CULTURAL CHRONOLOGY IN MANGAREVA (GAMBIER ISLANDS), FRENCH POLYNESIA: EVIDENCE FROM RECENT RADIOCARBON DATING

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Situated at the extreme southeast margin of French Polynesia, Mangareva occupies a key position in the prehistoric colonisation and settlement histories of southeastern Polynesia. Similarities in human biology, artefacts and language make Mangareva arguably a likely origin point for the founding populations of Rapa Nui (Green 1998, 2000; Stefan *et al.,* 2002). Likewise, recent geochemical characterisation of Eastern Polynesian basalt adze material shows that Mangareva was at the centre of a long-distance exchange system, reaching southeast to the Pitcairn Group and to the northeast as far as the Marquesas and the Society Islands (Green and Weisler 2000, 2002; Weisler 1995, 1998, 2002). In short, Mangareva is likely to yield information critical to answering some long-standing question of Eastern Polynesian prehistory, including issues in the chronology of colonisation and the nature of regional interaction spheres.

The internal dynamics of Mangarevan cultural history are also likely to be of considerable interest in their own right. Hiroa's classic "salvage ethnography" (1938) and the 19th century missionary account of Honoré Laval (1938), from which Hiroa derived much information, describe a society which displayed signs of a classic chiefly hierarchy severely challenged by resource limitations. Indeed, the Mangarevan environment in historic times was characterised by severe deforestation and indications of significant anthropogenic effects on the terrestrial, if not also on the littoral-lagoonal, ecosystems (Kirch 1984:141, Fig. 41). There are reasons to suspect that the long-term history of dynamically coupled human-natural systems in Mangareva may reveal a sequence in some respects parallel to that of Mangaia (Kirch 1996, Kirch *et al*. 1992).

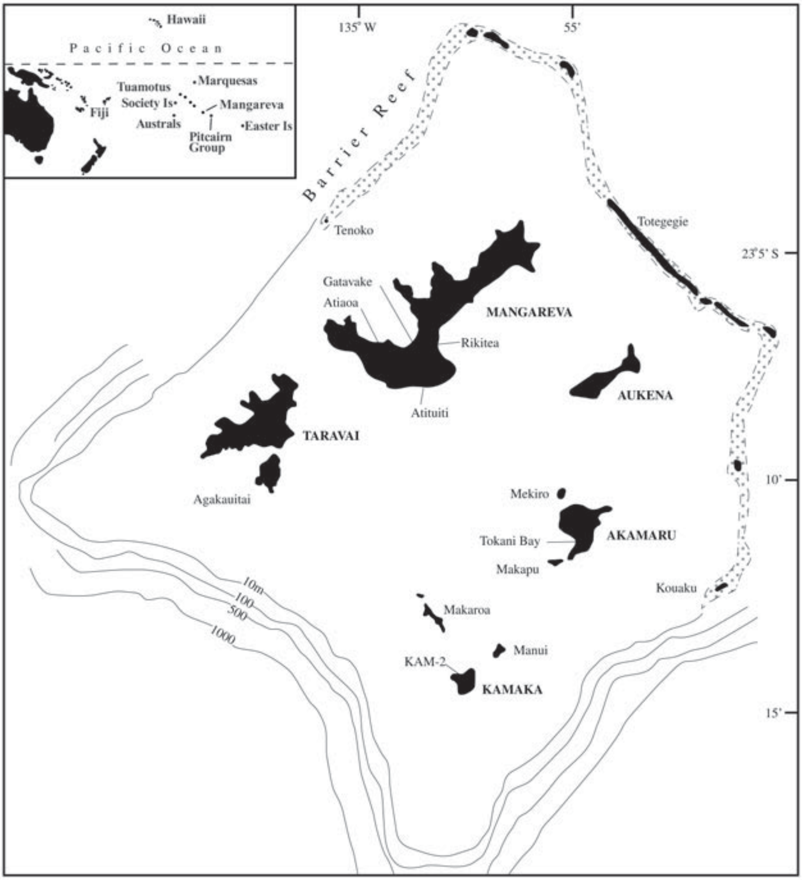

Figure 1: Map of the Mangareva Archipelago, showing locations of sites discussed in the text.

Despite these intriguing features of its ethnohistoric and regional context, Mangareva has remained one of the more neglected Polynesian archipelagoes from the viewpoint of archaeology and prehistory. Emory (1939) surveyed stone structures and concluded that most sites of any significance had been destroyed by the missionaries, with the exception of *marae* on the isolated atoll of Temoe. In 1959, Roger Green pioneered stratigraphic excavations in six rockshelters, three on Kamaka Island, two on Aukena Island and one on Mangareva Island. Initial radiocarbon dates from Green's excavations at "Kitchen Cave" and "Sancho's Cove" on Kamaka and Te Ana Puta Fua on Aukena were reported by Suggs (1961), but Green did not begin publishing the results of his work until much later (Green and Weisler 2000, 2002). Although Weisler (1996) carried out additional surface reconnaissance as part of his Pitcairn-Henderson Islands research project, no further excavations were made in the Mangareva archipelago. Thus, up to the present, what has been known of the Mangarevan cultural sequence and chronology is based on a mere eight radiocarbon dates from four sites (five dates from rockshelter site GK-1 on Kamaka Island). The oldest of these dates, from two rockshelters on Kamaka Island, are 850 ± 60 B.P. and 880 ± 70 B.P., calibrating roughly to the 11th-13th centuries A.D. (Green and Weisler 2002: Table 1).

