Appendix E

Midden analysis

One of the principal aims of PCCT's excavations was to collect comparable field-screened and flotation samples of domestic refuse from the Ilo-Tumilaca/Cabuza and Chiribaya groups, and from the Algodonal Early Ceramic group when that material was unexpectedly encountered. These midden samples were to serve three purposes.

First, the ceramic assemblages would serve to identify the cultural affiliation of each context excavated, including any associated features. In addition to simply serving as markers by which to divide the excavated samples for other analyses, the ceramics were expected to help to suggest the temporal and/or social relationships between the groups by the degree to which the styles were pure or mixed in different contexts and any cases of stratigraphic superposition of styles or grading of mixed assemblages.

Second, the detailed analysis of the domestic refuse at the between-group level would allow the partial reconstruction and comparison of the subsistence and economic strategies of the groups, in order to determine to what extent they specialized or emphasized different crops or other resources, or shared a common productive base. Evidence of surplus production, local and long distance exchange, and so on were also sought in this general analysis.

Third, within-group analyses were intended to assess the degree of variability in domestic debris that might indicate different degrees of socioeconomic specialization and/or stratification. The organization of activity areas, architecture and other features associated with refuse from evidently higher-status versus lower-status domestic units, and so on were expected to help in reconstructing and contrasting the social, economic, and political structures of the various groups. In contexts with mixed ceramic styles, patterning of subsistence and craft refuse with respect to the relative content of different ceramic styles might reinforce the between-group conclusions and shed light on inter-group relations.

PCCT succeeded in gathering and processing the desired field-screened samples, as is outlined below. The flotation samples were collected, floated, and 748 of the 893 samples, each with light and heavy fractions, have been rough sorted. The final sorting, identification, recording, and analysis remains to be done, so the discussion that follows is based entirely on field-screened collections. The first two of the three analytical goals have been met and the results are described in the following pages: the ceramic assemblages have been categorized and the degree of mixing carefully evaluated, and the midden has been extensively characterized and contrasted at the group level. Because the number of analyzed samples was a bit small to support further subdividing and there was no obvious patterning within the stylistic groups in ways that was important to the thrust of this dissertation, and because of time constraints, the third goal of reconstructing and contrasting within-group patterning has been deferred. Activity areas, particularly cooking areas, were found at all three excavated sites, midden was found in a possible ritual context at Loreto Viejo, and potentially status-related differences in midden contents and architecture were noted at Loreto Alto; the collections and coded data are expected to support a variety of additional analyses in the future.

Data collection and preparation

During excavation, all soil except for an eight-liter flotation sample from each stratigraphic unit other than a few mixed or nearly sterile overburden layers was passed through 1/4" screens, and all the cultural material was collected from the screens. Cultural material was defined as everything except unworked, naturally present rocks. The one category of cultural material that was intentionally not collected was small pieces of corn or cane stalks of minuscule width and under about one inch in length, which were present in such quantities that collecting them from a single screen took hours and added only a negligible mass to the bags of larger fragments that were collected.

Apparently because of the density of gravel and botanical material in many of the excavated contexts, many items that would normally pass through a 1/4" screen were collected in these samples, most notably large quantities of molle seeds, which are the size and shape of peppercorns. It is not clear whether there are any systematic biases in the collection of these items, but it is certainly possible. A few quinoa or amaranth stalks with seeds on them were recovered from the screens, but clearly the presence or absence of near-microscopic evidence such as quinoa seeds is not addressed by the screened data at all. All categories of the field-screened material are analyzed here, but conclusions concerning small seeds such as molle, coca, and quinoa should be considered tentative until the flotation data have been analyzed.

Field-screened material was all bagged together except for items that seemed likely to be damaged or lost in the general bag. These bags were returned to an indoor lab, where they were separated and rebagged into rough categories by semi-skilled workers. Ceramics were washed in order to make the surfaces and pastes visible, and soaked in a series of water baths for at least a week to rid them of salts. All the other midden material was rebagged without any treatment.

Based on field notes, drawings, and photographs, I coded all the excavated contexts by type of deposition, such as pit fill, floor, slump from upslope, and so on, and selected a subsample of context types that appeared to be best associated with the occupations of the domestic areas (the final analyzed subsample is described in a later section). These contexts were sorted into more detailed categories by the author and several skilled assistants, principally José Moya Y., Raúl Rosas H., and Gerardo Carpio D., whose work I supervised closely in order to maintain consistency among all the coders. Each category of material was counted and/or weighed as appropriate, and recorded on a standardized coding sheet using numeric codes to indicate the nature of the material. All material was coded except for ceramics and marine shells, which were separated for special handling. I coded all the ceramics, and Helberth Gamarra B. coded all the shell. Other categories such as animal remains, fish remains, coprolites, and so on, were separated after coding and stored together to facilitate specialized analyses in the future.

The coding sheets had spaces for both a written description of the material and a series of corresponding numeric codes that were taken from an extensive key that was posted on the wall of the lab for easy access. The coding system centered on three hierarchical codes. The first code identified a general category (ceramic, unworked botanical material, animal remains, worked bone, etc.). The second varied depending on the first, but generally identified a subcategory such as animal or plant species as well as could be determined, and the third added another, crosscutting subcategory such as part of the plant or animal (seed, stalk, vertebra, etc.). All items were further divided into completely burned, partially burned, and unburned. I personally checked every line of every coding sheet to ensure that the written and coded descriptions matched. Once corrected, if necessary, and approved, the numeric codes only were entered directly into a dBASE III+ file by my full-time typist and beautiful lover, Lía Zuñiga M..

Both the artifact coding sheet data and the context data, including screened and floated soil volumes, type of soil, interpretation of deposition, excavators, and so on, were completely proofread before analysis. The data coding sheets were set up in a tabular format directly analogous to the database structure, to simplify data entry and checking. I wrote a program that worked with the "SoundBlaster" audio board and driver software for the PC that allowed the computer to read the data files aloud. I listened to the computer and read along on the original coding sheets, stopping to correct typographical errors whenever a discrepancy occurred. This was a laborious process, but a large number of errors were corrected.

Subsample selection and general midden characteristics

The analyzed subsample is a selected subset of the recorded data, which was already selected to meet the provenience quality requirements used initially to choose stratigraphic units to be cataloged. Of these, only samples screened from over 15 liters of soil, and only samples that proved to have over 3 grams of cultural material per liter of screened soil were included.

These restrictions were added for statistical reasons. Many artifact categories are relatively rare, so small units and units with very low artifact densities tend to have no examples of them. The small units therefore introduce many cases of absence or zero frequency that are due more to the inadequacy of each sample size than the absence of the item from the vicinity. On the other hand, the presence of a single item in a small sample introduces an anomalously high frequency or density in that sample, because the value of any standardizing variable such as volume or total artifact mass is relatively low. The result is a mix of artificial zero values and artificial high values for less common categories, which is hard to interpret intuitively and gives unsatisfactory results with statistical significance tests. Moreover, the small and low density units are much more common at Loreto Alto than at the other two sites, probably due to differences in the duration and intensity of occupation of the site. This unbalanced distribution of sample sizes introduces a bias such that the Ilo-Tumilaca/Cabuza group is characterized by a poorly-behaved distribution of most artifact categories, with many zero values and many anomalously high outlying values, which does not lend itself to meaningful comparisons with the better-distributed data from other groups. The thresholds of unit size and density described above were selected not with any *a priori* knowledge of the size or density of a useful stratigraphic unit, but in an iterative process that balanced the need for reasonably well-behaved distributions of variables against the need for a reasonably large sample size.

By eliminating the small and low density contexts, the midden analysis is effectively limited to comparisons of the activities that result in medium to large sized, medium to dense deposits of domestic refuse. If the small or low density deposits represent not only inadequate samples, but also different types of activities or occupations, as they well might, then these activities are ignored in the analysis that follows.

Table E-1 describes the final, analyzed subsample. Despite the considerable amount of excavation described in Appendix A, the strict limitations on context types, mixing, size, and density yield final sample sizes that are rather small. The entire

Table E-1. The analyzed midden samples by context type and cultural affiliation.

Context type	Algodonal Early Ceramic				Ilo-Tumilaca/Cabuza				Mixed Ilo-Tumilaca /Cabuza and Chiribaya				Chiribaya			
	Num ber	Liters	Total g/l	Bot. g/l	Num ber	Liters	Total g/l	Bot. g/l	Num ber	Liters	Total g/l	Bot. g/l	Num ber	Liters	Total g/l	Bot. g/l
Area near hearth					1	52	17.2	0.5	1	18	16.0	1.9				
Floor									1	27	16.2	2.0	1	18	10.7	1.9
Hearth													1	32	6.9	0.3
Midden in pit	1	128	11.3	9.5					1	184	19.6	2.2	1	278	45.3	10.2
Occupation zone	3	100	3.9	0.4									1	32	4.6	0.4
Open midden	2	93	8.9	3.7	4	537	15.1	3.5	29	2695	39.5	3.4	12	1035	39.8	11.4
Pit fill	5	514	8.1	4.7	1	58	4.2	0.7	1	107	26.7	1.6	3	232	12.9	1.2
Placed fill									2	495	17.9	0.7				
Pos. occupation zone	2	107	5.6	1.1	3	54	6.3	0.5	1	40	3.5	0.1	2	131	6.1	0.5
Prob. assoc. w/occupation													4	213	9.0	0.7
Trench fill					1	56	7.7	0.3	2	52	16.5	8.2	7	541	9.6	2.3
Means	-	72	7.9	4.4	-	76	13.2	2.6	-	94	34.5	3.0	-	79	26.0	6.5
Totals (weights in kg)	13	942	7.4	4.1	10	757	10.0	2.0	38	3578	123.0	10.6	32	2512	65.3	16.4

Number: Number of stratigraphic units in the sample.
Liters: Total volume of screened soil .
Total g/l: Mass of all analyzed cultural material per liter of screened soil. Single items over 300g, such as posts and grinding stones, are excluded.
Bot. g/l: Mass of botanical material per liter of screened soil. Included in total above.
Means of "Total g/l" and "Botanical g/l" columns are weighted by volume.

sample of Ilo-Tumilaca/Cabuza material comes from only 10 stratigraphic units totaling only 757 liters of screened soil, and the total mass of analyzed Ilo-Tumilaca/Cabuza artifacts, including the heavy sherds, small lithics, and bone, was only 10 kg. The other samples are larger, but not generous. Table E-1 shows that the mean volume of the stratigraphic units analyzed is about the same for each of the four cultural-stylistic groups, although the amount of cultural material in them was somewhat more variable. It also shows that the four groups are represented by slightly differing assortments of context types.

