

The Onemea Site (Taravai Island, Mangareva) and the human colonization of Southeastern Polynesia

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Abstract

When first test excavated in 2003, the Onemea site on Taravai Island (site 190-12-TAR-6) yielded high densities of extirpated and extinct bird bones which, along with radiocarbon dates of AD 1000 to 1050, suggested a colonization phase occupation. Expanded excavations in 2005, reported here, revealed additional details of site stratigraphy, chronology and use. Initial human activity on the dune surface included exploitation of nesting or roosting seabirds, and sporadic use of combustion features. We interpret this initial phase as involving repeated, low intensity visits over a period of two to three centuries, beginning around AD 950, resulting in a palimpsest deposit (Layer III). Sometime in the 13th century intensive occupation on the dune commenced, resulting in the deposition of a cultural layer (Layer II) averaging 55–60 cm thick, containing earth ovens and with evidence for fishhook manufacture and use. Occupation of the Onemea dune ceased in the late 14th century AD. The chronology for the Onemea site, which is provided by 11 radiocarbon and three ²³⁰Th coral dates, lends support to a model of initial human colonization of southeastern Polynesia at around AD 1000.

The question of when Polynesians began to expand beyond the core Western Polynesian homeland to discover and settle the islands of Eastern Polynesia has been a matter of some contention (Anderson, 2001, 2003; Irwin 1981, 1992; Kirch 1986; Kirch and Ellison 1994; Sinoto 1996; Spriggs and Anderson 1993; Walter 1996). A 'long pause' of at least a thousand years duration between the initial Lapita settlement of Tonga-Samoa, and the subsequent expansion of Polynesian populations to the east is undoubted. But just when long-distance voyages of colonization to the east commenced and how rapidly the expansion into Eastern Polynesia took place, have remained topics of debate. Recent dating of key central and southeastern Eastern Polynesian sites, using AMS radiocarbon methods on better controlled samples has generally lent support to a 'short chronology' whereby central Eastern Polynesia did not

begin to be colonized until after AD 800 or later (Allen, 2004; Anderson *et al.* 1994, 1999; Anderson and Sinoto 2002; Conte and Anderson, 2003; Green and Weisler 2002; Kirch *et al.* 1995; Rolett, 1993, 1996; Rolett and Conte, 1995; Weisler 1994, 1995). Recent claims that Easter Island was not settled until AD 1200 (Hunt and Lipo 2006, 2008) are relevant, since linguistic models of Polynesian settlement place the Rapanui language as an initial branch off of the Proto Eastern Polynesian interstage (Marck 1996).

Mangareva, or Gambier Islands, lie at the southeastern extreme of French Polynesia (23°07' S., 134°58' W.), with the Acteon Group of the Tuamotu Archipelago 180 km northwest, and the Pitcairn-Henderson islands 540 km southeast. Mangareva was therefore critically situated along the chain of islands possibly followed by early Polynesian voyagers as they explored the southeastern Pacific towards Easter Island. Indeed, Mangareva has been proposed as a possible immediate homeland of the first colonists of Rapa Nui; it may be the 'Marae-renga' mentioned in the oral tradition of Hotumatua (Métraux 1940:56).

Although Mangareva was investigated by pioneering archaeologist Kenneth P. Emory in 1934 (Emory 1939), and was one of the first islands to be subject to modern stratigraphic excavations, by Roger Green in 1959 (Suggs 1961a), it has until recently remained one of the least known Polynesian archipelagoes. Green's excavations have only recently begun to be published (Green and Weisler 2000, 2002, 2004). Beginning in 2001 a new multi-institutional project organized by Conte and Kirch recommenced archaeological investigations in Mangareva (Kirch and Conte 2008). Fieldwork in 2003 included the test excavation of a sand dune site at Onemea Bay on Taravai Island, and initial radiocarbon dates combined with abundant bones of extirpated seabirds suggested that deposits here probably date to an initial colonization phase (Anderson *et al.* 2003; Conte and Kirch, 2004:82–85).

Because this was the first site in Mangareva with potential to yield data on this phase of pioneering settlement, additional fieldwork at Onemea was carried out by Conte and Kirch, assisted by graduate students Christelle Carlier and Emilie Dotte, from 11 August through 28 August, 2005. Specific objectives were to improve our understanding of the site's stratigraphy and chronology, and to obtain a larger sample of cultural materials, including avifaunal remains. The results of the 2005 field season,

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and subsequent laboratory analyses, are the subject of this article.

The Onemea Site: Background

The Onemea site, formally designated site 190-12-TAR-6, lies at the mouth of Onemea Bay, on the southwestern side of Taravai Island, second largest of the islets (5.3 km²) within the Mangareva Archipelago (Fig. 1). Although it is one of the smaller bays on Taravai, Onemea is associated in oral traditions with a famous navigator-priest named Te Agiagi, who discovered other islands to the southeast, possibly including Pitcairn (Hiroa 1938:24-30). The bay is roughly 400 m wide, rimmed by steep hillsides covered in *Miscanthus floridulus* cane, with a crescent-shaped sandy beach (Fig. 2). Onemea is divided into two valleys by a sharp ridge on which are exposed several basalt dikes, a probable source of dikestone lithics recovered during the excavations. One small intermittent stream in the northern valley and two smaller rivulets in the southern valley provide water sources. Several patch reefs dot the bay. The narrow valley bottoms are dominated by thick stands of *Hibiscus tiliaceus*, with some *Pandanus* and coconut; one large *Callophyllum inophyllum* tree stands atop the TAR-6

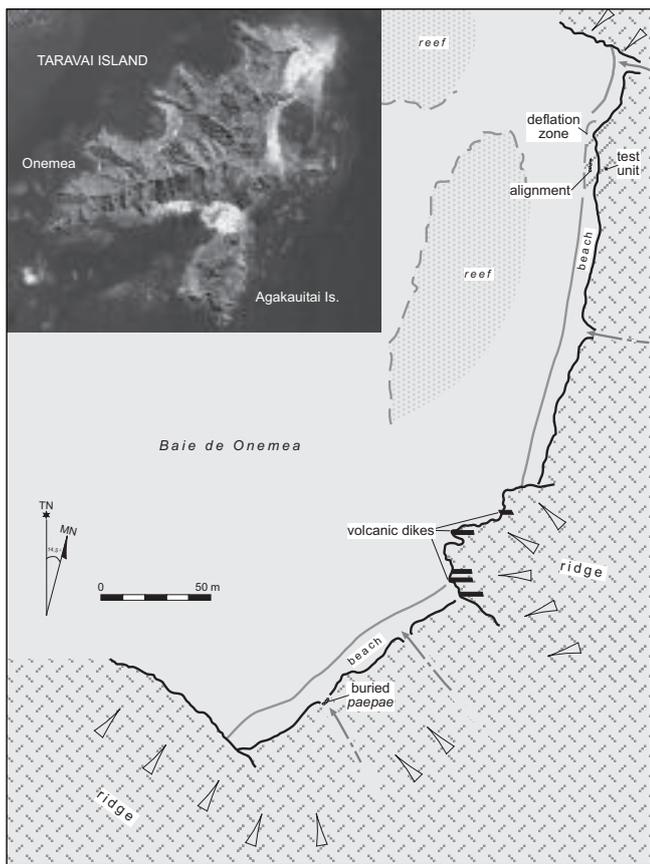


Figure 1. Map of Onemea Bay produced with a Garmin XL GPS instrument (WGS84 datum); inset is an aerial photograph of Taravai and Agakautai Islands. TAR-6 is situated at the north end of the bay where TP-1 is indicated by “test unit.”



Figure 2. View of Onemea Valley and TAR-6 from the bay, with the location of TP-1 indicated.

sand dune. Midden exposed in a wave-cut bank about 1 m high at the north end of the beach was first reported by Weisler (1996:73) during reconnaissance survey. In front of this bank is a deflation zone with volcanic fire-altered oven stones and shellfish detritus which has eroded out of the bank. A stone alignment is also visible here embedded in the beach within the tidal zone.

The TAR-6 site comprises a calcareous sand dune situated in the northern part of the main (north) valley, between the small stream and the ridge. The front of the dune where it meets the beach is currently truncated by a wave-cut bank, and a deposit of beach rock within the tidal zone suggests that the dune formerly extended some distance seaward. Active erosion is indicated by undercut or fallen coconut palms at the water’s edge. Two transect profiles were measured with tape and hand level from the beach up to the dune summit. Along transect 1 the maximum height of the dune is 9.7 m above sea level, achieved 62 m inland. Transect 2 has a steeper slope, with a maximum height of 13.6 m reached at a distance of 43 m inland. Unlike many coastal deposits in the central Pacific which are typically beach ridges formed by storm surges, the Onemea deposits appear to be of aeolian deposition. Onemea Bay faces directly southwest, the direction of periodic strong winds called *maragi* by the Mangarevans. We experienced such a *maragi* period toward the end of our stay in 2005, with gusts estimated at >40 knots, and observed active saltation of sand grains up the dune front.

In August 2003, Conte and Kirch revisited Onemea and conducted two test excavations: one (TP-1) 1.5 m inland of the wave-cut bank, and a second (TP-2) 18 m further inland, on top of the sand dune ridge. Both test units yielded cultural materials, as reported in Conte and Kirch (2004:82-5). Of particular interest was the presence, in TP-2, of a high density of bird bones at the base of the cultural deposit (Layer II), and extending down into what appeared to be a ‘sterile’ sand dune deposit (Layer III). The bird bones proved to be mostly those of seabird species now rare or extirpated in Mangareva, including significant quantities of a petrel, *Pseudobulweria* sp., currently limited in its distribution to the sub-Antarctic islands (Worthy and Tennyson 2004). Since such bird bone concentrations are characteristic markers of early phases of human

colonization of islands (Steadman 1995, 2006), we reasoned that the Onemea site might date to the initial period of Polynesian settlement of Mangareva. This hypothesis was further supported by three radiocarbon dates obtained from charcoal samples in TP-2 (Conte and Kirch 2004, table 4.2). The uppermost sample, from the top of Layer II, yielded a calibrated age (at 1 σ) of AD 1250–1280, while a sample from the base of Layer II gave an age of AD 1000–1030. A third sample, obtained from one of the seabird bones in Layer III, dated to AD 1000–1050.

