Quantitative Analysis of Shell Material Collected from the South Point Dune Site during the 1953–1958 Excavations

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Abstract

Pu'u Ali'i, also known as the South Point Sand Dune Site (H1), is one of the most important archaeological sites in the Hawaiian Islands. It was excavated by Kenneth Emory and Yosihiko Sinoto of the Bishop Museum, and William Bonk of the University of Hawai'i, Hilo between 1953 and 1958. The fishhooks which were recovered from the site led to the first material-based chronology for the Hawaiian Islands. Along with the fishhooks and other artifacts, a bulk sample from one of the excavation units was also collected. The focus of this current study was to analyze the shell material from this bulk sample to look for changes over time that may reflect a change in mollusk preference in the diet. A total of 2988.16 grams of shell material from three arbitrary six-inch levels was evaluated, representing an estimated habitation time frame of 350 years. Marine shells from 17 families were found to be represented in the material, along with miscellaneous fragments that could not be identified. The results of the analysis show several trends in the quantity of shells present in the different levels of the excavation, but give no indication of an overt shift in diet over time at Pu'u Ali'i.

Pu'u Ali'i, also known as the South Point Sand Dune Site or the H1 Site, is an important archaeological area near the southernmost point of Hawai'i Island (also known as the Big Island). Excavations conducted there in the 1950s by a team of archaeologists from the Bishop Museum and the University of Hawai'i, Hilo yielded the first material-based chronology for the Hawaiian Islands (Emory *et al.* 1968; Mulrooney *et al.* 2014:17), and radiocarbon dates from the Pu'u Ali'i site and other neighboring sites provided the first timeline of habitation (Esh 2015:18). During the excavations, over 14,000 artifacts were recovered from the site, the vast majority being either fishhooks or the tools used for making them (Kirch 1985:81). Numerous ecofacts were collected as well, including fish bones and marine shells, both of which were important components of the diet of ancient Hawaiian people.

The purpose of this collections-based research project is to determine the relative abundance, as measured by weight of the shell material, of the different shell families collected from each of the levels during the excavation of Pu'u Ali'i, and then to compare the family abundance over time to look for evidence of change. This will allow hypotheses to be generated regarding a shift in diet of the site's inhabitants or to infer some other reason for a change in preference of the species collected.

Background

Between 1953 and 1958, Kenneth Emory, Yosihiko Sinoto, and William Bonk conducted archaeological excavations at several sites in the Ka'u District on Hawai'i Island, near South Point. Through the excavations, these archaeologists were attempting to identify initial settlement sites and investigate cultural changes through time in the Hawaiian Islands (Esh 2015:18). Pu'u Ali'i is one of the sites that the venerable trio excavated. Radiocarbon dates obtained during the early excavations suggested that the site was occupied between approximately

A.D. 1000 and 1350 (Emory and Sinoto 1969:15). Reinterpretation of the radiocarbon dates by Tom Dye (1992:94), however, suggested that the site wasn't occupied until the early 15th century. This date, however, is also subject to dispute because of the quality of the original sample material: these samples consisted of either unidentified wood or marine shell and the radiocarbon age error ranges were greater than 10% (Rieth *et al.* 2011). As noted by Patrick Kirch, one of the foremost authorities on Pacific Island archaeology, "the radiocarbon dating of the Pu'u Ali'i dune site has posed more problems than probably any other site in Polynesia" (1985:82).

The assumption from the initial excavations was that Pu'u Ali'i was an "important fisherman's establishment" (Emory and Sinoto 1969:3). This was because of the number of artifacts related to fishing which were found, including 1,710 fishhooks and 11,714 abraders made from coral or sea urchin spine, which were used for making the hooks. While examining these fishhooks, Sinoto recognized style differences in the manufacture of the heads and bases of the hooks: some were notched, while others had knobs. In analyzing these differences, he established the first cultural timeline for the Hawaiian Islands, similar to the way ceramics of different styles were used in the American Southwest and other places to establish cultural chronologies in those areas.