Table E-1 also demonstrates an important substantive difference between the four social groups. Even after the low density contexts predominant at the Ilo-Tumilaca/Cabuza site of Loreto Alto are excluded, the Chiribaya and predominantly Chiribaya mixed deposits tend to be exceptionally rich in artifacts compared to deposits of other groups. In the analyzed samples, Chiribaya and predominantly Chiribaya mixed midden has two to three times as much mass of cultural material per liter of soil as Ilo-Tumilaca/Cabuza midden. This ratio would be even higher if the many lower density Ilo-Tumilaca/Cabuza deposits were included. This finding suggests that Chiribaya occupations may have been denser or longer-lasting than Ilo-Tumilaca/Cabuza occupations, and supports the claim in Chapter 7 and Appendix F that in order to use site areas as indices of relative population, Chiribaya site areas should be multiplied by some factor around 2 or 3 in order to make them more comparable to Algodonal Early Ceramic and Ilo-Tumilaca/Cabuza site areas as population indices. The tendency of Chiribaya deposits to be thicker than Ilo-Tumilaca/Cabuza deposits, both at the excavated sites and sites located during the survey, suggests that a greater correction factor might be appropriate, but the midden analysis cannot address its magnitude.

The ceramic analysis described below proved that 40% of the analyzed stratigraphic units and 60% of the cultural material by weight were from contexts with mixed Ilo-Tumilaca/Cabuza and Chiribaya ceramics. This material was analyzed as a separate "mixed" category, including stratigraphic units with from 8% to 56% Ilo-Tumilaca/Cabuza material. The mixed material was not consistently intermediate between the "pure" assemblages, nor could any other sensible pattern be detected in the pooled results or in a casual inspection of various values ordered by the relative proportions of the two styles present. These inconclusive and confusing results are reported in this appendix, but are not incorporated into the rest of the dissertation.

Assigning cultural affiliations to habitation contexts

Except for the terraced habitation area of El Algodonal, all the excavated areas samples remains that were clearly from occupations by a single cultural group. As described in Appendix A, the buried habitation terraces under the cemetery at El Algodonal had only Algodonal Early Ceramic sherds, as did the hillside terraced area at Loreto Viejo. The alluvial fan terraces at Loreto Viejo were purely Chiribaya, and the entire site of Loreto Alto was purely Ilo-Tumilaca/Cabuza. These field impressions were substantiated when all the ceramics were analyzed. The analyzed stratigraphic units from these areas were assigned to the appropriate ceramic style category based simply on where they were located, without further analysis of the ceramics in individual units.

Much of the material from the habitation terraces at El Algodonal included both Chiribaya and Ilo-Tumilaca/Cabuza ceramics in varying proportions, so the ceramics from each excavated area had to analyzed separately. Careful inspection of ceramic inventories from each level-locus in the excavated sample suggests that there is no intelligible patterning of variation in the proportions of ceramic styles within the undisturbed primary stratigraphic sequences of the excavation units. That is, there is no patterned superposition of differing styles within single units, nor are there clear differences between contiguous units. For this reason, "blocks" of contiguous excavation units are used as the standard unit for the ceramic analysis. Each block, comprising all the *in situ* loci of the types selected for analysis (midden, pit fills, trench fills, hearths, etc.), is considered a temporally and culturally homogeneous unit. All the stratigraphic units within the block are considered to relate to the same ceramic style or mixture of styles, even if few or no ceramics were found in that particular level and locus. This simplification is reasonable, since most of the analyzed stratigraphic units were directly in contact with or bracketed by level-loci with diagnostic ceramics.

The ceramic assemblages from the habitation terraces at El Algodonal vary at the level of the entire block from almost pure Chiribaya with minimal Ilo-Tumilaca/Cabuza material, to largely Ilo-Tumilaca/Cabuza with a considerable admixture of Chiribaya sherds. This mixture of ceramic styles occurs in all types of *in situ* deposits, from domestic midden, to debris on informal floors, to pit and wall trench fills. There is no stratigraphic indication that one or the other style of pottery is intrusive or became mixed with the other through some site disturbance process; on the contrary, they generally appear to have been deposited in the same way, at the same time, mixed with the same domestic garbage. Especially since the radiocarbon dates indicate that the Ilo-Tumilaca/Cabuza and Chiribaya styles were contemporary, the possibility must be considered that the El Algodonal material represents refuse either of two distinct groups living in such close proximity that their domestic garbage was consistently commingled within their living areas, or of one group that, unlike its single-style contemporaries at Loreto Alto and Loreto Viejo, used both styles of pottery at the same time.

Quantifying the mixing at El Algodonal: A mixing model

The ceramic data from the three excavated sites offer a rare opportunity to rigorously assess the degree of mixing in the different excavation blocks at El Algodonal. For analytical purposes, let us disregard any possible differences in site function, and consider the collections from Loreto Alto to be representative of a "pure" Ilo-Tumilaca/Cabuza ceramic assemblage, those from the low terraces of Loreto Viejo as representative of a "pure" Chiribaya assemblage, and those of the habitation area at El Algodonal as simple mixtures of the two "pure" assemblages. It is then possible to calculate the proportions of "pure" Ilo-Tumilaca/Cabuza ceramic debris and "pure" Chiribaya ceramic debris required to produce the sherd mixture observed in each excavation block at El Algodonal.

These proportions are useful in deciding whether a given block should be considered as pertaining primarily to one or the other cultural group, or as being in fact significantly mixed. They also provide a scale along which the mixed blocks may be ordered according to their proportion of one or the other style. This ordering can then be used in the analysis of other midden contents, for comparison with the "pure" Ilo-Tumilaca/Cabuza and Chiribaya contexts from the other two sites. Since the multi-ethnic nature of early LIP settlement in the valley probably played a crucial role in the sociopolitical development of the region, the analysis of these mixed contexts in contrast to the "pure" ones has the potential to lead to important conclusions about the nature of multiethnicity at El Algodonal. As noted above, the initial results from the mixed contexts have been difficult to interpret, and are not used in the body of this dissertation. I am convinced that they nevertheless reflect a past social reality, and that future studies of this and other mixed collections, probably using the ceramic analyses described here as a foundation or at least a datum, may yet help unravel the multiethnic puzzle in the coastal valley.

The first step in quantifying the mixing is to establish the composition of the two "pure" ceramic assemblages. The Ilo-Tumilaca/Cabuza "pure" assemblage is represented by all the coded ceramics excavated from Loreto Alto, and the Chiribaya "pure" assemblage is represented by all the coded ceramics excavated from the low terraces at Loreto Viejo. Since this analysis is intended to characterize the overall ceramic assemblage, the small and low density units were not excluded. For each of these two groups, the percentage of diagnostic Ilo-Tumilaca/Cabuza and Chiribaya sherds is calculated, both as the number of diagnostic sherds divided by the total number of sherds, and as the mass of diagnostic sherds divided by the total mass of sherds. There is no theoretical reason to prefer count or mass data, so both are presented. Since "Fine" paste is associated with Ilo-Tumilaca/Cabuza pottery (but not exclusively) and "Local" paste is associated with Chiribaya pottery (but not exclusively), the same procedure is followed with sherds of "Fine" or "Local" paste. Many diagnostic sherds are made of these pastes, so some of the same sherds enter into both analyses. Table E-2 shows the raw count and mass data on diagnostics and pastes for the "pure" Ilo-Tumilaca/Cabuza assemblage, the "pure" Chiribaya assemblage, and each block at El Algodonal.

The percentages that characterize the two "pure" assemblages are listed in Table E-3. This table indicates why a relatively sophisticated approach is necessary to

Table E-2. Count and mass data for "pure" assemblages and blocks at El Algodonal.

