Chapter 7

The competitive exclusion effect

The previous chapter considered what happens when the psycho-rational curve and the competition curve take on extreme values by respectively shifting to the right and reducing slope. Now let us consider the case in which the competition curve takes on extreme values in the opposite sense, by becoming unusually steep.

The arguments that follow will be clearest if we first consider exactly what is meant by the process of competition between social groups. As a quick look through the glossaries and indices of books on evolutionary theory, anthropology, sociology, and archaeology clearly shows, competition is one of those concepts that seems so simple and self-evident that, though constantly used, it is rarely defined or analyzed (but see Theodorson and Theodorson 1969; Amir 1981). In the realm of evolutionary biology, Darwin (1968 [1859]) clearly conceived of competition as a metaphor for processes resulting in differential success in producing surviving offspring in a situation in which resources are both limited and completely exploited. When circumstances favor the proliferation of one variety, the others must automatically decline in numbers, "as each area is already fully stocked with inhabitants" (Darwin 1859 [1968]:121). In more recent game theory or economic terms, competition resembles a process in which one category gains at another's expense in a "zero-sum game" (Von Neumann and Morgenstern 1944). In fact, in both biological evolutionary theory and social group theory, the "sum" is somewhat elastic, as will be discussed below, but the general idea still applies.

In biological contexts, competition between species implies a setting with finite resources, into which are born some high number of individuals of, for example, species A and species B. Most individuals of both species die, but the few that are successful at finding sustenance, surviving, and mating leave offspring (Darwin 1968 [1859]). The outcome of this "competition" is measured relatively; if relatively more offspring of species A survive to the next season than offspring of species B, then the population of A grows and the population of B declines. Species A has garnered more of the finite resources, and so has out-competed species B. Nevertheless, the competitive process itself is not waged by the species acting as opposing groups (but see Wynne-Edwards 1986; Mayo and Gilinsky 1987; Vining 1981), nor in general by individuals of species A directly besting individuals of species B, but by the accumulation of many differences in individuals' success at producing surviving offspring. The changing population sizes are not direct results of competition, but rather the rewards and penalties dealt out automatically by the system based on a comparison of the individuals' efficacy at converting resources into offspring. If this efficacy contest continues long enough, fewer and fewer individuals of species B will succeed in leaving offspring, the population of species B will eventually fall to zero, and only individuals of species A will remain.

Note that the concept of the zero sum refers not to the number of individuals, but to the finite available resources. Darwin equated resources with population ("fully stocked with inhabitants") because he assumed that all resources generally are fully utilized, that is, that all niches are generally filled to carrying capacity, which is a reasonable first approximation and is especially good for longer term observations. In fact, however, carrying capacity is an elastic concept, especially for human societies in which there may be a wide range of "carrying capacities" depending on trade-offs between numbers of individuals, standard of living, and subsistence strategies involving varying technology and labor inputs (Dewar 1984; Hardin 1986; Keegan et al. 1985; Williams 1989). Even non-human populations may track the quantity of available resources only approximately or with some time lag. A species that is losing access to resources because individuals of another species are more successful at getting them may still, at least for a time, maintain or increase its population. The individuals will just be less well provisioned, which in the long run will probably further reduce their ability to acquire resources and eventually begin to bring the population down through reduced survivorship and/or fecundity. Moreover, individuals of different species may not require the same quantities of resources. A small population of elephants could theoretically out-compete an enormous population of rodents that ate the same food. The total number of individuals would be lower, but the same resources would still be used. The process of competition really describes differential success in garnering resources, which is indirectly reflected in differential population growth.