For unknown reasons, Pu'u Ali'i was eventually abandoned as a fishing outpost. Sometime after the abandonment, a sand dune formed over the site, and it was eventually repurposed as a burial ground. The bones from at least 97 individuals were interred there (Underwood 1969:1). The burials were all located above the cultural deposits or were obviously intrusive to them, showing that the site was only used as a burial ground after its abandonment as a fishing outpost. Additionally, no artifacts of European origin were found in any of the layers underlying the site, signifying that use of the site for either purpose occurred before European contact (Emory and Sinoto 1969:3). These remains were some of the first ever to have been discovered and examined in the Hawaiian Islands and they allowed insight into the burial practices of the ancient Hawaiians prior to the arrival of the Europeans.

In addition to the artifacts and skeletal remains, Bonk, Emory, and Sinoto also collected numerous ecofacts, such as marine shells, which had likely been originally collected as a food source, but could also have been used for cultural artifact production (fishhooks, lures, jewelry, adzes, etc.). Unfortunately, there are few details on the collection or analysis of these ecofacts. Much of the early work of Emory, Sinoto, and Bonk that had been conducted near South Point, including the South Point Dune Site, was never fully written up due to a falling out between excavation team members (Kirch 1985:81). Archival research of the field notebooks and collections from the Bishop Museum and University of Hawai'i, Hilo will need to be conducted in order to fill in the gaps in knowledge.

Ho'omaka Hou

This current research project was conducted under the Ho'omaka Hou Research Initiative, established by the Anthropology Department of the Bishop Museum in 2013. Ho'omaka Hou means 'to begin again' and the program encourages continued work with the important archaeological collections already housed at the museum. The initial focus of the program is the material from sites that were excavated by Emory, Sinoto, and Bonk near South Point of Hawai'i Island in the 1950s. Previous researchers have felt that this area may have been the location of the initial settlement of the Hawaiian Islands. In an attempt to refine the chronology of the area, wood charcoal samples from one of the sites were recently submitted for radiocarbon dating using modern standards (Mulrooney 2014:5), and the resulting dates gave a significantly revised timeline for habitation of the site. The hope is that this work will contribute positively to recent efforts to re-examine other archaeological material from these key sites.

Methodology

The shell assemblage under study was collected as a quantitative, or bulk, sample from unit I12, a 3 foot by 3 foot square (Figure 1) during the initial excavation of Pu'u Ali'i. This excavation was conducted utilizing arbitrary 6 inch levels, and the material from three of these levels was available for this investigation: 0-6 inches, 6-12 inches, and 12-18 inches.

The shell material from each arbitrary level of the excavation was collected in paper bags initially, and then curated in 12-18 inch plastic bags which had each been labeled with the excavation level and the sort number. There were seven of these large bags in all, three from the lowest level and two each from

Figure 1. Excavation grid of Sand Dune Site H1, South Point (Ka Lae) Ka'u, Hawai'i from Emory and Sinoto (1969:11, Figure 5).

the other levels. The sort number assigned likely represented the order in which the bags were sorted, and the deepest level was sorted first. Thus, the bags from the 12-18-inch level had been designated sort 1, 2, and 4 (number 3 was not present). Sort numbers 5 and 6 represented the intermediate level (6-12 in), while 7 and 8 represented the top level (0-6 in). Within these bags from the different excavation levels, much of the shell material had been separated by taxa, placed in smaller plastic bags, and assigned a unique identification number by previous researchers. These uniquely numbered bags contained mostly fragmented shell material, but often had even smaller bags inside (up to 5 or 6). These smaller bags contained either non-fragmented specimens, misidentified material, or material with some other attribute that the previous investigators thought important, but they were not given unique identification numbers by the original researchers. To enable efficient analysis of the material, a unique number was therefore assigned to these unmarked smaller bags, based on the original number assigned to the parent bag. This newly assigned identification number was written on a small piece of paper, which was placed in the respective bag. Figure 2 is a photograph of the bag containing sort number 6 from the 6-12 inch excavation level, along with the smaller bags which were contained within it.

After all the bags were appropriately labeled, the contents of each of them were weighed using either an Ohaus Portable Advanced Scale (Model CT-600) with a range of 0.1-600 g for heavier material, or a Smart Weight Digital Jewelry Scale (Model GEM20) with a range of 0.001-20 g for lighter material. The results were recorded in an Excel spreadsheet. If a shell or shell fragment was not identified or was thought to be misidentified, an attempt was made

Figure 2. Example of the plastic bag system used by the original researchers in separating shells.