Research strategy and field methods

Our first task in 2005 was to obtain a thorough understanding of the site's environmental setting and details of site topography. Using bush knives and a chain saw, we cut a transect through the dense *purau* and other vegetation covering the sand dune, from the wave cut bank well inland to the top of the dune, along the same line on which TP-1 and -2 were located in 2003. A second, parallel transect was cut from the beach up across the dune face 45 metres to the south. Test excavations were positioned along these two transects, and in some cases offset from them.

Ten excavation units, each 1 m², were excavated, numbered in sequence of excavation, from TP-3 to TP-12. Excavation followed natural stratigraphy, paying careful attention to features such as ovens, fire hearths, and pits; thick deposits were subdivided into arbitrary levels (usually 5 cm thick) for vertical control. We used pre-printed field forms to consistently record aspects of stratigraphy, horizontal distribution of artefacts, and to log all recovered artefacts, faunal remains, and other specimens. All excavated sediment was sieved through screens with mesh size of 4 and 2 mm. Much of the sediment was wet-screened, making use of the calm waters of Onemea Bay, which greatly facilitated the recovery of minute faunal remains. All faunal materials were analyzed at the Oceanic Archaeology Laboratory at Berkeley; the Onemea collections are curated at the Centre International de Recherche Archéologique sur la Polynésie in Tahiti.

Excavations and stratigraphy

In order to determine whether cultural deposits would be found further inland than TP-2, we first laid out TP-3 and TP-4 along the same transect line as TP-1 and -2, running inland up the dune in an easterly direction (see Conte and Kirch, 2004, fig. 3.44 gives a profile). TP-3 was 30 m east (inland) of TP-2, at the top of a gentle slope rising about 4 m elevation higher than TP-2, while TP-4 was positioned yet another 15 m (inland) of TP-3. Two adjacent 1 m² units, designated TP-5 and -6, were laid out 0.5 m south of TP-2 and parallel to it. TP-5 and -6 were excavated simultaneously, and a third unit, TP-11, was then added to the east, forming a 1 x 3 m trench ('main trench'). Three other units were opened up in this part of the dune near the

main trench: TP-9 was situated on the dune slope midway between TP-1 and TP-2; TP-10 was located 5 m south of the main trench; and, TP-12 was located 5 m north of TP-2. Finally, two units, TP-7 and TP-8 were opened along Transect 2, 45 m to the south of the main transect. These excavations are described below, beginning with the main trench and nearby units, where the deepest cultural deposits were concentrated.

The main trench (TP-5, TP-6, TP-11)

The uppermost stratum, Layer I, an organically enriched dark reddish gray (Munsell 5YR4/2) sandy loam about 15 cm thick, was removed as a unit and dry-screened with 4 mm mesh. Layer II, beginning about 15 cm below surface, is the main cultural deposit, reddish gray in colour (Munsell 5YR5/2), consisting of fine-grained aeolian sand enriched with charcoal and organic materials, and containing considerable shell and bone faunal materials along with fire-altered volcanic oven stones. This unit was wet-screened using 2 mm mesh to ensure recovery of small faunal remains including bird bones and land snails. Layer II continues to a depth of about 70 cm, with some cultural features extending down to 90 cm below surface. There was a sharp contact between the base of Layer II and the underlying Layer III, a distinctive reddish-yellow (Munsell 5YR7/6), very fine-grained aeolian sand largely lacking in charcoal or organic staining, but containing considerable quantities of bird bones. This deposit was also wet-screened with 2 mm mesh, and careful attention was paid during excavation to whether it contained objects of cultural origin. Continuous stratigraphic profiles of the main trench are shown in Figure 3.

Several features were encountered during the excavation of Layer II in the main trench. In TP-5 a concentration of charcoal and several basalt cobbles (ca. 20–30 cm diameter) appeared at 59 cm below surface, and proved to be a combustion feature extending down to 84 cm with a 3–4 cm thick deposit of white ash at the base, overlying a zone of burned red sand (Munsell 10R5/6). At the base of this feature were several large pieces of *Acropora* sp. branch coral, showing signs of having been burned. Several of these coral branches were dated using the ²³⁰Th method (see below). A pearlshell fishhook (TP-5-53) was found in the feature's fill at 79 cm. TP-6 had a shallow combustion feature (possibly a hearth) in the center of the unit appearing at 39 cm (dimensions 40 x 50 cm). In TP-11, we exposed a succession of two large earth ovens (structures 1 and 2 in Figure 3). The upper oven (structure 1) contained 47 volcanic oven stones (4–15 cm size range, vesicular), and had a lens of whitish ash overlying burned red sand (7.5YR5/6). A pearl-shell fishhook (TP-11-30) was found in the fill of structure 1. The lower oven (structure 2), which extended down into Layer III, contained 74 volcanic oven stones, with a heavy charcoal concentration and white ash at the base, also overlying burned red sand (Fig. 4). Both oven structures had diameters of about 90 cm.

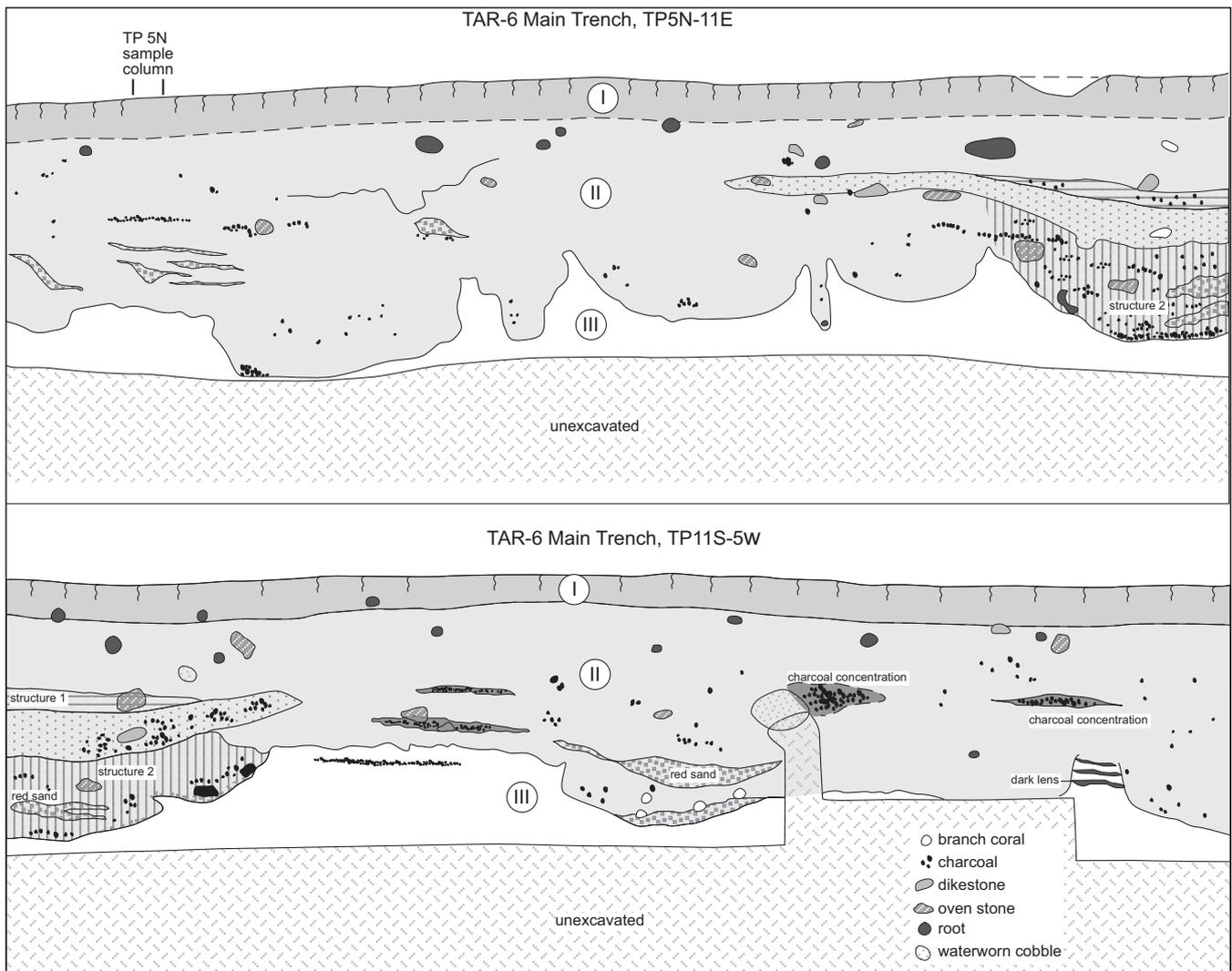


Figure 3. Stratigraphic profiles of the main trench (TP-5, -6, and -11). The upper profile runs from the north wall of TP-5 to TP-11 and ends with the east wall of TP-11. The lower profile runs from the south wall of TP-11 to TP-5 and ends with the west wall of TP-5.