Social groups are different from species. Social groups, by definition, act corporately in some circumstances, including raids and warfare in which resources or group members themselves may change hands (Peoples 1982; Vining 1981). Although there may be social groups among non-human species, the species themselves are analytical categories, not literal groups that can act corporately. There is no good analogy in human social group competition to the birth of an excessive number of individuals of varying species that are then culled by differential success. Individuals can switch from one social group to another through boundary porosity or conquest, but they cannot change their species. Most importantly, because human social groups have territories, rights, and property, at least some portion of the competition between groups is not only metaphorically, but also literally, an actual contest between them. The process of competition between social groups does not simply play itself out as an accumulation of more or less successful attempts to find resources in a universally accessible environment and convert them into surviving progeny; because most resources are owned or otherwise held by an individual or group, competition between social groups necessarily also involves members of one group literally taking resources or individuals away from the other group.

Put another way, even if social group A doubles in population every decade within its territory, while social group B barely maintains a constant population within its territory, social group B is not in any sense losing the competition and will never go extinct unless members of group A actually take away its resources or absorb or eliminate its membership. Unless resources or individuals change hands, group A is not winning the competition with group B. While the resources used by our hypothetical biological species are constantly available to whichever individual can reach them first, the resources used by social groups are generally in some sense owned by individual group members or the group as a whole, and defended by part or all of the group. For social groups to compete, that is, for groups to change in size in a zero-sum game, resources or individuals must change hands.

The importance of this difference between species and social groups is that what we mean by the term competition is distinct for each. We cannot simply rate the fecundity of two social groups and predict that the one producing more surviving offspring will necessarily drive the other to extinction. That result may be a likely long-term outcome, but it requires a stage either of literal conflict or conversions of members of one group to the other, both of which bring into play a host of additional factors beyond fertility that could stall or reverse the process. For practical purposes, there is no necessary correlation between success at producing surviving offspring and success at armed conflict or social competition for members through boundary porosity. Instead, success in competition between social groups depends upon maximizing a complex sum of factors that influence how successful the group is at gaining members directly from other groups by force or choice, and at gathering resources not from the environment at large, but from the holdings of other groups. As long as a group has at least the minimal efficiency at converting resources into members that is necessary to utilize the resources it gains, the only factors that matter in group competition are those factors that affect the group's ability to *decrease* the resource holdings or memberships of other groups. A group that can support only one person per unit resources but is invincible in war will drive to extinction a group that can maintain ten people per unit resources but is unable to defend itself.

We can now define some terms. Competition between groups is the process in which resources and/or individuals are transferred from one group to another. If it continues long enough, this process leads to the extinction of one or more groups which have suffered a net loss in resources and/or individuals, and the survival of one or more groups which have experienced a net gain. A group is extinct when no members are left in the group. Note that group extinction, unlike species extinction, does not necessarily imply the demise of individuals; the former group members may simply have changed their group affiliation. A group survives when it continues to have members. When competition proceeds to the endpoint of the extinction of all but one group, the process can be further specified as competitive exclusion.

In Chapter 2, the "tension" plotted on the vertical axis of the TGN graph of the effect of competition was rather vaguely said to measure "unrealized ecological potential". Let us replace this temporary allusion to the biological concept of competition with a more precise if more slippery one that better fits the concept of social group competition. Specifically, "tension" in the TGN graph of group competition measures the "unrealized potential total competitive ability" of the system. This phrase will take some effort to define, but doing so is necessary in order to correctly use this visualization of the action of competition. The seemingly complex conception of competition that results is useful both because it makes explicit some important aspects of competition as it relates specifically to social groups and because it justifies drawing competition we have been doing so far on a TGN graph so that its effect can be directly combined with that of the various psychological and rational forces that also affect group number.

By "competitive ability," I mean a measure of a group's ability to gain resources and/or individuals from other groups by any means. The competitive ability of a group is composed of several categories of factors. First and most basic is the groups' adaptedness in the ecological sense, that is, the group's efficacy at utilizing natural resources to physically sustain its members, or more precisely to produce surviving offspring. To be successful in competition, a group must have at least a minimal efficacy at converting resources into membership, or it will go extinct. To the extent that prestige, prowess at war, and other factors discussed below depend upon a large and/or growing population or a well-provisioned population, efficacy at utilizing resources may also affect other factors that contribute to a group's competitive ability.

