples (approximately 15%) extend back beyond the B.C./A.D. boundary, their occurrence is fortuitous. Since no areal excavations were performed, obtaining dating samples and cultural remains from the possible initial occupation of the atoll was considered to be a slight probability. The majority of the radiocarbon dates spans the period from A.D. 900–1300 when, presumably, the resident population would have been greater than at initial settlement. Few radiocarbon age calibrations have

been derived from the period postdating A.D. 1600, however. This is most likely due to the complete alteration or removal of surface and upper sedimentary horizons during the nuclear testing era.

The calendric ages (Klein *et al.* 1982) for archaeologically sampled areas on Bikini and Eneu exhibit an interesting pattern when grouped by distribution on the island (Table 2). The samples from near the present lagoon shoreline of Eneu Island (Test Pit 11 and the Shoreline Escarpment) suggest almost continuous habitation of the locale from as early as 1200 B.C. through the A.D. 1300's. The large number of functional features normally associated with Marshallese domestic habitation (earth oven pits, trash pits, house post molds, and a single burial pit) indicate that this site was a small nucleated settlement. The few radiocarbon age determinations from test excavations in the interior portions of Eneu, in contrast, suggest that dispersed settlement was present from A.D. 1400–1700. This chronological distribution may reflect changes in the size and shape of Eneu Island in response to eustatic sea level change. During the early prehistoric period Eneu may have been somewhat smaller and have extended over the shallow Eneu Channel situated to the west of the present island. As sea level dropped in later prehistoric times, Eneu has accreted to the north and east of the Shoreline Escarpment site. Refracted wave energy from shallow reef areas has probably eroded and redeposited the formerly inhabited land surface.

The distribution of radiocarbon age determinations from Bikini Island also suggests a similar process of erosion and accretion through time. Characteristics of the oceanward reef (including extensive lithified sand dune deposits) and lagoon longshore current patterns suggest that Bikini has been accreting along the lagoon shoreline since the earliest periods of human occupation. The interior portion of Bikini and the vicinity of Test Pit 2, would probably have been near a lagoon shoreline at initial occupation. Since then major accretional processes have occurred west and north of this area. Age determinations and sedimentary characteristics within archaeological test excavations near the present shoreline suggest that a phase of major shoreline erosion occurred in the period between A.D. 1100–1500, followed by accretion. The overall results illustrate the dynamic aspects of atoll islet landforms through time, thus indicating the manner in which archaeological sampling may be most successful.

Despite the massive alteration of land surfaces on both Bikini and Eneu, it is possible to infer the probable prehistoric cultural function of some areas through analysis of midden remains, subsurface features, and artifact assemblages. For example, the probable nucleated settlement at the Shoreline Escarpment site and dispersed settlement throughout the remainder of the island may reflect the importance of gardening on the island. The fine subsurface water resources on Eneu could have allowed for most of the island to be dedicated to gardening rather than habitation. The dispersed archaeological remains may be remnants of small field houses. Direct and intensive gardening exploitation of Eneu would have been important in a climate as at Bikini Atoll where severe periodic drought conditions are not uncommon.

The similar identification of probable prehistoric land use on Bikini Island is much more problematic. Virtually the entire central, northwestern and southwestern portions of the island contain intact cultural deposits. The densest prehistoric settlement appears to have been along former and present lagoon shorelines although more dispersed than on

Table 2. D

Sample
Eneu: Shoreline samp
1. Layer IV Sample
2. Feature Sample 3
3. Feature Sample 7
4. Test Pit 11, Leve
5. Layer Sample 3
6. Feature Sample 6
7. Test Pit 11, Leve
8. Feature Sample 2
9. Layer Sample 2
Eneu: Interior sample
1. Test Pit 9, Featu
2. Test Pit 7, Featu
3. Test Pit 10, Leve
Bikini: Shoreline sam
1. Well, Feature 1
2. House-16, Oven
3. Test 14, Feature
4. Test 14, Feature
5. Test 14, Feature
6. Auger Test-4
7. Test Pit 8, Level
8. Test Pit 8, Level
9. Shoreline Expos
Bikini: Interior samp
1. Test Pit 2, Layer
2. Test Pit 2, Featu
3. Test Pit 4, Featu
4. Test Pit 13, S.E.
5. Test Pit 12, Lev
6. Test Pit 5, Depo
7. Test Pit 2, Featu
8. Test Pit 2, Featu
9. Test Pit 4, Featu
10. Test Pit 3, Featu
11. Test Pit 13, Lev
12. Trench B-57, F
13. Test Pit 2, Featu
14. Test Pit 12, Lev

Table 2. Distribution of radiocarbon dating samples on Eneu and Bikini Islands.