Block	Ilo-Tumilaca/Cabuza diagnostics		Chiribaya diagnostics		Fine paste		Local paste		Entire assemblage	
	Number	Grams	Number	Grams	Number	Grams	Number	Grams	Number	Grams
* 521	0	0.0	4	20.3	2	26.5	26	559.2	43	767.1
515/517/523/524	2	7.3	33	98.3	6	37.8	171	3396.0	243	3946.8
503/505/506/509	12	48.1	43	251.7	169	618.8	424	2874.8	1011	6238.8
* 510	2	36.9	6	52.0	5	25.2	69	540.1	79	600.4
522	28	145.7	62	328.4	230	778.3	727	4105.0	1708	9489.4
527	59	382.1	110	584.9	439	1494.7	889	5199.2	3046	17490.4
* 516	4	26.5	3	31.5	18	101.0	40	273.0	162	1144.7
* 511	3	25.2	1	1.6	15	56.6	49	579.4	153	1389.7
525/529/530	114	842.6	28	181.6	229	9073	259	2151.7	2326	15766.3
"Pure" Ilo-Tumilaca/Cabuza	95	739.8	0	0.0	129	569.2	11	79.6	579	3369.2
"Pure" Chiribaya	1	22.7	85	558.3	6	15.9	1245	9804.2	1683	12953.5

* Blocks marked with an asterisk have sample sizes small enough to cast doubt upon the ceramic analysis results for them.

		Percent of sherd number		Percent of sherd mass	
		Pure I-T/C n=579	Pure Chiribaya n=1683	Pure I-T/C 3369 g	Pure Chiribaya 12954 g
Diagnostics	Ilo-Tumilaca /Cabuza	16.41	0.06	21.96	0.18
	Chiribaya	0.00	5.05	0.00	4.31
Pastes of non-diagnostics	Fine paste	22.28	0.36	16.89	0.12
	Local paste	1.90	73.98	2.36	75.69

Table E-3. "Pure" Ilo-Tumilaca/Cabuza and Chiribaya ceramic assemblages.

quantify the mixtures of these two assemblages: by count or mass, the "pure" Ilo-Tumilaca/Cabuza assemblage has a much higher proportion of diagnostic sherds than does the "pure" Chiribaya assemblage. Characterizing a mixed assemblage simply by the ratio of diagnostic sherds, for example, would severely overestimate the proportion of Ilo-Tumilaca/Cabuza material in the mixed lot. If equal amounts of Ilo-Tumilaca/Cabuza and Chiribaya diagnostics were found, for example, the simple interpretation would be that the mixture contains about half Ilo-Tumilaca/Cabuza material; taking the differing proportions of diagnostics into account as described below, the mixture proves to contain less than one quarter Ilo-Tumilaca/Cabuza material. The situation with the paste types is even more complex, since although their proportions in the "pure" assemblages differ dramatically, they are not associated exclusively with one assemblage or the other.

Figure E-1 graphically represents the simple mixing model for diagnostic sherds. In the pure Chiribaya assemblage on the far left, there are $\boldsymbol{C_{pure}}$% Chiribaya diagnostics, and 0% Ilo-Tumilaca/Cabuza diagnostics. In the pure Ilo-Tumilaca/Cabuza assemblage on the far right, there are $\boldsymbol{T_{pure}}$% Ilo-Tumilaca/Cabuza diagnostics, and 0% Chiribaya diagnostics. In a mixed assemblage composed of $\boldsymbol{i}$% Ilo-Tumilaca/Cabuza ceramics, there are $\boldsymbol{C_{mix}}$% Chiribaya diagnostics and $\boldsymbol{T_{mix}}$% Ilo-

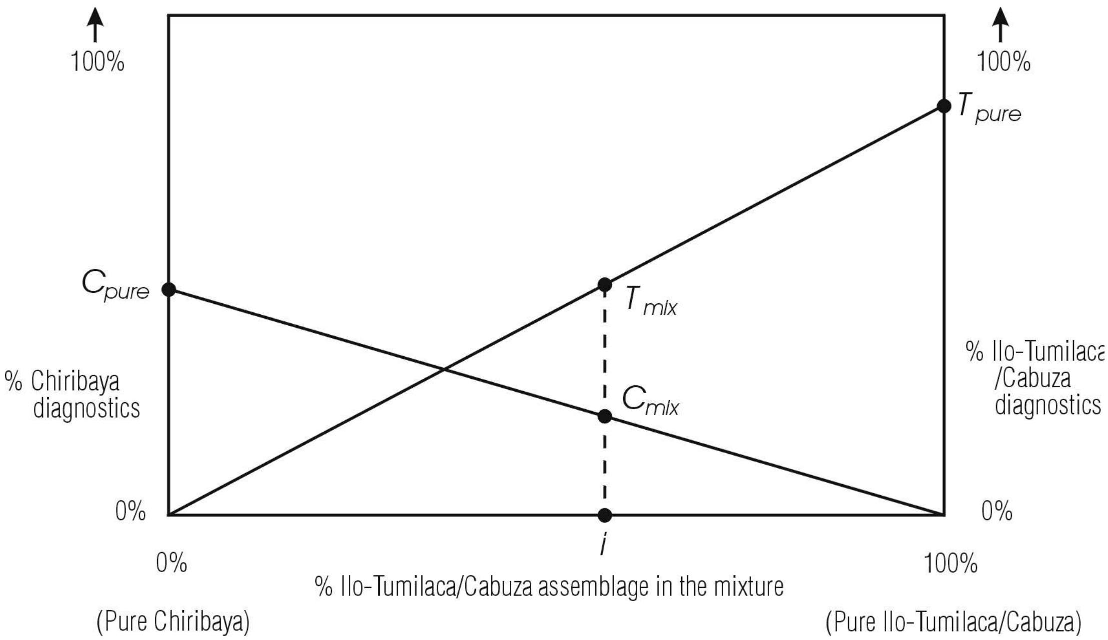

Figure E-1. Mixing model for diagnostic sherds.

Tumilaca/Cabuza diagnostics. To calculate the proportion of the "pure" Ilo-Tumilaca/Cabuza assemblage (***i***) in a mixed lot based on the observed percentages C_{mix} and T_{mix} of diagnostic sherds, we solve the following equation based on similar triangles:

$$\frac{T_{mix}}{C_{mix}} = \frac{i\,T_{pure}}{(1-i)\,C_{pure}}$$

Where

T_{mix} = Percent of mixed assemblage that is I-T/C diagnostic

C_{mix} = Percent of mixed assemblage that is Chiribaya diagnostic

T_{pure} = Percent of pure I-T/C assemblage that is diagnostic (16.41% in table E-3)

C_{pure} = Percent of pure Chiribaya assemblage that is diagnostic (5.05%)

i = Fraction of mixed assemblage that is "pure" I-T/C

Resulting in the following formula for $\boldsymbol{i}$:

$$i = \frac{\frac{T_{mix}}{C_{mix}} \frac{C_{pure}}{T_{pure}}}{1 + \frac{T_{mix}}{C_{mix}} \frac{C_{pure}}{T_{pure}}}$$

To calculate the same proportion based on paste types, we first subtract out the amount of each paste type that is present in the "pure" assemblage in which it is less prevalent. This adjustment reflects a simple model illustrated in Figure E-2 in which there is a constant amount of each paste present in both assemblages, plus a variable amount that ranges from zero in one "pure" assemblage to an observed higher value in the other "pure" assemblage. Using this model, the value of $\boldsymbol{i}$ based on pastes is given by

$$i = \frac{\frac{(F_{mix} - F_{const})}{(L_{mix} - L_{const})} \frac{L_{var}}{F_{var}}}{1 + \frac{(F_{mix} - F_{const})}{(L_{mix} - L_{const})} \frac{L_{var}}{F_{var}}}$$

Where

$\boldsymbol{F_{mix}}$ = Percent of mixed assemblage that is Fine paste

$\boldsymbol{L_{mix}}$ = Percent of mixed assemblage that is Local paste

$\boldsymbol{F_{const}}$ = Percent of Fine paste in pure Chiribaya assemblage (constant part) (.36%)

$\boldsymbol{L_{const}}$ = Percent of Local paste in pure I-T/C assemblage (constant part) (1.90%)

$\boldsymbol{F_{var}}$ = Percent of Fine paste in pure I-T/C assemblage minus $\boldsymbol{F_{const}}$ (9.14%)

$\boldsymbol{L_{var}}$ = Percent of Local paste in pure Chiribaya assemblage minus $\boldsymbol{L_{const}}$ (67.92%)

$\boldsymbol{i}$ = Fraction of mixed assemblage that is "pure" I-T/C

The example values given above are all based on sherd counts, but both sherd

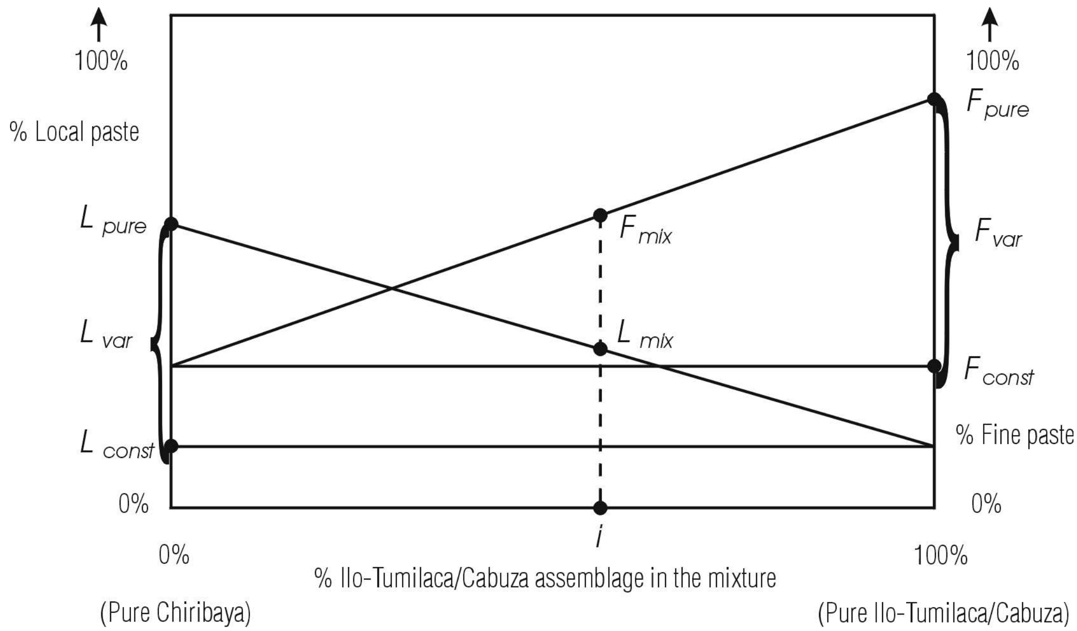

Figure E-2. Mixing model for pastes.

count and sherd mass calculations are presented and evaluated below.