Second is the group's efficacy at acquiring resources from other groups, most typically by force, either through raids in which resources are carried off, or territorial warfare in which the losing group is expelled from captured terrain. These tactics benefit the group both absolutely, in that capturing resources from other people may be more efficient that extracting them directly from the environment, and relatively, in that the expulsion or extermination of a vanquished group causes the victorious group to comprise a greater proportion of the remaining population. In situations of severe conflict, a group's ability to defend itself and minimize losses of resources to other groups may be more important than its offensive ability to acquire resources from other groups, but the logic is the same. All other things being equal, a group that is more effective at capturing resources from other groups and keeping them has a greater competitive ability.

Third is the group's efficacy at acquiring members themselves from other groups. A group might acquire members voluntarily by adoption, marriage, conversions such as fictive kinship or affiliation by residence, or *en mass* through alliances or fusion with other groups. A group's ability to gain members voluntarily depends in part on the perceived relative benefits of membership in comparison to other groups, which might have to do with real or perceived differences in material standard of living, security from other threatening groups, relative prestige based on ideology or other factors, social considerations such as the degree of individual freedom or social status mobility, and so on. A more desirable group will tend to attract members from a less desirable group, and so, all other things being equal, has a greater competitive ability. A group might also acquire members by force, for example through raids in which captives are taken or warfare in which populated regions or political units are taken over. All other things being equal, a group that is more successful than others in warfare has a greater competitive ability. This last conception of competition is the prime mover in Carniero's (1978) circumscription theory of the origin of states.

These categories are only illustrative; they may not cover all possible factors, and are occasionally ambiguous. The capture of members from another group, for example, might be interpreted as increasing membership, as capturing labor resources, or even as capturing material resources if the losers are made to supply levies or taxes in kind. Fortunately, the occasional analytical ambiguity becomes irrelevant when all the factors contributing to total competitive ability are summed up into a single composite quantity.

This total competitive ability of a group is the net result of all the factors that affect the group's relative ability to gain resources or members at the expense of other groups. Even though this ability is in part due to group features such as organization, in concept the group's total competitive ability can be divided across all its individual members, such that each individual represents some amount of competitive ability. A member of a group that is highly successful represents a larger amount of competitive ability than a member of a relatively less successful group. Except where groups are quite large or quite small, such that economies and costs of scale are significant considerations, the group's marginal return in competitive ability for each additional member is presumably higher for a group with high competitive ability than for a group with lower competitive ability. The effect is that when a group with high competitive ability gains a member, whether by internal increase or conversion by whatever means from another group, the total competitive ability summed across all the groups in the system increases more than when a group with a lower competitive ability gains a member. Equivalently, if an individual switches affiliation from a group with low competitive ability to one with high competitive ability, then the competitive ability contributed by that individual rises, and the total competitive ability summed across all the groups increases.

Although competitive ability clearly cannot be measured, we can easily recognize the relative competitive abilities of specific groups and the trend in total competitive ability of the system if we have access to historical data on the population size and group number over time in the region. Groups can be ranked in competitive ability by ranking their relative success in acquiring resources and/or individuals from other groups. The total competitive ability of the system is increasing when groups with greater competitive ability are increasing in size, while groups with lesser competitive ability are decreasing in size. The circularity should be obvious, and is exactly the same as the circularity of the biological concept of adaptedness and competition. The best adapted individuals are defined by the fact that they increase in number. Competition acts so that the best adapted always increase in number.

Despite the circular logic, adaptation in biology and competitive ability is social group theory are both useful concepts in visualizing the process of competition. Just as one can imagine the overall adaptedness of living things increasing over evolutionary time, from the first blue-green algae to the *Homo sapiens* which may yet exterminate the algae, so can one imagine overall social group competitive ability increasing from family-level foraging groups to the European Economic Community. In fact, while evolutionary biologists will wince at the suggestion that humans are more "adapted" than blue-green algae, the term "competitive ability" accurately conveys what is structurally the same concept but with a more straightforward acknowledgement of its purely analytical utility in an essentially circular construction.

