Dating the colonization of Rapa Nui (Easter Island)

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Introduction

Archaeologists have long accepted an early colonization date for Rapa Nui (Figure 1) that dates to ca. 400 or 800 AD. This "**Long Chronology**" holds that populations arrived about 1000 years before European contact (in 1722 AD) and slowly grew in numbers until the infamous "collapse" occurred in 1600AD or so (Bahn and Flenley 2003; Diamond 2004). Recently, a new suite of radiocarbon dates from excavations at Anakena have established a chronology beginning around 1200 AD (Hunt and Lipo 2006). Analysis of earlier radiocarbon determinations shows little reliable evidence for a longer chronology. Here, we present six lines of evidence in support of a "**Short Chronology**" (ca. 1200 AD) for the first human colonization of Rapa Nui and the potential impacts to our understanding of the famous prehistory of this island (Table 1).

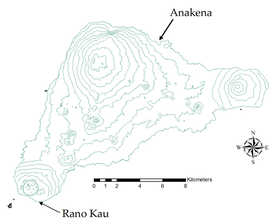

Figure 1. Rapa Nui (Easter Island) with Locations mentioned in the text. Contour intervals are 50 meters.

Table 1: Six lines of evidence for a ***short chronology*** on Rapa Nui

	Lines of Evidence	Description	*Results*
●	*Anakena Excavations*	New excavations at Anakena, a prime location for earliest location of occupation on the island	Stratigraphic layers with earliest date at ca. 1200 AD.
●	*Dates from Excavated Contexts and Rat-gnawed Palm Nuts from Rapa Nui*	Analysis of existing radiocarbon dates using standard "chronometric hygiene" protocol.	Earliest dates on island *no earlier than* 1200 AD.
●	*Lake-Core Dates*	Evaluation of lake-core radiocarbon dates used by Flenley (1993) to argue for earliest occupation.	Substantial mixing of material showing *no reliability in association of dates.*
●	*Dates of Deforestation*	Evaluation of radiocarbon dates related to the loss of the prehistoric palm forest.	Significant forest loss begins *after* 1200 AD.
●	*Obsidian Hydration Dates*	Analysis of obsidian hydration dates for Rapa Nui.	Obsidian hydration dates point to initial occupation beginning *after* 1200 AD.
●	*Colonization of East Polynesia*	Comparison of the timing of colonization of islands across East Polynesia.	Timings of colonization of islands in southern latitudes are consistent with 1200 AD .

Anakena Excavations

Renewed excavations of the stratified dune deposits at Anakena Beach have yielded significant evidence for the chronology of the island's colonization (Figure 2). At Anakena, cultural deposits extend down to a natural clay substrate with a palaeosol containing abundant cultural materials (e.g., obsidian artifacts, introduced rat bones, charcoal) embedded in its upper-most 5-10 cm (Figure 3) and riddled with the root molds of the extinct palm.

Multiple radiocarbon dates from Anakena show **a *consistently ordered chronology beginning around 1200 AD*** (Table 2).

Figure 2 (above). Anakena Beach (Image courtesy of Google.com)

Figure 3 (left). Stratigraphic profile from 2005 UH/CSULB excavations at Anakena Beach.

Table 2 Radiocarbon dates from recent excavations at the Anakena Dune site.

Sample Beta-	Material/Layer	Radiocarbon age (yr B.P.)	$^{13}C/^{12}C$	Conventional C^{14} age (yr B.P.)	2σ calibration (cal A.D.) (*19, 20*)	Probability
196711	Charcoal/Unit 1 Layer 8	660 ± 40	−24.9	660 ± 40	1294–1403	1.00
196712	Charcoal/Unit 1 Layer 5	690 ± 60	−25.6	680 ± 60	1274–1414	1.00
196713	Charcoal/Unit 1 Layer 8	670 ± 40	−24.8	670 ± 60	1291–1400	1.00
196714	Charcoal/Unit 1 Layer 9	600 ± 60	−26.0	590 ± 60	1300–1368 1373–1450	0.369341 0.630659
196715	Charcoal/Unit 1 Layer 11	670 ± 40	−22.5	710 ± 40	1279–1391	1.00
196716	Charcoal/Unit 1 Layer 12	720 ± 60	−24.7	720 ± 60	1229–1251 1260–1400	0.046194 0.953806
209903	Charcoal/Unit 5 Base	870 ± 80	−23.8	870 ± 80	1029–1300 1368–1372	0.996544 0.003456
209904	Charcoal/Unit 5 Base	870 ± 40	−23.8	870 ± 40	1055–1058 1151–1278	0.003916 0.996084

