CHAPTER 16

The Manufacture and Content of Pottery Vessels in Early Formative Mazatán

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The issue that unites this volume is inquiry into the social dynamics that generated tecomate-dominant and dish-dominant assemblages at contemporaneous sites a few kilometers from each other in Early Formative Mazatán. Existing interpretations of the pattern touch on many of the social transformations thought to have characterized early complex societies more generally: the adoption of sedentary lifeways, status competition and social inequality, the formation of multi-village polities, and the expansion of economic networks at the inter- and intra-community levels. Each of the chapters in this final section considers some specific dimension of the larger problem.

In this chapter, we explore two aspects of the possibility of specialized production at El Varal. Our evidence derives from chemical analyses of potsherds. Analyses included *compositional studies*—based on instrumental neutron activation analysis (INAA) and microwave digestion inductively coupled plasma mass spectrometry (MD-ICP-MS)—and *residue analysis* using gas chromatography mass spectrometry (GC-MS). These studies provide novel sources of evidence on the production, exchange, and use of ceramic vessels in late Early Formative Mazatán.

As noted in Chapter 1, when Carballo began the research reported here as his master's thesis work at UCLA (Carballo 2001) he and Lesure had great hopes that the data produced (particularly the residue analysis) would resolve the puzzle of Early Formative inter-site variability in the Mazatán region. Although those original high hopes have not been borne out, the work contributes crucial pieces of the picture built over the course of this volume that are synthesized into "concluding hypotheses" in Chapter 18.

Specifically, this chapter provides the best available evidence concerning two plausible explanations for inter-site variability in vessel forms. First, maybe tecomates dominate the assemblage at El Varal perhaps because that was where tecomates were manufactured—in a specialized productive system involving the transfer of *tecomates as products* to other sites. Second, perhaps the tecomates of El Varal were primarily used in the processing of a single primary estuary resource (Table 14.2, row 7). Alternatively, both of these hypotheses may not find supporting evidence in our study—leading us to explore other possibilities more seriously.

Sherds from several sites in the Mazatán region were included in the study, but our interpretations are primarily derived from just two: tecomate-dominant El Varal and dish-dominant Cantón Corralito (see Figure 1.1 or 15.2 for locations). Sherds from El Varal span the Early through Late periods. Cantón Corralito sherds

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were from test unit 10 in the San Carlos Mound area (see Chapter 17 for further discussion of that unit).

Our sample is small, and the residue analysis was affected by degradation of fatty acids. Still, neither study yields concrete evidence for specialized production in the organizational sense. Compositional analysis produced no clear evidence for specialized production of pottery. We suggest that the bulk of the pottery assemblage (including tecomates) at dish-dominant and tecomate-dominant sites was produced at the sites themsevles. Still, pottery vessels do seem to have occasionally been transferred to the inland site from some location in the estuary near El Varal (perhaps from El Varal itself).

Residue analysis, in turn, reveals no significant differences between vessel content at tecomate-dominant and dish-dominant sites or between dishes and tecomates. Further, the content of Varal tecomates seems to have been more varied than one might have expected from a pattern of specialized production of a single estuary resource. Finally, in the methodological domain our study demonstrates how different chemical analyses can be effectively used in conjunction to address more complex topics in material-culture studies.

Early Sedentism, Social Complexity, and Economic Specialization

The primary anthropological issues of interest in this study concern the evolution and maintenance of social complexity within the context of early sedentary communities. For the purposes of this chapter, we follow an evolutionary archaeological definition of complexity: a nonprogressive multilinear quantitative measure that describes a system based on continuous degrees of differentiation and integration in its constituent parts (e.g., Kantner 2002). Our use of the term *social complexity* is intentionally broad, intended to refer to an entire spectrum of potential social dynamics rather than to isolate particular arenas of human interaction—such as political, economic, religious, or kinship relations among individuals.

The earliest deposits in the Vásquez Mound at El Varal date from some 700 years after the appearance of ceramics in the region. As is clear from Clark's efforts at unraveling Early Formative sociopolitical transformations in the area, we can expect considerable "complexity" during the Cuadros and Jocotal phases—regardless of our position on the precise nature of that complexity (Clark 1994a, 1997; Blake and Clark 1999; Clark and Pye 2000; Lesure 2000; Cheetham 2006). Could inter-site assemblage variability at El Varal be ascribed to economic specialization? Such a claim would fit comfortably with the degree of late Early Formative political centralization hypothesized by Clark.

When we began the studies reported here, previous explanations for inter-site variability—including those emerging from Lesure's (1993) and Smith's (1997) work on El Varal materials—tended to assume that Early Formative communities with tecomate-dominant assemblages were occupied year-round and were under the political sway of some larger inland community. Inhabitants of tecomate-dominant sites might plausibly have been part-time specialists, producing some estuary product or products for exchange with inland communities.

The relationship between economic specialization and social complexity has long been of interest to archaeologists (Childe 1958; Costin 1991, 2004). Sorting out the causal relationships involved can be difficult (Clark and Parry 1990). Authors are not always explicit regarding whether they are presenting evidence for economic specialization as an *indicator* or as a *cause* of increased social complexity (Chapman 1996:74), and such ambiguity leaves important questions unresolved.

Foremost among such questions are the following. Did increased economic specialization stimulate incipient social divisions based on status and occupation, necessitating increasingly complex social arrangements between individuals? Alternatively, did preexisting social divisions provide the infrastructure that permitted specialized economic activities to evolve and comprise increasingly greater proportions of an economic system? Any particular case may have involved a confluence of both factors, developing a coevolutionary trajectory with "snowball" effects that drove accelerated social change. Archaeologists investigating particular sequences may, nevertheless, be able to identify which factors were of greater relative importance for particular portions of the sequence—and that was our goal in this study.

In developing a set of hypotheses for explaining the Early Formative inter-site assemblage variation in the Mazatán area, we searched for evidence of possible specialized economic activities against null hypotheses postulating lack of economic specialization. Carballo added hypothetical scenarios not involving specialization by considering the possibilities that the following two behaviors, or a combination of them, resulted in the pattern: residential mobility of inland populations who resided in the estuary seasonally [especially influenced by Arnold (1999)] and/or differential emphases in the material elaboration of food service [especially influenced by Clark and Blake (1994); see also Rosenswig (2007)].

Compositional Analyses

Chemical-composition studies of ceramics have been popular and productive methods for augmenting archaeological materials analyses (e.g., Neff 1992 and Tite 1999). The overwhelming majority have focused on reconstructing ancient exchange networks and interregional contacts. In this study, we applied compositional analyses to a more spatially restricted issue. Two separate analyses were conducted on the 51 sherds. First, Carballo and Kennett analyzed the samples at California State University, Long Beach (CSULB), using MD-ICP-MS following the procedures detailed by Kennett et al. (2001, 2002).

The analyses were undertaken when the CSULB laboratory methods were being developed and refined. To confirm the results of our analyses, pieces from the same samples were sent to the Missouri University Research Reactor (MURR) and analyzed by Neff and Glasscock using INAA and following MURR's well-documented procedures (Glascock 1992; Neff 2000). The pairing of these two analytical techniques allowed us to verify Carballo's (2001) interpretations derived from MD-ICP-MS alone.