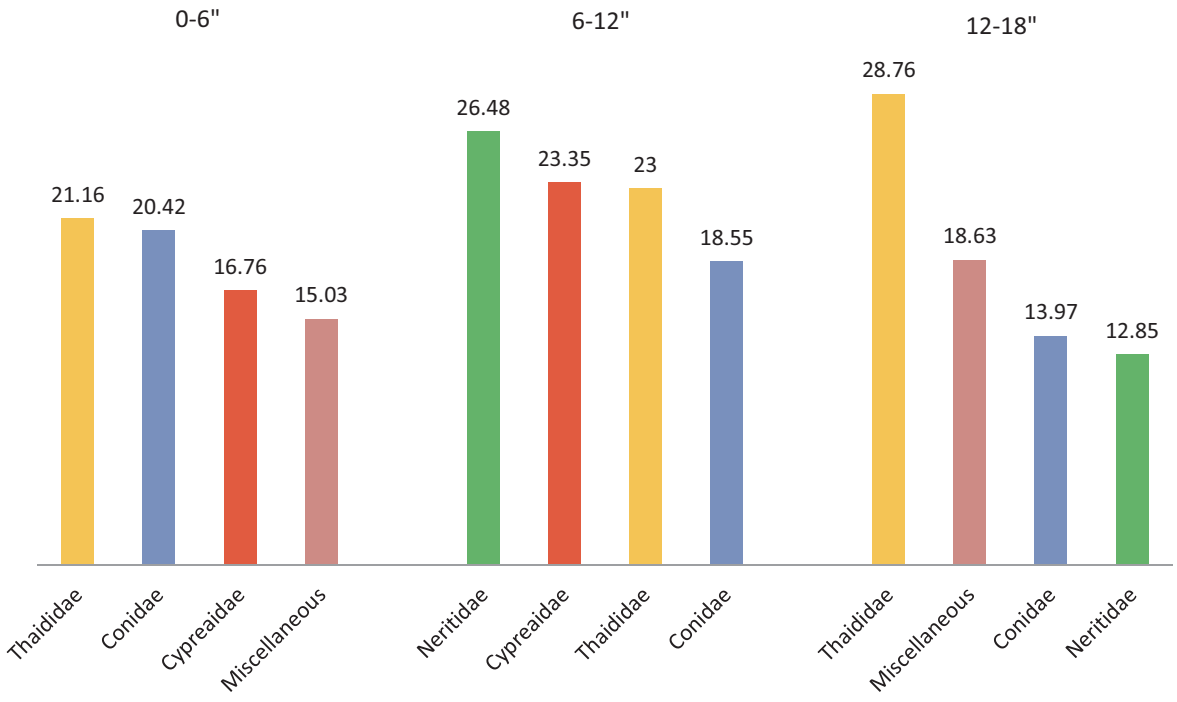

Figure 3. Top four shell families by weight in each of the excavation levels.

to verify its identity utilizing either Allison Kay's *Hawaiian Marine Shells* (1979), Mike Severns' *Hawaiian Seashells* (2000), or the on-line *Hawaiian Marine Shell Reference Collection* maintained by the Anthropology Department at the University of Hawai'i, Mānoa (2015).

Once the weights were obtained and recorded for the material in all of the bags, the data were grouped by taxonomic family, percentages were calculated, and the percentages of the different taxa were compared between the excavation levels.

Results

Table 1 contains the weights and percentages of the shell material analyzed during this project. Overall, the weight of the shells totaled 2988.16 g. The shell material from the 0-6 inch level had the highest combined weight of the three levels at 1770.99 g, followed by the material from the 6-12 inch level at 919.20 g, and lastly, the 12-18 inch level at 297.97 g. As seen in Figure 3, in the 0-6 inch level the top four shell families by percentage of total weight were Thaididae (21.16%), Conidae (20.42%), Cypraeidae (16.76%), and miscellaneous material (15.03%). In the 6-12 inch level, the top four families by weight were Neritidae (26.48%), Cypraeidae (23.35%), Thaididae (23.00%), and Conidae (18.55%). In this level, the miscellaneous shell material weighted 7.6 grams and made up 0.83% of the total weight. In the 12-18 inch level, the top four families by weight were Thaididae (28.76%), miscellaneous material (18.63%), Conidae (13.97%), and Neritidae (12.85%).