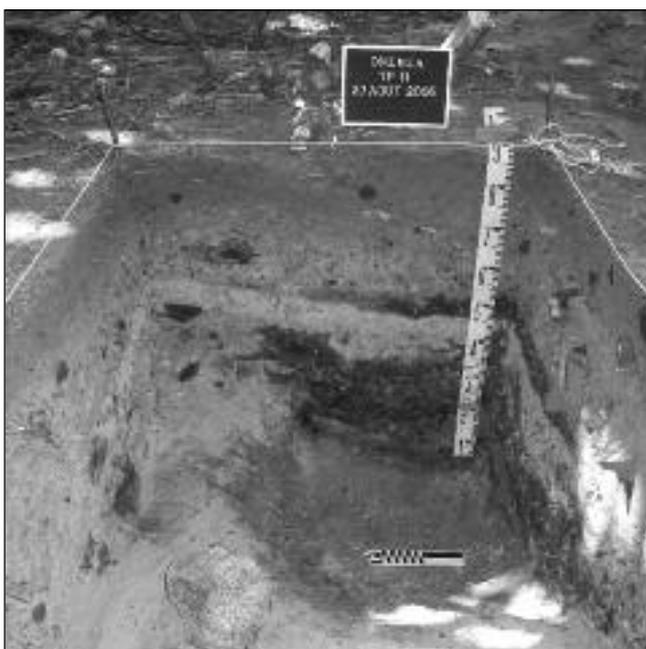


Figure 4. View of the main trench looking east to TP-11, showing the Structure 2 earth oven after excavation.

When TP-2 was excavated in 2003, we noted that Layer III with a high density of bird bones was of “particular interest for its paleoecological implications” (Conte and Kirch, 2004:84). The lack of any charcoal staining suggested that Layer III was not an *in-situ* occupation deposit, but the presence of three volcanic manuports, as well as 19 bones of the Pacific rat (*Rattus exulans*) and the shells of a Polynesian-transported land snail (*Allopeas gracile*) in TP-2 suggested that Layer III was deposited after Polynesian arrival on Taravai. In 2005, we excavated the top portion of Layer III very carefully, paying particular attention to any evidence of cultural presence. In TP-6, three shells of the marine limpet *Cellana taitensis*, three basalt flakes, and several small fragments of worked pearl-shell were all found in undisturbed Layer III context. In TP-11, a dikestone blade (TP-11-59), worked pearl-shell, fire-altered

basalt oven stone, and a fishbone were likewise all recovered in situ in Layer III. In addition, while excavating Layer III in TP-6, two very thin lenses (ca. 1 mm thick) of black (5YR2.5/1) carbonized material were encountered 6–10 cm below the Layer II/III contact. These were carefully scraped with a spatula into a specimen container, and the material was later screened through 1 mm mesh in the laboratory (eliminating the calcareous sand grains) and examined under a stereo microscope. Individual carbonized fragments ranged in length from 1–2 mm and were 0.5–1 mm thick, with a platy morphology, exhibiting fine parallel striations. They appeared to be carbonized vegetal material, quite possibly fragments of a burned *Pandanus* mat. About 20 of these fragments were submitted for AMS radiocarbon dating (see below). In sum, these cultural materials confirm that the upper 20 cm of Layer III, containing a high density of extirpated seabird bones as well as the shells of endemic terrestrial gastropods, was deposited after Polynesian arrival on Taravai. However, the nature of human activity at Onemea during this initial phase of human land use was such that it did not result in the deposition of a typical cultural layer with significant charcoal input and organic staining. We infer that the upper 15–20 cm of Layer III, with the high bird bone concentrations, is a palimpsest representing repeated very short term visits to the valley, primarily for exploitation of seabird populations. We will return to the probable nature of this initial phase in the Discussion.

In order to gain more information on the depositional processes that resulted in the stratigraphy at TAR-6, we took a series of column samples (10 cm sampling interval) from the north wall of TP-5. These were processed in the laboratory by dry sieving through nested geological sieves with mesh sizes from -2ϕ (phi) to 4ϕ and pan (Wentworth grade scale). As can be seen in Figure 5, the eight samples show a high degree of consistency in their grain size distributions, in all cases dominated by 2ϕ (0.25 mm) particles with a secondary mode of 3ϕ (0.125 mm) particles, i.e. sands in the fine to very fine range. The deepest sample, from Layer III, contained no larger particles

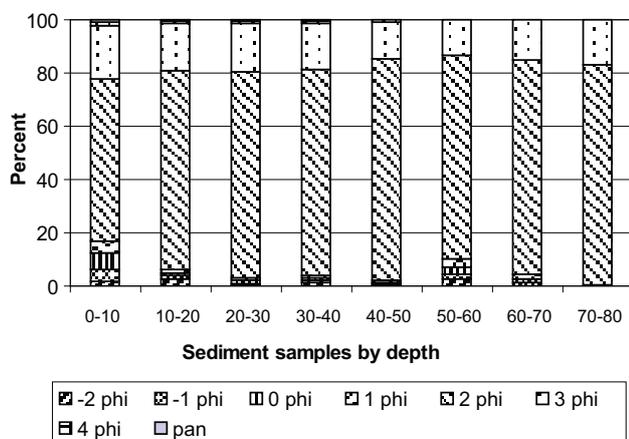


Figure 5. Grain size distribution in TP-5 sediment column, site TAR-6.

than 2ϕ , whereas higher samples from Layers II and I had between 3–20% of their constituent grains made up of particles in the 1 to -2ϕ range, reflecting the input of culturally derived materials such as shell and rock fragments. The very well sorted fine to very fine calcareous sand grains that dominate the sediment throughout are consistent with an interpretation of aeolian deposition of the dune. If the dune had resulted from storm surges its sediment would exhibit a wider mix of grain sizes including larger clasts.

Test pits 10 and 12

TP-10 was 5 m south of TP-11 and the ground surface here was 25 cm higher. The stratigraphy displayed the same succession of layers as in the main trench, with Layer II sloping downwards towards the north. Between 45–50 cm below surface the tops of two pits became apparent within Layer II. These pits, which had been dug down into Layer III, contained scattered charcoal and oven stones, but were not in situ combustion features. Rather they appeared to be refuse pits. The smaller pit had an oval form about 20 by 30 cm, whereas the larger pit (only partly exposed in the unit) was 60–70 cm wide and descended to a depth of 120 cm below surface. Layer III, where not disturbed by the two pits, contained abundant bird bones, as in the main trench.

TP-12 lies 7 m north of TP-11 and the ground surface was 30 cm lower than at the main trench. A similar stratigraphy to that in the main trench was encountered here, except that Layer II (which extended to 65 cm below surface) showed some mixing of grayish brown cultural deposit with white sand. This may have been due to the presence of three earth oven structures within Layer II, one of which penetrated down to 75 cm in Layer III. Excavating Layer III, we encountered a combustion feature with charcoal and fire-altered rock in the southeast part of the unit, at a depth of 106 cm. At this depth in the unit, only a part of the feature could be exposed, about 30 x 30 cm in area. Thus the size of the combustion feature and its complete form could not be determined. This combustion feature, well within Layer III, provides additional evidence for cultural presence at Onemea during the deposition of Layer III. Two samples of charcoal from the hearth at 106 cm were radiocarbon dated (see below).

Test pit 9

This unit was positioned on the sloping dune surface 8 m east of TP-1 and 9 m west of TP-2, along the original transect line cut in 2003 (see Conte and Kirch, 2004, fig. 3.44). The upper humus layer was about 20 cm thick, followed by a cultural Layer II 20–30 cm thick. Within Layer II a small combustion feature was exposed in the southeast part of the unit, consisting of a shallow basin-shaped depression 60 cm wide, with nine basalt stones at the base. There were also scattered fragments of branch coral which appeared to have been burned. This combustion feature was probably a small grilling hearth used to cook fish (or possibly to grill seabirds), which would have been

laid on top of the coral branches, in a method demonstrated to us by our Mangarevan collaborators. Layer III consisted of dune sand, and lacked the concentration of bird bones found higher up the dune in the main trench. The unit was taken down to 75 cm below surface.

Test pits 3 and 4

These test units were positioned to the east of the main trench, farther inland and higher up the dune. TP-3 was 29 m east of TP-2 and 4 m higher in elevation, while TP-4 lay another 14 m east of TP-3, and was 4.6 m higher than TP-2. Our objective in excavating these units was to determine whether the cultural deposits (Layer II) and the underlying Layer III with abundant bird bones continued into this higher, inland part of the dune. Both units exhibited a similar stratigraphy, with a relatively thin gray sandy loam (5YR6/2) cultural deposit (Layers IA and IB, total 30 cm depth), and an absence of bird bones in the underlying dune sand. TP-3 had a pit in Layer IB which extended down to 90 cm, containing scattered charcoal and some fishbones. Part of a pearl-shell fishhook was found in TP-3. At the top of the Layer II sterile sand in both units were substantial quantities of the endemic terrestrial gastropod *Omphalotropis margarita*, which may indicate some kind of forested environment.

Test pits 7 and 8

Finally, two units, TP-7 and -8 were opened along Transect 2, 45 m to the south of the main transect. Neither of these units revealed any significant cultural deposits, indicating that the main cultural deposits at Onemea are confined to a relatively small zone in the vicinity of the main trench.

Dating and chronology

We invested considerable effort in refining the chronology of the cultural deposits at Onemea, and applied both radiocarbon dating of a variety of sample materials, and, for branch corals, ²³⁰Th dating, which has much greater precision and does not suffer from calibration issues.