Hypotheses

Lesure has discussed the puzzles of inter-site assemblage variability in Early Formative Mazatán with numerous archaeologists over the years. Many of those consulted suggested that the abundance of tecomates at El Varal might indicate that the site was used for the manufacture of that particular vessel form. Although we were always skeptical of the idea, it seemed desirable to assess it empirically rather than dismiss it out of hand. Compositional analysis of sherds from El Varal and Cantón Corralito presented an opportunity to generate relevant evidence, even if the small sample of sherds available was unlikely to allow us to derive a definitive conclusion.

Clay is reasonably abundant in the deltaic deposits of the Mazatán region. It would seem most likely that people in each community manufactured their own pots from local clays. That idea became our null hypothesis. Pots at each site should generally be more similar to each other, irrespective of vessel form, than to those of another site. They should also be similar in composition to clay samples from the vicinity of the site.

Plausibly, however, the occupants of El Varal manufactured tecomates—which they exchanged with people living inland for products (maize?) not available in the estuary. They would, in that sense, have been specialists—presumably part-time, because they also fished and foraged in the vicinity of the site. If this pattern was a general one in the area, we might expect the tecomates of dish-dominant sites to be "imports" from tecomate-dominant sites. Conceivably, the tecomates of Cantón Corralito might actually be imports from El Varal itself. However, because there were numerous sites (both dish dominant and tecomate dominant) in the region it would have been possible for the inhabitants of El Varal to have been specialized tecomate producers even if none of their products ended up at Cantón Corralito. The pattern we are looking for would thus be a divergence between the clay composition of dishes and tecomates at Cantón Corralito, with dishes similar in composition to local clay samples and tecomates diverging from such samples.

There is, of course, a third possibility. Perhaps tecomates had a secondary use (other than cooking; see Chapter 9), such as in the transport of resources harvested at El Varal. The vessels do not seem well designed for such a use. When full, they would have been quite heavy. The lack of neck would in addition have made them impossible to close. Spillage during transport would seem a problem. Still, partly filled tecomates could have been readily transported by canoe. In this scenario, some tecomates might have moved between sites without any specialized production of this vessel form. Inhabitants of both dish-dominant and tecomate-dominant sites would have manufactured a full range of vessels, but some transport vessels might have ended up inland.

Sample and Methods

The samples used in this study were acquired through excavations conducted under the aegis of the Mazatán Early Formative Project (directed by John Clark and Michael Blake) and exported to UCLA by Lesure in 1996. Fifty-one sherds were selected for compositional analyses. Although these samples originated from five sites in the Soconusco, three of the sites are poorly represented (Paso de la Amada, *n* = 9; Aquiles Serdán, *n* = 2; and Los Alvarez, *n* = 2)—and our interpretations are based on samples from El Varal (*n* = 18) and Cantón Corralito (*n* = 20).

The samples from El Varal originated from the Step Excavation. Those from Cantón Corralito originated from unit 10 near the San Carlos Mound, excavated by Mary Pye and John Clark in 1990. The San Carlos Mound area is just across the modern highway from the main area of Cuadros-phase settlement at Cantón Corralito (Pérez Suárez 2002; Cheetham 2006). The comparison of El Varal to Cantón Corralito is one between social extremes. El Varal was a minor settlement, occupied only part of the year through most of its occupation. Cantón Corralito was a large permanent settlement near the heart of social, political, and economic power in the region.

Results

The sherd samples from El Varal and Cantón Corralito are characterized by very low chemical variability. Only a few elements—including Barium (Ba), Cesium (Cs), and Sodium (Na)—show substantial divisions between groups, and these elements fail to define completely discreet clusters (Figure 16.1). This relative ceramic homogeneity is likely due to the proximity of the two sites. Three clay samples taken by John Clark from the vicinity of El Varal, and a fourth taken from the Cantón Corralito site, do not clarify the situation because they all cluster along with the majority of the sherds from Cantón Corralito. In cases such as these, when individual element concentrations provide little information for how compositional groups are differentiated multivariate statistical methods such as principal component analysis (PCA) provide the most appropriate means of assessing the multiple axes of variability that exist in the data.

The concentrations registered through MD-ICP-MS (for 39 elements) and INAA (for 33 elements) were transformed from parts per million (ppm) into log-10 values. This step served to flatten the variability between elemental concentrations and to enable comparisons between samples on a more uniform scale. Individual elements that did not have registered concentrations for all sherd samples were discarded, leaving an overlap of 26 elements between the two methods. PCA was used to define the major compositional groupings and to evaluate which particular elements

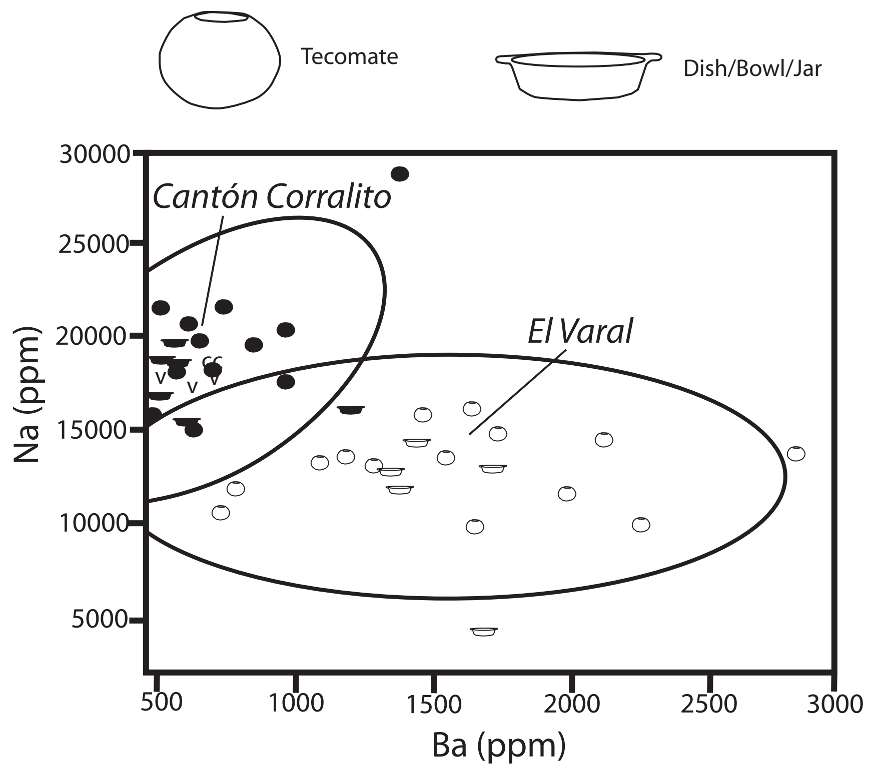

Figure 16.1. Bivariate projection of sodium and barium using INAA values in parts per million (ppm), and showing site pottery clusters within 95-percent probability ellipses for group membership. Open symbols represent samples excavated from El Varal. Those from Cantón Corralito are solid. Raw clay samples cluster with sherds from Cantón Corralito (V = Varal, CC = Cantón Corralito).

contributed the most to structuring the groups by condensing the multivariate data set into a few axes that explain most of the variability.