Dates from Excavated Contexts and Rat-gnawed Palm Nuts from Rapa Nui

Following standard protocols (Table 3), we evaluated all published radiocarbon dates reported as older than 750 BP (uncalibrated) for Rapa Nui. We are left with a sample of 11 radiocarbon dates of 750 BP or older; two from our excavations, six from earlier work at Anakena, and three from "agricultural features" (Figure 4). The calibrated probability distributions of these radiocarbon ranges center around cal AD 1200. Dates from rat-gnawed palm nuts (Figure 6) also point to 1200 AD as the approximate earliest occupation by humans (and rats).

The cumulative probability for the target event of the first human colonization (Figure 5) shows that a 0.50 confidence in the initial occupation date is not reached until cal AD 1222 for the date of initial occupation of Rapa Nui.

Table 3: Simplified Rejection Criteria for Radiocarbon Dates

1) Dates measured from animal bone that can be affected by incorporation of old carbon from the marine reservoir effect;
2) Samples of mixed isotopic fractionation (e.g., mixed charcoal and soil); and
3) Single radiocarbon dates not replicated by another with overlap at two standard deviations from the same archaeological context.

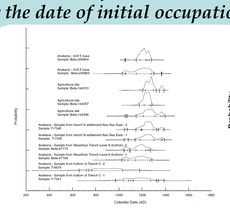

Figure 4. All acceptable pre-750 BP calibrated radiocarbon dates.

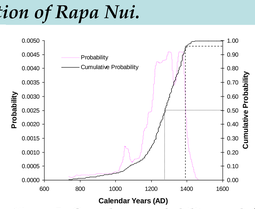

Figure 5. Cumulative probability graph for all pre-750 radiocarbon dates. 50% confidence is ca. 1200 AD.

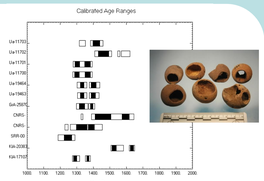

Figure 6. (A) Calibrated radiocarbon dates for rat-gnawed palm nuts. (B) Rat-gnawed palm nuts.

Lake-Core Dates

John Flenley (1993) and others have pointed to early dates (e.g., ca. 1000 AD) from lake-core samples associated with complete deforestation as evidence for settlement centuries earlier. However, the sequence of dates from Rano Kau bulk sediment, plant fragments, and pollen samples varied wildly (Figure 7).

Age determinations on lake-core sediment samples from Rapa Nui ***are probably too simplistic, unreliable and erroneous*** (Butler et al. 2004).

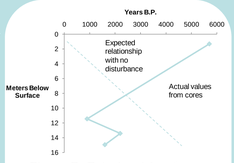

Figure 7. Relationship of radiocarbon dates and depth in Rano Kau lake-core samples. The relationship varies wildly.

Dates of Deforestation

Three independent research teams working on every part of the island, and publishing more than 54 radiocarbon dates, including some (n=12) directly on palm endocarps establish a chronology for initial deforestation that consistently begins after 1250-1300 AD (Figures 8-10).

No signs of human-induced ecological changes pre-date 1200 AD, offering independent evidence for the island's colonization.

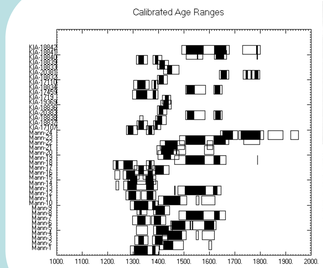

Figure 8. Calibrated radiocarbon dates for palm trees.

Figure 9 (top). *Jubea chilensis* palm, a related species of palm Figure 10 (bottom). Root mold casts of extinct palm.

Obsidian Hydration Dates

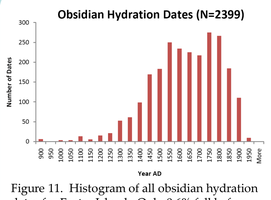

Figure 11. Histogram of all obsidian hydration dates for Easter Island. Only 0.6% fall before 1100AD consistent with measurement error.