If there are several groups of varying competitive ability in a given social and ecological niche, then the total competitive ability is maximized if all the people affiliate themselves with the group with the greatest competitive ability. This hypothetical maximum is the potential total competitive ability of the system. The unrealized potential total competitive ability of the system, then, is the difference between the hypothetical maximum total competitive ability and the actual total competitive ability. This difference is the "tension" shown on the vertical axis of the TGN graph of the effect of competition.

The TGN graph depicts competition as the process of people individually and collectively acting in such a way as to reduce the unrealized potential total competitive ability of their system. For example, when an individual changes affiliation from a group with lower prestige to one with higher prestige, the person increases his or her personal prestige or whatever are the benefits of membership in a prestigious group, which in turn contributes to increasing his or her individual contribution of competitive ability, which finally increases the total competitive ability of the system. Tension is reduced in the sense that a potential to increase the total competitive ability of the system has been fulfilled. At the same time, the balance of group membership is also shifted slightly such that, if the trend continues, the more prestigious group will grow until the less prestigious group goes extinct and the group number declines.

The slope of the competition curve indicates the amount of competitive ability that is gained or lost by the system as a result of any change in group number. If the curve is steep, then a great deal of tension is relieved when a group (by definition a less-competitive one) goes extinct. Alternatively, the tendency of the system to relieve tension exerts a great pressure to reduce the group number. In more conventional terms, the curve is steep when there is a pronounced difference in the competitive ability of the groups that are present. When a more competitive group grows and a less competitive group vanishes, there is a large increase in the total competitive ability of the system, or equivalently, the action of competition pushes more forcefully to increase the size of the more competitive group and drive the less competitive group to extinction. On the other hand, when the groups are more evenly matched, the competition curve is shallow, little tension is relieved if one group goes extinct, and competition exerts little pressure to reduce the group number.

What constitutes a "pronounced difference" in competitive ability varies according to circumstances of supply and demand for resources. In a situation of plentiful resources and sparse population, the amount of tension relieved by the extinction of one group might be small. In the same region in a time of severe resource scarcity due to a drought, for example, the extinction of the same group might relieve a considerable amount of tension. Because in times of scarcity a greater proportion of each group's resources must be seized from or defended from other groups, the same objective differences in military prowess, ability to attract voluntary converts, and so on has a greater effect on the survival or extinction of groups; in times of scarcity, the coin of competitive ability increases in value.

Since competition is defined as one group's gain at another's expense, competition does not occur between growing groups until they begin to impinge upon each other's resources or membership, even if they grow at differential rates. When a new niche is opened, multiple groups may grow without competing with each other until demand for resources becomes sufficiently large relative to the cost of extracting the resources from the environment that it becomes more efficient to capture resources from another group than to extract them directly. This initial low-competition phase is part of the gold rush effect discussed in Chapter 6.

If the demand for resources continues to rise relative to their availability, competition will grow more intense, that is, differences in the ability of one group to gain resources or members at the expense of another will exert an increasingly large pressure on the group number. As population rises, demand rises, the competition curve becomes steeper and increasingly overwhelms the contribution of the psycho-rational curve to the total forces curve, and competition may eventually drive the group number to one. This process in which the action of competition reduces the equilibrium group number to one is the competitive exclusion effect (Figure 7-1).

The differences in competitive ability between groups may become increasingly strong as one group captures a lion's share of the resources, population, and physical power and the others grow small, poor, and weak. This pattern actually describes a positive feedback mechanism, in that success in competition makes the winning group even more competitively able relative to the losers. This feedback mechanism may play a more or less significant role in affecting the equilibrium group number, depending on the specific circumstances and to what extent group size or growth affects the factors relevant to competitive ability in the particular case. Where competitive success feedback plays a significant role, the competition curve is more likely to be concave down in shape, rather than concave up as in all the illustrations. That is, the effect of competition will be most, not least, significant towards the end of the process, when one dominant group is beating out its last remaining weakened rivals.