In both cases, outliers were identified by examining whether they lay outside a 95-percent group membership ellipse for bivariate projections of the first three principal components (PCs)—and whether their Mahalanobis distances from the group centroid were considerably higher than the next highest sample. A tecomate (20 percent higher) and a dish (100 percent higher) fit these criteria for the ICP and NAA analyses, respectively. If not due to a lab inconsistency, outliers can be interesting in compositional studies because they may represent secondary or tertiary loci of production and vessels that were exchanged to the sites being studied.

In cases where outliers are so aberrant as to be classified as their own compositional group, they should be removed to better understand the composition of the majority of the group. In comparing our two analyses we noted that the sherd identified as an outlier by NAA was identified by ICP as having potentially been produced at El Varal and transported to Cantón Corralito. Its aberrant status in both analyses could be evidence of it having come from a third site or having been moved between sites. However, the ICP outlier clusters securely within the Cantón Corralito cluster in NAA—suggesting that the sample may represent a single discrepancy between labs.

Compositional groups were assigned based on the assumption that they corresponded with the number of statistically significant PCs, or factors (Bishop and Neff 1989; Glascock 1992; Neff 1994). The number of significant PC-based compositional groupings can be determined with the Kaiser criterion (which uses all factors with eigenvalues greater than 1) or with a scree test, which charts when the number of factors reaches the point of diminishing returns in explanatory value. Whereas the Kaiser criterion may result in the selection of too many factors because a factor only has to explain its proportional share of the variability, scree tests can select too few because compositional groups exhibit significant differences that are not part of the major axes of variability in multidimensional space (Madsen 1988).

By coupling the Kaiser criterion and the scree test, one obtains an upper and lower limit for group possibilities. If adding or subtracting groups would result in differing interpretations of the data, the analyst should comment on all possibilities. Otherwise, it is more desirable to retain fewer factors that explain proportionally more of the variability. Such was the case in our analyses where three groups (explaining 70 percent of the variability) were defined for the ICP data and six groups (explaining 77 percent of the variability) were defined for the NAA data. Group membership for individual sherd samples was assigned by creating hierarchical clustering dendrograms of the significant PCs using Ward's method (Figure 16.2).

Although variability existed between the two methods in the number of groups assigned by PCA, the methods were highly consistent with each other in their assignments of sherds to the two sites. The exception to this was due to a lab inconsistency in the ICP analysis in which the first group of sherds, run on a different day than the rest, recorded lower concentrations in certain elements—causing them to cluster apart from the rest in the second PC. The lower values were clearly the result of a lab discrepancy, and because dates were recorded for the processing of the samples we were able to catch this error.

A bivariate projection of the first and third PCs for the ICP samples shows strong variability between the samples from El Varal and Cantón Corralito, as does one of the first and second PCs for the samples run by NAA (Figure 16.3). Three-dimensional projections of the first three PCs also show strong divisions, and illustrate how the ICP lab-error group clusters apart based on PCs 1 and 2. Most important, a bivariate projection of the particular elements with the greatest contribution to the division of samples by site for NAA separates the ICP lab-error group out by site as well (Figure 16.4).

By coupling the results from these two compositional methods, we are confident that the division of the ceramic samples into two groups largely corresponds to their site of origin—suggesting that occupants of both sites produced their pottery on-site, with occasional movement of pots between sites. A sherd-by-sherd summary is provided in Table 16.1.

In examining group membership, we observe that of the 19 sherds run from El Varal all have signatures consistent with on-site manufacturing of ceramics. Of an equal number of samples from Cantón Corralito, however, between three and four samples (representing 16 to 21 percent) have signatures consistent with manufacture elsewhere. It is possible that all aberrant samples from Cantón Corralito originated from El Varal (or some other nearby special-purpose site) and were transported to Cantón Corralito—or that as many as three originated from a third site.

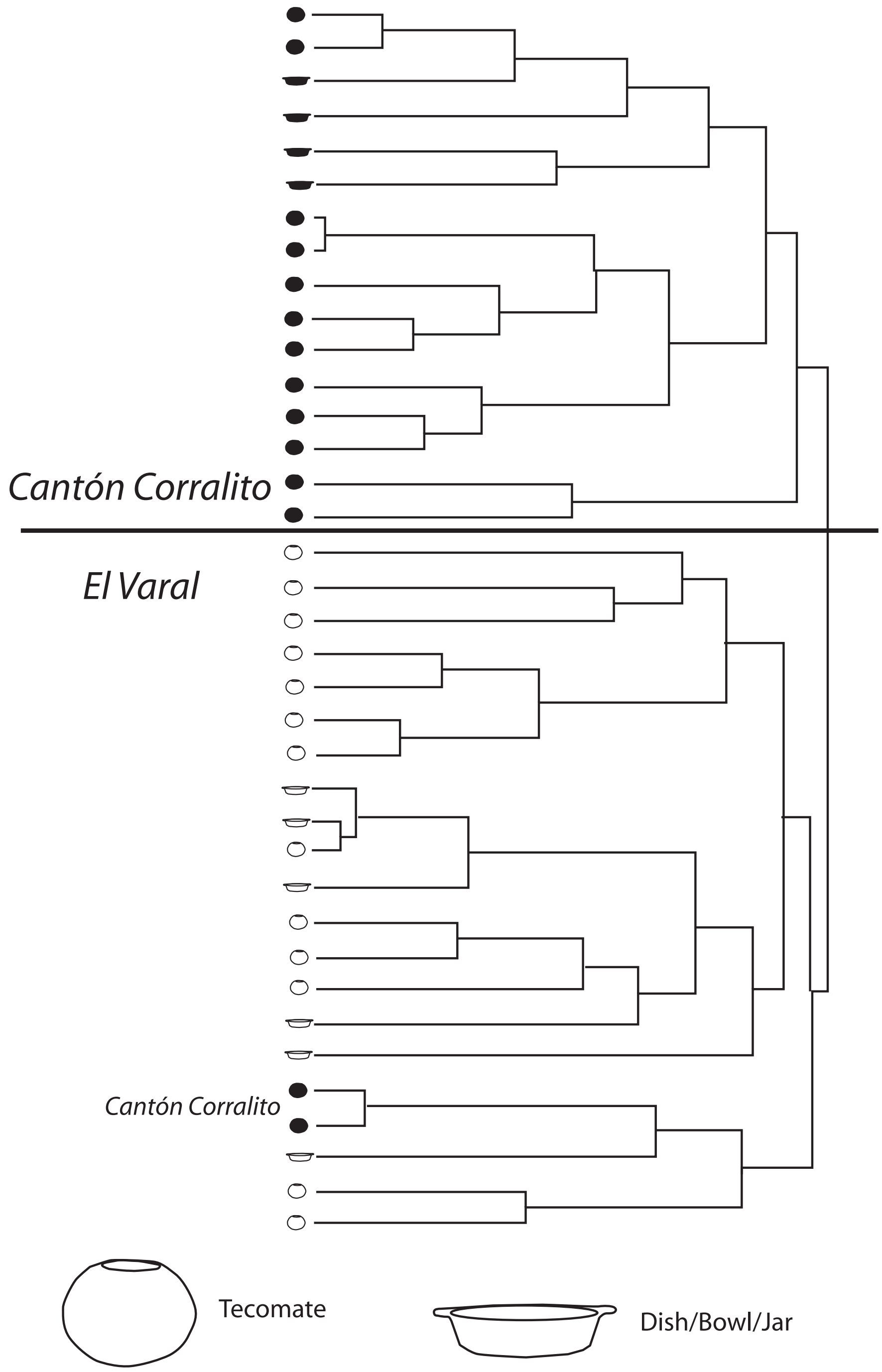

Figure 16.2. Cluster dendrograms for samples run by INAA. Open symbols represent samples excavated from El Varal. Solid symbols represent samples from Cantón Corralito.