Radiocarbon dating

Based on three radiocarbon dates obtained from the TP-2 excavations in 2003, initial occupation at Onemea was estimated to date to “the close of the 10th century or first few decades of the 11th century AD” and to have continued until “the mid-to-late 13th century” (Conte and Kirch, 2004:104). In 2005 we emphasized dating of the upper part of the Layer III deposit and the base of the Layer II cultural deposit. Eight additional samples, on a variety of different materials including carbonized wood, marine limpet shell, pulmonate gastropods, and the pincher of a terrestrial crab were submitted to Beta Analytic Inc. for AMS ¹⁴C dating. Details of all 11 samples from Onemea, including the three samples previously dated in 2003, are reported in Table 1.

Calibration of the ¹⁴C ages was performed using the

Oxcal 3.10 program (Bronk Ramsey 2005). Two samples were calibrated using the Marine04 curve (Hughen *et al.* 2004): the *Cellana* limpet shell (Beta-216273), and a procellariid bone (Beta-190114) since this seabird was presumably subsisting on a marine diet. For these samples, a marine reservoir offset (ΔR value) of 1 ± 18 was used, based on information for Mangareva provided in Petchey *et al.* (2008, table 1). The remaining samples were calibrated using the IntCal04 calibration curve (Reimer *et al.* 2004) as these are all materials of terrestrial origin. In Table 1 cal AD ages are reported at one standard deviation as this allows us to report cases where there are multiple intercepts with differential probabilities. Figure 6 is a plot of all 11 samples with Gaussian probability distributions shown at two standard deviations; the shaded rectangles indicate the likely depositional spans of Layers III and II at TAR-6.

The oldest sample from TAR-6 is Beta-216279 consisting of unidentified wood charcoal from the deep combustion feature within Layer III in TP-12. Because this sample returned such an unexpectedly early age, we selected a second charcoal sample from the same feature, splitting the

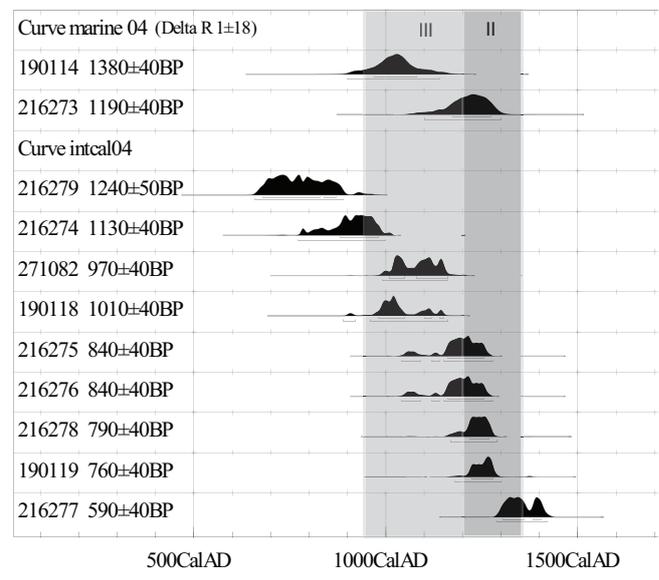


Figure 6. Oxcal plot of radiocarbon age determinations from site TAR-6. The upper two samples are calibrated with the marine04 curve, and the lower nine samples with the intcal04 atmospheric curve. The shaded bands indicate the probable age spans of the Layers III and II deposits at Onemea.

wood fragment and sending half each to Beta Analytic for dating and to G. Murakami (International Archaeological Research Institute, Inc., Honolulu) for identification. This second sample was identified as *Hibiscus tiliaceus*, a relatively short-lived shrubby tree common in Mangarevan valleys. This sample (Beta-271082) was dated to cal AD 1080–1160 (1σ) which we believe to be a reliable age for the use of the hearth; we reject the earlier date from Beta-216279 as likely deriving from old wood and therefore having a built-in age factor.

Lab. No. Beta-	Provenience	Material	Measured ¹⁴ C Age (B.P.)	δ ¹³ C Value (o/oo)	Conventional ¹⁴ C Age (B.P.)	Calibrated Age Range A.D. (1σ)*
190114	TP-2, Layer III, 103 cmbs	Procellariidae bone	1170 ± 40	-12.2	1380 ± 40	970-1080
190118	TP-2, base of Layer II, 58 cmbs	Unknown carbon clumps in sand	1010 ± 40	-24.7	1010 ± 40	980-1050 (59.9%) 1100-1120 (7.1%) 1140-1150 (1.2%)
190119	TP-2, interface of Layers I/II	<i>Artocarpus</i> wood	740 ± 40	-24.0	760 ± 40	1225-1280
216273	TP-6, Layer III	Marine limpet, <i>Cellana taitensis</i>	770 ± 40	+0.4	1190 ± 40	1175-1275
216274	TP-6, Layer III	Pulmonate gastropods, <i>Allopeas gracile</i>	730 ± 40	-0.5	1130 ± 40	880-980
216275	TP-6, Layer III	Pincher of terrestrial crab	620 ± 40	-11.6	840 ± 40	1160-1255
216276	TP-10, interface of Layers II/III	Twig-sized fragment of carbonized wood	860 ± 40	-26.0	840 ± 40	1160-1255
216277	TP-11, Layer II, from structure 1 earth oven, 42-44 cmbs	Carbonized wood, species not identified	610 ± 40	-26.4	590 ± 40	1305-1360 (50.1%) 1385-1405 (18.1%)
216278	TP-11, Layer III	Carbonized material, possibly <i>Pandanus</i> matting	830 ± 40	-27.2	790 ± 40	1219-1268
216279	TP-12, Layer III, hearth at 106 cmbs	Carbonized wood, species not identified	1260 ± 50	-26.0	1240 ± 50	680-830 (60.0%) 840-870 (8.2%)
271082	TP-12, Layer III, hearth at 106 cmbs	Carbonized wood, <i>Hibiscus</i> <i>tiliaceus</i>	990 ± 40	-26.0	970 ± 40	1080-1160 (42.6%) 1010-1050 (25.6%)

*Calibrations performed using Oxcal03; marine samples calibrated on marine04 curve with ΔR = 1 ± 18; terrestrial samples calibrated on intcal04 atmospheric curve.

Table 1. Radiocarbon age determinations from the Onemea site (TAR-6).

Several other samples provide what we regard as reliable age estimates for the upper part of Layer III. The procellariid seabird bone from TP-2 (Beta-190114) dates to cal AD 970–1080 (1σ), and was recovered from within the top portion of Layer III. Beta-216274 consisted of three shells of the small pulmonate, terrestrial snail *Allopeas gracile*, which is known to have been transported by Polynesians (Christensen and Kirch 1981); this returned an age of cal AD 880–980. A lens of carbonaceous material at the interface between Layers II and III, in TP-2, dates to cal AD 980–1050 (Beta-190118). The marine limpet shell (Beta-216273) and the pincher of a terrestrial crab (Beta-216275), both within Layer III, returned slightly later but overlapping ages of cal AD 1175–1275 and 1160–1255 respectively. The youngest material dated from a Layer III context was the possible carbonized *Pandanus* matting from TP-11 (Beta-216278) with an age of cal AD 1219–1268.

Layer II was directly dated with two radiocarbon samples. Beta-190119 is a sample of carbonized breadfruit (*Artocarpus*) wood at the top of Layer II, with an age of cal AD 1225–1280. Breadfruit can be relatively long-lived, so this sample has the potential for some in-built age. From TP-11 we also dated a sample of carbonized wood (taxon not identified) recovered from the structure 1 earth oven (Beta-216277), with a highest probability age of cal AD 1305–1360.

²³⁰Th dating of branch coral

The ages of three finger-sized branches of *Acropora* sp. coral were determined at the Berkeley Geochronology

Center via ²³⁸U-²³⁴U-²³⁰Th dating (²³⁰Th dating) using methods similar to those reported by Kirch and Sharp (2005). Two of the dated specimens came from the large pit feature which was concentrated in TP-5 and overlapped into TP-6 in the main trench, and one specimen came from TP-9 where it was associated with the small hearth feature. Stratigraphically, all three specimens are associated with the upper part of Layer II. The preservation of delicate surface structures (verrucae) and the lack of evidence of abrasion indicate that the corals were collected as living specimens. Their ²³⁰Th dates therefore closely correspond to use of the corals in the archaeological context in which they were found. Two of the dated coral branches lack their tips; thus, their ²³⁰Th dates precede their collection and use, however, we estimate this ‘in-built age’ to be no more than one to two decades.

Analytical data and dates for the corals are given in Table 2. Two of the dated corals (TP-6-43 and TP-5-61) meet geochemical criteria widely used to identify corals suitable for accurate ²³⁰Th dating. That is, they have U (~3.0–3.5 ppm), common Th (²³²Th, ~100 ppt or less), and initial ²³⁴U/²³⁸U activity ratios (1.147 ± 0.007) that are similar to those of living or young, well-preserved shallow-water corals elsewhere in the Pacific (cf. McCulloch *et al.* 2008, table 1; Shen *et al.* 2008). Specimen TP-9-12 has a ²³⁴U/²³⁸U activity ratio slightly higher than the preferred range, indicating that its U-Th system may not have remained closed since coral growth; accordingly, we consider our most reliable dates to be those for corals TP-6-43 and TP-5-61. We note that their dates, respectively, of AD 1353 ± 8 yr. and 1344 ± 7 yr. (errors are two standard deviations) are analytically indistinguishable.