Quantifying the mixing at El Algodonal: Results

The results of these calculations for each excavation block in the El Algodonal habitation terraces are given in Table E-4. The four blocks in which the sample size is small enough to throw the results into doubt are flagged.

The values based on diagnostic sherds, both by count and by mass, correspond reasonably well with field impressions, which were also based largely on diagnostic sherds. A few other data tend to corroborate the general results based on diagnostic sherds. First, block 525/529/530 contained the only house construction at El Algodonal in the style described by Goldstein for Tumilaca phase structures in the Moquegua area (thin posts located on either side of the cane wall), and it is precisely this block that has the largest fraction of Ilo-Tumilaca/Cabuza ceramics. The walls and posts in other blocks such as 527 and 503/505/506/509 correspond more closely to

Block All units from El Algodonal (AD)	Count		Mass	
	I-T/C % (***i***) by diagnostics	I-T/C % (***i***) by paste	I-T/C % (***i***) by diagnostics	I-T/C % (***i***) by paste
* 521	0	18%	0	17%
515/517/523/524	2%	10%	2%	5%
503/505/506/509	8%	57%	6%	48%
* 510	9%	19%	19%	17%
522	12%	51%	13%	45%
527	14%	62%	18%	56%
* 516	29%	60%	22%	62%
* 511	48%	51%	84%	30%
525/529/530	56%	75%	60%	65%

* Blocks marked with an asterisk have sample sizes sufficiently small to cast doubt on the calculated results.

Table E-4. Percentage of Ilo-Tumilaca/Cabuza ceramics by block by various methods.

Chiribaya norms (larger posts in line with the cane wall), and these blocks contain relatively more Chiribaya pottery.

The values based on pastes arrange the excavation blocks in an order grossly similar to that based on diagnostic sherds, but there are many discrepancies, the differences are less clear, and the values tend to indicate a much higher percentage of Ilo-Tumilaca/Cabuza pottery in any given mixed lot. The paste and diagnostic sherd measures in fact correlate (Pearson's product-moment correlation) significantly at the .05 level (p=0.04) when calculated on the basis of sherd count, but do not correlate significantly when calculated on the basis of sherd mass (p=0.47). I suspect that there is some real association of Fine paste with the Ilo-Tumilaca/Cabuza assemblage, and of Local paste with the Chiribaya assemblage, but that the trend is obscured by difficulties in consistently categorizing paste types visually. Variable proportions of both paste types may have been classified as "other" or "indeterminate". Alternatively, the relationship of these two paste types to the stylistic/cultural units may be more complex, possibly having to do with differences in activities involving ceramics, or access to clay or temper sources based on factors independent of the ceramic style used.

Because the distinctions based on paste types seem to be less secure than those based on stylistically diagnostic sherds, the rest of this analysis will use the values based on diagnostic sherds. It should be borne in mind, however, that these figures are sometimes based on small numbers of sherds and that the same method applied to paste types generally suggests a greater fraction of Ilo-Tumilaca/Cabuza material in the mixed assemblage than the diagnostic sherds indicate.

A methodological point of interest is that the results calculated from sherd counts are all generally within 5 to 10% of those calculated from sherd mass, except where fewer than ten sherds are involved. The two quantification methods are equally useful for this analysis. The results are also fairly insensitive to variations in lumping, excluding cases, weighting, and averaging; a variety of approaches were tried in the course of exploratory analysis, and the general order, distribution pattern, and magnitudes of the mixing values for each excavation block were not notably affected by the variations in analytical methodology. The results calculated from the diagnostic ceramics are fairly robust and probably represent real patterns, rather than artifacts of the laboratory and analytical methods.

Based on the mixing values calculated from diagnostic sherds (Table E-4), the excavation blocks fall into three broad categories. The first group, comprising blocks 521 and 515/517/523/524, contains effectively pure Chiribaya ceramics, with negligible Ilo-Tumilaca/Cabuza material. These blocks are included in the Chiribaya sample for further midden analysis. Applying the mixing model allowed us to conclude that the Ilo-Tumilaca/Cabuza component in the 515/517/523/524 block really represents only about 2% of the assemblage, and can be reasonably considered negligible.

The second group comprises blocks 527, 522, 510, and 503/505/506/509. These blocks all contain 6 to 19 percent Ilo-Tumilaca/Cabuza ceramics. This amount of Ilo-Tumilaca/Cabuza pottery seems too much to consider intrusive, but it is nevertheless embedded in a primarily Chiribaya assemblage. These excavation blocks can be interpreted in various ways. They may sample essentially Chiribaya households that used minor quantities of Ilo-Tumilaca/Cabuza ceramics; they may represent essentially Ilo-Tumilaca/Cabuza households that used largely Chiribaya wares for their decorated pottery; the may be households that were in some other manner transitional between the two stylistic groupings (although no transitional burials are known); or they may indicate depositional or redepositional mixing due to two distinct groups living in close proximity. Further ceramic and midden analysis may help distinguish between these possibilities.

The last group comprises blocks 516, 511, and 525/529/530. These blocks contain large proportions of Ilo-Tumilaca/Cabuza pottery. The two small blocks, 511 and 516, contained only 4 and 7 diagnostic sherds, respectively, and the calculated proportions of Ilo-Tumilaca/Cabuza material in them must be taken as very approximate. The larger block, 525/529/530, has a respectable 142 diagnostic sherds and yields a high 56 to 60 percent of Ilo-Tumilaca/Cabuza material. As noted above, this block contained remains of a cane walled structure constructed in the style described by Goldstein (1989a) for the Tumilaca phase in the Moquegua area. The high representation of Chiribaya ceramics (40 to 44%) precludes considering this material as the remains of a household of Ilo-Tumilaca/Cabuza people in the manner of households at Loreto Alto, while the house construction suggests that neither does it represent an essentially Chiribaya household that used a lot of Ilo-Tumilaca/Cabuza pottery. A reasonable hypothesis is that this block samples refuse of a principally Ilo-Tumilaca/Cabuza household that also used Chiribaya pottery, or had immediate neighbors that used Chiribaya ceramics. Again, further ceramic and midden analysis may tend to confirm or disconfirm this hypothesis.

All of these blocks with Ilo-Tumilaca/Cabuza ceramic components of 6% to 60% are treated as a "mixed" category in the rest of the midden analysis. Applying the mixing model allows us to conclude that none of the El Algodonal assemblages should be included in the Ilo-Tumilaca/Cabuza sample, not even the 525/529/530 block, which includes a Tumilaca-style structure and midden in which by simple count 80% of the diagnostic sherds are Ilo-Tumilaca/Cabuza.

The final cultural affiliations assigned to all the habitation units excavated by PCCT are summarized in Table E-5.

Analytical methods: Standardized measures and statistical tests

The first problem in interpreting midden data is measuring how much of any given item is present, or how common it is. The most obvious approach is to simply count or weigh the items of interest, but total counts and weights reflect how much excavation was done in each area as much as they do prehistoric activities. The next alternative is to standardize by the volume of soil excavated for each context, that is, to divide the number or mass of the items from stratum A by the volume of stratum A. Where the nature of the deposits and the soil deposition regimes are relatively uniform across all the stratigraphic units being analyzed, standardizing by volume is an

Units or Block	Style/group	Percent I-T/C (*i*) by count	Percent I-T/C (*i*) by mass
AD 373-376	Algodonal Early Ceramic	0	0
LV 2507-2510, LV 2513-2514	Algodonal Early Ceramic	0	0
LA 1501-1533	Ilo-Tumilaca/Cabuza	100%	100%
LV 2502-2506	Chiribaya	0	0
* AD 521	Chiribaya	0	0
AD 515/517/523/524	Chiribaya	2%	2%
AD 503/505/506/509	Mixed: Chiribaya with Ilo-Tumilaca/Cabuza	8%	6%
* AD 510	Mixed: Chiribaya with Ilo-Tumilaca/Cabuza	9%	19%
AD 522	Mixed: Chiribaya with Ilo-Tumilaca/Cabuza	12%	13%
AD 527	Mixed: Chiribaya with Ilo-Tumilaca/Cabuza	14%	18%
* AD 516	Mixed: Chiribaya with Ilo-Tumilaca/Cabuza	29%	22%
* AD 511	Mixed: Chiribaya andIlo-Tumilaca/Cabuza	48%	84%
AD 525/529/530	Mixed: Chiribaya and Ilo-Tumilaca/Cabuza	56%	60%

* Blocks marked with an asterisk have sample sizes small enough to cast doubt on the calculated style mixtures.