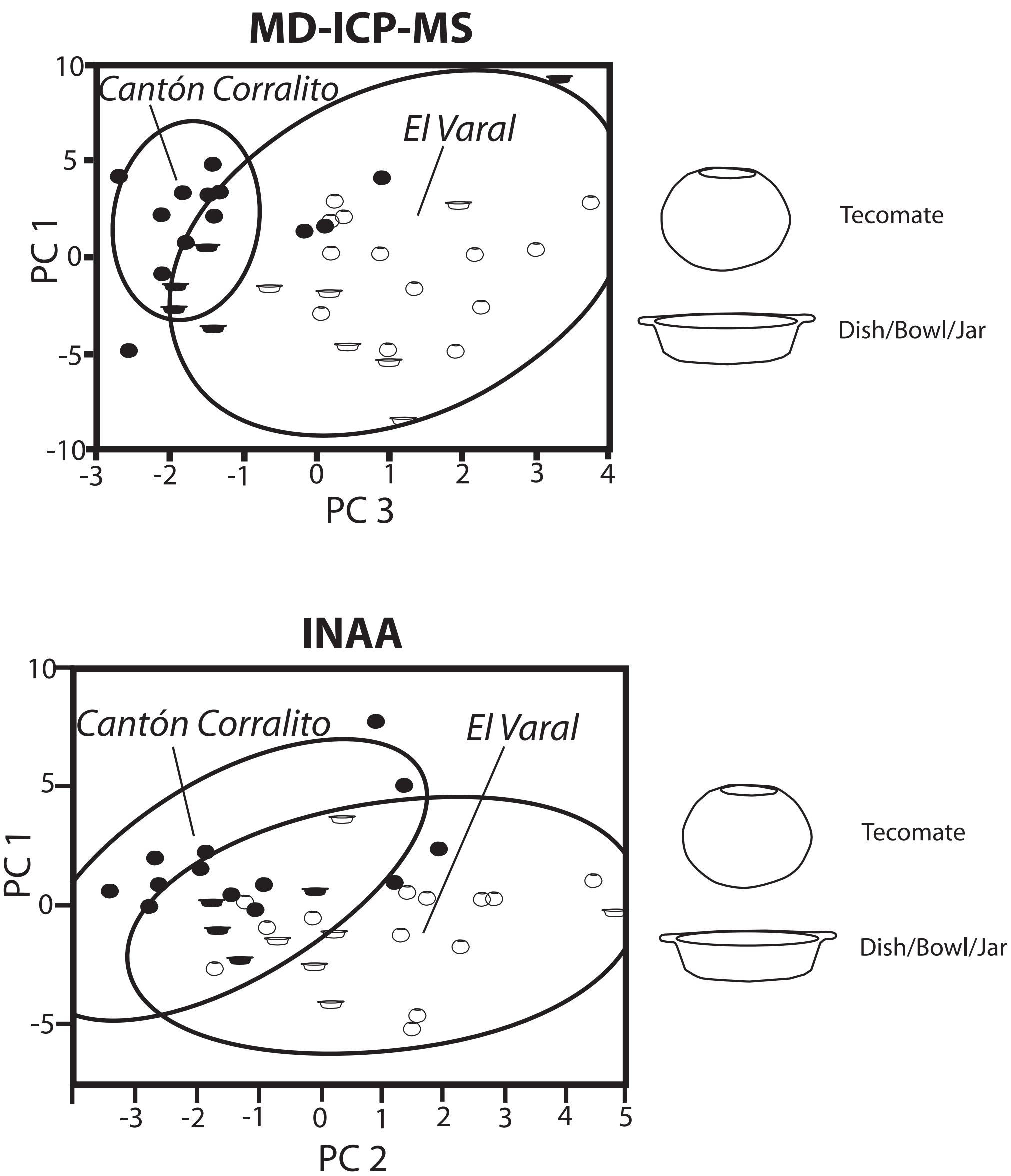

Figure 16.3. Bivariate projection of principal components for MD-ICP-MS (above) and INAA (below) showing site pottery clusters within 95-percent probability ellipses for group membership. Open symbols represent samples excavated from El Varal. Those from Cantón Corralito are indicated with solid symbols.

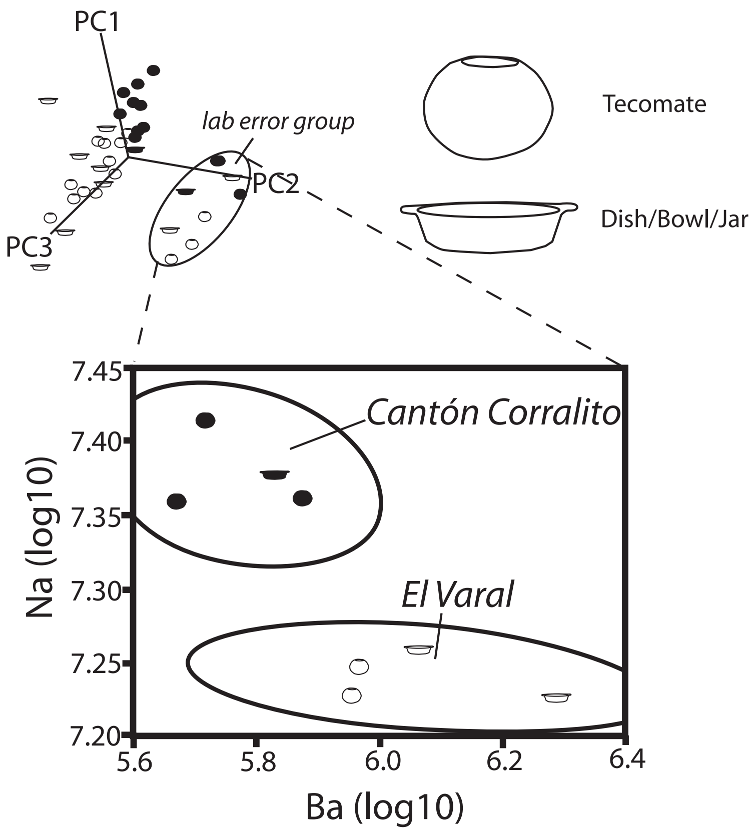

Figure 16.4. MD-ICP-MS lab-error group depicted in a spinning ("three-dimensional") plot with three principal components as axes X-Y-Z (top) and in a sodium-barium bivariate projection with 95-percent probability ellipses dividing the group by site (bottom). Open symbols represent samples excavated from El Varal. Those from Cantón Corralito are indicated with solid symbols.

The two forms of analyses can consistently support a scenario in which a thick tecomate was transported from El Varal to Cantón Corralito and a Tacaná White bowl was produced at a third site and transported to Cantón Corralito. However, they differ in the case of two Suchiate Brushed tecomates that were potentially manufactured at El Varal (and a third site) and transported to Cantón Corralito (following ICP)—an alternative being that one was manufactured at Cantón Corralito and the other made at El Varal and transported to Cantón Corralito (following NAA).