Sample	Depth below surface (cm)	Stratum	Corrected calendar age	Mid-point
Eneu: Shoreline samples				
1. Layer IV Sample	94–110	IV	1210–275 BC	742 BC
2. Feature Sample 3	70–84	IV	1095 BC–AD 220	447 BC
3. Feature Sample 7	130–137	IV	365 BC–AD 220	72 BC
4. Test Pit 11, Level 7	62–75	III	AD 410–765	AD 587
5. Layer Sample 3	30–45	III	AD 465–870	AD 667
6. Feature Sample 6	75–81	III	AD 600–870	AD 735
7. Test Pit 11, Level 8	71/73–98	III	AD 630–905	AD 767
8. Feature Sample 2	42–54	III	AD 860–1225	AD 1042
9. Layer Sample 2	22–47	III	AD 1200–1405	AD 1302
Eneu: Interior samples				
1. Test Pit 9, Feature 1	65–83	II	AD 1400–1515	AD 1457
2. Test Pit 7, Feature 1	27–40	II	AD 1415–1675	AD 1545
3. Test Pit 10, Level 2	48–68/70	II(?)	AD 1415–1680	AD 1547
Bikini: Shoreline samples				
1. Well, Feature 1	84–95	(?)	AD 1030–1325	AD 1177
2. House-16, Oven Feature	3–16	(?)	AD 1245–1425	AD 1335
3. Test 14, Feature 2	64–76	II	AD 1400–1525	AD 1462
4. Test 14, Feature 14	48–54	II	AD 1400–1525	AD 1462
5. Test 14, Feature 1	34–40	II	AD 1425–1655	AD 1540
6. Auger Test-4	38–52	(?)	AD 1650–1950	AD 1800
7. Test Pit 8, Level 2	20–40	II(?)	AD 1650–1950	AD 1800
8. Test Pit 8, Level 3	40–54	II(?)	AD 1650–1950	AD 1800
9. Shoreline Exposure	45–57	II(?)	AD 1665–1950	AD 1808
Bikini: Interior samples				
1. Test Pit 2, Layer IIIa/b	60–72	III	1965–1665 BC	1812 BC
2. Test Pit 2, Feature 4	42–45	III	650–490 BC	570 BC
3. Test Pit 4, Feature 3	44–56	II	AD 925–970	AD 947
4. Test Pit 13, S.E. Feature	39–44	II	AD 930–965	AD 947
5. Test Pit 12, Level 4	22–31	II	AD 930–965	AD 947
6. Test Pit 5, Deposit	7–16	II	AD 930–1070	AD 1000
7. Test Pit 2, Feature 6	24–30	II	AD 890–1170	AD 1030
8. Test Pit 2, Feature 2	17–24	II	AD 900–1210	AD 1055
9. Test Pit 4, Feature 1	31–50	II	AD 1030–1250	AD 1140
10. Test Pit 3, Feature 2	38–49	II	AD 1050–1265	AD 1157
11. Test Pit 13, Level 5	48–63	II	AD 1040–1335	AD 1187
12. Trench B-57, Feature	50–59	II	AD 1055–1350	AD 1202
13. Test Pit 2, Feature 1/2	16–22	II	AD 1190–1315	AD 1252
14. Test Pit 12, Level 5	31–42/54	II	AD 1255–1435	AD 1345

Eneu. It is likely that Bikini Island served primarily as a residence area during prehistory. Other islands in the atoll may have contributed to the support of this population. Any permanent settlement on these islands may have been necessarily compressed so as not to impinge on cultivation areas.

The central, interior portion of Bikini Island appears to contain many large (1–2 meters wide by at least 70–100 cm deep) earth ovens, while features indicative of domestic habitation (trash pits, burial pits, coral pebble pavements, and house post molds) are rare. Several of the oven features are associated with midden remains containing high densities of pelagic fish bones, including two features exclusively containing bones from Diodontidae. The Diodontidae (porcupine or burr fish) can be poisonous and must be specially prepared for consumption. Species of this fish may have had a traditional religious or ceremonial context on Bikini Atoll as is found in Belau (Johannes 1981). The high percentage of pelagic fish bone may indicate that some of these earth ovens were used for special social or ceremonial functions. The fish remains assemblages from excavations elsewhere on Bikini and Eneu are dominated by bone from nearshore reef species.

Significance and Conclusions

The results from this project, in conjunction with other recent research in the Marshall Islands, can increase our understanding of several major prehistoric issues in Micronesian archaeology. Minimally, these projects suggest that the Marshallese atolls were inhabited for a much longer period than previously was considered feasible.

A long habitational sequence is indicated by this research. Additional extensive and intensive archaeological investigation in the Marshall Islands may find similar cultural remains of equal or greater antiquity. Although the dynamics of coral reef growth and eustatic sea level change are not fully understood, it is likely that most, if not all, of the atolls of the Marshall Islands existed when Bikini Atoll was first settled. The higher incidence of cyclonic storms in the northern Marshall Islands could have caused them to be of higher relief and less susceptible to adverse effects.

Smaller resident populations in the northern Marshall Islands than in the wetter southern atolls may have contributed to the preservation of older cultural deposits from disturbances through time. Because of the limited atoll land areas, the smaller the resident population the more likely that no disturbance will occur to cultural deposits through successive re-use of an area. The small size of the Bikinian community, 167 persons when evacuated in 1946, has been interpreted as indicative of recent initial human occupation on the atoll (see Alkire 1978, Bryan 1972, Kiste 1974). It was thought that such a small community could not be maintained over a long period of time. Recent research into the dynamics and biological variability of atoll populations would suggest, however, that the size of the Bikinian community is within the range for maintenance over long periods of time (Williamson & Sabath 1984). Only a slight increase in total annual or seasonal rainfall in the northern Marshall Islands would have made them much more attractive and productive for human occupation. Such climatic perturbations may have occurred several times during prehistory resulting in increased environmental carrying capacity. Such events could be indicated by the dense occurrence of domestic subsurface cultural features on Bikini and Eneu islands.

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