Sample No.	U (ppm)	²³² Th (ppt)	(²³⁰ Th/ ²³² Th)	(²³² Th/ ²³⁸ U) x10 ⁵	±%	(²³⁰ Th/ ²³⁸ U) x10 ³	±%	(²³⁴ U/ ²³⁸ U) ^a	±%	Uncorrected Date (AD) ^b	Corrected Date (AD) ^c
TP-9-12	3.51	117	597.3	1.103	0.34	6.59	1.78	1.158	0.31	1384 ± 11	1385 ± 11
TP-6-43	2.97	63.6	966.2	0.706	0.45	6.82	1.28	1.141	0.20	1352 ± 8	1353 ± 8
TP-5-61	2.94	61.0	1021.0	0.683	0.49	6.98	0.96	1.152	0.50	1344 ± 7	1344 ± 7

^a Initial (²³⁴U/²³⁸U) ratios for these samples exceed measured ratios by only 0.00026 to 0.00028.

^b Date not corrected for ²³⁰Th non-radiogenic (²³⁰Th_{nr}). Errors are analytical errors only.

^c Date corrected for initial Th assuming a ratio of (²³⁰Th_{nr}/²³²Th)_{atomic} = 4.5x10⁻⁶; initial Th ratio is assigned an error of ± 50%, which is propagated into final date-errors.

Table 2. ²³⁰Th Dates for branch corals from the Onemea site (TAR-6). Isotope ratios are measured values expressed as activity ratios; errors are 95% confidence interval. Decay constants used are those of Cheng *et al.* (2000). Analyses performed in 2007.

The three branch coral samples were obtained from stratigraphic contexts associated with the final phase of deposition of Layer II. Their ages are consistent with radiocarbon sample Beta-216277 from the structure 1 earth oven in TP-11, and together with that sample indicate that cultural occupation at Onemea ended during the mid-to-late 14th century AD.

Site chronology

Based on the dates reported above, we suggest the following chronology for the Onemea site. Initial human presence on the dune is indicated by the deposition of seabird bones, limited hearth or cooking activity such as the combustion feature in TP-12 and a small quantity of fishbone and shell midden, and introduction of *Allopeas* snails and the Pacific rat (*Rattus exulans*). Human activities may have commenced by cal AD 950, and continued to as late as cal AD 1250, when the probable *Pandanus* mat was burned. In our view, the upper part of Layer III is therefore a palimpsest reflecting intermittent human activity on the dune surface over a period as long as three centuries. This is not surprising given that Onemea is a small valley and unlikely to have ever been a major center of human occupation. However, some kind of more intensive human activity on the dune commenced during the 13th century, and continued for a century or so, until the late 14th century. During this time the various earth ovens were dug and used, and sufficient charcoal and organic refuse generated to result in the deposition of Layer II.

Artefacts

The artefact assemblage at TAR-6 is limited to basalt lithics, a few fishhooks, and two branch coral files, described below. The restricted diversity of this assemblage suggests that the Onemea site was not a primary habitation, but rather a specialized activity area.

Basalt lithics

The most abundant artefacts encountered while excavating at TAR-6 were flakes and cores of basalt, of which 345 were recovered from the main trench (TP-5, -6, and -11). Almost

all of these were from Layer II, although as noted earlier one dikestone blade was found in situ in Layer III. These lithics appear to come from at least two distinct sources, based on visual inspection. The majority are of dikestone which has a natural tendency to yield prismatic blades. Several dikes which were the likely source of these lithics occur to the south of TAR-6 where a rocky headland juts into the bay (Fig. 1). However, several other specimens exhibiting large whitish phenocrysts are probably from a different source. The flakes range in length from 16 to 102 mm. Two particularly large basalt cores, illustrated in Figure 7, were recovered from TP-4 and TP-11. Unlike the majority of prismatic blades, these are not of dikestone, and were probably brought to Onemea from another locality either on Taravai Island or elsewhere.

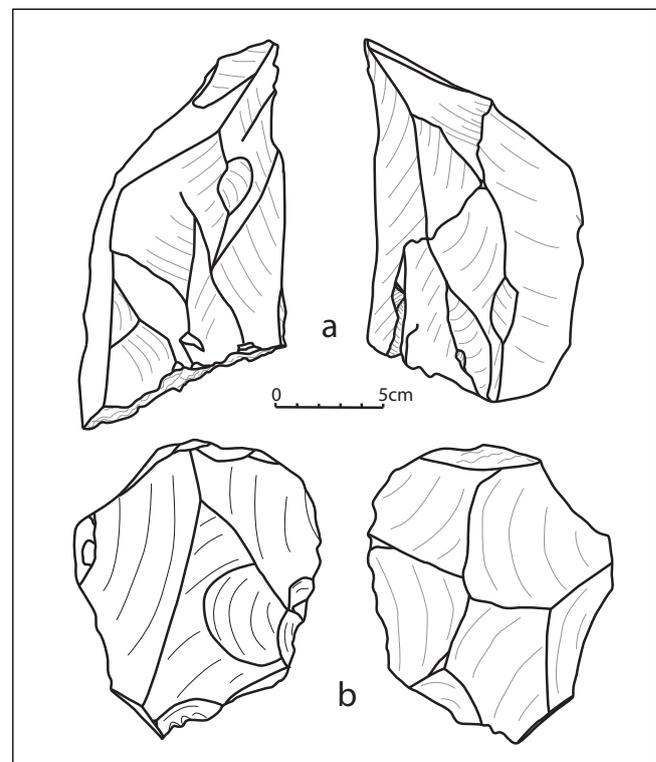


Figure 7. Two large basalt cores from site TAR-6: a, from TP-4; b, from TP-11.

Test Pit and Specimen Number	Head	Shank	Bend	Point	Unfinished hook	Preform	Fishhook Blank	Worked Pearl-shell
TP-3								
# 8	X	X						
TP-4								3
TP-5								2
# 5		X			X			
# 24			X					
# 38		X			?			
# 53	X	X	X				1	3
TP-6								
# 53	X	X	X					2
TP-10								
# 6						X		
#45			X					
TP-11								
# 29		X					1	3
# 30	X	X						
# 48				X				
TP-12								4

Table 3. Fishhooks and worked pearlshell from the Onemea site (TAR-6); X = present.

Pearl-shell fishhooks

As enumerated in Table 3, the Onemea excavations yielded eight specimens of finished but broken fishhooks, two unfinished hook fragments, one fishhook preform, two blanks (rectangular pieces of pearl-shell not yet showing the fishhook outline), and 17 worked pieces of pearl-shell (showing obvious cut marks). All of the specimens are of the large pearl oyster *Pinctada margaritifera*, which grows abundantly in the lagoons of Mangareva. As far as can be determined, all of the hooks were probably of the “rotating” rather than “jabbing” type (following the definitions of Emory *et al.* 1959). The finished pieces showing diagnostic traits are illustrated in Figure 8.

Three of the hooks are quite large (Fig. 8b, 8e, and 8f), with shank lengths between 52–55 mm, and hook widths estimated at approximately 45 mm. The shanks of the two largest hooks have widths of 6 and 8 mm. The specimen from TP-11 (Fig. 8g) is more slender, with a shank length of 39 mm and shank width of 4 mm. This latter hook is similar to that from TP-3 (Fig. 8a) for which shank length cannot be determined, but shank width is also 4 mm. The most diminutive hook is a bend fragment from TP-5 (Fig. 8c) with a hook width of 15 mm and a shank width of 2 mm. The preform from TP-10 (Fig. 8d) was intended for an even smaller fishhook, which when finished could not have had a shank height of more than 18 mm. Although limited, this assemblage nonetheless indicates a significant range in hook sizes. The larger hooks were likely intended for hand-line angling for benthic species such as serranids, the bones of which were recovered at TAR-6 (see below). The smaller hooks could have been used either for hand-line angling or casting with a rod, especially for smaller reef fish such as acanthurids and holocentrids, both of which are represented in the faunal remains at TAR-6.

Because the fishhook assemblage at Onemea is limited, we must be cautious in making stylistic comparisons with other early Eastern Polynesian assemblages. The large rotating hooks from TP-5 and -6 are similar to Suggs’s (1961b:81, fig. 26i, fig. 27) ‘rotating hook’ which he found only at the Ha’atuatua site on Nukuhiva. Rolett also found this hook type (which he calls his ‘Circular’ type) at Hanamiai on Tahuata, where it occurred only in the deepest two stratigraphic zones (1998:table 7.1, figs. 7.6, 7.7). The Onemea hooks have head types (‘line lashing devices’) marked by a notched facet on the inner face of the shank and a protruding knob on the outer face of the shank. Such head types are also characteristic of early fishhook assemblages in the Marquesas (Rolett 1998, figs. 7.6, 7.7), at the Tangatatau rockshelter site on Mangaia (Kirch *et al.* 1995), and of the fishhooks made from imported *Pinctada* shell recovered by Weisler (1995, fig. 6) on Henderson Island.



Figure 8. Fishhooks from site TAR-6: a, head and shank, TP-3-8; b, bend, TP-10-45; c, bend, TP-5-24; d, preform, TP-10-6; e, head, shank, and bend, TP-5-53; f, head, shank, and bend, TP-6-53; g, head and shank, TP-11-30.

Coral abraders and worked pearl-shell

One abradar consisting of a branch of *Acropora* sp. coral with evident use wear on the tip was found in Layer II of TP-11 at a depth of 42 cm. A second possible specimen, on

which use wear was less evident was found at 38 cm depth in Layer II. In addition to these abraders, we recovered 17 pieces of pearl-shell with cut marks (Table 3), and other smaller fragments were also evident in the shell faunal assemblage. These provide additional evidence that fishhook manufacturing took place at TAR-6 during the period that Layer II accumulated.