In either case, the two analyses yielded largely comparable results, with a disagreement on only one sample (designated as aberrant through ICP but not NAA) out of 38—a concordance of greater than 97 percent. They indicate that the inhabitants of El Varal produced their pottery on-site, including tecomates and serving vessels, and that vessels were neither transported to the site through exchange nor moved with residentially mobile populations who came to the estuary on a seasonal basis. Finally, the two analyses indicate that some movement of pots from the estuary to inland locations occurred during the Jocotal phase (all three of the most likely candidates for an El Varal origin were deposited in the upper stratum at San Carlos, unit 10, level 2).

Residue Analysis

The analysis of vessel residues offers archaeologists the exciting prospect of determining what foods were associated with specific pots. The technique functions on the logic that different plants and animals vary in their organic composition, and that differing organic compounds or relative concentrations of compounds can leave their traces in archaeological ceramics by being absorbed into the pores of vessel walls during cooking, storage, or consumption activities.

Such compounds are more likely to be absorbed during cooking or storage, but may also be absorbed as served food provided that contact between food and vessel is long and/or repeated enough. At the time of our study, archaeological applications of residue analysis were considerably less developed than was the case for

Table 16.1. Provenience summary for all El Varal and Cantón Corralito samples[a]

No.	Site	Lab No.	Vessel Form	Vessel Type	ICP Interpretation	NAA Interpretation
1	El Varal	B26	Pedestaled censer	Censer	Site cluster	Site cluster
2	El Varal	B22	Jar	Eroded	Site cluster	Site cluster
3	El Varal	B23	Jar	Pacaya Red	Site cluster	Site cluster
4	El Varal	B24	Jar	Pacaya Red	Site cluster	Site cluster
5	El Varal	B25	Jar	Aquiles Mottled Orange & Brown	Site cluster	Site cluster
6	El Varal	B20	Bowl	Tacaná White	Site cluster	Site cluster
7	El Varal	T38	Tecomate	Suchiate Brushed	Site cluster	Site cluster
8	El Varal	T39	Tecomate	Suchiate Brushed	Site cluster	Site cluster
9	El Varal	T40	Tecomate	Suchiate Brushed	Site cluster	Site cluster
10	El Varal	T42	Tecomate	Suchiate Brushed	Site cluster	Site cluster
11	El Varal	T41	Tecomate	Suchiate Brushed	Site cluster	Site cluster
12	El Varal	T37	Tecomate	Suchiate Brushed	Site cluster	Site cluster
13	El Varal	T34	Tecomate	Suchiate Brushed	Site cluster	Site cluster
14	El Varal	T57	Tecomate	Guamuchal Brushed	Site cluster	Site cluster
15	El Varal	T58	Tecomate	Guamuchal Brushed	Site cluster	Site cluster
16	El Varal	T59	Tecomate	Guamuchal Brushed	Site cluster	Site cluster
17	El Varal	T16	Tecomate	Mendez Red Rim	Site cluster	Site cluster
18	El Varal	T74	Tecomate	Tilapa Red-on-White	Site cluster	Site cluster
19	El Varal	T14	Tecomate	Michis Red	Site cluster	Site cluster
20	Corralito	B13	Bowl	Siltepec White	Site cluster	Site cluster
21	Corralito	B12	Bowl	Pampas Black-and-White	Site cluster	Site cluster
22	Corralito	B11	Bowl	Pampas Black-and-White	Site cluster	Site cluster
23	Corralito	B4	Bowl	Pacaya Red	Site cluster	Site cluster
24	**Corralito**	**B19**	**Bowl**	**Tacaná White**	**Produced at Varal or at a third site**	**Produced at a third site**
25	Corralito	T11	Tecomate	Michis Red	Site cluster	Site cluster
26	Corralito	T10	Tecomate	Michis Red	Site cluster	Site cluster
27	**Corralito**	**T70**	**Tecomate (thick)**	**Thick Tecomate**	**Produced at Varal or at a third site**	**Produced at Varal**
28	Corralito	T73	Tecomate	Tilapa Red-on-White	Site cluster	Site cluster
29	Corralito	T31	Tecomate	Suchiate Brushed	Site cluster	Site cluster
30	Corralito	T33	Tecomate	Suchiate Brushed	Site cluster	Site cluster
31	**Corralito**	**T26**	**Tecomate**	**Suchiate Brushed**	**Produced at Varal**	Site cluster
32	Corralito	T28	Tecomate	Suchiate Brushed	Site cluster	Site cluster
33	Corralito	T32	Tecomate	Suchiate Brushed	Site cluster	Site cluster
34	Corralito	T29	Tecomate	Suchiate Brushed	Site cluster	Site cluster
35	Corralito	T30	Tecomate	Suchiate Brushed	Site cluster	Site cluster
36	**Corralito**	**T27**	**Tecomate**	**Suchiate Brushed**	**Produced at a third site**	**Produced at Varal**
37	Corralito	T55	Tecomate	Guamuchal Brushed	Site cluster	Site cluster
38	Corralito	T56	Tecomate	Guamuchal Brushed	Site cluster	Site cluster

a. Sherds that do not cluster by site are indicated in bold.

geochemical compositional studies. Archaeologists are only recently developing measures that will standardize procedures (Bernard et al. 2007).

Under the supervision of Smith, Carballo processed the samples from El Varal and Cantón Corralito at the University of California, Santa Barbara, for lipid analysis using GC-MS. Lipids are organic compounds that are relatively insoluble in water. Lipid analyses employing GC-MS have been productive endeavors for archaeologists because of the detectability and relative stability of lipids. However, past cooking activities and postdepositional processes clearly expedite their degradation (e.g., Malainey et al. 1999b and Eerkens 2005). If relative rates of degradation are accounted for, fatty acids such as carboxylic (carbon-based) acids may be registered in the lipids of vessel residues. Our methods for detecting and comparing carboxylic acid concentrations largely mirror those of Eerkens (2005) and Malainey and associates (1999a, 1999b, 1999c).

Hypotheses

Remains of a variety of fauna were recovered from archaeological deposits at El Varal (Chapters 5 through 7). Estuary fish were apparently particularly important as a food source, along with mollusks and crabs. More rare but present were reptiles, amphibians, and terrestrial mammals. Our recovery of botanical remains was much more limited, but maize was present and we suspect that it was consumed on a regular basis (Chapter 8).

Finally, a substantial portion of the tecomates was probably used to reduce brine to salt. Because our goal was to look for the possibility of specialization in some particular resource, we chose as our null hypothesis the proposition that pots at El Varal were generalized rather than special purpose in function. In this scheme, the pottery of El Varal was used to prepare, cook, and consume all types of foods. Further, because the range of food remains at inland dish-dominant sites does not differ in any dramatic way from that of El Varal (Chapter 15) we might expect uses of pottery at Cantón Corralito that are quite similar to those at El Varal. If pots at El Varal were generalized in function, we would expect a variety of fatty acid signatures among the sherds and general overlap between Cantón Corralito and El Varal—irrespective of vessel form.