In late 2001, we undertook renewed archaeological work in Mangareva, with financial support from the Ministry of Culture, Territory of French Polynesia.[1] As described in greater detail elsewhere (Anderson *et al.* n.d.), our project was directed to four major objectives: (1) to contribute to the inventory of archaeological sites in Mangareva, especially stone structures that had not been previously recorded; (2) to obtain new information regarding the chronology of human settlement of the archipelago; (3) to contribute to the evolving archaeological evidence for prehistoric interactions or exchanges between Mangareva and other islands and archipelagoes of Eastern Polynesia; and (4) to add to our understanding of the dynamic relationships between people and their island ecosystems. Surface survey and test excavations were conducted on the islands of Mangareva, Akamaru, Kamaka and Aukena; additional work was carried out by Conte and Weisler on Temoe Atoll (Weisler and Conte n.d.).

An important result of this renewed archaeological research is the analysis of a suite of 18 radiocarbon dates from nine different sites or localities, yielding important new empirical information on Mangareva cultural chronology. In this article, we provide information on these new dates and their stratigraphic and cultural contexts, and conclude with a brief discussion of their significance for Eastern Polynesian prehistory.

METHODS

During fieldwork, samples for radiocarbon dating were collected directly into aluminum sample tins, from features or contexts where the samples could be closely related to particular stratigraphy and associated cultural materials. A much larger number of samples were collected than could be dated within the project budget and from these 18 samples were selected for an initial run of radiocarbon dates (Table 1). (The remainder have been retained for future analyses.) For this pioneering research phase, samples were chosen to represent as many different sites as possible in order to give a broad indication of the probable temporal framework for a Mangarevan cultural sequence. As research in Mangareva continues, it will be desirable to run multiple samples from the same context(s) in order to test for chronological variability within specific site and stratigraphic contexts.

Fifteen (GAM-1 to -15) samples were examined in the Oceanic Archaeology Laboratory at University of California–Berkeley by James Coil, in an attempt to ascertain botanical identifications of individual specimens chosen for AMS dating. Both a low-power Wild M5a stereoscope and a higher-power Olympus BHS metallurgical scope were used to examine the specimens for key anatomical features and to compare them with a collection of reference specimens assembled from Hawai'i, Mangaia and the Marquesas. Because of the limitations of our reference collection, positive identifications to a generic level could be reached for only five samples. These include the economically important taxa *Artocarpus altilis* (breadfruit), *Cocos nucifera* (coconut), *Aleurites moluccana* (candlenut) and *Pandanus* sp. (screw pine). The small size of many samples, and the lack of an extensive reference collection for native Mangareva woods, meant that some samples could only be identified as dicotyledonous wood, though two of these specimens showed a close resemblance to the genus *Bauhine*. Photomicrographs were taken of all submitted specimens and digitally recorded for future comparison to expanded reference materials. Details of identification are summarised in Table 1, which also offers an assessment of the likelihood of an inbuilt age potential (the so-called "old wood factor") for each sample. Samples consisting of annually-produced seeds or of young wood with a twig morphology have "low" likelihoods of in-built age, whereas unidentified fragments of dicotyledonous wood have the greatest potential to yield ages somewhat older than the cultural event which is the "target age" of the sample.

Samples GAM-1 to -15 were submitted to Beta Analytic Inc. for pre-treatment and accelerator mass spectrometry (AMS) radiocarbon dating. The same pre-treatment procedure was applied to all samples in order to eliminate contaminants such as carbonates and secondary organic acids, along with modern rootlets. The samples were gently crushed and dispersed in de-ionised water, followed by hot HCl acid washes and alkali (NaOH) washes; these procedures were followed by a final acid rinse to neutralise the solution before drying (Darden Hood, pers. comm. 4 February 2003).

Three additional samples (GAM-16a, b, c) consist of sub-samples ("splits") from a single bulk sediment sample taken from a buried gleyed clay horizon in Rikitea Village. This bulk sample was processed in the field by wet sieving with fresh water through a 3.2mm mesh and by hand picking small charcoal fragments with forceps. Three separate subsamples were sent to Beta Analytic and to the radiocarbon dating laboratories at the Australian National University and the University of Waikato for independent dating. All three dates are AMS dates, and pretreatment methods with acid/alkali washes were comparable.

RADIOCARBON DATING RESULTS

The results of AMS dating on the 18 samples are given in Table 2. Somewhat surprisingly, five samples yielded ages that are reported in Table 2 as "pMC" or "percent modern carbon". These samples are less than 50 years old, meaning that there was a greater concentration of ^{14}C in the sample than in the A.D. 1950 reference standard (95% of the ^{14}C content of the National Bureau of Standards Oxalic Acid). According to Darden Hood (pers. comm. 3 February 2003) this is because of extra ^{14}C generated during atomic bomb testing.

For the 13 other samples listed in Table 2, we have provided the results in terms of the measured ^{14}C age (calculated using the Libby ^{14}C half-life of 5568 yrs), the ratio ($\delta^{13}C$) between ^{13}C and ^{12}C (calculated relative to the PDB-1 international standard), the "conventional radiocarbon age" (as defined by Stuiver and Polach 1977) and the calibrated age range at one standard deviation (68% probability). Calibration follows the calibration database and methods of Stuiver *et al*. (1998) and of Talma and Vogel (1993).

We now turn to a brief discussion of the various dates reported in Table 2, in relation to their stratigraphic and archaeological contexts. The first five localities discussed below are situated on Mangareva Island, followed by those on Akamaru and Kamaka Islands (see Figure 1).

