Journal of Pacific Archaeology – Vol. 10 · No. 1 · 2019

– ARTICLE –

New Excavations at Faʻahia (Huahine, Society Islands) and Chronologies of Colonization in Central East Polynesia

Atholl Anderson,[1*] Eric Conte,[2] Ian Smith[3] & Katherine Szabó[4]

ABSTRACT

The six-hectare site of Vaitoʻotia-Faʻahia on Huahine Island in the Leeward Societies is renowned for its wealth of material culture typifying early East Polynesian settlement, including items of wood and fibre preserved by waterlogging, through the research of Yosihiko Sinoto and colleagues in particular. However, the stratigraphy for much of the excavated area is sketchy and no precise chronology of settlement is available. Renewed excavations in the Faʻahia site area in 2007, although relatively limited in scope, produced more stratigraphic detail, additional faunal remains and artefacts, including a patu, and 12 new radiocarbon dates on short lifespan material from the lowest cultural layer which indicate initial human occupation about AD 1050–1160. In the light of this result, recent arguments for earlier initial colonisation of Central East Polynesia are reviewed. Chronological evidence adduced in these relies primarily upon radiocarbon samples with potentially substantial inbuilt age, and it is concluded that there is no empirical case for colonization of the region prior to the early eleventh century AD.

Keywords: Vaitoʻotia-Faʻahia, Central East Polynesia, radiocarbon dating, initial colonization

INTRODUCTION

The timing of initial human colonisation of oceanic islands is a significant consideration in thinking about the motives, means and directions of maritime migration. There is more than timing involved, of course, but where patterns and sequences of initial island occupation are inferred, contending hypotheses about colonising behaviour can be evaluated. In East Polynesian archaeology a choice of approaches to constructing radiocarbon chronologies exists (as discussed by Allen 2014), and there is implicit theoretical contention about how chronological models match contrasting assumptions about colonising mobility (Howe 2006; Anderson 2017). We discuss these matters as they concern central East Polynesia (CEP) in the light of new archaeological evidence from Vaitoʻotia-Faʻahia (ScH-1-2) on the northwest coast of Huahine Island in the Leeward Group of the Society Islands, French Polynesia (Sinoto 1988: Figure 1).

Publication of research bearing on the initial human colonisation of the high islands of CEP has flourished recently, especially for the Marquesas (Allen and McAlister 2010, 2013; Conte and Molle 2014; Allen 2014; Huebert and Allen 2016), southern Cook Islands (Allen *et al.* 2011, Allen and Morrison 2013; Kirch 2017; Niespolo *et al.* 2018) and the south-eastern archipelagos (Kirch *et al.* 2010; Weisler and Green 2011; Anderson and Kennett 2012), but with few exceptions (e.g. Kahn 2012, Kahn and Sinoto 2017) the Society Islands have been relatively neglected. In the Leeward Group, Motu Paeao in Maupiti was re-examined in 1999 (Anderson *et al.* 2000), but the most extensive and diverse of the early leeward sites is at Vaitoʻotia-Faʻahia.

Some areas of it were excavated 1973–1984 (Sinoto 1979, 1983, 1988; Sinoto and Han 1981; Sinoto and McCoy 1975; Emory 1979; Leach *et al.*, 1984) and others in 1983–1985 (Pigeot 1986, 1987). Altogether, these excavations (Figures 1 and 2) amount to about 8% of the site area. Sinoto (1979: 15, 1988: 127) argued that the site had been occupied over several centuries from as early as AD 650 up to about AD 1200. Subsequent radiocarbon dating of Vaitoʻotia-Faʻahia and other early CEP sites indicated they were younger than initially thought, dating to around the end of the first millennium AD (Anderson and Sinoto 2002), but as none of

1 Archaeology and Natural History, ANU, Canberra ACT 2600, Australia
2 Université de la Polynésie française, CIRAP, Tahiti, Polynésie française
3 Archaeology, University of Otago, PO Box 56, Dunedin, 9054, New Zealand
4 Indigenous Studies Centre, Monash University, Vic 3800, Australia
*Corresponding author: atholl.anderson@anu.edu.au
Submitted 12/3/19, accepted 5/5/19

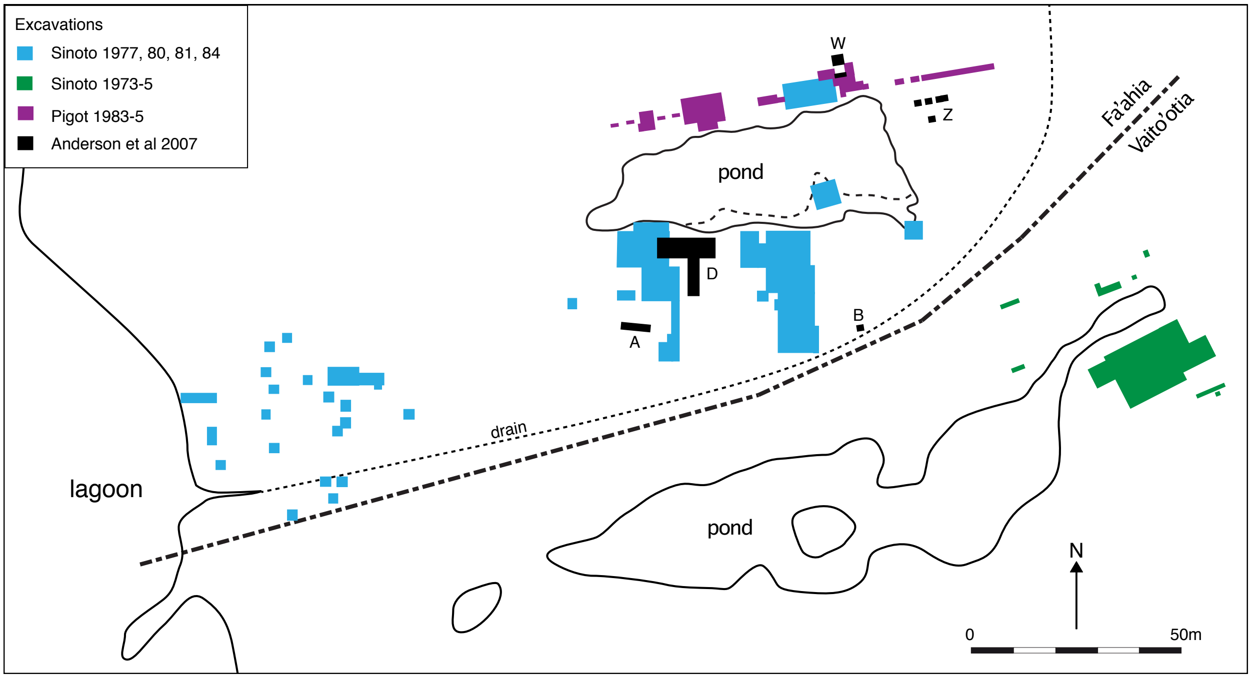

Figure 1. 2007 excavation areas A,D,W,Z (in black), with Pigeot excavations (mauve), and Sinoto excavations at Fa'ahia (blue) and Vaito'otia (green).

the available samples were on short lifespan material (SLM) of vegetative origin or refined terrestrial bone collagen, the ages they returned could not be considered precise.

As colonisation timing, here meaning initial habitation, is likely to vary between islands and across regions in East Polynesia at only centennial or even decadal scales, chronological precision is important, especially for sites having characteristics indicative of initial human occupation. Vaito'otia-Fa'ahia is one of these. It has a prime location immediately inside the main leeward reef pass; remains of at least seven extinct, and another six extirpated, species of land birds (Kirchman and Steadman 2006); evidence of intensive early exploitation of turtle populations (c.f. Rolett 1998: 103, 242); early adze types and about 12 examples of a rare artefact, the patu (Sinoto 1979, 1988).