There were a total of 17 different families of mollusks represented in this bulk sample, plus the miscellaneous shell material. Ten of these families were present in all levels, and with the exception of the contribution to the total weight from the family Mitridae, these ten families made up the bulk of the material. Eight of the mollusk families were present in only one of the levels, and of these, Turbinidae and Cerithiidae made the greatest contribution to the total weight of the material from their respective levels, at 0.06% and 0.07%.

Discussion

In examining the data in Table 1, several trends are noted. Overall, the total weight of the shell material collected from each level increased consistently through the three levels, but the percentage of weight of the shells from individual families in the different levels was highly variable. The families Conidae and Patellidae showed an increasing trend through the levels (Conidae: 13.97% in 12-18 inch level, 18.55% in 6-12 inch level and 20.42% in 0-6 inch level; Patellidae: 1.31% in 12-18 inch level, 2.25% in 6-12 inch level, and 3.55% in 0-6 inch level), while the family Thaididae showed a decreasing trend (28.76% in 12-18 inch level, 23.00% in the 6-12 inch level, and 21.16% in the 0-6 inch level). The representation of all of the other families present in all three levels fluctuated between the different levels.

While the subtle increase in weights seen in the families Conidae and Patellidae, and the subtle decrease seen in the family Thaididae do denote a change in quantity over time, whether this represents a significant change in dietary habits over time is uncertain. One reason this claim may not be accurate is the percentage change between the levels for the three families was relatively small: only one of the changes was over 5% (Thaididae with a change of 5.76% between the deepest two levels), and four were under 2%. If the changes had been more substantial it would be easier to hypothesize that they were not due to random chance. A second reason it is difficult to make the claim that the changes seen represent a change in diet is that, over the 350-year habitation time frame of the site, there were only three data points for each of the shell families. Had these trends been seen across a larger number of analytical units, more confidence would be imparted that the differences seen actually represent a significant change in diet.

Including the weight of the miscellaneous material in this analysis serves to confound the interpretation of the data on weights for the other shell families. As Figure 3 shows, the miscellaneous material made up one of the top four shell groups by percentage of weight in two excavation levels in this analysis: in the 0-6 inch level, it represented the 4th greatest weight (15.03%) and in the 12-18 inch level, the 2nd greatest weight (18.63%). In the 6-12 inch level, the miscellaneous material made up only the 10th greatest weight at 0.83%. The fact that there was a greater amount of miscellaneous material in the 0-6 inch and 12-18 inch levels was simply a result of the shell material in these levels not being able to be sorted as thoroughly because much of it was in in a highly fragmented or overly worn or degraded state. Although most of the miscellaneous shell material was

Table 1. Quantitative content of mollusk material from the Pu'u Ali'i Sand Dune Site (H1), Square I12 (weight in grams, number in parenthesis equals percentage)