Faunal remains

Faunal remains recovered from the Onemea excavations include marine mollusks, echinoderms, crustaceans, mammal, bird, and fish bone. In the field, the faunal remains were sorted into shell, bone, and terrestrial gastropod. In the laboratory, the remains were cleaned to remove dirt and sand, sorted, classified, and identified to the lowest taxonomic category possible using reference collections in the Oceanic Archaeology Laboratory and the Museum of Vertebrate Zoology at U.C. Berkeley.

Vertebrate remains from TAR-6 are dominated by bird and fish, with lesser quantities of rat, pig, medium mammal, and miscellaneous bone. The distribution of non-fish vertebrate remains by layer is given in Table 4.

Faunal Category	I		II		III		Total	
	NISP	g	NISP	g	NISP	g	NISP	g
Bird	38	1.7	626	53.9	518	35.6	1,182	91.2
Medium mammal	30	29.9	12	15.9			42	45.9
<i>Sus scrofa</i>			83	17.2	2	0.2	85	17.4
<i>Rattus</i> sp.	23	3.3	129	4.4	19	0.4	171	8.2
Miscellaneous bone	48	4.2	3,278	161.7	1,361	22.9	4,687	188.8
Total	139	39.1	4,128	253.1	1,900	59.1	6,167	351.5

Table 4. Non-fish vertebrate remains by stratigraphic layer from the Onemea site (TAR-6).

Bird

Bird bones from the 2005 TAR-6 excavation totaled 1,185 NISP (total weight 91.52 grams), with 518 NISP in Layer III and 626 NISP in Layer II. Based on the detailed analysis of the 2003 bird bone assemblage from TP-2 by Worthy and Tennyson (2004), the majority of the bones are from several species in the Procellariidae (petrels and shearwaters), including representatives of the genera *Pseudobulweria* and *Puffinus*; also present are *Phaethon rubricauda* (red-tailed tropic bird) and *Gygis alba* (white tern). Our preliminary sorting of the 2005 assemblage was checked by David Steadman, who also noted the rare presence of 4 bones of pigeon, 3 bones of fruit dove, and 2 bones of chicken (*Gallus gallus*). The chicken specimens came from the base of Layer II in TP-11. The pigeon and fruit dove bones are likely to be from endemic species now extinct in Mangareva. Specialist studies of the bird bones are in process, and a detailed taxonomic account of the 2005 Onemea avifaunal assemblage will be published separately.

A major question arising after our 2003 excavation was whether the high frequency of bird bones in the upper portion of Layer III derived from natural depositional processes (such as a massive die-off due to the introduction of avian disease or non-human predators) or from direct human predation on the local bird populations. Observing that a number of the bird bones were fractured, we carried out a systematic examination of all major wing and leg (tarsometatarsus, tibiotarsus, femur, humerus, ulna, radius) bones for fracture patterns, for remains from TP-5, -6, -10, and -11. Bones were categorized as to whether they are: (1) non-fractured, i.e. intact; (2) fractured with one end intact; (3) shafts lacking both ends; or (4) shaft fragments split down the middle. The results of this analysis of bird-bone fracturing are shown in Table 5. Of 682 bones examined and classified, 601 or 88.1% exhibited some kind of fracturing. These fractures are almost entirely old breaks and hence not due to excavation. These data offer strong evidence that the avifaunal remains at Onemea represent birds that were being taken by humans and consumed.

Provenience	Non-fractured bones	Bones with one end intact	Shaft fragments without ends	Split bone fragments
TP5	12	53	39	25
TP6	18	59	47	41
TP10	16	60	36	15
TP11	35	112	54	35
Totals	81	284	176	141

Table 5. Fracture patterns in bird bones from the Onemea site (TAR-6).

Rat

171 NISP rat bones were identified weighing a total of 8.09 grams (Table 4). Virtually all of these are of the Polynesian introduced species *Rattus exulans* (the TAR-6 specimens were compared with MVZ reference specimen no. 129820 collected from Morobe Province, Papua New Guinea). However, one bone from Layer I of TP-10 is probably from *R. rattus* given its large size. Significantly, 19 NISP of *R. exulans* were present in the Layer III deposit, thus indicating that Polynesian introduced rats were present on Tarava Island even before Onemea began to be permanently occupied.

Fish

A total of 3,846 NISP of fishbone was recovered from the TAR-6 excavations (Table 6). Fishbones were separated into identifiable elements, vertebrae, and miscellaneous fishbone. Following Dye and Longenecker (2004) five cranial elements and special bones were used for identification to genus and species: premaxilla, maxilla, dentary, angular, and quadrate. Special bones included the pharyngeal plates of Scaridae sp. and Labridae sp., tangs from Acanthuridae sp., and scales from Ostraciidae sp. Elements were identified to the lowest taxonomic category

possible, using the comparative reference collection in the Oceanic Archaeology Laboratory, or by reference to Dye and Longenecker (2004). For each of the five cranial elements specific diagnostic characteristics were used to calculate MNI. These diagnostic characteristics were the distal end of the premaxilla and dentary, the distal end of the maxilla with the premaxillary sulcus, the quadrate facet and postarticular process of the angular, and the collus of the quadrate. Only 75% intact special bones were counted in estimating MNI. Distinctive bones that could not be identified were kept separate and included teeth and otoliths. All other bones were bagged as 'miscellaneous fishbone'.

The distribution of fishbone NISP by stratigraphic layer is shown in Table 6. The majority of fishbone occurs in Layer II, but a not insignificant total of 483 NISP was recovered from Layer III, a further indication of cultural activity during the period that this deposit accumulated. A total of 51 fish MNI were identified for the TAR-6 assemblage. The MNI count is as follows: 19 Serranidae spp. including 2 *Plectropoma* sp. and 2 *Epinephelus* sp., 17 Scaridae sp., 4 Labridae sp., 2 Holocentridae sp., and 1 each of Acanthuridae sp., Lethrinidae sp., Ostraciidae sp. and shark. These taxa are all quite common in the inshore reef and lagoon environments of Mangareva (Fourmanoir *et al.* 1974). As noted earlier, the serranids are likely to have been taken with the large rotating fishhooks found at Onemea, while the smaller holocentrids, acanthurids, and lethrinids may have been taken with the smaller pearlshell hooks. The scarids and labrids, however, are more likely to have been taken with nets than with hooks.

Pig

Pig (*Sus scrofa*) was ethnographically reported to have been exterminated in Mangareva prior to European contact, possibly as a result of trophic competition with humans for the islands' limited food supply (Hiroa 1938:194-95; Kirch 2001). Green and Weisler (2004) reported the rare presence of pig bones or teeth in Green's rockshelter excavations,

while Conte and Kirch (2004:117) found only a single tooth in the Neneka-Iti site on Agakauitai. In our 2005 Onemea excavations we recovered a single identifiable pig premolar, probably mandibular and juvenile, from Layer II of TP-11. Some unidentifiable bone fragments of 'medium mammal' size class from Layer II are also likely to be of pig. These finds add further supporting evidence that pig was introduced to Mangareva with the initial Polynesian colonizers.

Unidentifiable mammal

Excavations yielded 42 NISP unidentified mammal bone fragments (45.89g), from Layers I and II. Several of the larger pieces fit together. The fragments are in a size range consistent with pig, human, or possibly dog. Several rib bones from TP-11 in particular are most likely to be pig.

Marine mollusks

Mollusks were identified to genera with reference to Salvat (1974) and Salvat and Rives (1991). The minimum number of individuals (MNI) and the number of identified specimens (NISP) counts were carried out using the guidelines from previous analysis of specimen from this site (Howard and Kirch 2004). Results of the analysis of marine mollusks are presented in Table 7. *Nerita* spp. were not differentiated to species but include *N. plicata*, (the most abundant), *N. picea*, and *N. morio*. *Drupa* spp. includes *D. ricinus*, *D. morum* and *Morula uva*.

The most common mollusks in the TAR-6 assemblage are those which inhabit rocky shorelines. These include the limpet *Cellana taitensis*, the nerites, drupes, and small cowries. All of these could readily have been gathered on the rocky headlands to either side of Onemea Bay. The *Turbo*, however, are more likely to have come from the outer barrier reef, whereas the *Pinctada* pearl oysters would have been obtained within the lagoon. Most of the *Pinctada* shell is probably the detritus from preparing pearl-shell for fishhook manufacture.

Taxon	I		II		III		Total	
	NISP	g	NISP	g	NISP	g	NISP	g
Acanthuridae sp.	1	0.3	1	0.1	1	0.3	3	0.7
<i>Epinephelus</i> sp.	5	5.6	2	1.2			7	6.8
Holocentridae sp.			9	2.2			9	2.2
Labridae sp.	1	0.2	23	7.4			24	7.6
Lethrinidae sp.	2	2.6	3	1.9			5	4.6
Ostraciidae sp.			13	0.3			13	0.32
<i>Plectropoma</i> sp.	3	4.3	11	17.9			14	22.2
Scaridae sp.	15	11.8	363	67.1	23	5.5	401	84.4
Serranidae spp.	5	2.8	117	36.3	6	1.4	128	41.3
Elasmobranch (shark or ray)			18	3.2	2	0.1	20	3.31
Miscellaneous fish	145	30.3	2,266	338.2	451	45.7	2,862	414.4
Total	177	57.8	2,826	475.9	483	53.1	3,486	587.8

Table 6. Distribution of fish remains by stratigraphic layer in the Onemea site (TAR-6).