Rikitea Village Area

Both Weisler (1996:70) and Green and Weisler (2000:32, 2002:232) have argued, on environmental grounds, that the area of Rikitea Village on Mangareva Island was likely to have been "an ideal locale for initial occupation of the Mangarevan group". Rikitea offers a sheltered bay and canoe landing, along with one of the largest valleys with many freshwater springs at the base of Mt Duff that are watering a swampy alluvial basin which in historic times contained the most important zone of intensive taro (*Colocasia esculenta*) cultivation. Not surprisingly, Rikitea was the residence of the principal chiefs. Their major *marae*, Te Kehika dedicated to the god Tu, was situated on the colluvial slopes overlooking the taro grounds (Emory 1939:7). The ritual and political significance of this locality also suggest a long history of settlement.

Table 1: Mangareva Radiocarbon Dating Samples: Provenience and Identification

LABORATORY & FIELD CODES	SITE NO.	PROVENIENCE	BOTANICAL IDENTIFICATION	IN-BUILT AGE POTENTIAL
Beta-174777, GAM-1	190-06-ATA-1	Unit F11, Layer II, Level 3, 50-60 cm (oven)	Dicotyledonous wood, cf. *Bauhine*	High
Beta-174778, GAM-2	190-06-ATA-1	Layer III, Level 1	Unident. Seed tissue	Low
Beta-174779, GAM-3	190-06-ATU-2	Layer I, Level 5, 52 cm	Dicotyledonous wood	High
Beta-174780, GAM-4	190-06-GAT-3	Layer II	Dicotyledonous wood, cf. *Bauhine*	High
Beta-174781, GAM-5	190-06-GAT-3	Layer I, horizon A	Dicotyledonous wood, twig morphology	Low
Beta-174782, GAM-6	Akamaru, TP1	Layer IB, Level 2, 30-39 cm, oven	Unident. Seed tissue	Low
Beta-174783, GAM-7	Akamaru, TP2	120-128 cm, soil + charcoal	Semi-carbonised material	?
Beta-174784, GAM-8	190-04-KAM-2	Layer III, Level 3 (no. 59)	*Artocarpus* wood	Medium
Beta-174785, GAM-9	190-04-KAM-2	Layer IV, Level 2 (no. 70)	*Cocos* wood	Medium

Beta-174786, GAM-10	190-04-KAM-2	Layer V, Level 2 (no. 80)	*Pandanus* wood	Medium
Beta-174787, GAM-11	190-04-KAM-2	Layer VI, Level 6 (no. 99)	*Pandanus* fruit (key)	Low
Beta-174788, GAM-12	Rikitea Transect	Louis' Place, Core 2, 55-60 cm	Unident. wood	High
Beta-174789, GAM-13	190-06-ATA-4	Core hole 5, 74 cm	Dicotyledonous wood	High
Beta-174790, GAM-14	190-06-ATA-4	Core hole 6, 60 cm	*Aleurites* endocarp	Low
Beta-174791, GAM-15	090-06-GAE-1	Interface erosional deposit with terrestrial gastropods and underlying sand	Dicotyledonous wood	High
ANU-11927, GAM-16a (split)	Rikitea trench	Gley layer, 90 cm below surface	"Creeper twig" charcoal	Low
NZA-15383, GAM-16b (split)	Rikitea trench	Gley layer, 90 cm below surface	"Creeper twig" charcoal	Low
Beta-?????, GAM-16c (split)	Rikitea trench	Gley layer, 90 cm below surface	"Creeper twig" charcoal	Low

One component of our field strategy involved stratigraphic coring along multiple transects running from the shoreline inland, cross-cutting the low accretionary sandy berm that separates the taro swamp from the sea. This berm was likely to have been a major place of habitation throughout prehistory (as it is today). In several transects, subsurface cultural deposits or simply dispersed charcoal flecks were encountered. At one transect in particular ("Louis' Place") a fairly deep cultural layer, containing charcoal and overlying a coarse carbonate sand and grit, was encountered in Core 2 about 15m inland of the road and on the margins of the taro swamp. A charcoal sample of unidentified wood from 55-60cm depth was radiocarbon dated (Beta-174788, GAM-12), giving a calibrated result of A.D. 1160-1220. This is the oldest of any of our radiocarbon dates and corresponds closely with two dates obtained by Green and Weisler (2000: Table 2) from the GK-1 (190-04-KAM-1) and GK-2 (190-04-KAM-2) rockshelters on Kamaka Island (with 2σ calibrated ranges of A.D. 1065-1294 and 1025-1292).[2] The Rikitea date offers strong support for the hypothesis that early habitation deposits are located there. This area will be targeted for expanded excavations in future research in order to ascertain the nature of the buried cultural sediments.

As indicated above, the low-lying basin-shaped depression between the coastal sand beach ridge and the base of the colluvial slopes at Rikitea was formerly a major zone of wet taro cultivation. This area was originally identified from a buried soil layer ("gley") that forms when fresh water saturates buried soils. In this instance, the gley layer was recorded on a French Polynesian soil map and we discovered cultural deposits there precisely at the predicted location (Weisler 1996:80-81). Fortunately for the project team, before we arrived on Mangareva, a trench more than 75m long had been dug by heavy machinery to ameliorate drainage problems in the modern village. The trench started at the base of the colluvial slope, ~175m inland from the sealed road that runs through Rikitea, and is perpendicular to the shoreline exposing the buried gley layer c.1m below surface. We took advantage of this situation and recorded the stratigraphy at a locality about 10m seaward of the base of the cliffs inland from the Mairie. The key stratigraphic unit here was the 25cm-thick gley layer consisting of a black (N2.5/2.5) clay-silt-gravel without large stones, but gritty and containing small amounts of finely dispersed charcoal.