An alternative possibility (Chapter 15) is that the faunal and botanical remains recovered at El Varal are simply the extraneous food remains of site occupants whose primary purpose was specialized production of one particular food item or some other resource. There are options other than salt. Shrimp, for instance, are known to swarm during the dry season in the lagoons of the Acapetahua Estuary—and large-scale shrimp harvesting has been suggested as an activity of Archaic inhabitants of that area (Voorhies 2004:147–157). During the Varal excavations, our workmen caught shrimp in the canal flowing through the site (Figures 14.8 and 14.9).

The hypothesis to be examined through residue analysis is the idea that the occupants of El Varal were conducting large-scale harvesting and exchange of a single resource available in the lower estuary but not at sites further inland. Our emphasis is not on shrimp per se but on whether there was some *specific* resource—potentially one that left little obvious evidence in the archaeological deposits, given that the actual remains of fauna (at least) are diverse (Chapter 15).

If tecomates were an important tool in the production of such a resource, we would expect a distinct *redundancy* of fatty acid signatures among Varal tecomates. In other words, Varal tecomates should all have essentially the same signature. The specific acid ratios might also allow us to identify the resource involved. Under this hypothesis, we would expect greater variety among fatty acids identified in other vessel forms at El Varal and in all vessel forms (including tecomates) at Cantón Corralito.

Sample and Methods

All of the sherd samples from El Varal and Cantón Corralito that were part of the compositional analysis were also processed for the residue analysis. Unfortunately, fatty acid concentrations were so low in an initial set of samples run through the GC-MS that additional grinding and processing were needed. Storage of ground sherd powder for several months seems to have resulted in additional lipid degradation to practically undetectable levels.

Of the samples that were ground and immediately processed for analysis, 16 had intensities comparable to an internal standard included in each sample—allowing for evaluation free of the background noise that interferes with weak signals. Fourteen of these were from sherds that were also part of the compositional analysis, all of which clustered with their site of origin. Two dish sherds from Varal were added to the analysis.

Our procedure largely mirrored the one presented by Eerkens (2005:88). It included pulverizing the interiors of sherds and mixing the sherd powder in a 2:1

mixture composed of (respectively) chloroform and methanol so that lipids absorbed into vessel walls would be detectable. Inorganic sherd residues were removed by siphoning out the solvent and lipids before placing the samples in a vacuum centrifuge to dry. Lipids were then transformed into fatty acid methyl esters by adding methanolic HCl (100:1), heating to 60° C for one hour, and allowing them to dry again. These were revived with a solvent (hexane) and internal standard mixture prior to introducing them via syringe into the gas chromatograph, which separated acid compounds based on differential rates of burn-off. The mass spectrometer measured the relative concentrations of carboxylic acids in each sample.

Carballo also processed a few experimental food samples, eight of which registered useful signal intensities on possible Soconusco foodstuffs obtained from markets in Southern California—including Pacific Coast shrimp and fish, maize, pinto beans, cacao, chia, and combinations of these foods. Unfortunately, no signals were registered on experimental vessels that were ground and processed following the same procedure as the artifact samples. Half were registered on scrapings from the scum lines of experimental pots, and half were introduced into the solvent directly as powdered substances.

The latter were not included in the analysis, as they did not undergo the expected fatty acid degradation associated with cooking (Malainey et al. 1999b; Eerkens 2005). In hindsight, it would have been desirable to have many more reference samples applicable to our particular case—especially for shrimp, crabs, and mollusks. As it is, the data set is too limited to allow us to confidently identify any particular food signature. Common carboxylic acid ratios were compared primarily with data from California (acquired by Eerkens) and published data from western Canada (Malainey et al. 1999b). The few cooked experimental samples run by Carballo (maize, beans, fish, and shrimp) allow single points of comparison, but only the maize and fish samples can be joined with Malainey's data to create 95-percent confidence ellipses for food identifications.

The use of ratios (as opposed to absolute values) of fatty acids facilitates inter-sherd comparison. This is largely a result of not being able to control the amount of residue extracted from a sherd and of variations in the density of fatty acids in archaeological sherds. Moreover, because fatty acids tend to degrade over time due to hydrolysis and oxidation (Christie 1989; Frankel 1998) it is important to use the ratios of fatty acids that decompose at approximately the same rate—as we did in this study.

The extent of degradation in a sherd depends on the depositional context, how well lipids are sealed, and the length of time since the pot was used. In previous studies by Eerkens (2005), the following fatty acid ratios were found to be of use in discriminating between residues extracted from pots used to cook different types of foods: C15:0 + C17:0 to C18:0, C16:0 to C18:0, C16:1 to C18:1, and C12:0 to C14:0. This classification system is followed here, although we have added maize as a distinct residue category. Note, however, that the "maize" ellipse was defined based on only four reference samples: one processed by Carballo and three published in Malainey et al. (1999b). Other categories were based on larger sample sizes.

Results

Overall, the recovery of fatty acids from the El Varal and Cantón Corralito sherds was low—suggesting that significant degradation has taken place. When we conducted the residue study, we were still strongly skeptical of the possibility of salt production at El Varal based on the inefficiency of the tecomate if the goal is simply evaporation of liquid (see Chapters 1 and 14, including Figure 14.2). The use of tecomates for salt production would leave no lipids in the pots. Could salt production by itself explain our results? We cannot rule out the possibility, although we are skeptical because low signatures were found for all vessel forms and for both the dish-dominant and tecomate-dominant sites.

We proceed, then, with an analysis based on the idea that some or all of the pots were used for food. C12:0 was unfortunately not recovered in any of the sherds, making it difficult to evaluate the relative influence of meats versus plant products among the recovered fatty acids. However, it was also not recovered from the experimental samples Carballo processed for maize, beans, fish, and shrimp. C12:0 was absent or only recorded in trace quantities by Malainey et al. (1999b) for the Canadian foodstuffs with reasonable analogs in the prehispanic Soconusco (i.e., maize, beans, squash, fish, and terrestrial mammals).

C12:0 is more common in greens and plant root foods. The remaining fatty acids were recovered in greater frequencies from the sherds, especially C16:0, C18:0, and C18:1. The relatively high concentrations registered of the latter (C18:1, oleic acid) suggest that our attempt to draw some interpretations from the data is not an exercise in futility. Malainey et al. (1999a) report large decreases of C18:1 in their replicated decomposition experiment, with the concentration decreasing by as much as half in its relative percentage in some cases.

In contrast, the sherd samples on which we base our interpretation registered high C18:1 concentrations (range, 9 to 76 percent; mean, 45 percent; standard deviation, 20 percent). Therefore, based on these samples and their ratios of acids that decompose at similar rates we first examine their degree of overlap with certain types of foods. However, these identifications bring very little new to the discussion—and we only present them as potential avenues for future investigations. We can comment with somewhat greater conviction on the general patterning of vessel usage at the two sites, and the lack of evidence for specialized production in the tecomates at El Varal.

Following the ratios and food reference data used by Eerkens (2005), the current suite of fatty acid ratios suggests that we can rule out the presence of greens having been prepared or stored in these vessels—and only two of the sherds have ratios that overlap with the ranges reported for root products. Instead, the majority of the sherds have fatty acid ratios consistent with that observed among maize, fish, terrestrial mammals, seeds, and berries.