Table E-5. Cultural affiliations of all excavated habitation units.

excellent solution that avoids many of the logical pitfalls that other approaches encounter.

Unfortunately, PCCT excavated in areas with wildly differing densities of cultural material and markedly differing soil deposition mechanisms and rates. The cultural debris on the Chiribaya and mixed Late Intermediate Period habitation terraces is much denser than in other contexts, as shown in Table E-1. The Ilo-Tumilaca/Cabuza refuse from Loreto Alto is mostly of extremely low density, and Table E-1 shows that even the dense middens there still have substantially less cultural material per unit volume of soil than the middens from Chiribaya areas. Finally, the Algodonal Early

Ceramic deposits, especially those at Loreto Viejo, accumulated in an entirely different depositional regime from the Late Intermediate Period refuse. The later midden is mostly mixed with minimal soil and gravel, probably material that was scuffed up or swept from the occupied terrace surfaces themselves. The Algodonal Early Ceramic terraces are located on steep, gravelly slopes, and at least at Loreto Viejo they seem to have accumulated to sometimes considerable depths through the mixing of domestic debris with a continual influx of gravelly talus migrating down onto the occupied terraces from the hillside above.

Some of the variation in midden density is probably due to differences in activities or settlement behavior between the groups, but much of it is demonstrably not. Standardizing the PCCT data by excavated volume would have the predictable effect, for example, of making the Ilo-Tumilaca/Cabuza group appear to have significantly less of everything than either of the other groups. While this finding would certainly tell us something about the Ilo-Tumilaca/Cabuza occupation of Loreto Alto, it is not very illuminating. The low density of midden at Loreto Alto might indicate a brief occupation, a low density of settlement within the site, an impoverished population, or refuse disposal practices or natural conditions such as high winds that discouraged the accumulation of dense garbage heaps. Screened soil volume is not a good standardizing variable for the PCCT collections; a different approach is needed to bring out the contrasts between the groups more clearly.

No single variable stands out as a reasonable one by which to standardize the midden data. In some areas, for example, it may be appropriate to standardize, directly or indirectly, by the amount of grinding stone present, since groundstone food preparation equipment might be a rough index of the number of people in an area and duration of their occupation (Russell 1988). In the coastal Osmore sites, however, I could identify no artifact category that was both ubiquitous and could be reasonably argued to act as an index of population independent of inter-group variation in material culture or refuse disposal practices.

An alternative approach is to tally the percentage of all excavated stratigraphic units in which the item of interest is present; common items with have a high percentage presence or ubiquity (Pearsall 1989, Popper 1988). This method considers only presence vs. absence; it disregards the *amount* present in any given unit. Since the number of units in the PCCT analyzed sample is very small, ubiquity may take only a limited number of values: there are precisely eleven possible ubiquity values (0, 10%...100%) for any item in the Ilo-Tumilaca/Cabuza sample of ten contexts. The effect of chance on ubiquity figures from such small samples is high, and few patterns will prove to be statistically significant. With such small numbers of sampling units and the excellent preservation of virtually all types of artifacts, it seems inappropriate to limit the analysis to ubiquity and to discard the information contained in the amount of the item present in each context.

For lack of a better solution, then, the PCCT data are standardized by a variety of bulk measures of cultural material such as the total mass of cultural material from the stratigraphic unit, the total mass of botanical material from the stratigraphic unit, and other values as appropriate, such as the total mass of shell, animal remains, and so on. Dividing the mass of corn cobs, for example, by the total mass of cultural material, gives simply the percentage of the midden collection by mass that is corn cobs. Such percentage data suffer from a number of well-known failings. First, an increase in one category necessarily causes a decrease in the others. If a group adds corn to their diet, for example, percentage data will automatically make it appear that other crops were used less, which may not be a valid conclusion. Second, percentage data reflect only differences in the composition of an assemblage, not the absolute amount of it or of any item in it. If the Ilo-Tumilaca/Cabuza group really was generally impoverished relative to the Chiribaya, percentage data will never show that. This failing is also the advantage of these standardizing variables: they evaluate the composition of the midden independently of the otherwise confounding differences in density and amount.

Wherever possible, a variety of standardizing variables are used with each item being evaluated, and a conclusion is considered supported if most or all of the ways of measuring the item give the same result in the statistical tests. These different measures are only partially independent, since the mass of all botanical material might be used as a standardizing variable when it also enters into the total mass of all cultural material, which is used as another standardizing variable. Another partially dependent standardizing variable is "identified botanical material," which excludes the large mass of sticks, twigs, and cane and/or corn stalk and leaf fragments that are included in "all botanical material". I suggest that using such large, lumped categories as standardizing variables is particularly reasonable when the items being standardized comprise minuscule fractions of these totals. The total artifact mass, often measured in kilograms, is in practice relatively independent of the mass of squash seeds, which may represent only a few ten-thousandths of the total. Alternatively, when the artifact category is not botanical, then the total mass of botanical remains is truly an independent standardizing variable. In the tables of results and significance tests that follow, each item is standardized in several different ways, and each line identifies not only the item being evaluated, but also the variable that it is standardized by for that particular test.

When the standardized values of any artifact, for example "shell/total artifact mass," are calculated for each of the analyzed stratigraphic units, they are generally distributed in a very non-normal pattern. Standardized measures of rare artifacts are usually distributed as many zero values and a few relatively large values, while measures of more common artifacts may be far from normal due to the random sampling effects inherent in small sample sizes. These non-normal distributions are difficult to describe with a single figure such as a mean or median. Means are highly susceptible to outlying values, both low (zero) and high, such that the mean often gives a misleading impression of the prevalence of the item. Medians are less sensitive to outlying values, but are zero for all items that are found in fewer than half of the stratigraphic units, so they do not capture the prevalence of less-common items and cannot distinguish between items that are uncommon and those that are absent. Worse yet, since items are more often absent from small sampling units than from large ones, rare items are prone to have zero medians more often in groups of small units than in groups of large units, where the median will more often be small but not zero. The effect is that medians make rare items disappear preferentially from samples in which the sampling units are small, like those from Loreto Alto. Some measure of the amount of the item present is necessary, simply to get an idea of how much is present and to answer the important question of which group has more or less of the item.

For descriptive purposes in the analysis that follows, all the midden from all the stratigraphic units is pooled together, and the total mass of the item in question from all the stratigraphic units is divided by the total standardizing variable (such as total artifact mass) of all the stratigraphic units. This method is equivalent to a weighted mean of the measures. It yields a single standardized figure for the entire group of stratigraphic units that is insensitive to variations in sample size and non-normal distributions of values across different units. This is the value that is reported to describe the prevalence of each item in the tables that follow.

For the purposes of statistical testing, however, it is necessary to maintain the separate values of each stratigraphic unit. Because these values are distributed so non-normally, parametric statistics such as t-tests and chi-square tests give meaningless results, in effect because the variances of the non-normal distributions are so large that two such distributions are almost never found to be significantly different.

The analysis that follows uses a non-parametric significance test, the Wilcoxon rank-sum test, to determine whether the prevalence of an item is significantly different in different groups. This test in effect arranges the values from both distributions in numerical order, and evaluates the probability of that order resulting from random sampling of a single population. The magnitudes of the values are ignored. If the values from one group are sufficiently improbably clustered at the low or high end of the ranking, then the groups are deemed to have been drawn from significantly different populations. The rank-sum test does not assume that the samples are normally distributed. It is less sensitive, and so more conservative, than the common parametric tests are to differences between samples of more normally distributed data. For data such as the archaeological material discussed here, however, parametric statistics are so confounded by the non-normal distributions that the non-parametric tests that make fewer assumptions about the data actually find many more statistical differences and seem to better capture the variability in the data.

Because the data are so ill-behaved, none of these approaches is perfect. Occasionally a Wilcoxon rank-sum test will indicate that group A has significantly more of an artifact than group B, while the lumped total value for the artifact for each group will indicate the opposite. These anomalies are possible because the lumped total value is more sensitive to extreme outliers than the non-parametric significance test. When the two ways of characterizing the data disagree, the pattern one chooses to see in the data depends on what aspect of the distribution (the magnitude of occasional outliers or the frequency of moderate values) seems most important for the question at hand; there is no correct or incorrect interpretation. In this analysis, these cases are generally treated as inconclusive or ambiguous.

Finally, some artifacts are excluded from the analysis in order to prevent unwanted distortions of the remaining data. All single items with mass greater than 300 grams are excluded, since the presence of one such large, rare item in the standardizing variable would reduce the standardized amount of all the other items drastically. Most of the excluded heavy items are wooden posts and rare large stone items, typically cobbles with grinding or battering wear. Several other categories of cultural material, such as ash, mortar, and finely divided materials such as some deposits of feces that were collected along with considerable quantities of dirt, are excluded from the analysis in order to maintain a fair representation of other midden contents.