Charcoal dispersed through sedimentary deposits that accumulate over time—such as that represented by the Rikitea gley layer—can be difficult to date reliably. This is because the origin of the sediments—and charcoal particles—can change over time and the depositional environment can be disturbed and reworked centuries after first deposition. Roots of shrubs and trees can penetrate soil layers adding more recent carbon to ancient sediments. This is especially problematic when vegetation burns and the fire follows the roots well below the surface, thus adding younger charcoal to old. Mindful of these potential problems, we removed a bulk sediment sample from the grey layer 90cm below surface and processed it in the field. The sediment was placed on a 3.2mm sieve and washed with fresh water. Charcoal was collected with forceps and placed in a plastic bag. The single sample (GAM-16) was then split into three sub-samples, each being sent to a different laboratory (as noted above). One sub-sample (NZA-15383, GAM-16b) yielded a "modern" age, while the other two subsamples yielded ages of 450 ± 40 and 320 ± 180 B.P. (Beta-168443, GAM-16c; ANU-11927, GAM-16a). The latter date has a rather large standard deviation, but overlaps with the Beta-168443 date that we take to be a best estimate for the deposition of the gley layer. This date, calibrated to A.D.1430-1460, suggests that the Rikitea taro swamp was in use as an agricultural system by at least this time.

Atituiti-Raro Area (Site 190-06-ATU-2)

Atituiti is another area of significant settlement with ethnohistorical documentation. It lies to the south of Rikitea, in the lee of Mt Duff. A number of important sites are located here, including a large *paepae* (platform) and associated structures on the natural terrace called Atituiti-Runga. On the coastal flat called Atituiti-Raro are the apparent remains of an important *marae* (Te Mata-o-Tu), several stone pavements and a buried midden deposit exposed by coastal erosion. We excavated a single 1m^2 test unit into this cultural deposit (site 190-06-ATU-2) that extended to 60cm below surface. No artefacts were found, but faunal materials and charcoal were encountered to the bottom of the sandy deposit. A sample of wood charcoal collected 52cm below the surface was submitted for dating (Beta-174779, GAM-3), yielding three calibrated age ranges: A.D. 1650-1680, 1770-1800 and 1940-1950. Given that the last age can be ruled out in the absence of any modern materials, it seems likely that the deposit accumulated in the late pre-contact era. Further excavations in this area have the potential to yield valuable data on late prehistoric settlement and residential patterns.

Atiaoa Valley (Sites 190-06-ATA-1 and -4)

At the northwest side of Mangareva Island, the Atiaoa Valley offers a gently-sloping alluvial basin well suited to horticulture. The valley contains the remains of a small irrigated pondfield system and adjacent residential *paepae*, and a level, sandy coastal plain where modern habitation is concentrated. In addition to mapping surface stone structures, we tested a small rockshelter

Table 2: Mangareva Radiocarbon Dating Samples: Results

LABORATORY & FIELD CODES	MEASURED ^{14}C AGE (B.P.)	$^{13}C/^{12}C$ RATIO (^{0}/oo)	CONVENTIONAL ^{14}C AGE (B.P.)	CALIBRATED AGE . RANGE (1σ) A.D
Beta-174777, GAM-1	670 ± 40	-23.9	690 ± 40	1280-1300
Beta-174778, GAM-2	113.8 ± 0.6 pMC	-25.5	113.9 ± 0.6 pMC	------
Beta-174779, GAM-3	210 ± 40	-24.9	210 ± 40	1650-1680, 1770-1800, 1940-1950
Beta-174780, GAM-4	190 ± 40	-25.2	190 ± 40	1660-1680, 1740-1810, 1930-1950
Beta-174781, GAM-5	100.1 ± 0.5 pMC	-12.6	190 ± 40	1660-1680, 1740-1810, 1930-1950
Beta-174782, GAM-6	430 ± 40	-28.2	380 ± 40	1450-1520, 1590-1620
Beta-174783, GAM-7	120.7 ± 0.8 pMC	-27.9	121.4 ± 0.8 pMC	------
Beta-174784, GAM-8	230 ± 40	-26.1	210 ± 40	1650-1680, 1770-1800, 1940-1950

Beta-174785, GAM-9	240 ± 40	-25.3	240 ± 40	1640-1670
Beta-174786, GAM-10	460 ± 40	-25.1	460 ± 40	1420-1450
Beta-174787, GAM-11	330 ± 40	-21.2	390 ± 40	1450-1510, 1600-1620
Beta-174788, GAM-12	860 ± 40	-24.6	870 ± 40	1160-1220
Beta-174789, GAM-13	109.3 ± 0.5 pMC	-28.2	110.0 ± 0.5 pMC	------
Beta-174790, GAM-14	650 ± 40	-23.2	680 ± 40	1280-1300
Beta-174791, GAM-15	220 ± 40	-23.2	220 ± 40	1650-1670, 1770-1800, 1940-1950
ANU-11927, GAM-16a (split)	------	-24.0 (estimated)	320 ± 180	1400-1850, 1900-1950
NZA-15383, GAM-16b (split)	98.7 ± 0.7 pMC	-25.8	180 ± 57	------
Beta-168443, GAM-16c (split)	410 ± 40	-22.3	450 ± 40	1430-1460

(site 190-06-ATA-1) and carried out transect coring operations across the coastal flat, locating a buried cultural deposit (site 190-06-ATA-4).