The site is about 6 ha in extent and divided approximately in half by the land boundary between Vaito'otia and Fa'ahia (Sinoto 1988: Figure 1). We hoped to excavate in both areas but, in the event were restricted to Fa'ahia. Nevertheless, the prospect existed not only of obtaining samples suited to a more precise chronology, but also of investigating the stratigraphic context of wooden artefacts preserved by waterlogging. In addition, we hoped to bring more evidence to bear on the nature of the site as a settlement, and how the early occupation ended. Sinoto (1988) had read his results as indicating a large planned settlement with cooking and midden dumping near the shore, canoe storage, adze manufacturing and houses in the centre, and more structures plus a possible marae behind. He argued that occupation was terminated by a tsunami. Pigeot (1986, 1987) proposed repeated temporary occupations concerned especially with the exploitation of turtles and large pelagic fish, and that the stratigraphy indicated progressive sedimentation in protected waters.

The interpretational differences are resonant of a broader debate about mobile foraging versus sedentary agriculture in the initial occupation dynamics of East Polynesia (e.g. Kirch and Green 2001; Leach and Davidson 2001; Anderson 2003), and they are open to empirical examination. However, that must await the completion of faunal, artefactual and palaeoenvironmental research, still in progress. This paper focuses upon the stratigraphy, associated artefacts, and radiocarbon dating at Fa'ahia, and compares the Fa'ahia case with others of similar age in CEP.

EXCAVATIONS AND STRATIGRAPHY

Our excavations occurred 24 June–12 July 2007 and we opened up 48.4 m^2, of which 35.6 m^2 of cultural deposit were fully excavated. The difference arises mainly because our excavation area D, placed to be adjacent to an earlier excavation by Sinoto in his section 3 (Figure 1), was found to partly overlap his area. Our excavations concentrated on Sinoto's sections 3 and 4, southwest and northeast respectively of the large pond (Figure 2). Our intention was to sample two different sets of archaeological stratigraphy and contents. Section 3 contained the deepest stratigraphy in Vaito'otia-Fa'ahia by virtue of an old watercourse that crossed it, and in which canoe pieces and other wooden artefacts were found. Section 4 was in a more typically

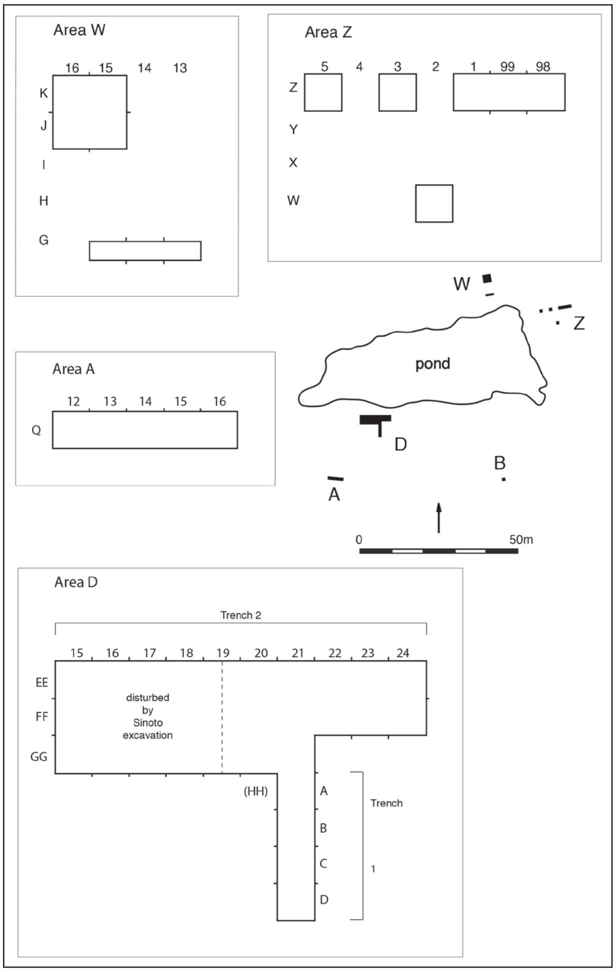

Figure 2. Location and plans of our excavation areas at Fa'ahia, 2007.

shallow part of the site which had produced numbers of shell artefacts and unusually abundant fish and other bones.

Section 3 excavations

Excavation A (Figure 2) was an east-west 5 m trench immediately west of the estimated position of Sinoto's (1988: Figure 1) section 3 excavations, approximately along the X or Y line of his squares (which were 2 × 2 m). This area was waterlogged and incoming flow overwhelmed the pumps at the base of the excavation. Only 2 m² (Q15, Q16) was excavated down to a 0.25 m thick, coral sand containing sparse archaeological material (turtle plastron, *Terebra* shell, basalt cobbles, flecks of charcoal) above hard-packed coral boulders and grit of a former watercourse.

Excavation D began with a 4 m² north-south trench (Trench 1: A–D, Figure 2) running from 6 to 11 m south of the pond and situated east of the Sinoto section 3 excavations. The upper strata included an old coral road (shown in Sinoto 1988: Fig. 1) but consisted otherwise of coral sand and shell grit, largely free of pebbles, cobbles or large pieces of coral, which extended to approximately 1 m deep. Beneath these layers and lenses, there was a 0.15–0.3 m thick layer of pale yellow to white coral sand containing abundant turtle bone, fish bone, coconut shell, charcoal, and some basalt cobbles and unworked wood. This layer was underlain by fine coral sand packed with numerous large coral pieces and boulders.

Once the trench excavation was finished, an area of 26 m² lying east-west was laid out immediately north of it. This was the main excavation, (Trench 2 of area D), in 2007 (Figure 2). Rubble, including the former coral road, was stripped by back-hoe to about 0.6 m depth, with excavation below to the main cultural level, layer 6 (Figure 3). In the western 13 m² we found the remains of Sinoto's excavation of the area containing canoe planks and related artefacts. Spade pits showed that it was fully disturbed down to natural and no further work was undertaken there. In the eastern part of area D the stratigraphy was the same as in Trench 1, although the extent of bioturbation was more readily apparent. Infilled crab holes extended throught the upper layers and one reached the surface of layer 6. The recovered material was the same as in Trench 1 although more abundant, turtle bone especially. Artefacts were few (Table 1), mainly a few pieces of worked pearl shell, but we

Figure 3. Area D looking east to 24EE/FF baulk; showing part of area excavated by Sinoto (foreground), and excavations in progress in layer 6.

Table 1. *Artefacts from 2007 Excavations.*

Area:Square	Layer:spit	Description	NISP
A:Q15	below 70 cm	ovenstone?	1
D:C21	1	basalt fragments	6
D:GG21	5	hammerstone?	1
D:EE21	6:1	ovenstone fragment	1
D:FF19	6:1	bone patu	3
D:GG21	6:1	drilled tooth	1
D:EE22	6:2	basalt adze preform	1
W:G13	2	ovenstone fragments	5
Z	surface	basalt adze?	1
Z	surface	shell adze	1
Z:W2	3	hammerstone?	1

also recovered the greater part of a whalebone patu. Large sediment samples, approximately 1 m^3 in total, were taken from the main excavation to analyse for invertebrate and plant remains. Additionally, In square HH, a 0.8 × 0.5 m column sample was taken from the junction of the main excavation and Trench 1.

Section 4 excavations

Excavation W consisted of 4 m^2 (J15, J16, K15, K16), on the north side of Pigeot's (1986: Figure 2) excavation area, Locus 1, and another 1 m^2 in G13–15. Only the J15 and K16 squares were excavated fully because the others had been largely disturbed by bioturbation. Below a thick organic layer of 0.4 m, disturbed by crab and root holes (layer 1), was a layer of gray sand (layer 2), about 0.2 m thick, containing pieces of coral (Figure 4). This layer, excavated in two spits, contained a lithic fragment along with turtle and other bones. Layer 3 comprised white sand with turtle and other bones in the top 0.2 m but was sterile below about 0.75 m. It was also excavated in two spits.