Results and conclusions

Selected midden analysis results are presented in tables in the body of the dissertation, specifically Tables 7-1, 7-2, and 7-5. Table 7-1 lists the major components of domestic midden by broad categories for the Chiribaya and Ilo-Tumilaca/Cabuza groups, and indicates whether one group had significantly more than the other. Table 7-2 does the same for marine shell varieties. Table 7-5 compares the prevalence of selected items in Algodonal Early Ceramic contexts with both Ilo-Tumilaca/Cabuza and Chiribaya groups. Table E-6 summarizes the differences and similarities of Ilo-Tumilaca/Cabuza and Chiribaya midden qualitatively. Finally, Tables E-7 through E-16 list the basic midden data and statistical tests of difference between all of the groups in all the detail that was attempted here. The data are coded in much greater detail than these summary data indicate; future work may make further use of comparisons between different parts of plants, degrees of burning, axial bones versus limb bones versus foot bones, and so on.

In all of these tables, the values are masses in grams unless specified otherwise. A few types of items, such as large seeds, are also measured by counts. Categories such as plant and animal species or varieties include all parts of the animal or plant unless specified otherwise. "Bean," for example, includes seeds, pods, and attached twigs.

The second goal of the midden analysis was to reconstruct and compare the subsistence and economic strategies of the prehistoric groups, including exchange and other specialized activities. All three analyzed groups clearly employed mixed subsistence strategies emphasizing farming of corn, yuca, beans, and various subsidiary crops; herding camelids for wool, meat, and probably transport; and gathering marine resources, primarily shellfish but also including fish. The relative importance of the different foods in the diet are difficult to reconstruct, due to unknown variation in the survival of recognizable refuse after processing, disposal patterns, preservation, and recovery. No attempt is made here to determine the proportions of foods actually consumed. Nevertheless, it seems that the emphases changed over time (see Table 7-5), possibly in response to increasing population and

More in Ilo-Tumilaca/Cabuza	More in Chiribaya	No significant difference (selected)
	Overall density	
	Botanical/all	
	Botanical/screened volume	All/screened volume
	Animal remains	
Animal/all	Cuy	
Large animal/all	Cuy feces/feces	Camelid feces/all
Camelid feces/feces	Feces/all	Large animal/animal
	Plant remains	
Maize cobs, etc/all maize	Maize	Achira
	Algarrobo (?, weakly)	Algarrobo (?, moderately)
	Molle	Bark
	Guava	Beans
Black beans/beans	Lucuma (exclusively)	Black bean/all
		Black bean/botanical
		Coca
Squash (minuscule amounts)	Cotton/all (?, weakly)	Cotton (?, most measures)
	Gourd	Pacay
Tubers/identified botanical (lots)		Tubers/all
		Tubers/botanical
		Yuca
	Marine and riverine resources	
	Algae	
Crayfish	Fish	Shell/all
Crepipatella slipper shell 3%	*Aulacomya* mussel <1%	*Balanus* barnacle <1%
Choromytilus mussel 84%	*Chiton* chiton 30%	*Concholepas* false abalone 1-2%
	Donax small surf clam 4%	*Echinoidea* sea urchin <1-6%
	Perumytilus <1%, exclusively	*Fissurella* limpet 2-16%
	Semele clam 9%, exclusively	*Oliva* olive shell <1%
	Tegula snail 2%, exclusively	*Turritella* snail <1%
	Textiles	
		Textiles in general
Wool textiles/textiles		Wool textiles/all
Colored thread/textiles		Wool textiles/all botanical
Colored thread/threads	Cotton textiles	Colored thread/all
		Colored thread/all botanical
	Ceramics	
		Ceramics/all
		Burned ceramics (?, mostly)
Fine paste	Local paste	Decorated ceramics
	Miscellaneous	
		Wood chips/all
		Rope
		Flaked lithics
Wood and chips		Groundstone <300g
Charcoal	Land snail shell	Human remains

Table E-6. Qualitative comparison of Chiribaya and Ilo-Tumilaca/Cabuza midden.

the need to use less desirable resources as it became harder to find or produce increasing amounts of the most favored ones to meet the rising demand. There is little evidence for hunting; projectile points are rare, and the vast bulk of the animal bone is from camelids. Bird bone is scarce. None of the three groups appears highly specialized, although differences in the plant and shellfish species mixes can be construed to imply either differences in cultural preferences, or that the Chiribaya had generally better access to many probably preferred resources than the Ilo-Tumilaca/Cabuza people at Loreto Alto. There is no evidence at all for long-distance exchange except for a variety of coca that is currently said to come from further north on the Peruvian coast (John Dendy, pers. com.); nothing else in the middens could not have been produced locally. The relative scarcity at Loreto Alto of some probably prized items, such as cuyes and various tree fruits, that are significantly more common at El Algodonal suggests that there may even have been very little exchange between sites within sight of each other in the coastal valley. There is virtually no evidence for craft production other than the craft goods themselves, although this absence may be due to the small size of the sample.

Despite real changes in emphasis, the entire known ceramic-period prehistory of the coastal Osmore valley is characterized by people who used grossly similar settled, agro-pastoral subsistence strategies with little exchange within or beyond the coastal valley. Within that general subsistence scheme, however, the Chiribaya people left denser, deeper refuse with significantly more remnants of many valued products than did the Ilo-Tumilaca/Cabuza people at Loreto Alto, suggesting that the Chiribaya may have lived in denser and/or longer-lasting settlements, and may have had preferential access to some resources or areas including several tree crops and a variety of shellfish species.

Table E-7. Midden data: Corn and tubers.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Corn/all	2.27	0.27	3.07	15.06	.17	* .002	* .0001	* .0001	* .007
Corn/all botanical	36.48	1.34	35.51	59.20	.62	* .0004	* .0001	* .0001	.74
Corn/identified botanical	81.51	14.42	177.56	304.44	.59	* .0001	* .0001	* .0001	.42
Corn cob, husk, kernels/all	19.91	0.15	0.94	2.80	.19	.16	* .0003	* .003	* .002
Corn cob, husk, kernels/all botanical	35.84	0.74	10.89	10.99	.55	* .02	* .003	* .02	.12
Corn cob, husk/identified botanical	80.09	7.94	54.48	56.53	.50	* .02	* .001	* .002	.31
Corn cobs & kernels/all corn	98.26	55.06	29.14	14.90	.96	* .002	* .05	* .03	.86
Corn flower/all	0.0081	0.0418	0.0435	0.2847	.78	* .0001	* .0009	* .004	* .01
Corn flower/all botanical	0.015	0.211	0.504	1.119	.84	* .0001	* .0007	* .0007	.13
Corn flower/identified botanical	0.03	2.27	2.52	5.76	.97	* .0001	* .006	* .007	.32
Tubers/all	2.05	0.68	0.02	0.13	.55	* .007	.34	* .04	* .0001
Tubers/all botanical	3.69	3.44	0.18	0.52	.98	* .04	.30	* .04	* .0005
Tubers/identified botanical	0.24	36.88	0.88	2.68	.46	* .02	* .06	* .01	* .002
Yuca/all	2.03	0.57	0.01	0.12	* .03	* .03	.12	.85	* .0001
Yuca/all botanical	3.65	2.86	0.11	0.46	* .03	* .07	.10	.94	* .0002
Yuca/identified botanical	2.25	30.72	0.55	2.35	.19	* .09	.29	.73	* .0008
Yuca peel/all	0.482	0.416	0.009	0.061	* .03	* .01	.20	.76	* .0002
Yuca peel/all botanical	0.868	2.104	0.101	0.238	* .05	* .07	.20	.83	* .0006
Yuca peel/identified botanical	1.94	22.37	0.51	1.22	.21	* .04	.37	.65	* .002
Yuca peel/yuca	23.79	73.46	91.53	52.04	.59	.77	.44	.35	.39
Yuca root/all	1.545	0.150	0.001	0.056	.34	.37	.79	.22	* .03
Yuca root/all botanical	2.782	0.760	0.009	0.219	.38	.44	.76	.22	* .03
Yuca root/identified botanical	0.31	8.15	.05	1.13	.75	.42	.94	.18	* .04
Yuca root/yuca	76.21	26.54	8.47	47.96	.59	.77	.44	.35	.39

Table E-8. Midden data: Minor food crops.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Beans/all	1.21	0.08	0.08	0.31	* .03	* .007	.50	.95	.15
Beans/all botanical	2.18	0.42	0.95	1.21	* .07	* .05	.65	.87	.33
Beans/identified botanical	4.87	4.48	4.77	6.18	.14	* .02	.98	.71	.68
Brown bean/all	0.0094	0.0100	0.0002	0.0067	.85	.29	.48	.30	* .008
Brown bean/all botanical	0.017	0.050	0.002	0.027	.85	.31	.48	.30	* .008
Brown bean/all beans	0.779	12.048	0.197	2.198	.56	.13	.63	.20	* .006
Black bean/all	0.136	0.018	0.017	0.236	.21	* .002	.33	.56	.48
Black bean/all botanical	0.245	0.091	0.194	0.926	.41	* .004	.30	.64	.29
Black bean/all beans	11.23	21.69	20.35	76.82	.96	* .04	* .09	.58	.11
Pallar/all	0.20	0.00	0.00	0.00	* .009	* .0001	-	-	-
Pallar/all botanical	0.35	0.00	0.00	0.00	* .009	* .0001	-	-	-
Achira/all	0.12	0.35	0.05	0.26	.82	.52	.88	.22	.11
Achira/all botanical	0.22	1.78	0.55	1.00	.97	.84	.58	.17	.18
Achira/identified botanical	0.50	19.11	2.73	5.16	.48	.96	.48	.17	.25
Squash/all	0.0040	0.0020	0.00	0.0002	.74	.11	* .05	* .006	.31
Squash/all botanical	0.0073	0.0101	0.00	0.0006	.67	.12	* .05	* .006	.31
Squash/identified botanical	0.016	0.108	0.00	0.003	.59	.11	* .04	* .004	.32
Squash, number of seeds/all	0.0269	0.0299	0.0008	0.0015	.67	.11	* .05	* .04	.95
Squash, number of seeds/all botanical	0.0485	0.1510	0.0094	0.0060	.67	.12	* .05	* .04	.98
Squash, number of seeds/identified botanical	0.108	1.620	0.00	0.031	.59	.11	* .04	* .004	.32
Algae/all	0.024	0.004	0.019	0.479	.65	* .09	* .03	* .08	* .09
Algae/all botanical	0.044	0.020	0.221	1.882	.70	* .08	* .05	* .08	.23
Algae/identified botanical	0.10	0.22	1.10	9.68	.94	* .05	* .06	.10	.31

Table E-9. Midden data: Tree crops (page one of two).