The action of competition may be further compounded by a sympathetic effect on the psycho-rational curve. If one group is generally perceived to be growing at the expense of others, that group may gain in prestige relative to others, and rational calculations may increasingly favor other groups' allying themselves or fusing with the

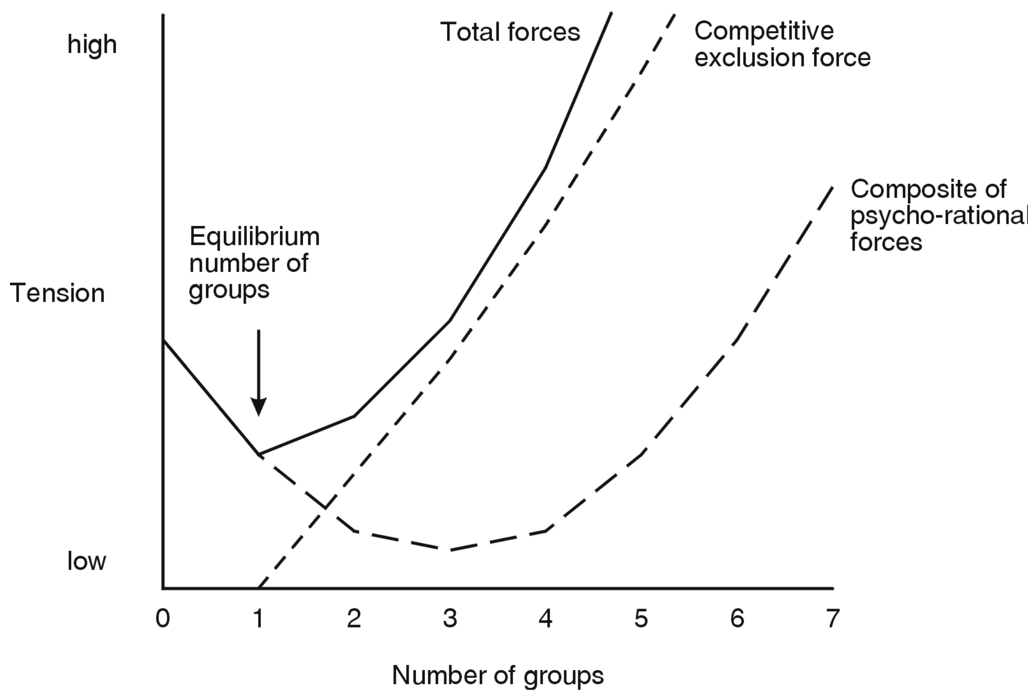

Figure 7-1.The competitive exclusion effect.

growing group, or individual defections from shrinking groups to the growing one. Similarly, if one group is perceived as more powerful, aggressive, or successful in self-defense, rational calculations of security may favor groups or individuals joining the more competitively able group. Many of the same conditions that tend to make the competition curve steep, then, also may tend to shift the psycho-rational curve to the left. The effects of these changes are complementary, and work together to reduce the equilibrium group number, in extreme cases to one.

Because of the inherently circular nature of competition arguments, in social group theory as in biology, it is not strictly possible to prove that an observed change is due to competition. It is possible, however, to show that an observed change is or is not consistent with a competition model. Let us consider some conditions that must be met for an observed culture-historical process to be consistent with the competitive exclusion effect.

First, the groups involved must be competing for the same resources or members, that is, they must occupy overlapping social and ecological niches. To demonstrate that groups' niches overlap, in turn, it is necessary to show that they exploit the same types of resources, and that they would have access to the same sources of those resources in the absence of previous claims. Archaeological groups can be argued to have used the same types of resources if analyses of food refuse in domestic midden, tools used for subsistence tasks, isotopic analysis of human bone, and other approaches to reconstructing subsistence indicate similar subsistence strategies. Note that the groups need not have exactly the same subsistence strategies to be in competition for some or all of the same resources. In fact, some differences are to be expected in any obviously competitive situation, since the groups must have differed in competitive ability enough for competition to have a notable effect, and differences in subsistence strategies are likely to contribute to or be affected by differences in competitive ability. A more subtle analysis might determine that two groups use the same resources even with very different subsistence strategies, as in the case of traders with pack animals and herders who consume domestic animal products, both of whom might depend indirectly upon access to pasture lands. The specific arguments will vary for each case studied. Groups can be argued to have had potential access to the same sources of resources if their respective settlement patterns were such that sites were located conveniently to the same sources.