Excavation Z comprised a discontinuous line of five excavated squares, plus one square offset. This excavation area was located along the Z line of Pigeot's (1986: Figure 2) section 3, immediately south of his Sondages Est and to the east of the pond. The stratigraphy was similar throughout (Figure 4). Below a 0.25–0.4 m thick organic layer 1 there was *ca.* 0.3 m of grey coral sand and rubble (layer 2) overlying a light brown sand and organic material (layer 3) *ca.* 0.1–0.3 m thick. Below this was a white coral sand and rubble (layer 4). Cultural material was scattered through the grey sand but was concentrated in layer 3. It consisted mainly of fish and turtle bone, but there were also pieces of worked shell, a possible hammerstone, some basalt adze flakes and charcoal.

Stratigraphical issues

The W and Z excavations had stratigraphy comparable to the lower levels in area D. The thick organic layer 1 in W/Z is probably equivalent to layer 3 in area D, the underlying grey sand (W/Z layer 2) to area D layer 4, and the white coral sand at the base of the W/Z profiles (W layer 3, Z layer 4) to area D layer 6. Above the basal sand there is a brown organic layer in area Z (layer 4) and area D (layer 5), but no discernible equivalent in area W. The lowest cultural material was found in the top 0.2 m of the white coral sand (Area D layer 6, Area W layer 3) or in the brown sand (Area Z layer 3).

Our area D excavation is close to the place in section 3 where Sinoto (1979) found canoe planks and other wooden artefacts. We cannot pinpoint the spatial relationship exactly, but the easternmost of Sinoto's excavated 4 m^2 squares is his #42 line (Sinoto 1988: Figure 1). We assume that these are represented by the north-south edge of the disturbed ground running through our squares 19EE and 19FF (Figure 5). The location of our Area D relative to the southern edge of the pond and the line of the coral road, indicates that the northern edge of our excavation extends east-west approximately along the line of demarcation between Sinoto's #O and #P squares. As the stratigraphy of the O/P boundary along squares O43 to O45 is published (Sinoto 1979: Figure 4), it is possible to compare this, alongside our stratigraphic section in Figure 5.

Sinoto's (1979:7) Level I, a 'dark, humus-mixed overburden' which was the modern soil layer prior to road construction, is equivalent to the brown-grey, humus-enriched sediments of our layer 3. The immediately underlying lens

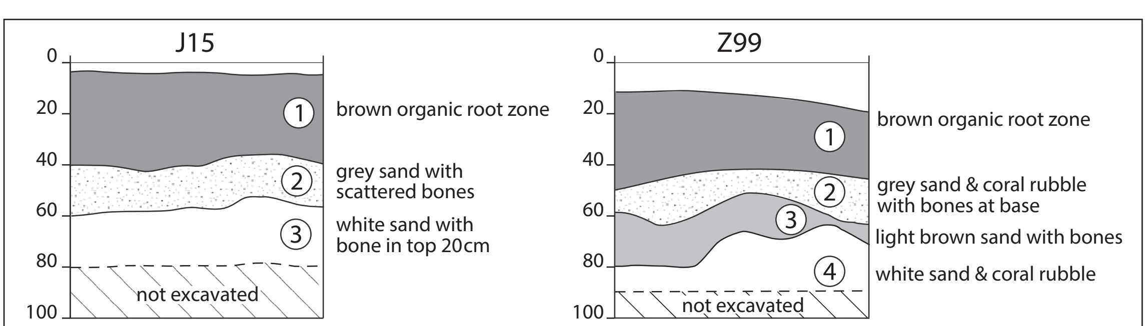

Figure 4. Stratigraphy of areas W (south baulk of J15) and Z (north baulk of Z99).

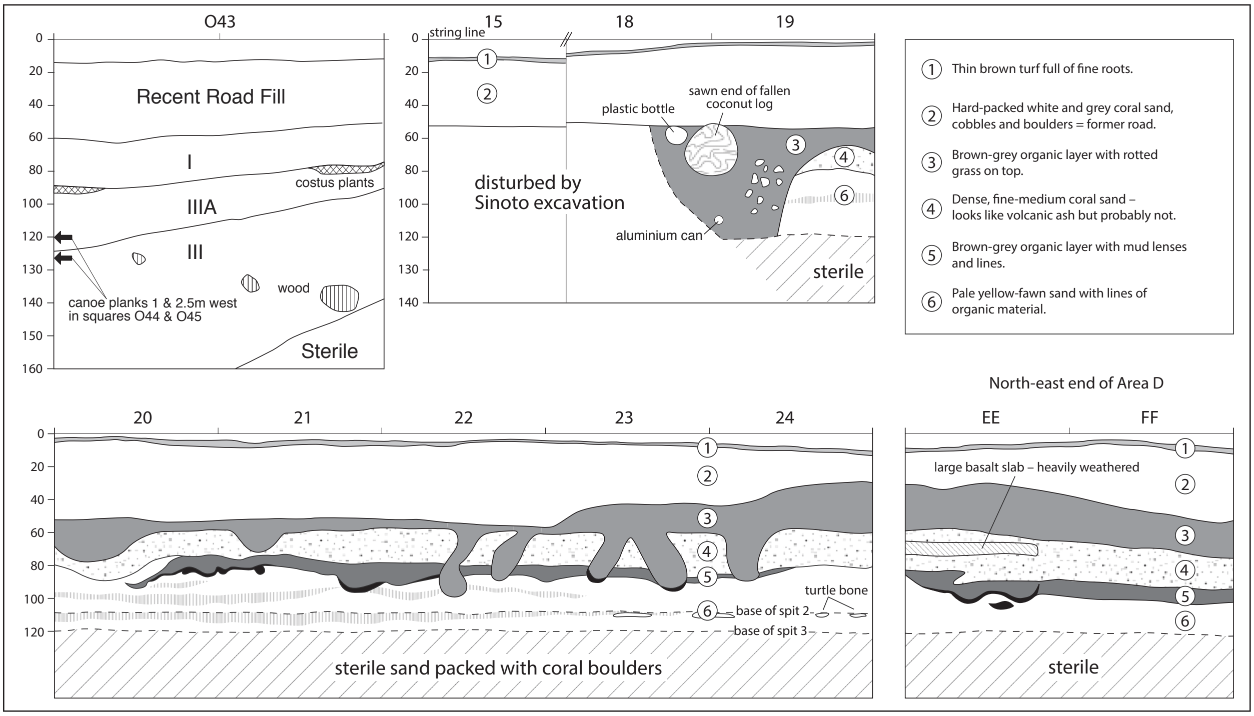

Figure 5. Stratigraphy of area D, north baulk of row EE (bottom and top centre). At top left is the profile from Sinoto's (1979: Figure 4) square O43 which was about where our rows 15 and 16 are. Also shown are the levels at which canoe planks were found further to the west (see text).

IIIA (Sinoto 1979: Figure 4) could be a part of our layer 3 or layer 5, because Level II, a pale coloured sand deposit widely observed in Vaitoʻotia-Faʻahia generally, was noted by Sinoto (1979: 7) as missing in section 3 stratigraphy. However, we think that it exists, in our area D at least, as layer 4, a pale grey coral sand (Figure 5). At the east end of area D the edge of a large basalt slab was apparent, probably indicative of late pre-European stone structures that occurred elsewhere in the site (Sinoto 1979). Level III is 'the cultural layer' in Vaitoʻotia-Faʻahia as a whole. It is brownish-gray, silty and 10–15 cm thick (Sinoto 1979: 7).