The rockshelter lies a few metres off the main road, where a large outcrop of volcanic breccia with an overhanging cliff protects a floor area of about 8m by 4m. We excavated a single 1m^2 test pit (grid unit F11) in the rear central part of the rockshelter floor, fine-screening all sediment through 0.25 and 0.125 inch mesh for faunal and floral materials. Much fine fish bone and some bird bone were noted during screening. Figure 2 shows the stratigraphic section consisted of two cultural deposits (Layers I and II) of very dark gray silty clay, overlying a culturally-sterile layer (III) of dark reddish brown clay, with some charcoal flecking present in the upper part of Layer IIIA. Two samples from this site were submitted for dating. The first (Beta-174777, GAM-1) was wood (cf. *Bauhine*) charcoal from an oven feature exposed in the north profile (see Figure 2). The second (Beta-174778) was an unidentified seed from the top of Layer IIIA. The seed sample yielded a modern age, but the sample from the earth oven yielded a calibrated age range of A.D. 1280-1300.

Seaward of the rockshelter, the coastal flat extends about 125m to the modern shoreline, with a small freshwater spring feeding a complex of taro planting beds. Surface reconnaissance revealed a concentration of basalt lithics, as well as fire-cracked oven stones, in an area seaward of the road that had been turned over recently by gardening activities. To assess further the nature of subsurface cultural deposits, we augered several core holes through this flat along a main transect and several off-transect cores. Buried sediments containing charcoal were found in a zone extending about 50m seaward of the rockshelter. Two samples were submitted for radiocarbon dating. One sample (Beta-174789, GAM-13) of unidentified wood returned a modern age, but the second sample of candlenut endocarp (Beta-174790, GAM-14) yielded an age range of A.D. 1280-1300, identical to that from the nearby rockshelter.

The two acceptable dates from Atiaoa sites ATA-1 and -4 (GAM-1, -14) are only slightly younger than our oldest dates from Rikitea and the Kamaka Island rockshelters and suggest that settlement in the Atiaoa Valley may have considerable time depth. We plan to further investigate sites ATA-1 and -4 in the future.

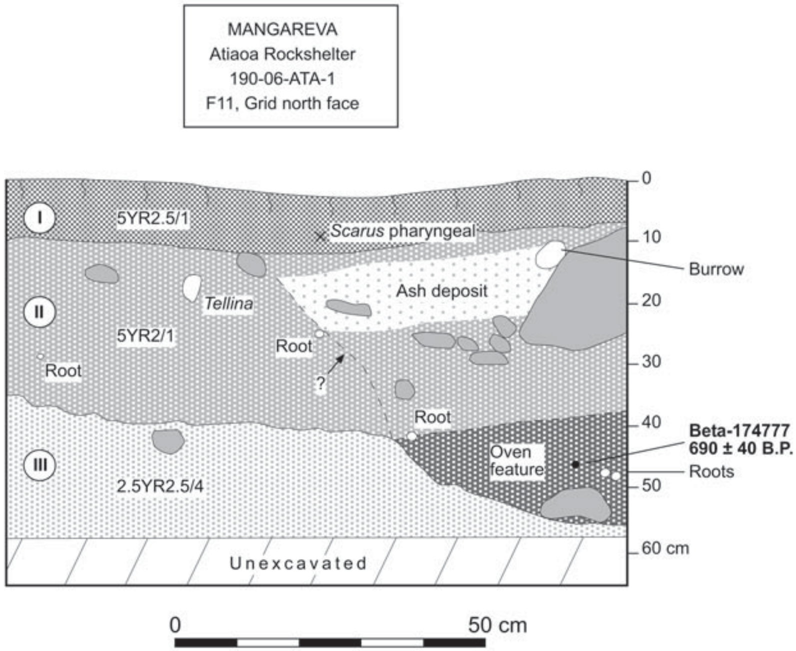

Figure 2: Stratigraphic section of the north face of test unit F11, site 190-06-ATA-1, a rockshelter at Atiaoa.

Gatavake Valley (Site 190-06-GAT-3)

Gatavake Valley, directly across the low mountain pass from Rikitea and east of Atiaoa, was another major place of settlement, on the evidence of oral traditions. Weisler (1996:72) had observed buried cultural deposits exposed in the banks of a narrow, intermittent stream, a locality we revisited and designated site 190-06-GAT-3 (Weisler's site MAN-5). Figure 3 shows the three main strata evident in the stream bank. Layer I, a dark yellowish-brown silty clay about 80cm thick, incorporates several basalt and coral boulders that appear to be part of a platform, pavement or other cultural structure. A basalt adze section was also found in this layer. Layer II, from 80-120cm below surface, consists of an anthropogenic soil horizon (probably a garden soil) with much dispersed charcoal throughout. The basal Layer III (below