Taxon	I			II			III			Totals		
	NISP	MNI	g	NISP	MNI	g	NISP	MNI	g	NISP	MNI	g
<i>Cellana taitensis</i>	89	47	33.1	861	476	355.9	47	36	54.9	997	559	443.9
<i>Chama</i> sp.				1	1	0.3				1	1	0.3
Chiton				9		0.8				9		0.8
<i>Codakia</i> sp.	2		3.4							2		3.4
<i>Conus</i> sp.	1		2.2							1		2.2
<i>Cypraea</i> sp.	3		2.0	14	1	15.7	1		2.4	18	1	20.1
<i>Drupa</i> sp.	27	6	22.1	240	31	192.5	9	1	5.4	276	38	220.0
<i>Haliotis pulcherrima</i>				1	1	0.5				1	1	0.5
<i>Latiris nodatus</i>	6		2.1	14	2	15.8				20	2	17.9
<i>Littorina</i> sp.				6	6	0.9				6	6	0.9
<i>Nerita</i> sp.	42	14	12.9	558	134	120.9	48	12	8.3	648	160	142.1
<i>Pinctada margaritifera</i>	77		22.6	466		200.1	29		6.5	572		229.2
<i>Turbo argyrostomus</i>				2	1	107.8	3	1	31.9	5	2	139.7
<i>Turbo</i> cf. <i>setosus</i>	16	1	31.5	71	1	95.6	4		11.9	91	2	139.0
<i>Turbo</i> sp. operculae				4	3	18.3	1	1	7.4	5	4	25.7
Miscellaneous shell	57		21.2	242		104.3	26		5.5	325		131.0
Total	320	68	153.1	2,489	657	1,229.4	168	51	134.2	2,977	776	1,516.7

Table 7. Marine mollusks by stratigraphic layer from the Onemea site (TAR-6).

Echinoderms and crustacea

Both echinoderms (sea urchin) and crustaceans (crab) were found at TAR-6. Only nine fragments of sea urchin spines and body were identified with a total weight of 1.38 grams. Three of the spines appear to have been from the large slate-pencil sea urchin, *Heterocentrotus mammillatus*. These show no signs of having been used as abraders.

Crab NISP totalled 1,379 with a weight of 168.32g. The crab pincer and body fragments are concentrated in the lower layers (especially Layer III). Most of the crustacean remains probably derive from the land crab *Cardisoma* sp. which is not present on Taravai today (Howard and Kirch 2004).

Discussion and conclusions

The 2005 excavations at TAR-6 have significantly enhanced our understanding of the depositional history, chronology, and nature of human activities at Onemea. As it is the earliest known site within the Gambier Islands, the evidence from Onemea also has wider implications for early Eastern Polynesian settlement.

Onemea is one of the smallest – and most exposed – bays on Taravai Island, and unlikely to ever have been a major locus of permanent settlement. During the early contact period, the majority of the island's population resided on the eastern side at Aukokoti, with secondary villages at the mouths of the large bays of Gahutu and Agarei (Hiroa 1938:6, fig. 2). These locations are also likely to have been early loci of population concentration, as they are situated in the most sheltered locations, have the best fresh water sources, and largest areas of arable land. Nonetheless, at just 5.3 km², Taravai is a small island, and it would not have been difficult for people residing in these larger valleys to travel – either overland or by canoe – to Onemea to exploit

particular resources. These resources could have included nesting or roosting seabird populations (prior to their extirpation) as well as fish and shellfish in the bay.

Our careful efforts to document the nature of the Layer III deposit with its high density of seabird bones, combined with nine radiocarbon dates from this stratum, make it clear that Layer III was deposited gradually over a period of two to three centuries, and is therefore a palimpsest reflecting a series of periodic, low-intensity visits to the valley and sand dune. As we have demonstrated, the large quantities of the seabird bones in Layer III show an unmistakable taphonomic signature of human modification – in other words, the bones were deposited as a result of human predation and consumption. Fishbones and the occasional mollusk shell also indicate that people from time to time ate meals on the dune, but no large earth ovens are evident. Instead, we have only the deeply buried combustion feature in TP-12, along with a few scattered oven stones in Layer III in the main trench. Other indirect signs of human presence are of course the synanthropic Pacific rat and the garden snail *Allopeas gracile*.

The suite of nine radiocarbon dates from Layer III convinces us that this deposit is indeed a palimpsest, and not a rapid depositional event. We discount the oldest age determination (Beta-216279) from the hearth in TP-12 as likely having an in-built “old wood” age factor. But the second sample from this feature (Beta 271082) is of *Hibiscus* wood and meets any reasonable criteria for a valid age determination. The other seven samples, on a variety of materials as described earlier, are all equally acceptable age determinations, each representing different specific events. In aggregate, they indicate a phase from about cal AD 950 until sometime in the 13th century during which we infer that Polynesians were present on Taravai, and making periodic visits to Onemea to exploit its resources, especially roosting or nesting seabirds. Then, probably around the mid-13th century, human activity at Onemea entered a new, more

intensive phase, resulting in the fairly rapid deposition of Layer II. During this phase a number of large, typical Polynesian earth ovens were constructed and repeatedly used, generating large quantities of charcoal and ash. Fishing was a key activity, as indicated by the several fishhooks recovered, and some fishhook manufacture was being carried out, although the small quantities of worked pearlshell and coral files suggest that this was limited. Shellfish were gathered along the rocky shores of the bay, and the occasional pig may have been brought from elsewhere to be cooked at Onemea. Our impression is that during this period Onemea may have served as a fishermen's camp, with people residing for periods of time (days or even weeks) but not permanently. By the late 14th century, the dune was abandoned, never to be reoccupied.

Aside from opening a window on the nature of Polynesian colonization – especially in its pioneering phase when birds and other natural resources were abundant – the data from Onemea are relevant to the larger debate about the timing of Polynesian expansion into the southeastern Pacific. As argued here, our radiocarbon corpus supports a chronology with Polynesians present on Taravai by AD 950. This is highly consistent both with the evidence from the Tangatatau Rockshelter on Mangaia Island in the southern Cooks for initial settlement there by AD 1000 (Kirch *et al.* 1995:52, table 2), and with Weisler's radiocarbon evidence for initial human presence in the Pitcairn group by AD 1050 (Weisler 1995:389, table 2, fig.5). And, although Hunt and Lipo (2006, 2008) have argued that Rapa Nui was not settled until AD 1200, the full corpus of dates now available from the Anakena dunes (including those of Steadman *et al.* 1994) are in our view fully compatible with a colonization date of around AD 1000. In short, the Onemea site lends additional support to the hypothesis that Polynesians expanded rapidly through the chain of islands extending from the southern Cooks through at least some of the Australs, to Mangareva, the Pitcairn-Henderson group, and to Rapa Nui, at approximately AD 1000.

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References

- Allen, M.S. 2004. Revisiting and revising Marquesan culture history: New archaeological investigations at Anaho Bay, Nuku Hiva Island. *Journal of the Polynesian Society* 113:143-196.
- Anderson, A. 2001. The chronology of prehistoric colonization in French Polynesia. In C.M. Stevenson, G. Lee, and F.J. Morin, eds, *Pacific 2000: Proceedings of the Fifth International Conference on Easter Island and the Pacific*, pp. 247-52. Los Osos: Easter Island Foundation.
- Anderson, A. 2003. Initial human dispersal in Remote Oceania: Pattern and explanation. In C. Sand, ed., *Pacific Archaeology: Assessments and Prospects*, 71-84. Le Cahiers de l'Archéologie en Nouvelle-Calédonie, No. 15. Noumea: Service des Musées de du Patrimoine.
- Anderson, A., E. Conte, G. Clark, Y. Sinoto and F. Petchey 1999. Renewed excavations at Motu Paeao, Maupiti Island, French Polynesia. *New Zealand Journal of Archaeology* 21: 47-66.
- Anderson, A., E. Conte, P.V. Kirch and M. Weisler, 2003. Cultural chronology in Mangareva (Gambier Islands), French Polynesia: Evidence from recent radiocarbon dating. *Journal of the Polynesian Society* 112:119-140.
- Anderson, A., H. Leach, I. Smith and R. Walter, 1994. Reconsideration of the Marquesan sequence in East Polynesian prehistory, with particular reference to Hane (MUH1). *Archaeology in Oceania* 29: 29-52.
- Anderson, A. and Y. Sinoto 2002. New radiocarbon ages of colonization sites in East Polynesia. *Asian Perspectives* 41:242-257.
- Bronk Ramsey, C. 2005. *OxCal v. 3.10*. Available at <http://www.rlaha.ox.ac.uk/oxcal/oxcal.htm>
- Cheng, H., R.L. Edwards, J. Hoff, C.D. Gallup, D.A. Richards and Y. Asmerom 2000. The half-lives of uranium-234 and thorium-230. *Chemical Geology* 169:17-33.
- Christensen, C.C. and P.V. Kirch 1981. Nonmarine mollusks from archaeological sites on Tikopia, Southeastern Solomon Islands. *Pacific Science* 35:75-88.
- Conte, E. and A.J. Anderson 2003. Radiocarbon ages for two sites on Ua Huka, Marquesas. *Asian Perspectives* 42:155-160.
- Conte, E. and P.V. Kirch, eds. 2004. *Archaeological Investigations in the Mangareva Islands, French Polynesia*, Contributions of the Archaeological Research Facility, No. 62. Berkeley: University of California.
- Dye, T.S. and K.R. Longenecker 2004. *Manual of Hawaiian Fish Remains Identification Based on the Skeletal Reference Collection of Alan C. Ziegler and Including Otoliths*. Honolulu: Society for Hawaiian Archaeology.
- Emory, K.P. 1939. *Archaeology of Mangareva and Neighboring Atolls*. Bernice P. Bishop Museum Bulletin 163. Honolulu.
- Emory, K.P., W. Bonk and Y.H. Sinoto 1959. *Hawaiian Archaeology: Fishhooks*. Honolulu: Bishop Museum Press.
- Fourmanoir, P., J.M. Griessinger and Y. Plessis 1974. Faune ichtyologique des Gambier. *Cahiers du Pacifique* No. 18, Vol. II, pp. 543-559. Paris : Fondation Singer-Polignac.
- Green, R.C. and M.I. Weisler 2000. *Mangarevan Archaeology: Interpretations Using New Data and 40 Year Old Excavations to Establish a Sequence from 1200 to 1900 AD*, University of Otago Studies in Prehistoric Anthropology No. 19. Dunedin: University of Otago.
- 2002. The Mangarevan sequence and dating of the geographic expansion into Southeast Polynesia. *Asian Perspectives* 41:213-241.
- 2004. Prehistoric introduction and extinction of animals in Mangareva, Southeast Pacific. *Archaeology in Oceania* 39:34-41.
- Hiroa, Te Rangi, (P.H. Buck) 1938. *Ethnology of Mangareva*. Bernice P. Bishop Museum Bulletin 157. Honolulu: Bishop Museum.
- Howard, N. and P.V. Kirch, 2004. Zooarchaeological analysis of faunal assemblages. In E. Conte and P.V. Kirch, eds, *Archaeological Investigations in the Mangareva Islands, French Polynesia*, pp. 106-121. Contributions of the Archaeological Research Facility, No. 62. Berkeley: University of California.