However, as Sinoto's section 3 excavations generally follow the course of a 6 m wide former stream bed, there is a 'deep, convexed Level III' that extends to at least 1.1 m below lens IIIA (Sinoto 1979: 7; Sinoto 1988: 116 suggests the deposit was 2 m deep along the stream bed). As a result, Sinoto's site-wide description of level III does not fit the deeper parts of section 3 stratigraphy, and he has published no specific description of those. It is apparent from numerous published images of the Sinoto excavations at Faʻahia, and especially of areas where planks and other canoe remains were discovered (1979: Figure 17; 1988: Figure 2; 2016: 127, 131; Carroll 2005: 55, 60, 63), that only the upper part of this level in section 3 fits Sinoto's general site description. In our area D excavation this is layer 5, a brown, silty sand with mud lenses and lines and numerous pieces of wood, some bearing chop marks, but lacking midden or charcoal. There is an uneven but sharp contact between layer 5 and the pale yellow-grey (drying to white) coral sand of layer 6 below, although some pieces of timber were partly embedded in both layers. In layer 6 there are at least two bands of midden, charcoal and artefacts (Figure 5). Our stratigraphy combined with Sinoto's (1979: Figure 4) suggests that the canoe planks were in a layer equivalent to our layer 5.

The bone patu (Figure 6) from Area D, was recovered from square 19FF at the boundary between layers 4 and 6 (Figure 6). It was assigned to layer 6 spit 1, because Layer 5 as an observable sedimentary unit did not reach that far west in the excavation. In its stratigraphical place were jumbled, waterworn, logs and branches. The patu handle lay directly on the higher part of a log partly embedded in layer 6 and the blade was broken where it projected over an adjacent hollow in the log. Breakage and loss of some of the blade probably occurred during deposition of the logs. If so, the original provenance of the patu is unknown. Of the three earlier patu described from the site (amongst more than 12 that were recovered, according to Sinoto 1988: 119), two were picked from dredge tailings while the third, a wooden example, came from area A at Vaitoʻotia where it was found in layer IV, the upper part of the lower cultural layer (Sinoto's 1979, 1988).

The jumbled logs and the muddy character of layer 5, where it exists, raise a key issue in interpretation of the site. Sinoto (1979: 5, 8, 1988: 116–117, 2016: 123; Sinoto and Han 1981: 5) argued that tidal waves from a tsunami, or pos-

Figure 6. Bone patu during excavation (above) and after cleaning (below).

sibly a catastrophic storm, washed a layer of clean beach sand over the entire site, and in doing so terminated the initial occupation (his lower level III or layer V). In doing so, some of the cultural material from the initial occupation layer, especially wooden artefacts, was incorporated in the overlying, coral sand introduced by marine flooding, thereby producing a redeposited layer IV (the upper part of level III). In Faʻahia especially, the flooding mobilised logs and other timber, as well as numerous wooden artefacts, and spread them about, leaving them stranded as the waters receded, in the lowest areas of the site, particularly in a stream bed.

Whether the events were catastrophic is debatable; there is, for instance, little evidence of large coral lumps and poorly-sorted sediments, indicative of tsunami action, in layer IV at Vaitoʻotia, described as ʻwell-drained limey sands' (Sinoto and McCoy 1975: 149), and neither is tsunami sedimentation characteristic of our layer 5 in Faʻahia. Yet, there can be little doubt that the jumble of timber and cultural material, with many pieces aligned along the course of the stream (Sinoto 1988: 116) constitutes plausible evidence of flooding, although not necessarily by seawater. In area D layer 6, there was also evidence that the cultural material had been subjected to water flow. The turtle bone and other bone, marine shell, and pieces of basalt ovenstone were mostly clean and free of charcoal, fish scales or other material easily washed away. Conversely, most broken coconut shell was resting in a stable position relative to fluid motion, i.e. as a dome with the broad base down, and in at least six cases these shells concealed small clumps of midden, including charcoal and fish scales. We infer sheetwash through the site, more probably from stream overflow than seawater surge, at a velocity insufficient to carry away the heavier or protected midden components.

Two important conclusions follow. First, that the original locations of the cultural material, whether in the site or elsewhere in the vicinity, are unknown and that the associations of material as excavated provide no assurance that such associations existed prior to the flooding. Second, as the recovery of material moved by flooding was largely confined to the upper part of Sinotoʻs level III, our layer 5, the material was deposited at some time after the earliest occupation of the section 3 area, represented by the bands of cultural material in our layer 6. These points have implications for considering whether the artefact types from the lower layers at Faʻahia, or the site as a whole, constitute a cultural assemblage representative of a narrow period of manufacture. A full analysis is beyond the scope of this paper, but it is worth considering an example, the wooden pieces interpreted as parts of a large sailing canoe.

The canoe pieces

Bailers, small dugout hulls and other pieces indicate the manufacture or repair of canoes at the site (Sinoto 1979: 12–13, Figures 15 and 16), but the most important discovery at Faʻahia (Sinoto 1988: 116) was the remains of a ʻlarge ocean-going canoe', estimated at, ʻabout sixty-five feet long' (Sinoto 2016: 123, 139). No hull was discovered, and Sinoto (1988: 117) thought it had been swept out to sea, but a voyaging canoe, nevertheless, was conjured by linking scattered pieces together. One was an unfinished steering paddle with a broken handle, that was possibly around 4 m long originally. It was dredged up in the section 3 pond and has no stratigraphic provenance.

Two probable canoe planks about 7 m long and identical in shape were found a few metres from the western edge of our area D. Details published for one of them (Sinoto 1979: 13, Figure 16b) show it is L-shaped in cross-section with the base part 0.43–0.51 m wide, and a 0.24 m wide flange standing at a right angle along one side. The top edge of the flange is rabbeted, and the outer edge of the base is rounded. There are lashing holes along the unflanged side of the plank and at one end where the plank butt has a lap-join to fit against another plank with the complementary shape. Sinoto (1979: 13) thought initially that these planks formed the edges of a large platform extending between two hulls of a double canoe that would have been 24 m long, although a piece described as a canoe foreboom is interpreted as an outrigger fitting (Sinoto 1979: Figure 16a). Later Sinoto (1983: 14; 1988: 116) considered that the planks had been topstrakes of a double canoe. There has been no apparent consideration of a role for the planks in domestic or religious architecture.

The planks lack some of the common characteristics of hull pieces from large canoes. They have no curvature longitudinally, transversely, or in plan shape and show neither ribs left proud of the inner surface during shaping of the plank, or lashing holes indicative of attachment to fitted ribs. If the planks were strakes on a dugout hull, with the flange projecting inward as a stringer, then they lack any evidence of attachment to a hull or lower strake. The nearest analogue available from historical evidence of nautical architecture can be seen in some 18th century drawings of Tahitian double canoes which appear to show topstrakes with the gunwale expanded horizontally into an external lip (e.g. Dodd 1972: 86–87, 93), although those indicate longitudinal curvature and lack lap-joins. The case could be stronger if details were published of, 'a third wooden piece, nine feet long [that] had been crafted to fit the bow or stern of a canoe' (Carroll 2005: 60). It may be the long triangular piece partly hidden under the western plank in Figure 5 of Sinoto (1979), but that does not show the lashing holes or a lap-join implied by the canoe figure in Sinoto (1983: 12).