Second, since the competition curve must have been steep, the demand for one or more resources must have been great relative to the supply. There are a variety of ways to assess the intensity of competition with archaeological data. One approach to evaluating this criterion is to reconstruct both the population size and the productive capacity of the region in question and compare the adequacy of the production to meet the biological needs of the population. Unfortunately, in most archaeological cases it will be difficult to calculate both quantities sufficiently precisely for the comparison to be meaningful. A more direct approach is to evaluate evidence of stress or shortages as indications of unmet demand. Analyses of human remains may show demographic patterns with high mortality rates, or high frequencies of pathologies that are indicative of stress. Evidence of more intensive or complete use of the available resources might also indicate stress, as might be suggested by increasing representation of remains of less-preferred food resources in domestic midden or the adoption of more labor-intensive subsistence practices to increase the productivity of the limited available resources.

Anthropological readers will suspect (and economists consider it axiomatic) that most people value products in amounts well beyond what they need for bare survival (Hardin 1986). This additional demand depends on cultural values that may be difficult or impossible to reconstruct, so the total demand may often be an unknown amount higher than that implied by calculations from population figures and a knowledge of human biology or inferred from indicators of acute scarcity. There may be significant competition even in the absence of these indicators, or the competition may be even greater than these indicators suggest if present. For this reason it is useful to consider another category of criteria that indicate a steep competition curve independently of acute scarcity or stress, specifically evidence of cultural responses to intense competition.

One set of cultural responses to intense competition reflect the physical threat of raids or warfare. The archaeological evidence includes fortified or otherwise defensible sites and direct indications of warfare such as a proliferation of weapons or increasing mortality, especially of mature males, due to trauma. Even if the competition is of a less acutely violent nature, it may encourage a variety of practices contributing to social boundary-marking that may be evident in the archaeological record (Hodder 1979; Wobst 1977). Stylistic differences in display goods such as clothing and decorated ceramics may suggest boundary maintenance behavior. Differences in ritual activities such as burial practices may also indicate affirmation of group distinctness and solidarity by members of each group, as well as relative isolation and ignorance of other groups' practices due to limited communication across group boundaries. Pronounced social boundaries may also be indicated by divergence between groups in what Sackett (1982) refers to as "isochrestic" stylistic traits, that is, traits that may vary without affecting an object's utility and also without serving to communicate group membership. Isochrestic stylistic traits might include virtually invisible technological aspects of ceramic production such as paste and temper composition, choices among textile dyestuffs that produce indistinguishable colors, and so on. Such isochrestic traits might tend to diverge in situations of strongly marked social boundaries because craftspeople in well-demarcated groups may not often come in contact with each other or share technological information and practices, leaving them free to develop or randomly drift along independent lines. The connection of boundary marking to competition is even more likely if boundary maintenance seems to increase at the same time as other indicators of competition increase. Evidence of boundary marking does not conclusively imply strong competition, but it does suggest it, and can bolster an argument for competition that includes some of the other features discussed here.

Finally, even an unquantifiable reconstruction of increasing or unusually high regional population can be taken as an indirect indication of increasing competition. Even without knowing the absolute population of a region or its productive capacity with any precision, it is fair to suggest that when the population attains historically high levels, competition for resources is probably high, or at least higher than usual in the region. Similarly, observing that a population has grown significantly, even without knowing the absolute size or exact growth rate, implies that competition has increased simply because more people necessarily demand more products unless their values are somehow adjusted downward.