	0-6"	6-12"	12-18"	Total
Neritidae	242.46 (13.69)	243.40 (26.48)	38.28 (12.85)	524.14 (17.54)
Conidae	361.56 (20.42)	170.50 (18.55)	41.63 (13.97)	573.69 (19.20)
Cypraeidae	296.80 (16.76)	214.60 (23.35)	33.41 (11.21)	544.81 (18.23)
Thaididae	374.70 (21.16)	211.40 (23.00)	85.70 (28.76)	671.80 (22.48)
Littorinidae	37.10 (2.09)	10.00 (1.09)	4.75 (1.59)	51.85 (1.74)
Patellidae	62.92 (3.55)	20.70 (2.25)	3.89 (1.31)	87.51 (2.93)
Isognomon	74.80 (4.22)	22.50 (2.45)	22.66 (7.60)	119.96 (4.01)
Bivalvia	51.60 (2.91)	9.00 (0.98)	11.40 (3.83)	72.00 (2.41)
Mitridae	1.69 (0.10)	8.40 (0.91)	0.05 (0.02)	10.14 (0.34)
Turbinidae	1.00 (0.06)	_	_	1.00 (0.03)
Lucinidae	0.10 (0.01)	_	_	0.10 (0.00)
Trochidae	_	0.90 (0.10)	_	0.90 (0.03)
Hipponicidae	_	0.20 (0.02)	_	0.20 (0.01)
Muricidae	_	_	0.30 (0.10)	0.30 (0.01)
Nassariidae	_	_	0.08 (0.03)	0.08 (0.00)
Cerithiidae	_	_	0.20 (0.07)	0.20 (0.01)
Pyramidellidae	_	_	0.10 (0.03)	0.10 (0.00)
Miscellaneous	266.26 (15.03)	7.60 (0.83)	55.52 (18.63)	329.38 (11.02)
Total	1770.99 (59.27)	919.20 (30.76)	297.97 (9.97)	2988.16

Figure 4. Easily identifiable shells from the family Thaididae.

likely from shell families already represented in the assemblage, the fragmentation did not allow positive identification of this shell material, preventing the weight from being added to the correct family, and skewing the importance of the miscellaneous category in the contribution to the total weight of the level. The inclusion of the miscellaneous material could thus have masked a shift in diet that would have been found if the material had been able to be included with the correct family. Figure 4 is a photograph of easily identifiable shells from the family Thaididae and Figure 5 is a photograph of some of the shell material, which was difficult to identify because it was highly fragmented or overly worn. Most of this later material was classified as miscellaneous shell.

Overall, the amount of material recovered from Unit I12 of the Pu‘u Ali‘i Sand Dune Site excavation was relatively small, so the changes in weight through the different levels may not be truly representative of the dietary importance of the different mollusk families to the inhabitants of the area at the time. When compared with the data on shell weights from a bulk sample collected from a comparable excavation unit at the Wai‘ahukini Shelter Site (H8), which is less than three miles away, was occupied during a similar time frame, and was also excavated by Emory, Sinoto, and Bonk (Emory *et al.* 1969), presumably using similar techniques, the H1 site yielded a much lower amount of shell material (2988.16 grams versus 21,866.39 grams; see Table 2). Possible reasons for

Figure 5. Highly fragmented shell, much of which was non-identifiable and therefore classified as miscellaneous shell material.

the smaller amount of shell material recovered from the Pu‘u Ali‘i Sand Dune Site include the following: 1) that the area was predominantly utilized as a workshop instead of a living or eating area, 2) since the Pu‘u Ali‘i Sand Dune Site is in an non-sheltered area very near the shoreline, environmentally-related taphonomic processes such as shifting sand dunes, high water, or wave action may have occasionally removed a portion of the midden material, 3) it could have been simply random chance that the unit from which the bulk sample was collected contained very little midden material.

Similar to the findings of this analysis, Emory, Bonk and Sinoto (1969:9) found no evidence of a shift in diet over time related to mollusk families at the Wai‘ahukini Shelter Site. From the weight of the shell material recovered at that site, which is presented in Table 2, they judged the top four preferred mollusk families to be Neritidae, Muricidae, Cypraeidae, and Conidae. In the current analysis, the top four families by weight were Thaididae, Conidae, Cypraeaidae, and Neritidae. The family Thaididae, however, is very closely related to the family Muricidae, with many malacologists considering the former to be a sub-family of the latter (Kay 1979:239). Thus, the top four shell families present in the archaeological record of both sites were the same, although in different rank order. This would be expected since the sites are near each other and the marine and littoral environment near both should be similar.