The putative 'canoe mast' is more problematic. It was found in zone B, section 5, about 70 m seaward of the area where the planks were recovered (Sinoto 1988: 118, Figure 1). What at the time was thought 'possibly a mast for a canoe' (Sinoto 1988: 118) later became an accomplished fact; 'when we finally dug it up, we discovered it was an enormous mast!' (Sinoto (2016: 123; Carroll 2005: 60). It is a log of *mara* (*Nauclea forsteriana*) wood about 12 m long and, judging by images (e.g. Carroll 2005: 63) it is slightly crooked and does not appear to have been cut at top or bottom. No shaping of it or any other cultural modifications have been reported. Lying beside and parallel to it was a coconut log, 'possibly used as a large house beam' (Sinoto 1988: 118). As long, slender *mara* logs were also used in house construction (Sinoto 2016: 143) there is no reason in the evidence to assign the adjacent logs different functions. Equally likely is that both logs, recovered near the lagoon, were simply driftwood. Sinoto (1988: 118) found them 'in a secondary deposit' with other debris piled up against them.

In short, some construction of canoe parts was evidently occurring at the site, but if the finished planks and unfinished steering paddle suggest canoes of a size capable of inter-island travel, they do not imply the same canoe or that the pieces were in use at the same time. There is no justification for claiming that the *mara* log was a mast. The steering paddle has no stratigraphical context and the planks are very probably not in their original site of deposition. None of the pieces are dated directly or indirectly by radiocarbon assay, but fibres observed in some of the lashing holes on the planks suggest a means, which we are pursuing, to fill that absence.

RADIOCARBON DATING RESULTS FROM FAʻAHIA

Following excavation, samples of SLM, primarily coconut shell (*Cocos nucifera* endocarp) were selected for radiocarbon dating at the Waikato Radiocarbon Laboratory, University of Waikato, New Zealand. They were taken from the lowest cultural strata in each area except area W, where layer 3 yielded no suitable SLM, and samples were taken from layer 2. Submitted samples were washed in hot 10% HCl, rinsed and treated with hot 1% NaOH. The NaOH insoluble fraction was treated with hot 10% HCl, filtered, rinsed and dried. Measurement was by AMS. CRA values were calibrated using SHCal13 (Hogg *et al.* 2013). Earlier dates from Faʻahia-Vaitoʻotia were also recalibrated using SHCal13 for terrestrial samples, and Marine13 (Reimer *et al.* 2013) for marine samples with delta R set to 17 ± 24, the regional value for the Society islands (Petchey *et al.* 2008). Details of the results are in Table 2 and Figure 7. All radiocarbon ages mentioned in the text are cited as AD and at 1σ unless specified otherwise.

Radiocarbon ages on coconut shell produced consistent results, especially for layer 6 in excavation D (Table 2). They show no measurable difference in age between spits 1 to 3 in layer 6 and are treated as repeated sampling of a single stratigraphic event, for which Bayesian analysis is not needed (Buck and Juarez 2017). Instead, the mean ages have been pooled (Ward and Wilson 1978: 19–31). This indicates occupation of layer 6 at 1050–1159 (Table 3). Combining these results with the coconut sample from area Z layer 3 produces almost exactly the same pooled mean age, but the area W result for a coconut sample remains separate. This is consistant with it position higher in the stratigraphic profile and suggestive of a slightly later occupation in the twelfth century (Table 3). The *Pandanus* samples, excluding the modern result, are a century or so younger than nearly all those on coconut shell, although the area Z *Pandanus* and coconut shell dates overlap and yield a pooled mean age of 1187–1261 (Table 3) suggesting some slightly later occupation northeast of the pond in section 4.

These results can be compared to radiocarbon dates obtained in earlier research at Vaitoʻotia-Faʻahia (Figure 7). A coconut shell age from layer V in Vaito'otia (Table 4) combined with our excavations D and Z coconut shell results produces a mean pooled age of 1051–1160 (Table 3). However, calibrated results on pearlshell samples (Table 4 from section 2 at Faʻahia, an area on the south bank of the pond east of section 2, and closer to section 4, gave a pooled mean age of 1154–1258 (Table 3), adding to the inference, above, that some occupation in these areas was slightly later than in layer 6, excavation D. Adding in a pearlshell date from Vaito'otia produces nearly the same result (Table 3).

Our pooled coconut shell results indicate that the stratigraphically lowest human occupation at Vaitoʻotia-Faʻahia is dated to 1050–1160 (1045–1180 at 2σ). There is evidence of occupation about a century later in sections 2 and 4. We have no SLM samples for dating layer 5 directly, the interval in which flooding moved material around the site, nor for any higher levels in our excavations, but a basalt slab in layer 4 at excavation D, and similar observations elsewhere (Sinoto 1979: 6, 15) suggest that the site was occupied on later occasions. The matter of principal interest here is how the age of initial occupation in our evidence compares with others in CEP.

Table 2. *New radiocarbon dates from Faʻahia.*

						Calibrated age range†	
Lab No	**Area: square**	**Layer:spit**	**Material**	**CRA**	**δ¹³C**	**1SD**	**2SD**
Wk-23333	Z: Z99	3	*Pandanus* keys	827 ± 35	−26.2 ± 0.2	1225–1270	1190–1192 1198–1286
Wk-23334	Z: Z99	3	Coconut shell	922 ± 39	−25.7 ± 0.2	1054–1059 1068–1077 1147–1217	1040–1228
Wk-23335	W: J15	2:1	*Pandanus* keys	102.6 ± 0.4 %M	−26.2 ± 0.2	Modern	Modern
Wk-23336	W: J15	2:1	Coconut shell	768 ± 31	−25.9 ± 0.2	1234–1242 1265–1299	1226–1310 1360–1379
Wk-23337	D: GG19	6:1	*Pandanus* keys	871 ± 30	−24.3 ± 0.2	1184–1230 1249–1261	1162–1173 1175–1270
Wk-23338	D: FF20	6:1	Small Coconut	970 ± 30	−24.8 ± 0.2	1045–1092 1107–1122 1128–1157	1031–1179
Wk-23339	D: FF21	6:2	Coconut shell	954 ± 32	−25.7 ± 0.2	1046–1088 1110–1118 1131–1177	1037–1203
Wk-23340	D: FF20	6:2	Coconut shell	960 ± 33	−26.0 ± 0.2	1046–1088 1110–1118 1131–1177	1032–1192 1198–1200
Wk-23341	D: FF23	6:3	Coconut shell	945 ± 34	−25.4 ± 0.2	1048–1084 1138–1194 1196–1200	1042–1211
Wk-23342	D: EE19	6:3	Coconut shell	969 ± 33	−25.8 ± 0.2	1045–1094 1107–1123 1127–1157	1029–1184
Wk-23343	D: EE21	6:3	Coconut shell	938 ± 34	−25.3 ± 0.2	1051–1080 1145–1206	1045–1100 1105–1215
Wk-23344	D: FF24	6:3	Coconut shell	982 ± 32	−26.3 ± 0.2	1044–1097 1106–1124 1126–1149	1027–1163 1168–1176

† calibrated with Calib 7.1.0 using SH13 dataset (Hogg *et al.* 2013)

OCCUPATION CHRONOLOGIES IN CEP

There are various potential approaches to estimating the inception of human occupation in CEP, including palaeoecological research. As that has its own methodological problems and uncertainties (e.g. Anderson 1996), we do not consider it here, except to note that assertion of human occupation on Moʻorea in the 10th century AD is founded upon radiocarbon dates from unidentified bulk sediment because 'an obstacle we could not overcome is the lack of suitable dating material for much of the core (that is a lack of macro-botanical remains) along with uncertainties about the proportion of old carbon in the calcareous mud' (Stevenson *et al.* 2017: 1972). Of early archaeological ages from Moʻorea, sample B-411533 from Te Amaama, dating 1059–1264 is on SLM, coconut shell, but 95% of the 2σ range is 1154–1264 (Kahn and Sinoto 2017: Table 2). *Hibiscus tiliaceus* samples B-278687 dating 1031–1210 from GS-1 (Kahn 2012: 59), and B-335458 from Ana Paia dating 1033–1204 at 2σ could have few or many decades of inbuilt age.