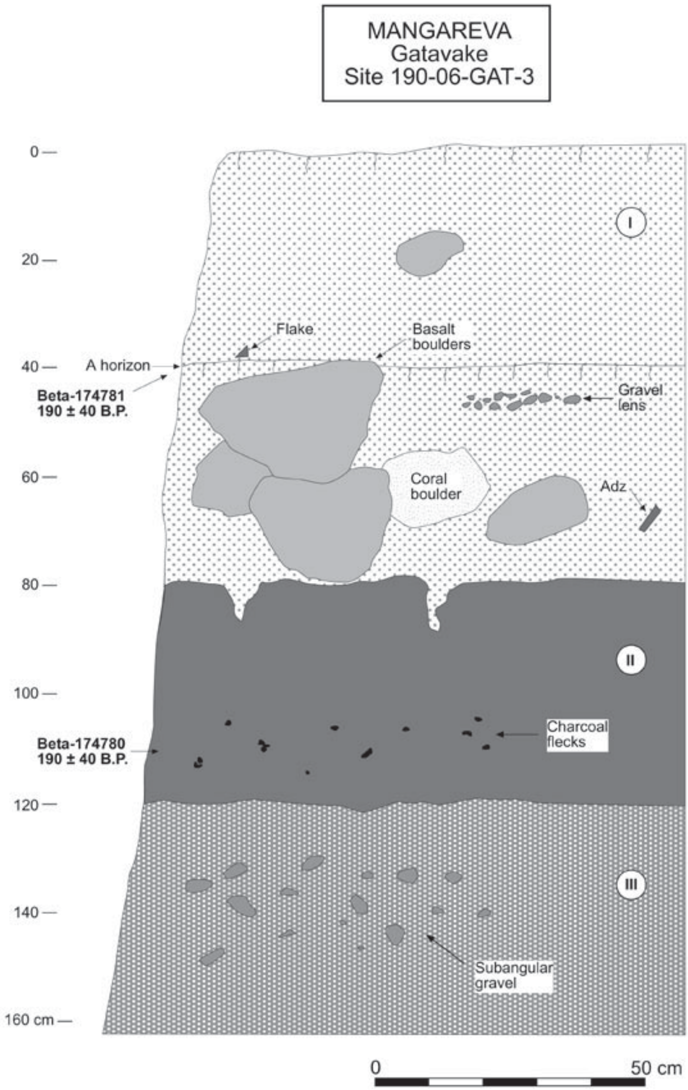

Figure 3: Schematic stratigraphic section of the stream-cut bank at Gatavake Valley, site 190-06-GAT-3.

120cm) consists of a dark brown gravelly clay alluvium and appears to lack charcoal or any other evidence of human activity.

Charcoal samples were submitted from both Layer I (Beta-174781, GAM-5) and Layer II (Beta-174780, GAM-4) and returned essentially identical results after calibration: A.D. 1660-1680, 1740-1810 and 1930-1950, at 1σ. Again, the absence of any evident recent historical artefacts leads us to reject the most recent age range, suggesting that the cultural deposits here are of late prehistoric age (17th-18th centuries). It is worth noting that the thick clay deposit (Layer I), which covers the older anthropogenic gardening soil, seems to have derived from rapid erosion of unstable slopes inland of the site. This is the kind of geomorphic sequence anticipated from the early historic descriptions of a largely deforested landscape dominated by grasslands.

Gaeata Landsnail Deposit (Site190-06- GAE-1)

Gaeata is a small valley at the northeastern tip of Mangareva Island, a locality where Weisler (1996:73) earlier observed an eroded coastal bank with a terrigenous deposit containing endemic (probably extinct) terrestrial gastropod snail shells (Weisler site MAN-7, here designated site 190-06-GAE-1). We re-examined this locality, cleaning the stratigraphic section that consisted of a deposit of clay, which had derived from erosion upslope in the small valley head and which overlay sterile calcareous beach sand. The terrigenous deposit contained both endemic pulmonate gastropods and dispersed charcoal flecking and was judged to provide important evidence for environmental conditions during the period of human occupation. A single piece of dicotyledonous wood from the base of the clay deposit was submitted for dating (Beta-174791, GAM-15), yielding calibrated age ranges (1σ) of A.D. 1650-1670, 1770-1800 and 1940-1950. Again, we reject the last range on independent evidence and concluded that the burning and erosion that resulted in the deposition of the clay layer occurred sometime during late prehistory (17th-18th centuries).

Akamaru Island

Akamaru is the third-largest volcanic island in the Mangareva group. In the 19th century was the seat of Père Laval's missionary endeavours; his church and residence still stand on the northern side of the island. This northern part of Akamaru is notable for its broad, protected coastal flat nearly 200 metres wide. We cored for possible buried cultural deposits along a transect running from the low beach ridge inland to the base of the steep colluvial slope, finding low concentrations of charcoal and other cultural materials throughout the coastal plain. At the location of Core 3, 100m inland of the beach ridge, we dug a 1m^2 test pit that revealed a small earth oven. It also yielded a fragment of a pearlshell fishhook. An unidentified carbonised seed from this oven was submitted for dating (Beta-174782, GAM-6), yielding calibrated age ranges (1σ) of A.D. 1450-1520 and 1590-1620. This date confirms the presence of occupation deposits on Akamaru Island dating to approximately the 15th-16th centuries.

A second sample of carbonised material (Beta-174783, GAM-7) was submitted from a test pit excavated near the base of the island's volcanic ridge through the edge of the fan of colluvial detritus down to the contact with the underlying calcareous sand flat. However, this sample returned a "modern" age and had been contaminated with post-bomb radioactive materials.

Kamaka Island Rockshelter (Site 190-04-KAM-2)

Our final excavations were at Kamaka Island in the smaller of two rockshelters originally excavated by Roger Green in 1959. This overhang shelter, labelled site GK-2 by Green and re-labelled site 190-04-KAM-2 by us, had produced a radiocarbon date (Beta-109019) of 890 ± 70 B.P. (cal A.D. 1025-1292 at 2σ) on charcoal originally collected by Green (Green and Weisler 2000, 2002). This was the earliest radiocarbon date known for Mangareva. With the permission and assistance of the landowner, Mr. Tihoni Reasin (who, incidentally, also assisted Green in 1959), we were able to discern the outlines of Green's back-filled square Z-1. This was cleaned out and a 50 x 100cm test pit was dug following the stratigraphy visible in the profile of Green's trench.