The third condition that must be met in order to show that an observed process is consistent with the competitive exclusion effect is that during the time in which competition was intense, the populations of groups must have shifted in favor of some groups at the expense of others, eventually leading to group extinctions and the group number declining, finally dropping to one. Criteria for distinguishing social groups in the archaeological record were discussed in Chapter 6. The necessary shifts in population can be shown by estimating the population of each group at each of several successive time periods. If absolute population sizes cannot be estimated, it is sufficient to show relative changes, that is, some percentage decline or increase, or even a qualitative trend of decline or increase. All but one group should shrink and eventually go extinct. If sufficient data are not available to estimate even qualitative population size trends for some groups, then the groups should at least be shown to go extinct at some point before the end of the competitive process.

A fourth condition is that there be differences in competitive ability among the groups, but demonstrating that this condition is met is both practically and logically problematic. Competitive ability is such a complex congeries of factors that it would be difficult in practical terms to rank even living, well-studied groups by competitive ability without resorting to the circularity of checking historical trends of the group's relative growth or decline in size and any changes in group number that may have occurred. Even more important, however, is that competitive ability is not an independent quantity that can be measured, even in concept. It is defined simply as the sum of factors contributing to the group's relative success in acquiring resources and/or individuals, and as such is really measured only by the outcome of the competition itself, that is, by shifting group populations that eventually lead to group extinctions and changes in group number. When competition occurs and group number declines, we infer that the groups must have differed in competitive ability and that the surviving group was most competitively able, just as biologists infer that when some varieties survive and others do not, the varieties must have differed in adaptedness or fitness and that the variety that survived was the fittest.

When the group number declines rapidly or substantially, we may infer either that competition was particularly intense due to a large discrepancy between supply and demand, or that there were particularly great differences in competitive ability among the groups. Either condition (or both) would cause the competition curve to be steep. Sometimes it may be possible to assess the magnitude of the discrepancy between supply and demand. If demand was not far above supply but the competition curve was evidently steep, then the relative differences in competitive ability between the groups probably were large and the explanation for the observed process should be sought in inter-group differences. If demand was clearly far above supply, then the competition curve could be steep even if the groups were very closely matched, and the explanation for the competitive situation lies with the causes of the unmet demand. Less often, it may be possible to independently guess that the differences in competitive ability were large, as in a case where one group has exclusive access to an important military technology or resource such as horses or quantities of metal for arms. In these cases, the discrepancy between demand and supply need not have been great. In practice, though, few cases will be so extreme that one or the other factor can be recognized in the archaeological record as being either overwhelmingly important or definitely negligible. Most of the time, the relative contributions of unmet demand and differential competitive ability to the steep slope of the competition curve will be difficult to assess separately.

This analytical difficulty has a positive side. When we observe a case in which group number seems to have been influenced by a steep competition curve, which is most plausibly inferred when the group number has been reduced to one by the apparent action of competitive exclusion, and neither unmet demand nor inter-group differences is obviously overwhelmingly responsible, we are generally safe to assume that *both* unmet demand *and* differential competitive ability contributed to some degree to the intensity of competition. This conclusion focusses the investigation in two specific directions that may shed light on the particular case.

Late Intermediate Period multiethnicity to monoethnicity

In Chapter 6, I showed that as many as five distinct, contemporary social groups occupied the coastal Osmore valley or the immediate vicinity for one or two centuries following the collapse of Tiwanaku in the middle valley around AD 950. This multiethnic settlement pattern did not last for long, and PCCT recovered considerable evidence that suggests how the decline in group number proceeded over time. In the following sections, I will argue that the coastal Osmore data are consistent with the competitive exclusion effect, and that the observed process is understandable as a case of competitive exclusion among social groups.