Four sites elsewhere in CEP are thought to exhibit good evidence of older initial occupation, but the cases are not beyond question. Our review centres upon chronological sampling, notably of unidentified or non-SLM samples, a common problem exemplified in earlier work by most Polynesian archaeologists (e.g. Anderson and Kennett 2012). With standards and protocols in radiocarbon dating changing rapidly in the Pacific (Allen 2014, Schmidt 2018) such problems need to be addressed, *inter alia*, by critical analysis that elucidates weaknesses in our earlier methods and interpretations. This process can divide opinion; Conte disagrees here with comments on Hane and Onemea and some points on CEP colonisation.

Henderson Island (Pitcairn group)

There are no SLM dates reported for Henderson Island and all age ranges are 2σ. The oldest, 670–890 (OxA-5454), from site Hen-5, is on a sternal fragment of extinct *Ducula* ground dove. Although associated with ovenstones

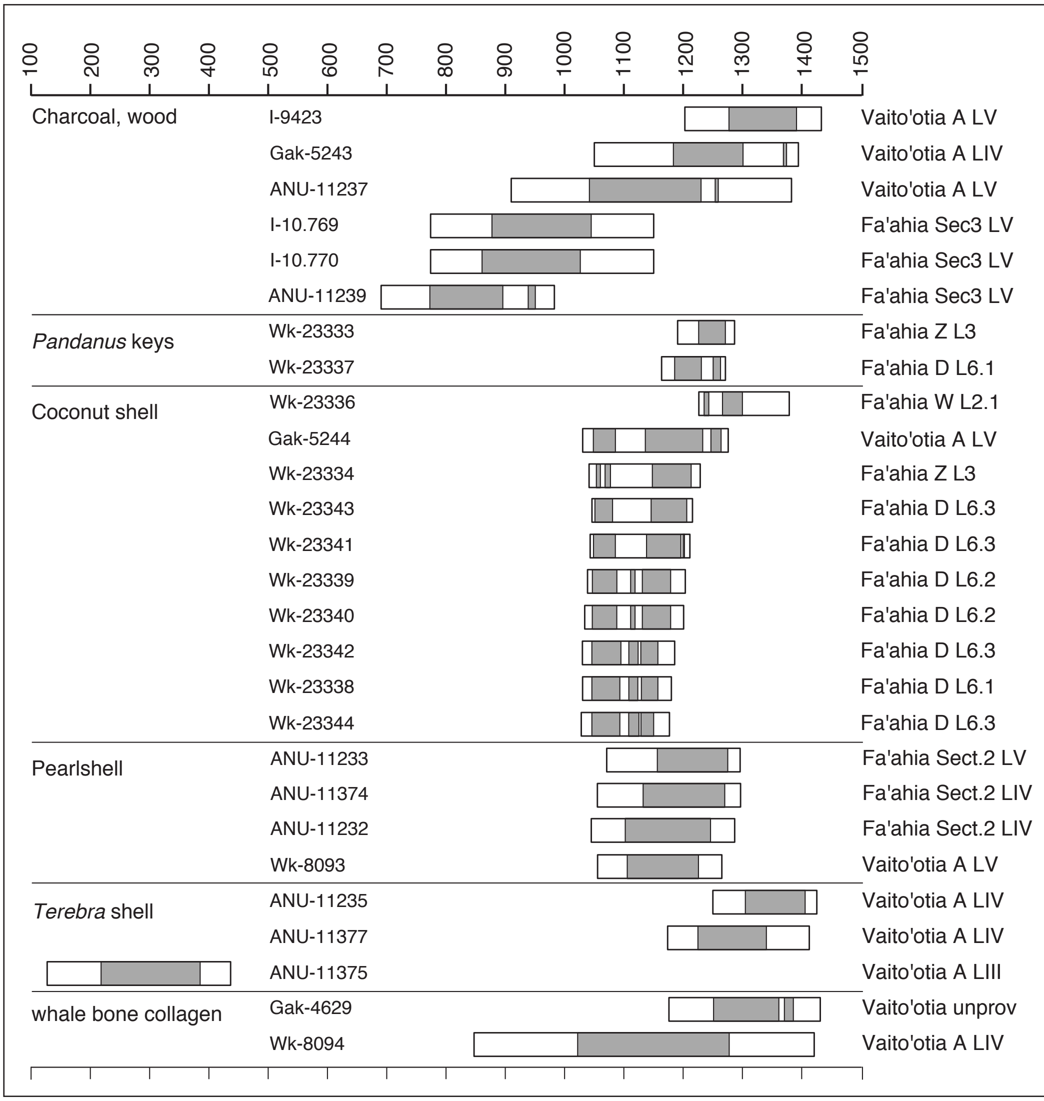

Figure 7. Radiocarbon ages for Vaitoʻotia-Faʻahia, at 2σ with calibration intercepts shaded.

Table 3. *Comparisons of data sets.*

							Calibrated age range†	
Dataset	Description	n	At 95%	T	Xi²	Pooled mean age	1SD	2SD
1	Area DL6 all coconut	7	same	1.31	12.6	960 ± 12	1050–1081 1143–1158	1045–1093 1106–1123 1127–1178
2	set 1 + Area Z coconut	8	same	2.19	14.1	957 ± 12	1050–1080 1144–1159	1046–1090 1107–1123 1129–1180
3	Set 2 + Area W coconut	9	different	34.71	15.5			
4	Set 2 + Vaitoʻotia coconut	9	same	2.19	15.5	956 ± 12	1051–1080 1145–1160	1046–1090 1107–1122 1129–1181
5	Faʻahia Sect.2 pearlshell	3	same	0.13	5.99	1232 ± 35	1154–1258	1079–1280
6	Set 5 + Vaitootia pearlshell	4	same	0.36	7.81	1242 ± 28	1140–1240	1077–1269
7	Area Z coconut/*Pandanus* pair	2	same	3.29	3.84	869 ± 26	1187–1230 1250–1261	1164–1167 1176–1270
8	Area D coconut/*Pandanus* pair	2	different	5.45	3.84			

† calibrated with Calib 7.1.0 using SH13 dataset (Hogg *et al.* 2013)

Table 4. *Earlier radiocarbon dates from Vaito'otia-Fa'ahia.*

Lab No	Site	Area:square	Layer:spit	Material	CRA	δ13C	1SD	2SD
I-9423	Vaitootia	A:E19	V	wooden post	715 ± 89		1276-1391	1202-1432
Gak-5243	Vaitootia	A:D15	IV	charcoal	810 ± 80		1182-1300, 1368-1372	1049-1083, 1140-1393
ANU-11237	Vaitootia	A:J5	V	charcoal	920 ± 110	-19±2.0	1041-1229, 1253-1258	909-913, 970-1314, 1357-1381
I-10.769	Faahia	Sect.3:N43	V	charcoal	1120 ± 80		877-1044	772-825, 827-1073, 1076-1149
I-10.770	Faahia	Sect.3:D19	V	charcoal	1145 ± 80		860-1026	772-825, 827-1073, 1076-1149
ANU-11239	Faahia	Sect.2:J22	V	charred wood	1230 ± 50	-19.5±0.2	772-894, 938-951	690-733, 764-981
Gak-5244	Vaitootia	A:D14	V	coconut shell	910 ± 75		1047-1085, 1136-1232, 1246-1263	1029-1275
ANU-11233	Faahia	Sect2:L23	V	pearlshell	1220 ± 50	-1.0±0.2	1156-1274	1070-1295
ANU_11374	Faahia	Sect2:Q32	IV	pearlshell	1230 ± 60	-2.2±2.0	1131-1269	1054-1296
ANU-11232	Faahia	Sect.2:J22	IV	pearlshell	1250 ± 60	-0.9±0.2	1101-1245	1044-1286
Wk-8093	Vaitootia	A:E21-29	V	pearlshell	1260 ± 40	2.4±0.2	1104-1225	1055-1264
ANU-11235	Vaitootia	A:E25-12	IV	Terebra shell	1040 ± 60	3.8±0.3	1304-1404	1259-1449
ANU-11377	Vaitootia	A:E25-12	IV	Terebra shell	1120 ± 60	3.5±2.0	1224-1339	1171-1411
ANU-11375	Vaitootia	A:E5-2-2	III	Terebra shell	2100 ± 60	0.2±2.0	218-385	127-439
Gak-4629	Vaitootia	unprov		whale rib coll.	1100 ± 70		1250-1360, 1370-1385	1174-1430
Wk-8094	Vaitootia	A:J7-2	IV	whale bone coll.	1260 ± 150	-23±0.2	1021-1297	847-1420