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Lucuma/all	0.00	0.00	0.54	0.34	* .0001	* .0005	* .002	* .0001	.63
Lucuma/all botanical	0.00	0.00	0.62	1.33	* .0001	* .0005	* .002	* .0001	.37
Lucuma/identified botanical	0.00	0.00	3.10	6.83	* .0001	* .0005	* .003	* .0001	* .08
Guava/all	0.015	0.00	0.047	0.042	.43	* .07	* .03	* .02	.49
Guava/all botanical	0.027	0.00	0.546	0.167	.43	* .07	* .03	* .02	.24
Guava/identified botanical	0.06	0.00	2.73	0.86	.46	* .05	* .04	* .02	.21
Pacay/all	0.29	0.52	0.28	0.21	.44	.25	.87	.31	.15
Pacay/all botanical	0.52	2.65	3.21	0.84	* .03	* .006	.66	.13	* .006
Pacay/identified botanical	1.16	28.46	16.05	4.32	* .02	* .008	.20	.26	* .0001
Pacay seed/pacay	29.44	58.06	6.58	13.26	.46	.96	.25	* .04	.37
Pacay seed/identified botanical	0.34	16.52	1.06	0.57	* .04	.11	.19	.21	.73
Pacay, number of seeds/all	0.16	2.41	0.07	0.06	.16	.37	.24	.34	.74
Pacay, number of seeds/all botanical	0.29	12.21	0.84	0.23	* .07	.15	.27	.34	.51
Pacay, number of seeds/identified botanical	0.65	107.71	4.04	1.11	.15	.11	.40	.50	.44
Pacay pod/pacay	69.63	24.48	92.08	80.50	.30	.98	* .05	* .002	* .05
Pacay pod/identified botanical	0.81	7.00	14.78	3.48	.30	* .04	.73	* .002	* .0001
Algarrobo/all	0.008	0.126	0.016	0.033	.97	* .03	.12	.25	.12
Algarrobo/all botanical	0.015	0.634	0.181	0.128	.97	* .01	* .09	.14	.54
Algarrobo/identified botanical	0.03	6.80	0.91	0.66	.86	* .02	.26	.32	.68
Algarrobo, number of seeds/all	0.081	0.861	0.145	0.286	.97	* .04	.12	.29	.13
Algarrobo, number of seeds/all botanical	0.146	4.351	1.680	1.126	.97	* .02	* .08	.17	.45
Algarrobo, number of seeds/identified botanical	0.33	46.67	8.40	5.70	.86	* .03	.29	.35	.81

Table E-10. Midden data: Tree crops (page two of two).

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Molle seed/all	0.004	0.002	0.040	0.351	.89	* .0001	* .0004	* .02	* .001
Molle seed/all botanical	0.007	0.010	0.458	1.381	.81	* .0004	* .001	* .02	* .004
Molle seeds/identified botanical	0.02	0.11	1.80	1.43	.80	* .03	* .09	.15	.79
Molle, number of seeds/all	0.04	0.03	3.49	6.53	.81	* .02	* .07	.12	.47
Molle, number of seeds/all botanical	0.07	0.15	40.49	25.66	.81	* .02	* .06	.12	.68
Molle, number of seeds/identified botanical	0.16	1.62	91.24	48.66	.80	* .03	* .09	.14	.85
Sticks and twigs/all	19.30	8.66	4.98	8.83	* .01	.22	* .06	.34	* .02
Sticks and twigs/all botanical	34.75	43.79	57.66	34.70	.23	.64	.25	.95	* .09
Bark/all	0.84	5.05	0.22	0.46	.16	* .008	.82	.95	.48
Bark/all botanical	1.52	25.52	2.57	1.80	.88	* .09	.42	.66	.51
Wood and wood chips/all	0.29	12.61	0.37	0.37	.12	.96	* .06	.20	.18
Wood and wood chips/all botanical	0.52	63.73	4.23	1.47	* .004	.34	* .005	* .06	* .009

Table E-11. Midden data: Coca, industrial crops, and charcoal.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Coca/all	0.00	0.0050	0.0002	0.0006	.11	.29	.26	.12	.61
Coca/all botanical	0.00	0.0252	0.0019	0.0024	.11	.29	.28	.12	.61
Coca/identified botanical	0.00	0.27	0.01	0.01	* .09	.29	.21	* .09	.63
Coca, number of seeds/all	0.00	0.1892	0.0016	0.0123	.11	.22	.39	.12	.35
Coca, number of seeds/all botanical	0.00	0.9565	0.0188	0.0482	.11	.22	.42	.12	.37
Coca, number of seeds/identified botanical	0.00	10.26	0.09	0.22	* .09	.29	.21	* .09	.63
Cotton/all	0.53	0.09	0.06	0.17	* .01	* .01	* .05	.73	* .0001
Cotton/all botanical	0.95	0.45	0.75	0.67	.18	.49	.29	.77	* .001
Cotton/identified botanical	2.13	4.86	3.74	3.43	.30	.19	.86	.45	* .007
Cotton, number of seeds/all	3.07	0.31	0.17	0.50	.12	.11	.11	.42	* .0001
Cotton, number of seeds/all botanical	5.54	1.56	1.97	1.97	.51	.61	.40	.48	* .004
Cotton, number of seeds/identified botanical	12.10	16.74	8.04	9.20	.63	.23	.92	.10	* .02
Gourd (unworked)/all	0.33	0.01	0.06	0.12	* .007	.13	* .005	* .0006	.32
Gourd (unworked)/all botanical	0.59	0.05	0.65	0.47	* .03	.96	* .02	* .005	.98
Gourd, unworked/identified botanical	1.32	0.49	3.23	2.41	* .05	.81	* .04	* .009	.64
Gourd, number of seeds/all	0.34	0.09	0.02	0.29	* .05	.79	* .05	.18	* .07
Gourd, number of seeds/all botanical	0.61	0.45	0.28	1.14	* .07	.83	* .05	.14	.19
Gourd, number of seeds/identified botanical	1.35	4.86	1.27	5.81	.12	.96	* .09	.28	.16
Charcoal/all	3.17	1.93	0.43	0.84	.51	* .0008	* .0003	* .0001	.97
Charcoal/all botanical	5.71	9.74	4.99	3.31	* .02	* .03	* .0004	* .0003	* .02

Table E-12. Midden data: Animal remains.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Shell/all	9.33	17.02	30.83	16.04	.11	.19	.14	.17	* .0001
Fish/all	0.86	1.10	1.11	2.53	.62	.13	* .05	.81	* .007
Crayfish/all	0.60	0.06	0.04	0.03	.64	* .02	* .04	* .02	.58
Crayfish/all botanical	1.08	0.30	0.47	0.13	.31	.14	* .009	* .03	* .07
Animal/all	0.37	21.40	10.95	16.38	* .0001	* .0001	* .01	* .0004	.14
All feces/all	6.90	3.29	3.95	9.08	.60	* .03	* .002	* .07	* .0001
Large mammal/all	0.16	20.30	10.30	15.06	* .0001	* .0001	* .01	* .0009	.23
Large mammal/all animal	43.17	93.75	93.37	90.41	* .0004	* .0001	.19	.28	* .001
Camelid/all	0.03	3.99	2.13	0.90	* .02	* .07	.20	.61	.10
Camelid/all animal	8.12	18.44	19.30	5.43	* .06	.14	.28	.91	* .08
Camelid feces/all	4.06	2.85	2.61	2.21	.88	.58	.52	.35	.40
Camelid feces/all feces	58.85	86.47	66.20	24.37	* .03	* .02	* .0001	* .01	* .0001
Cuy/all	0.02	0.00	0.04	0.06	.43	.18	* .06	* .04	.76
Cuy/all botanical	0.03	0.00	0.41	0.23	.43	.18	* .06	* .04	.65
Cuy/all animal	5.17	0.00	0.32	0.36	.41	.22	* .06	* .04	.78
Cuy feces/all	0.21	0.00	0.65	3.65	* .07	* .0001	* .0001	* .0001	* .0002
Cuy feces/all botanical	0.38	0.00	7.50	14.39	* .07	* .0001	* .0001	* .0001	* .007
Cuy feces/all feces	3.07	0.00	16.40	40.18	* .05	* .01	* .0001	* .0001	* .006
Algae/all	0.024	0.004	0.019	0.479	.65	* .09	* .03	* .08	* .09
Algae/all botanical	0.044	0.020	0.221	1.882	.70	* .08	* .05	* .08	.23
Insect/all	0.0081	0.0070	0.0007	0.0453	.52	.33	.91	.13	* .03
Land snail/all	0.00	0.00	0.11	0.26	* .0001	* .0002	* .0009	* .0002	.25
Land snail/all botanical	0.00	0.00	1.23	1.01	* .0001	* .0002	* .0009	* .0002	.80
Human remains/all	0.00	0.00	0.10	0.05	* .0001	.22	.28	.19	.62