The exposed stratigraphic section of our TP1 unit is shown in Figure 4. Under a thin deposit of loose sand and decaying vegetation (Layer I), we exposed a deposit of dark brown silty clay mixed with calcareous sand (Layer II), followed by alternating lenses of dark reddish brown and black sediment rich in charcoal (Layer III). At this point we encountered several slabs of sandstone "beach rock", two of which had been set upright as part of a pavement edging or structure of some sort (Layer IV). Beneath these slabs the cultural deposits continued with a dark gray, sandy midden containing a great many charcoal flecks and pieces (Layer V). Intercutting this midden deposit were several large, deep earth ovens, producing a rather complex stratigraphic situation within our small test unit. Unfortunately, the presence of these ovens meant that we were unable to expose undisturbed basal cultural deposits.

Since Green had dated only a single sample from the base of this important site, we wished to date additional samples that might indicate the time span for the entire stratigraphic sequence. Four samples were selected, beginning

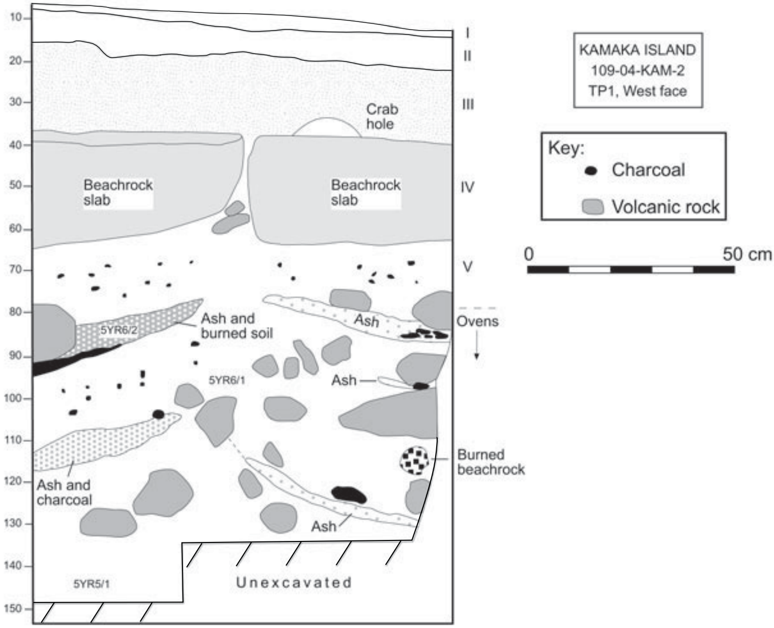

Figure 4: Stratigraphic section of the west face of test unit TP1, site 190-04-KAM-2.

with a fragment of *Artocarpus* wood from Layer III (Beta-174784, GAM-8), followed by *Cocos* wood from Layer IV (Beta-174785, GAM-9), *Pandanus* wood from Layer V (Beta-174786, GAM-10) and finally a *Pandanus* fruit ("key") from one of the deep ovens in Layer VI (Beta-174787, GAM-11). Table 2 indicates that the results are fairly consistent with stratigraphy. The Layer III sample has 1σ calibrated age ranges of A.D. 1650-1680, 1770-1800 and 1940-1950; the last date again can be rejected on the total absence of recent historic materials from the deposits. The underlying Layer IV sample has a calibrated age range of A.D. 1640-1670. These two dates indicate that the beach rock pavement and the midden deposit that developed on top of it were deposited in a time frame encompassing the 17th-18th centuries, i.e., the proto-historic period just before European contact. The Layer V midden underlying the pavement, however, yielded a significantly older age range of A.D. 1420-1450. This raises the possibility of a hiatus in the use of the rockshelter between the Layer V midden and the construction of the Layer

IV pavement. The sample from one of the deep ovens (Layer VI) returned calibrated age ranges of A.D. 1450-1510 and 1600-1620. The earlier of these ranges overlaps with the range for Layer V, from which the Layer VI oven pits were cut. Most likely, both the Layer V midden and the ovens date to a time period of approximately the 13th-14th centuries.

As mentioned above, the presence of the large, inter-cutting ovens prohibited us from obtaining a good *in situ* charcoal sample from the true basal cultural deposits (Green's Layer G, see Green and Weisler 2000: Fig. 14). We have no reason to doubt the validity of the date obtained by Green from this deposit, calibrated to A.D. 1025-1292, since this date

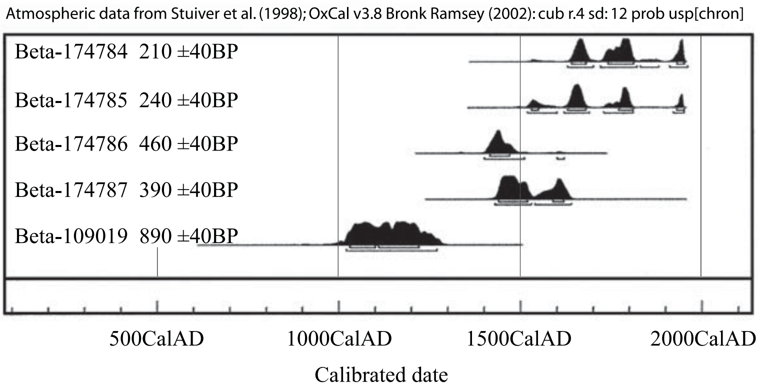

Figure 5: Oxcal plot of probability distributions for five radiocarbon dates from the site 190-04-KAM-2 rockshelter, in stratigraphic order.

is reinforced by a date of almost identical age from the nearby GK-1 (= KAM-1) rockshelter on Kamaka Island (Green and Weisler 2000: Table 2). An Oxcal plot of the probability distributions of all five available dates from the KAM-2 rockshelter is given in Figure 5. The expanded range of radiocarbon dates from site KAM-2 would suggest the following temporal sequence: (1) initial occupation in the 11th-13th centuries, followed by a possible hiatus; (2) continued occupation in the 13th-14th centuries, including the use of the shelter for cooking, as indicated by the large ovens; (3) a possible hiatus in use of the site in the 15th-16th centuries; and (4) construction of a beach rock pavement and edging, and subsequent re-occupation in the 17th-18th centuries.