(Weisler and Green 2011: 241), natural deposition cannot be ruled out. The oldest charcoal sample (B-45596), calibrated to 870–1050 by Weisler and Green (2011: 245,[1] was collected across the full depth of the cultural layer and unidentified except for some fragments of coconut shell. Significant inbuilt age was thought 'very unlikely' in B-45596, and by implication in other radiocarbon samples because only 8 of 900 charcoal pieces identified to taxa by Jon Hather, 'could have significant inbuilt age' (Weisler and Green 2011: 241). This is an indirect assurance at best. The 8 pieces were gymnosperm, possibly *Araucaria* sp. driftwood (Weisler (1998: 77), but the Henderson forest is primarily of broadleaf, notably *Pisonia grandis* and *Thespesia populnea* which grow where the main sites are located (Bourne and David 1985: 83). It is odd that no material of such medium to long-lived taxa was identified in the charcoal samples, and it cannot be assumed as absent (cf. Kirch and Conte 2004: 15).

Weisler and Green (2011: 244–245) argued that the earliest ages are indicative of 'scouting behaviour', meaning brief, early visits manifested by isolated features below cultural layers. In the only such case assayed, an isolated hearth in Hen-10 (Weisler 1995: Figure 4) was dated 1280–1430 (B-45601), but this is younger than basal ages for Hen-11, at 1020–1220 (B-45603), or 1045–1214 (B-59005) or Hen-5 (Weisler 1995: Table 2), making 'scouting' later than substantial occupation. Another 27 ages for Henderson Island (Weisler 1995: Table 2) are eleventh century or younger.

Onemea Du ne site (Taravai, Gambier Islands)

There are no unequivocally SLM samples. The base of the main cultural level (Layer II) dates to 980–1150 (B-190118) on 'unknown carbon clumps in sand' and the interface of Layers II and III to 1160–1255 (B-216726 in Kirch *et al.* 2010: Table 1) on twig charcoal, The upper 15–20 cm of layer III contained sparse remains of cultural activity, and unidentified charcoal produced an age of 680–870 for a hearth (B-216279), which was also dated on *Hibiscus tiliaceous*, a species of short to moderate lifespan, to 1010–1160 (B-271082). Charcoal in Layer III, possibly of *Pandanus*, an SLM species, dated 1219–1268 (B-216278) and other Layer III samples were dated to 1160–1255 (B-216275, terrestrial crab pincer) and 1175–1275 (B-216273, marine limpet).

Two older samples from Layer III are argued to indicate 'repeated, low intensity visits over a period of two to three centuries beginning about AD 950' (Kirch *et al.* 2010: 66, 70). One sample consisted of three small terrestrial snails of a species sometimes transported by Polynesians, which dated 880–980 (B-216274), and the other of a procellarid bone dated 970–1080 (B-190114). The sample

1 In conversation with Weisler, Anderson (2003: 75) understood the sample to be located >0.85 m below habitation levels, until Weisler and Green (2011: Figure 12.2, 245–6) produced a stratigraphic drawing and description.

types are problematic. Some landsnails return accurate radiocarbon ages but many produce aberrantly old results through contamination by old carbon (Goodfriend and Hood 1983; Dye 1994; Quarta *et al*. 2007), including from calcareous sand as at Onemea. The bone sample is thought cultural because 88% of the bird bones collected were fractured (Kirch *et al*. 2010: 75). However, most of the Layer III bone is from colonial-nesting procellarids which leave numerous bones, often fractured by sunlight, crabs and other scavengers. Moreover, as procellarid hunting targets squabs, a predominance of juvenile bone could be expected but almost none was recorded at Onemea (Rigal *et al*. 2018). With expected prey choice and damage patterns equivocal at Onemea the cultural status of the sample is uncertain. If these faunal samples are set aside then initial occupation between about 1000 and 1250 is suggested by B-271082 and ages at the interface between Layers II and III.

Hane Dune site (Ua Huka, Marquesas)

A new chronological framework for Hane suggests that 'the discovery of the island and the archipelago as a whole could have taken place around the beginning of the ninth century', as part of an exploratory process prior to colonisation (Conte and Molle 2014: 133). Although some samples were identified to taxa, none were of SLM, and the results for the lowest stratigraphic units, levels H, I and J (Phase I, Conte and Molle 2014: Figure 9), are open to alternative interpretations. A fire pit in level J is the oldest archaeological feature, dated by possible palm wood (B-260937) to 891–1024, and by unidentified broadleaf wood (Wk-29718) to 894–1014. Unidentified broadleaf wood (Wk-27331) dated 1025–1173, and a charred twig (B-260938) dated 1159–1278 are also from level J.

Conte and Molle (2014: 130; Allen 2014: 7) suggest that there were multiple, brief occupations in Phase I, but the radiocarbon ages on them are not in stratigraphic order. The level I results (B-260935 of palm wood, at 895–1150 (88% in 895–1048), and B-260936 of possible palm husk at 974–1155) are bracketed by older and younger results from level J. The radiocarbon age sequence for the early levels might be affected by variable inbuilt age. Many East Polynesian broadleaf trees can reach 100 years, e.g. *Metrosideros* spp., and coconut palms 80 years old, while fallen trunks can have storage ages of several decades.

Tangatatau Shelter (Mangaia, southern Cook Islands)

Tangatatau has an AMS radiocarbon series on plant SLM samples and a ^{230}Th (Thorium) series on abraders of *Acropora* and *Porites* corals (Kirch 2017). Occupation at the site began in sedimentary level (SZ) 2, in the 14th century, but if rat bones and *Morinda citrifolia* charcoal in SZ-1 are in primary deposition, then Bayesian analysis suggests human occupation between 850–1136 (maximum) and 1315–1386 (minimum). Niespolo *et al*. (2019: 3) take these results to show 'that earliest human presence begins between 850 and 1136 CE, placing [the site] among the oldest settlements of Eastern Polynesia' and suggest that SZ-1B represents brief visits to Mangaia prior to established occupation.

On that assumption, a ^{230}Th date of 1011.6 ± 5.8 on abrader #25 is consistent with radiocarbon dates for SZ-1, except that abrader #25 came from SZ-2. Niespolo *et al*. (2019: 29–30), propose that it was re-deposited from a primary location in SZ-1B, although no other artefacts appear to have come from SZ-1B. If there was re-working across the SZ-2/SZ-1B boundary then rat bone and *Morinda* charcoal could have been displaced downward, just as easily, into a natural SZ-1 deposit that preceded the advent of people.

The ^{230}Th date on abrader #25 is >150 years older than on abrader (#9) in SZ-2, which dates much closer to radiocarbon estimates for this level. Abrader #9 is in *Acropora*, which is relatively easy to assess for in-built age, but abrader #25 is in the more difficult *Porites*. Niespolo *et al*. (2019: 30) argue that intact surficial structures on abrader #25 indicate its immediate origin in a coral colony but it could be equally intact had it lain long in undisturbed marine sediments. As the 'discordant' (Niespolo *et al*. 2019: 30) ^{230}Th age of abrader #25, is an outlier in relation to the chronology of SZ-2, and thus not clearly assignable to an hypothesized origin in SZ-1 it cannot reliably 'imply humans were present on Mangaia by 1012 CE' (Niespolo *et al*. 2019: 31). Abrader #9 might suggest that people were present around its ^{230}Th age of 1167 ± 12.