Stevenson (1984) and others (Wozniak 2003) have reported more than 2400 obsidian hydration dates for Rapa Nui (Figure 11). Out of the available set of 2399 dates only 16 (0.6%) fall before 1100 AD, likely representing measurement outliers (i.e., we should expect to get such values on the "tails" of the overall distribution, where the same is probably true for the recent dates as well [e.g., dates of ca. 1950 AD]).

The obsidian hydration values are ***consistent with the short chronology established by radiocarbon dates***.

Colonization of East Polynesia

As on Rapa Nui, careful scrutiny of existing radiocarbon chronologies, new field research, and additional "re-dating" of the earliest deposits in Polynesia have consistently shown ages for island colonization to be hundreds of years later than originally reported. The erroneous chronologies in places like the Hawaiian Islands, Marquesas, Cook Islands, and New Zealand resulted from accepting problematic radiocarbon results from archaeological and palaeo-ecological contexts. Figure 12 shows the colonization dates now emerging from additional research and re-evaluations from the region.

A 1200 AD chronology for Rapa Nui fits well wi the evidence for East Polynesia in general. The earlier chronologies for Rapa Nui would envisio Polynesian colonists by-passing several island groups in an apparent rush to reach the Pacific's most remote eastern landfall.

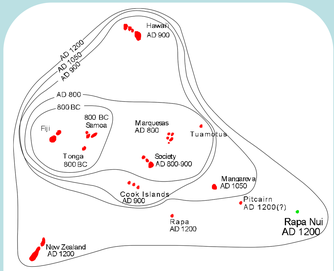

Figure 12. The new understanding of timing of colonization of islands across East Polynesia. Islands in the lower latitudes are colonized in geographic sequence after islands in higher latitudes and at roughly the same time.

* Note that the Tuamotus are not inhabited until after 1200 AD though they are located closer to the Society islands due to their late emergence caused by falling sea levels.

Findings and Implications

Multiple lines of evidence support the "Short Chronology" (ca. 1200 AD) for the initial colonization of Rapa Nui from southeastern Polynesia.

Arguments for a longer chronology must rely on accepting isolated and problematic radiocarbon dates bolstered by claims of "missing evidence" in the archaeological record from a long, cryptic human presence on this tiny island (Table 4). Long chronologists must also assume other archipelagos were skipped in colonizing the eastern Pacific; that humans and introduced rats had no visible environmental impacts for 400 to 800 years; that human population growth was remarkably slow for centuries; and that subsistence included a 400 to 800 year cryptic, even "pre-agricultural" phase despite the fact that cultigens were carried by Polynesian colonists. The assumptions necessary for a long chronology, upon critical reflection, remain untenable in ecological, demographic, and evolutionary dimensions.

Getting Rapa Nui's chronology right has significant implications for understanding the island's remarkable cultural and environmental history. ***We must now reevaluate the standard "story" about the prehistory of this famous island.***

Table 4. Assumptions and implications of the "Long" and "Short" chronology for Rapa Nui

Assumptions	"Long Chronology" (400-800 AD)	"Short Chronology" (ca. 1200 AD)	References
Colonization	Skip other archipelagos en route to Rapa Nui	Near-simultaneous with SE Pacific	Anderson et al. 2006; Kennett et al. 2006
Archaeological Visibility	Cryptic, "missing sites/deposits"	Visible, deposits present	Hunt and Lipo 2006, in press
Direct Ecological Impacts	800-400 years after colonization	ca. 50-100 years after colonization	Hunt 2007; Mieth & Bork 2004
Indirect Ecological Impacts (rats)	800-400 years after colonization	Immediate; visibility is a function of the resolution of record	Athens et al. 2002; Hunt 2007; Towns et al. 2006; Wilmshurst and Higham 2004
Human Population Growth Rate	Slow (~ 1%)	Fast (~ 3%)	Birdsell 1957
Subsistence	Cryptic, "pre-agricultural"	Visible, opportunistic foraging, agriculture	Anderson 1995; Hunt and Lipo, in press

Acknowledgements

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References Cited

For references cited and for more information, please see: http://www.csulb.edu/~clipo/papers/HuntAndLipo-2007-DatingTheColonizationOfRapaNui-References.pdf