DISCUSSION AND CONCLUSIONS

The new suite of radiocarbon dates reported herein allows us to begin to refine the tentative Mangarevan cultural sequence proposed by Green and Weisler (2002), which, as they noted, was based on a handful of dates from rockshelters on the smaller and ecologically more marginal islands of the group. One of our most important results is certainly the demonstration that relatively early cultural deposits are to be found in the Rikitea Village area on Mangareva Island, a place predicted to be a likely area for initial human settlement. The calibrated age of A.D. 1160-1220 from the core at "Louis' Place" on the sand ridge between the sea and the large taro swamp overlaps with the two oldest dates obtained by Green from his excavations at the Kamaka Island rockshelters. It is also worthy of note that a small trapezoidal adze collected from a recently bulldozed area near the core locality was sourced by geochemical analysis to the Eiao Island quarry source in the Marquesas Islands (Anderson *et al*. 2003:49). This indicates that within the Rikitea area we are likely to find sites providing evidence of an earlier period of extensive long-distance exchange within southeastern Polynesia (Weisler 1998).

At this point, there is no reason to think that we have located the oldest or initial settlement at Rikitea. More extensive coring and test excavations are required to work out a more detailed history of settlement and land use in the area. Green and Weisler (2002:233) suggest that the earliest phases of Mangarevan history are as yet unrepresented in the archaeological record, and they "believe that two to four centuries of Mangarevan prehistory awaits definition with earliest human evidence possibly predating A.D. 800". Anderson is not convinced of this view (see Anderson and Sinoto 2002), but we plan to carry out additional work in the Rikitea area in the near future with the aim of testing alternative hypotheses.

Even though they are situated on one of the smaller islands of the Gambier group, the Kamaka rockshelters, originally excavated by Green, remain key sites in the archipelago's archaeological record, for they have yielded the majority of artefacts and other materials upon which a culture-historical framework can be constructed (Green and Weisler 2000, Steadman and Justice 1998). Our re-dating of the KAM-2 sequence helps to refine the internal chronology of one of these key sites. Like other rockshelters in southeastern Polynesia, the depositional sequence in KAM-2 may not be continuous, but rather episodic. Our re-examination of stratigraphy suggests such changing patterns of use over time. These refinements in chrono-stratigraphic interpretation will be critical in efforts to link individual rockshelter sequences to build a larger cultural chronology.

In the Atiaoa Valley of Mangareva, our work at rockshelter site ATA-1 and at the nearby open site of ATA-4 demonstrates that occupation began by the late 13th century A.D. These Atiaoa sites hold considerable promise for yielding information on Mangarevan economy and society following initial settlement, but before the developments of the late prehistoric period. Worthy of note is the large collection of basalt flakes and debitage at the ATA-4 site. The basalt has been geochemically characterised as deriving from a previously unknown, and presumably local, Mangarevan quarry source, perhaps in the Atiaoa Valley.

Several other sites, including ATU-2 at Atituiti-Raro, GAT-3 in the Gatavake Valley and TP-1 on the Akamaru Island coastal plain, have been dated to the final three centuries of pre-European occupation. Consequently, further work at these localities should provide important information on the late phases of Mangarevan culture, the period most closely reflected in Hiroa's (1938) salvage ethnography and in the early missionary accounts.

Finally, the erosional deposits at GAT-3 and GAE-1, the latter containing extinct endemic pulmonate snails indicative of former native vegetation, begin to provide some chronological data on the timing of human-induced impact to the Mangarevan landscape. In both of these sites, relatively massive deposits of clay—derived from the slopes directly inland—reflect erosion from what had presumably become deforested or largely denuded hillsides. As noted earlier, accounts from the historic period indicate that by the 19th century, the Mangarevan islands lacked endemic or indigenous forest and were largely blanketed in what is hypothesised to be an anthropogenic vegetation dominated by *Miscanthus* grass and other fire-tolerant species. Our initial dates on two erosional deposits suggest that this phase of deforestation may have occurred fairly late in the island's cultural sequence, possibly correlating with the period of maximal human population and pressure on land for agriculture. Assuredly, this aspect of Mangarevan cultural and ecological history will repay additional investigations.

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NOTES

1. Author order of this paper is alphabetical, reflecting the team collaboration in the field. P.V. Kirch drafted the manuscript, which then benefited from editorial input from all co-authors.
2. The site numbers given in this paper have been assigned according to the new French Polynesian archaeological site numbering system developed by the Service de la Culture et du Patrimoine, Pape'ete, Tahiti. In this system, the first numeric code 190 represents the Gambier Archipelago, the second numeric code the specific island (04 = Kamaka, 06 = Mangareva), and the alpha code a local district or place (e.g., ATU = Atituiti, ATA = Atiaoa). Sites are then numbered sequentially by locality.

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