Table 2. Quantitative content of mollusk material from the top 18 inches of Square E8, Wai'ahukini Shelter Site (H8), from Emory and Sinoto (1969:11, Table 1) (weight in grams, number in parenthesis equals percentage)

	0-6"	6-12"	12-18"	Total
Neritidae (pipipi)	2490.4 (40.83)	4501.85 (47.00)	3119.99 (50.40)	10112.24 (46.19)
Neritidae (kupee)	39.75 (0.65)	81.58 (0.85)	77.13 (1.25)	198.46 (0.91)
Cypraeidae (keho)	990.0 (16.23)	1370.0 (14.31)	893.46 (14.43)	3253.46 (14.38)
Muricidae (pupa 'awa)	1541.4 (25.27)	2289.87 (23.92)	1379.62 (22.29)	5210.89 (23.83)
Conidae (pupu)	412.7 (6.7)	257.34 (2.69)	334.73 (5.41)	1004.77 (4.60)
Patellidae (opihi)	183.2 (3.0)	361.27 (3.77)	246.97 (3.99)	791.44 (3.62)
Littorinidae (pipipi kolea)	45.2 (0.74)	82.68 (0.86)	63.36 (1.02)	191.24 (0.37)
Miscellaneous	396.48 (6.50)	632.02 (6.60)	75.39 (1.22)	1103.89 (5.05)
Total	6099.13 (27.89)	9576.61 (43.80)	6190.65 (28.31)	21,866.39

The shell material from the Wai'ahukini Shelter Site was collected from one 3x3 foot excavation unit, just as the material from the Pu'u Ali'i Sand Dune Site which was analyzed during this study. In comparing the weight of the miscellaneous shell material recovered from each, we find that the total percentage of miscellaneous shell material from the Pu'u Ali'i Sand Dune Site is over twice the total percentage from the Wai'ahukini Shelter Site (11.02% versus 5.05%). One possible reason for this is that, while the sample from the Pu'u Ali'i Sand Dune Site was obtained through bulk collection, Emory, Bonk, and Sinoto's article makes no mention of bulk collection of samples at the Wai'ahukini Shelter Site, only that "all of the shells and bones from each 3-inch level were collected from the central square E 8" (Emory *et al.* 1969:5). If the material was screened, much of the fragmented material may have passed through the screen and not been collected, which may have made positive identification of the shell material that was collected much more likely. This would explain why they were able to identify such a high percentage of shell material when compared to the bulk sample collected from the Pu'u Ali'i Sand Dune Site, which was highly fragmented.

There were several limitations to the interpretation of the data analyzed during this project. One is that, utilizing the archaeological standards of the time, the initial excavation was conducted using arbitrary six-inch levels instead of stratigraphic layers. These levels may have incorporated material from different stratigraphic layers into the same analytical unit, or conversely, may have broken up material from the same stratigraphic layer and so divided material from the same cultural period. Interpreting the data on shell weights may have thus given an artificial impression of no change in diet preference, whereas, if the material from one stratigraphic layer had been considered together, a significant change would possibly have been seen. A second limitation to the interpretation of the data from this study was noted earlier: since there were only 18 inches of cultural

material at the site and the levels were excavated in six inch increments, there were only three chronological data points for each shell family. As discussed above, working with a greater number of analytical units may have substantiated the trends noted in the analysis and imparted more confidence that the changes were actually significant. To illustrate this point, the shell material from the Waiʻahukini Shelter Site was analyzed in three-inch levels and extended to a depth of 25.5 inches, giving the researchers at that site nine data points to compare for each family. A third limitation to the study was the experience of the author in identifying shell fragments. With no formal training in shell identification, the author may not have been able to identify fragments that a more experienced or formally trained researcher may have been able to identify. Without positive identification, this material was placed in the miscellaneous category and its contribution in weight to its true family was lost.

Conclusions

During this study, the shell material collected during the initial excavation of the Puʻu Aliʻi Sand Dune Site between 1953 and 1958 was analyzed. That excavation turned out to be one of the most significant archaeological research projects conducted in the Hawaiian Islands in terms of cultural chronology. The results of this study showed a few potential trends in the preference of shell family collected at the site, but no overt indication of a change in preferred mollusk species over time. Though the total amount of shell material evaluated was relatively small, the findings are consistent with the results of a similar study conducted by Emory, Sinoto, and Bonk at a nearby site which was occupied during approximately the same period of time. Further research could compare the results of this study with other dietary material present from the bulk sample, including animal and bird bones, and fish bones and scales, in order to get a better understanding of the overall diet of the site's inhabitants.

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