Common Soconusco foods such as shrimp, crabs, and mollusks are missing from this comparative database—as is the specificity of knowing, for instance, whether certain North American root products have signatures similar to that of manioc. Figure 16.5 depicts two of these ratios for the seven sherds that had enough data to be plotted. The figure suggests that outside a dish from Varal that closely matches ratios for fish the majority of sherds overlap with the ranges associated with maize, seeds, berries, roots, and terrestrial mammals. It further appears that most of the tecomates are close to the ratios derived from maize samples, although

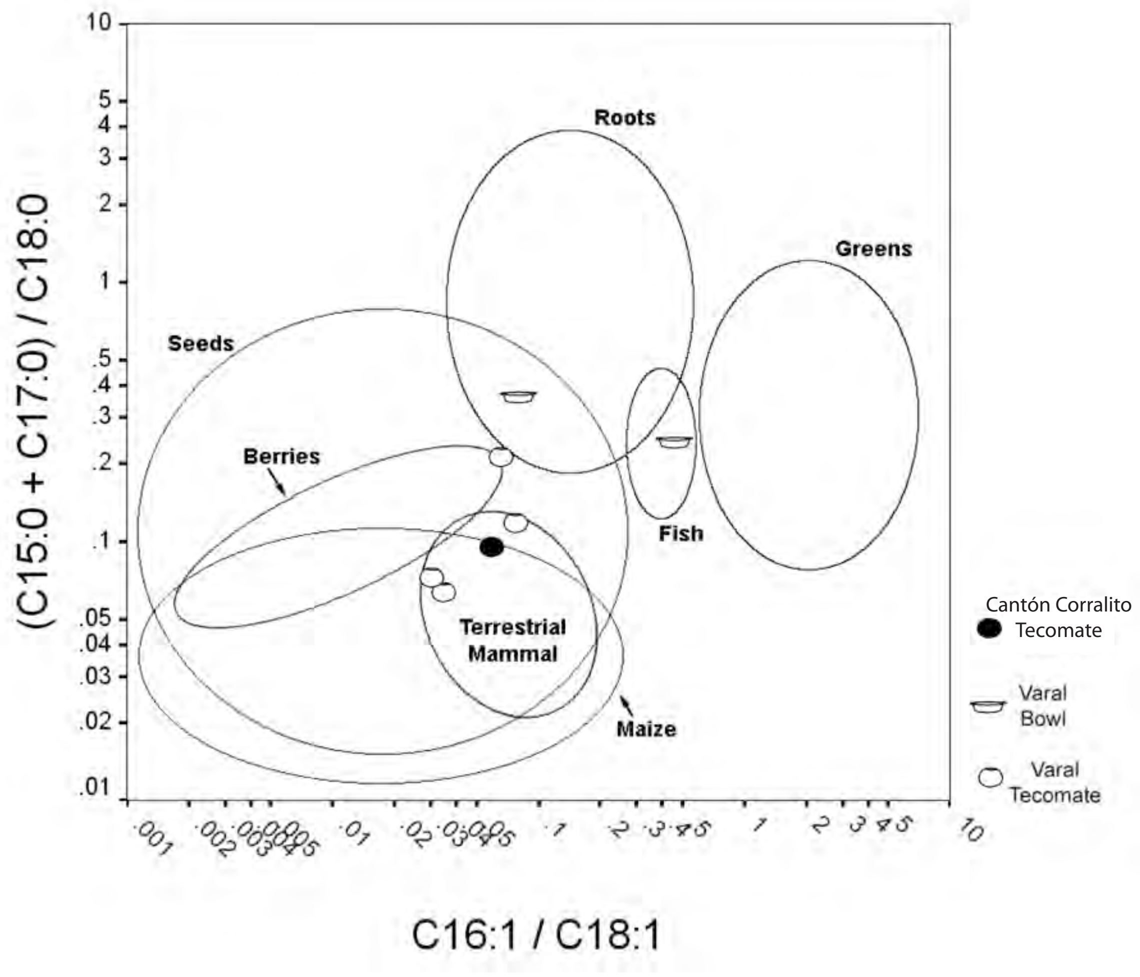

Figure 16.5. Bivariate projection of fatty acid ratios, including sherd samples for which data is available and showing 95-percent confidence ellipses for food types.

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the maize ellipse would likely grow larger were additional food reference samples included—and thus might grow to encompass the other archaeological samples.

The fact that the maize and terrestrial mammal ellipses largely overlap in the comparison of these particular residues is particularly frustrating because it prevents us from teasing apart two Soconusco food categories that speak to wildly divergent usages, as could be accomplished if we were able to compare C12:0 to C14:0. Malainey et al. (1999c) based most of their interpretations on the relative percentages of C18:1, C18:0, and medium-chain acids (C12:0, C14:0, and C15:0).

Following this methodology, the Mazatán samples look more similar to the signature these authors report for mixtures of maize and fish (with decreasing relative quantities of the acids cited previously) than to the signatures of plants or large terrestrial mammals. However, the Mazatán samples registered higher 18:1 concentrations across the board—with a range of 9 to 76 percent (mean of 45 percent), compared to the 15- to 27.5-percent range they report. The maize issue is of interest because tamale steaming was the usage for coastal tecomates, suggested by Coe and Flannery (1967:102). An *atole*-like maize beverage and a fermented maize beer could also be possibilities.

The processing of maize products in tecomates also offers a possible explanation for the overabundance of broken tecomates in relation to the remains of the frequently proposed animals, in that botanical preservation is limited. The inhabitants of El Varal might have been able to grow small dry-season plots of maize, or they could have brought it from inland gardens. Still, maize as a primary subsistence item at the site would be something of a surprise.

The ratios of the two solitary cooked and scraped residue reference samples run for pinto beans and shrimp are as follows: beans (C15:0 + C17:0/C18:0 = 0.028, C16:1/C18:1 = 0.641); shrimp (C15:0 + C17:0/C18:0 = 0.551, C16:1/C18:1 = 1.114). These ratios fall well outside the range of values in the archaeological sherds presented in Figure 16.5, with beans joining the confidence ellipse for greens and shrimp positioned apart from any of the sherds or food ellipses. However, given that these are only single reference samples any conclusions should be drawn with extreme caution.

We hold out more hope for our general inter-site comparisons. Figure 16.6 plots three fatty acid ratios, comparing the sites of Varal and Cantón Corralito and comparing dishes with tecomates. The figures show that the fatty acid ratios from the two sites, divided by vessel type, largely overlap. This suggests one of two possibilities. Either pots were generally used for the same types of foods or degradation has been so extensive that evidence of such differences is no longer obtainable. As mentioned previously, the C18:1 concentrations recorded in the samples are not consistent with the experimentally degraded samples in Malainey et al. (1999a). Moreover, differences are observable between