- Hughen, K.A., M.G.L. Baillie, E. Bard, A. Bayliss, J.W. Beck, C. Bertrand, P.G. Blackwell, C.E. Buck, G. Burr, K.B. Cutler, P.E. Damon, R.L. Edwards, R.G. Fairbanks, M. Friedrich, T.P. Guilderson, B. Kromer, F.G. McCormac, S. Manning, C. Bronk Ramsey, P.J. Reimer, R.W. Reimer, S. Remmele, J.R. Southon, M. Stuiver, S. Talamo, F.W. Taylor, J. van der Plicht and C.E. Weyhenmeyer. 2004. Marine04 Marine radiocarbon age calibration 26-0 ka BP. *Radiocarbon* 46:1059-1086.
- Hunt, T.L. and C.P. Lipo, 2006. Late colonization of Easter Island. *Science* 311:1603-1606.
- 2008. Evidence for a shorter chronology on Rapa Nui (Easter Island). *Journal of Island and Coastal Archaeology* 3:140-148.
- Irwin, G. 1981. How Lapita lost its pots: The question of continuity in the colonisation of Oceania. *Journal of the Polynesian Society* 90:481-94.
- 1992. *The Prehistoric Exploration and Colonisation of the Pacific*. Cambridge: Cambridge University Press.
- Kirch, P.V. 1986. Rethinking East Polynesian prehistory. *Journal of the Polynesian Society* 95:9-40.
- 2001. Pigs, humans, and trophic competition on small Oceanic islands. In A. Anderson and T. Murray, eds, *Australian Archaeologist: Collected Papers in Honour of Jim Allen*, pp. 427-39. Canberra: Australian National University, Centre for Archaeological Research and Department of Archaeology and Natural History.
- Kirch, P.V. and E. Conte 2008. Comblent une lacune dans la préhistoire de la Polynésie orientale: Nouvelles données sur l'archipel des Gambier (Mangareva). *Journal de la Société des Océanistes* 128 :91-115.
- Kirch, P.V. and J. Ellison 1994. Palaeoenvironmental evidence for human colonization of remote Oceanic islands. *Antiquity* 68:310-321.
- Kirch, P.V. and W. Sharp 2005. Coral ²³⁰Th dating of the imposition of a ritual control hierarchy in precontact Hawaii. *Science* 307:102-104.
- Kirch, P.V., D.W. Steadman, V.L. Butler, J. Hather and M.I. Weisler 1995. Prehistory and human ecology in Eastern Polynesia: Excavations at Tangatatau rockshelter, Mangaia, Cook Islands. *Archaeology in Oceania* 30:47-65.
- Marck, J. 1996. Eastern Polynesian subgrouping today. In J. Davidson, G. Irwin, F. Leach, A. Pawley and D. Brown, eds, *Oceanic Culture History: Essays in Honour of Roger Green*, pp. 491-511. New Zealand Journal of Archaeology Special Publication. Dunedin, New Zealand.
- McCulloch, M.T. and G.E. Mortimer 2008. Applications of the ²³⁸U-²³⁰Th decay series to dating of fossil and young corals using MC-ICPMS. *Australian Journal of Earth Sciences* 55:955-965.
- Métraux, A. 1940. *Ethnology of Easter Island*. Bernice P. Bishop Museum Bulletin 160. Honolulu: Bishop Museum Press.
- Petchey, F., A. Anderson, A. Zondervan, S. Ulm and A. Hogg, 2008. New marine ΔR values for the South Pacific subtropical gyre region. *Radiocarbon* 50:373-397.
- Reimer P. J., M.G.L. Baillie, E. Bard, A. Bayliss, J.W. Beck, C. Bertrand, P.G. Blackwell, C.E. Buck, G. Burr, K.B. Cutler, P.E. Damon, R.L. Edwards, R.G. Fairbanks, M. Friedrich, T.P. Guilderson, K.A. Hughen, B. Kromer, F.G. McCormac, S. Manning, C. Bronk Ramsey, R.W. Reimer, S. Remmele, J.R. Southon, M. Stuiver, S. Talamo, F.W. Taylor, J. van der Plicht, and C. E. Weyhenmeyer. 2004. IntCal04 Terrestrial radiocarbon age calibration, 0-16 cal kyr BP. *Radiocarbon* 46:1029-1058.
- Rolett, B.V. 1993. Marquesan prehistory and the origins of East Polynesian culture. *Journal de la Société des Océanistes* 96:29-47.
- 1996. Colonisation and cultural change in the Marquesas. In J. Davidson, G. Irwin, F. Leach, A. Pawley, and D. Brown, eds, *Oceanic Culture History: Essays in Honour of Roger Green*, pp. 531-40. New Zealand Journal of Archaeology Special Publication. Dunedin, New Zealand.
- 1998. *Hanami: Prehistoric Colonization and Cultural Change in the Marquesas Islands (East Polynesia)*. Yale University Publications in Anthropology No. 84. New Haven: Yale University.
- Rolett, B.V. and E. Conte 1995. Renewed investigation of the Ha'atuatua dune (Nukuhiva, Marquesas Islands): A key site in Polynesian prehistory. *Journal of the Polynesian Society* 104:195-228.
- Salvat, B. 1974. Mollusques des "récifs d'îlots" du récif barrière des îles Gambier. *Cahiers du Pacifique* No. 18, Vol. II, pp. 601-603. Paris: Fondation Singer-Polignac.
- Salvat, B. et Rives, C. 1991. *Coquillages de Polynésie*. Delachaux et Niestlé, Lausanne, 391 p.
- Shen, C.-C., K.-S. Li, K. Sieh, D. Natawidjaja, H. Cheng, X. Wang, and R.L. Edwards 2008. Variation of initial ²³⁰Th/²³²Th and the limits of high precision U-Th dating of shallow water corals. *Geochimica et Cosmochimica Acta* 72:4201-4223.
- Sinoto, Y.H. 1996. Tracing human movement in East Polynesia: A discussion of selected artifact types. In M. Julien, M. Orliac, and C. Orliac, eds, *Mémoire de Pierre, Mémoire d'Homme: Tradition et Archéologie en Océanie*, pp. 131-52. Publications de la Sorbonne, Paris.
- Spriggs, M.J.T. and A. Anderson 1993. Late colonization of East Polynesia. *Antiquity* 67:200-217.
- Steadman, D.W. 1995. Prehistoric extinctions of Pacific island birds: Biodiversity meets zooarchaeology. *Science* 267:1123-1130.
- 2006. *Extinction and Biogeography of Tropical Pacific Birds*. Chicago: University of Chicago Press.
- Steadman, D.W. and L.J. Justice 1998. Prehistoric exploitation of birds on Mangareva, Gambier Islands, French Polynesia. *Man and Culture in Oceania* 14:81-98.
- Steadman, D.W., C. Vargas and F. Cristino 1994. Stratigraphy, chronology, and cultural context of an early faunal assemblage from Easter Island. *Asian Perspectives* 33:79-96.
- Suggs, R.C. 1961a. Polynesia. *Asian Perspectives* 5:88-94.
- 1961b. *The Archaeology of Nuku Hiva, Marquesas Islands, French Polynesia*. Anthropological Papers of the American Museum of Natural History, Vol. 49, Part 1. New York.
- Walter, R. 1996. What is the East Polynesian 'Archaic'? A view from the Cook Islands. In J. Davidson, G. Irwin, F. Leach, A. Pawley and D. Brown, eds, *Oceanic Culture History: Essays in Honour of Roger Green*, pp. 513-29. New Zealand Journal of Archaeology Special Publication. Dunedin, New Zealand.
- Weisler, M.I. 1994. The settlement of marginal Polynesia: New evidence from Henderson Island. *Journal of Field Archaeology* 21:83-102.
- 1995. Henderson Island prehistory: Colonization and extinction on a remote Polynesian island. *Biological Journal of the Linnean Society* 56:377-404.
- 1996. An archaeological survey of Mangareva: Implications for regional settlement models and interaction studies. *Man and Culture in Oceania* 12:61-85.
- Worthy, T.W. and A.J.D. Tennyson 2004. Avifaunal assemblages from Nenega-iti and Onemea. In E. Conte and P.V. Kirch, eds, *Archaeological Investigations in the Mangareva Islands (Gambier Archipelago), French Polynesia*, pp. 122-127. Archaeological Research Facility Contribution No. 62. Berkeley: University of California.