Table E-13. Midden data: Marine shell.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Choromytilus chorus mussel/all	7.09	14.23	22.58	5.11	.18	.51	* .04	* .09	* .0001
Choromytilus chorus mussel/all shell	76.06	83.60	73.25	31.83	.29	* .0009	* .05	.95	* .0001
Crepipotella slipper shell/all	0.183	0.433	0.097	0.020	* .03	.61	* .0001	* .03	* .0002
Crepipotella slipper shell/all shell	1.96	2.55	0.315	0.121	* .01	.66	* .0001	* .01	* .0003
Chiton chiton/all	0.00	0.14	1.15	4.73	.11	* .0001	* .001	* .0003	.30
Chiton chiton/all shell	0.00	0.84	3.72	29.51	.13	* .0001	* .0008	* .004	* .0002
Semele solida clam/all	0.00	0.00	0.62	1.37	* .0001	* .004	* .01	* .0001	.42
Semele solida clam/all shell	0.00	0.00	2.02	8.53	* .0001	* .006	* .01	* .0001	.69
Donax obesulus small surf clam/all	0.00	0.02	0.19	0.69	* .04	* .001	* .06	.15	.26
Donax obesulus small surf clam/shell	0.00	0.12	0.61	4.33	* .05	* .002	* .09	.26	.14
Tegula atra snail/all	0.01	0.00	1.29	0.27	.43	* .0005	* .0009	* .0001	* .0001
Tegula atra snail/all shell	0.13	0.00	4.20	1.67	.41	* .002	* .0009	* .0001	* .007
Aulacomya ater mussel/all	0.160	0.00	0.073	0.143	.23	.46	* .05	* .02	.40
Aulacomya ater mussel/all shell	1.72	0.00	0.24	0.89	.21	.53	* .05	* .02	.66
Perumytilus small mussel/all	0.00	0.00	0.20	0.04	* .0001	* .05	* .08	* .0001	* .0001
Perumytilus small mussel/all shell	0.00	0.00	0.63	0.27	* .0001	* .06	* .08	* .0001	* .0001
Fissurella keyhole limpet/all	0.22	0.30	2.04	2.52	.19	* .01	.36	* .03	.26
Fissurella keyhole limpet/all shell	2.37	1.76	6.62	15.72	.22	* .02	.28	.17	.89
Echinoidia sea urchin/all	0.004	0.939	0.101	0.052	.21	* .02	.39	.10	.29
Echinoidia sea urchin/all shell	0.043	5.519	0.327	0.324	.20	* .01	.37	.10	.97
Concholepas false abalone/all	0.00	0.10	0.64	0.30	.29	.16	.84	* .04	* .0005
Concholepas false abalone/all shell	0.00	0.59	2.07	1.89	.32	.18	.84	* .04	* .0006
Balanus barnacle/all	0.080	0.021	0.054	0.008	.76	.71	.96	.19	* .002
Balanus barnacle/all shell	0.852	0.123	0.177	0.052	.75	.67	.99	.12	* .004
Oliva olive shell/all	0.078	0.00	0.015	0.009	.12	.18	.36	.12	.20
Oliva olive shell/all shell	0.838	0.00	0.048	0.056	.11	.11	.36	.12	.20
Turritella cingulata snail/all	0.00	0.00	0.00	0.005	-	.57	.63	-	.31
Turritella cingulata snail/shell	0.00	0.00	0.00	0.029	-	.59	.63	-	.31
Identified shell/all shell	83.97	95.10	94.24	95.22	.26	.69	.30	1.00	* .009

Table E-14. Midden data: Craft goods.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Flaked lithics/all	0.003	1.29	0.55	0.11	.85	.73	.96	.16	* .01
Flaked lithics/all botanical	0.005	6.50	6.42	0.42	.85	.69	.96	.15	* .008
Flaked lithics/all stone (<300 g)	0.03	100.00	8.15	5.26	1.0	.84	.75	.47	.91
Ceramics/all	21.20	14.35	41.62	25.46	.10	* .001	.14	* .003	* .002
Decorated ceramics/all	0.00	5.48	2.94	1.53	* .006	* .001	.52	.47	* .0008
Decorated ceramics/all ceramics	0.00	38.16	7.06	6.00	* .02	* .01	.14	.54	* .01
Burned ceramics/all	3.44	7.71	17.25	16.30	.32	* .0008	* .03	* .001	* .08
Burned ceramics/all ceramics	16.22	53.74	41.45	64.04	.41	.22	.54	.88	.10
Fine paste ceramics/all	0.00	3.94	3.34	0.11	* .002	.16	* .002	* .03	* .0001
Fine paste ceramics/all ceramics	0.00	27.44	8.02	0.45	* .008	.27	* .0004	.59	* .0001
Local paste ceramics/all	0.335	0.003	12.770	19.893	.67	* .0001	* .0001	* .0001	.14
Local paste ceramics/all ceramics	1.58	0.02	30.68	78.15	.43	* .0001	* .0001	* .0001	* .0001
Mean sherd size (mass)	14.85	6.83	6.15	9.15	.27	.94	.10	.30	* .04
Basket/all	0.00	0.00	0.023	0.004	* .0001	.40	.47	.49	.99
Basket/all botanical	0.00	0.00	0.263	0.015	* .0001	.40	.47	.49	.99
Estera mat/all	0.6197	0.00	0.0233	0.0081	.12	* .02	.63	.24	.12
Estera mat/all botanical	1.116	0.00	0.270	0.032	.12	* .03	.63	.24	.12
Wood chips/all	0.03	11.25	0.13	0.18	.44	.18	.19	.10	.84
Worked shell/all	0.00	0.00	0.0024	0.0607	-	.40	.47	.49	.92
Worked shell/all botanical	0.00	0.00	0.0282	0.2384	-	.40	.47	.49	.94
Worked shell/all shell	0.00	0.00	0.0079	0.3767	-	.42	.47	.49	.92
Worked *oliva*/all	0.00	0.00	0.0024	0.0011	-	.57	.63	.49	.62
Worked *oliva*/all botanical	0.00	0.00	0.0282	0.0042	-	.57	.63	.49	.60
Worked *oliva*/all shell	0.00	0.00	0.0079	0.0067	-	.59	.63	.49	.62
Leather/all	0.00	0.095	0.015	0.070	.30	* .04	.30	.98	.05
Leather/all botanical	0.00	0.478	0.169	0.276	.30	* .04	.28	.98	.05

Table E-15. Midden data: Textiles.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
Textiles all types/all	0.14	3.17	0.26	1.16	.98	.15	.39	.41	.40
Textiles all types/all botanical	0.25	16.01	3.03	4.55	.30	* .04	.76	.81	.67
Wool textiles/all	0.08	2.70	0.25	1.13	.43	* .05	.58	.45	.65
Wool textiles/all botanical	0.14	13.66	2.92	4.45	.14	* .02	.68	.81	.54
Wool textiles/all textiles	56.86	85.32	96.53	97.79	* .0004	* .0002	* .04	.19	* .08
Cotton textiles/all	0.063	0.465	0.017	0.133	* .005	* .02	* .04	* .06	.13
Cotton textiles/all botanical	0.114	2.351	0.202	0.524	* .005	* .07	* .04	* .06	.60
Cotton textiles/wool textiles	46.08	14.68	6.67	11.52	* .0004	* .0003	* .03	.15	* .04
Colored threads/all	0.0040	0.0269	0.0045	0.0052	* .09	.21	.27	.11	.56
Colored threads/all botanical	0.0073	0.1359	0.0516	0.0205	* .05	.17	.17	.13	.81
Colored threads/all textiles	2.94	0.85	1.71	0.45	* .05	.23	.10	* .05	.53
Colored threads/all wool threads	8.11	38.57	31.25	9.83	* .09	.25	* .08	.15	.88
Wool rope/all	0.0013	0.0607	0.0294	0.0317	.17	.36	.46	.87	.40
Wool rope/all botanical	0.0024	0.3071	0.3407	0.1246	.15	.36	.37	.80	.28

Table E-16. Midden data: Standardizing variables.

Trait	Value for lumped sample				Wilcoxon rank sum significance				
	Algodonal Early Ceramic	Ilo-Tumilaca/ Cabuza	Mixed I-T/C and Chiribaya	Chiribaya	A. Early Ceramic & I-T/C	A. Early Ceramic & Chiribaya	Chiribaya & I-T/C	I-T/C & Mixed	Chiribaya & Mixed
All/screened volume	7.88	13.27	34.12	25.98	.16	* .007	.18	* .0006	* .003
All botanical/screened volume	4.38	2.62	2.94	6.61	* .04	.61	* .01	* .003	.84
All botanical/all	55.55	19.78	8.63	25.44	* .006	* .07	* .02	.40	* .001
Identified botanical/all	24.86	1.84	1.73	4.95	* .001	* .04	* .02	.54	* .0007
Identified botanical/all botanical	44.75	9.32	20.00	19.45	.10	.27	.21	.45	* .01