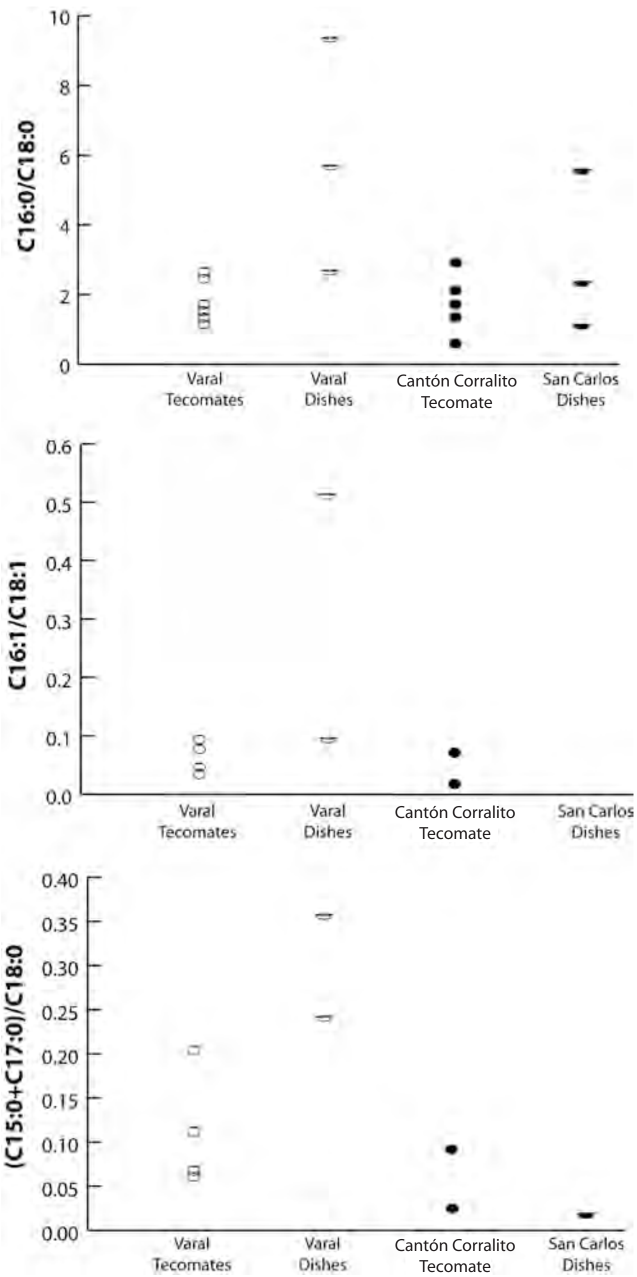

Figure 16.6. Plots of individual fatty acid ratios and sherd samples, divided by site and vessel type.

vessel types—which we would expect to have become equally obscured through degradation. Nevertheless, the generally weak signals of the samples are troubling.

With these provisos in mind, the ratios from the two sites seem to be equally variable. More specifically, there appears to be slightly greater variation among the Varal samples as a whole (their coefficients of variation are greater for two of the three ratios). However, as can be observed from the charts the variability of all samples together obscures a more restricted variability among tecomates.

Looking exclusively at tecomates, those from Varal are slightly less variable than those from Cantón Corralito. For instance, in the ratio of C16:0/C18:0 the coefficient of variability of Varal tecomates is 34 percent—whereas that of the Cantón Corralito tecomates is 49 percent. Although there are too few samples from Cantón Corralito to calculate meaningful coefficients for the other two ratios, visual inspection suggests that Varal tecomates are less variable in one ratio and more variable in the other. This general equality in the level of variability of fatty acid ratios runs contrary to the hypothesis positing the processing of a single specific estuarine food.

An interesting point of contrast is that tecomates at both sites have a more restricted range of fatty acid ratios than do dishes, suggesting that the latter might have been associated with a greater variety of source products and that the former may have been more standardized in their function. Although this finding is consistent with the expectations for specialization in food processing activities involving tecomates, the tecomates from Varal and Cantón Corralito appear to be equally standardized against the expectation of inter-site variability.

A possible alternative lies in vessel function. It seems likely that tecomates were used for cooking a range of available resources. Little work in residue analysis has been done to gauge the effects of long vessel use-lives involving the cooking or processing of diverse foodstuffs. Thus far they have been more successful with specialized vessels such as oil or wine amphorae, or vessels for storing milk. This alternative possibility fits nicely with Arnold's (1999) characterization of tecomates as a versatile vessel form for populations who still retained significant mobility in their subsistence activities.

Furthermore, there is no reason to think that Formative cuisine in the Soconusco could not have been as intricate as many modern Mexican dishes. Given the environment, mixtures of fish or shrimp tamales, seafood stews/chowders, and a range of combinations involving terrestrial resources are all imaginable. Perhaps the generalized utility of tecomates has resulted in the admixture of numerous intricate combinations of food signatures acting to reduce the variability among specimens.

Discussion

The results of the analyses provide new insights into the social dynamics underlying the tecomate-dominant versus dish-dominant assemblage pattern. The two compositional studies allow us to discard and/or refine scenarios related to the predominance of tecomates at estuary sites. First, the compositional analyses indicate that pottery was produced in the estuary at El Varal throughout the Cuadros and Jocotal phases. Although it is not necessarily indicative of permanent occupation in the estuary, the evidence is suggestive of at least extended stays.

Second, the tecomates produced at El Varal were not regularly produced for export to inland sites such as Cantón Corralito—although some vessels moved in that direction. Nor were serving wares produced inland for export to the estuary. None in the sample appears to have been exchanged in the opposite direction.

Although lipid preservation was unfortunately poor in the samples, several general trends in the data can be inferred. Because the fatty acid ratios recorded from vessels originating at El Varal and Cantón Corralito largely overlap, they do not support the interpretation of intensive specialization of some specific estuarine resource at El Varal. The lipid analyses are more consistent with processing and/or the consumption of a range of similar resources at both sites.

Due to the small sample size and comparative collection, however, subtle differences in the usage of the vessels from Cantón Corralito and El Varal cannot be discerned. Our food identifications can be read as consistent with the faunal and botanical analyses in support of the consumption of maize and fish. A root crop such as manioc might also have been important. Our single experimental shrimp sample did not register ratios similar to those of the archaeological samples, but this finding is relatively meaningless and more studies are needed as a foundation for more sound interpretations.

More interesting for the initial goals of the study, the analyses are more supportive of two scenarios that would adequately explain the higher proportion of tecomates at the estuary site of El Varal: some degree of residential mobility and/or a greater emphasis on food service assemblages at inland sites relative to estuary sites. These possibilities are not mutually exclusive.

A combination of the two could involve certain segments of inland communities alternating between a first household and a second (seasonal) household in the estuary. Due to the status of this segment of the population or to differential norms regarding food consumption practices, there was less of a need for elaborated serving wares in the estuary. Communal pots or perishable individual plates may have been more common.

Indeed, the evidence presented here is largely consistent with a social interpretation of residential mobility combined with variability in consumption practices. Seasonal mobility would suggest that some resource was culturally desirable in the estuary. If inland and estuary populations were largely one and the same, or were at least significantly integrated through kin or exchange relations, we might expect to see evidence of the consumption of similar foods with slightly greater redundancy in food processing in estuary tecomates (as suggested by residue analyses). We may also expect that vessels made in the estuary were occasionally transported inland as containers, as suggested by compositional analyses.

Once again, we are less confident with our interpretations based on the residue data. However, the interpretations we present fit comfortably with multiple lines of evidence presented in this volume. If our interpretations are correct, specialization should be rethought as an explanation for the inter-site pattern. We would not have evidence for specialization defined as one community producing beyond its own needs (e.g., Arnold 1987), but we would have evidence for intra-community specialization if we accept a broader definition of community.

Returning to our discussion of complexity, a more fluid definition of later Formative communities in the Mazatán region—involving movement between larger inland sites and smaller estuary sites by people who consider themselves members of the same community—provides greater support for complex economic and kinship ties linking affiliated groups of people (rather than the political subordination of one community to another).