General points

In each of these cases it is argued that fleeting occupations, a century or more earlier, preceded established settlement, with the implication that this was integral to the colonising process; explicitly for Henderson Island and Tangatatau, and implicitly for Onemea and Hane. In a general sense the concept of a period of visitation, or 'scouting behaviour' (Weisler and Green 2011: 228) after discovery and prior to full-scale settlement is a venerable one, going back to traditionalist views about Polynesian seafaring performance (Anderson 2017), that were later formalised as a colonisation model (Graves and Addison 1995). The idea is especially plausible where islands are in fairly close proximity, as in central East Polynesia, but difficult to test stratigraphically (Weisler 1998: 74–75). Isolated structures or other sparse remains below layers of denser occupational evidence present cases *prima facie* (Weisler and Green 2011: 228–229), although the Hen-10 hearth, above, was not supported by radiocarbon ages, and level J at Hane has conflicting age estimates.

More often, a gradational stratigraphy is observed, as at Hen-5 where there was 'one thick, dark cultural layer grading to grey, then into the sterile, white subsoil' (Weisler 1995: 387; the gradation is missing in Weisler and Green 2011: 245–246, Figure 12.2). Such stratigraphies in the upper part of an otherwise sterile unit below a cultural layer, as at Onemea (Kirch 2010 *et al.* 69–70), are common in coastal Polynesian habitation sites. As literal and figurative 'grey areas' they could indicate a visitation-occupation sequence, or merely occasional site use from more established settlement in the vicinity. That changing social circumstances could also be involved (Conte and Molle 2014: 134), is suggested by the inverse case, in southern New Zealand, where there is often intensive initial occupation, followed by intermittent occupation indicative of lower population density and/or higher subsistence mobility (Anderson and Smith 1996). Increasing discard with continuous population growth or variable accumulation of blown sediment are other possibilities. Taphonomic re-working downward of material from a habitation layer is especially likely and could occur by drainage, root holes, tunnelling invertebrates such as crabs, or burrowing vertebrates, notably procellarids in Polynesia (e.g. Anderson *et al.* 2001: 27–28).

Given uncertainties of stratigraphic interpretation, and a scarcity of radiocarbon dating on SLM samples, the proposition of pre-11th century occupation of CEP islands remains tenuous on current data. In fact, even if samples on unidentified charcoal are included in analysis, the age of initial colonisation might not change much. A recent test, using Bayesian Outlier models for East Polynesian radiocarbon datasets that included SLM samples and charcoal samples of indeterminate age (Schmidt *et al.* 2018: Table 3) found that SLM samples alone, and the two groups combined, give very similar estimates of colonisation timing, The combined (posterior) results were: (AD) 997–1079 (Societies), 1099–1208 (Gambiers), 1231–1290 (southern Cooks), 1224–1265 (Marquesas), and (1391–1517), Australs.

CONCLUSIONS

Our excavations, although comparatively limited, encountered a relatively thin, and essentially single-phase, cultural layer at Fa'ahia, and there appear to be areas with even less cultural stratigraphy at the eastern and western ends of the section 3 pond. Turtle bone was common, but shell midden almost absent, and fishbone mainly of small taxa. Possible pig and dog bone was recovered, bird bone was scarce, and chicken and rat bone seemed absent, but these impressions might be overturned by detailed analyses. Coconut shell and *Pandanus* keys are abundant in the site but no coconut husk or other plant remains were noted during excavation. The preservation conditions seemed more suited to conserving timber. Artefactual remains were relatively scarce and no additional canoe parts or any other wooden artefacts were recovered. Basalt tools and flakes were scarce, and likewise pearl shell tools or worked pieces. The sense of material culture abundance conveyed by earlier research might be formed partly by the extent of area excavated (288 m² alone in Fa'ahia by Sinoto: 1988: 115). If the rich deposit of material encountered in the former stream bed by Sinoto is disregarded, then Fa'ahia does not appear to be a locality of intensive or long-term settlement. Our impression is similar to that of Pigeot (1986: 57, 1987: 41–43), that repeated, possibly seasonal, habitation in temporary houses was the norm.

Our particular focus was upon the early chronology of Fa'ahia. The radiocarbon samples refer to the earliest cultural stratigraphy in areas D, W and Z, and they show that site occupation began no earlier than the 11th century. Bands of cultural debris in Area D layer 6 have some structure which probably represents successive habitation, but radiocarbon dating by 10 cm spits with SLM samples shows that this is indistinguishable in age. Serial site use is suggested, but not over an extended period. Above layer 6 there is abundant evidence of bioturbation (Figure 5), some reaching the top of layer 6. Although no holes filled with material from above were observed in layer 6, there is some uncertainty about the integrity of the upper part of the layer. As bioturbation was similarly extensive in excavations in areas W and Z, this is an issue that needs more attention in interpreting the faunal and material culture remains from Fa'ahia.

The main outstanding issue in the Fa'ahia chronology remains the origin and age of the silty sediments, logs and associated artefacts, that are designated layer 5 in area D. Deposition in the section 3 stream bed suggests flooding but not necessarily a major event. If the two canoe strakes and bow piece can be shown to fit together, then their recovery in the same place might indicate that they were in, or close to, the place they lay prior to floodwash. The material in layer 5, and its correlates in earlier excavations, does not seem to represent tsunami or similarly devastating events. That aside, it is imperative that this material is dated on SLM samples to see whether it is of the same age as material in area D, layer 6, or represents a later cultural complex.

Arguments for the wider colonisation of CEP before the 11th century are based mainly on approaches to chronology that fall within Allen's (2014), Synthetic category, and the common proposition arising from them of extended visitation occurring between initial discovery and eventual settlement of a locality or island, while hypothetically plausible, is questionable. Many of the radiocarbon ages held to support it are either contradicted by later ages from the same stratigraphical contexts, or upon samples in which significant inbuilt age cannot be ruled out. Obtaining precise radiocarbon ages on SLM samples is essential to building intra-site chronologies and, eventually, to developing the extensive and reliable radiocarbon databases in which regional variation in colonising mobility might be modelled without continually debilitating uncertainty about the quality of the evidence.

Acknowledgements

The project was conducted under the auspices of CIRAP, supported by Madame Louise Peltzer (Minister of Culture and Higher Learning of French Polynesia 2007). Dr Yosihiko Sinoto was involved in planning but was unable to join in fieldwork or analysis. We acknowledge the Service de la Culture et du Patrimoine, Papeete, for its assistance, particularly Dr Tamara Maric, and the ARC (DP0664546) and UPF for financial support. We thank our fieldworkers: Rosanne Anderson and Sophie Collins (ANU), Angela Middleton (Otago University), Rachael Egerton (Department of Conservation, New Zealand), Yolanda Vogel (New Zealand Historic Places Trust), Helene Martinsson-Wallin (University of Gotland), Hinanui Cauchois (University of Hawaii), Tamara Maric (SCDP), Emilie Dotte (ANU/Paris 1), Jeong-In Choi and Guillaume Molle (Paris 1), and Tamatea Mataoa, Jules Shan, Stephen Maraetaata, Leila Tekehu, and Heipoe Tunutu (UPF). Matiu Prebble and Nick Porch (ANU) and Janet Wilmshurst (Landcare Research, New Zealand) conducted palaeoenvironmental research. Fiona Petchey (Waikato Radiocarbon Laboratory) assayed the radiocarbon samples.

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