The archaeological evidence allows us to reconstruct the decline in group number as a process because it spans several distinguishable chronological phases. Since the phases cannot be further subdivided at present, the resolution of the data is coarse. That is, presumably continuous trends must be approximated by just a few data points, many of which each represent not a moment within a phase, but rather a representative or average value for the entire phase. If population was increasing during phase A, for example, then the population estimate for phase A will roughly correspond to the average population for the whole phase. It will underestimate the maximum population reached at the end of the phase, overestimate the population at the beginning of the phase, and for analytical purposes attribute one value to the chronological middle of the phase even though that value actually occurred at some unknown time during the phase. Moreover, other data are tied not to an entire phase, but to the beginning or end of a phase. For example, if pottery type 1 characterizes phase A, then we say that type 1 pottery first appears at the beginning of phase A. Further, if pottery type 1 is a marker of a social group, then we say that just prior to phase A, that social group had a population of zero, and that the population increased to some average value calculated for the entire phase that for lack of better information is said to occur around the middle of the phase. Finally, the archaeologically identifiable chronological divisions within contemporary cultures may not always fall at the same time. That is, roughly contemporary phases may be known to start and end at different times or to have had different durations, yet these somewhat incongruent cultural-temporal units must nevertheless be compared to each other for lack of a better alternative. These are common problems with archaeological data, and more sophisticated approaches simply require data with higher temporal resolution than are available here (Dewar 1991).

Given these analytical caveats, the chronological framework of blocks of time and transitions between them by which we will trace the decline in group number in the coastal Osmore valley is as follows. First, all five groups identified in Chapter 6 by their pottery styles, that is, Chiribaya, Ilo-Tumilaca/Cabuza, Osmore Multicolor, Ilo Multicolor, and Viboras, were present during some portion of the 100 to 200 years following the collapse of Tiwanaku in the middle valley around AD 950 or 1000. This block of time, the Early Late Intermediate Period, is the earliest distinguishable segment of the Late Intermediate Period, and is marked by the Algarrobal phase Chiribaya and Ilo-Tumilaca ceramic styles. Second, this block of time ends somewhere around AD 1050 to 1125, when the Algarrobal phase Chiribaya and Ilo-Tumilaca styles are replaced by later variants. By this time the other three styles have disappeared, and the groups that made them have presumably gone extinct. Third, only the Chiribaya and Ilo-Tumilaca/Cabuza groups continue into the second distinguishable block of time in the Late Intermediate Period, the Middle Late Intermediate Period, which is marked by pottery in the post-Algarrobal phase Chiribaya and Ilo-Cabuza styles. Fourth, around AD 1250 the Ilo-Cabuza style disappears, presumably indicating that the group that produced it has gone extinct. Fifth and finally, only the Chiribaya tradition continues into the third theoretically distinguishable segment of the Late Intermediate period, the Late Late Intermediate Period, which is marked by the exclusive presence of post-Algarrobal phase Chiribaya pottery in the coastal valley.

Because Ilo-Cabuza pottery may be absent from sites with post-Algarrobal phase Chiribaya pottery even during the time period in which both were used, determining which Chiribaya sites were occupied contemporarily with the Ilo-Cabuza group and which were occupied after the Ilo-Cabuza style vanished is presently impossible in the field. The existence of this period of monoethnicity is known only because radiocarbon dates and associations with later imported ceramic styles indicate that post-Algarrobal phase Chiribaya ceramics were used in the valley well after the Ilo-Cabuza style is thought to have disappeared. Because post-Algarrobal Chiribaya sites without Ilo-Cabuza pottery cannot be classified into the second versus the third block of time, all the post-Algarrobal phase Chiribaya data are lumped together and represents a slightly longer and later period of time than the Ilo-Cabuza material with which it is compared, and one that combines evidence from both multiethnic and monoethnic situations.

The following four sections evaluate how well the archaeological evidence from the early Late Intermediate Period coastal Osmore corresponds to each of the four conditions that must be met in order for the competitive exclusion effect to be an appropriate model.

The shared resource base

The first condition for applying the competitive exclusion effect is that the groups in question must exploit at least some of the same resources from the same sources. That is, there must be one or more resources that both groups need and for which they compete with each other. PCCT's survey and excavations recovered ample evidence with which to reconstruct many aspects of the subsistence bases of both the Chiribaya and the Ilo-Tumilaca/Cabuza groups, and I will show below that these two groups definitely depended on many of the same resources. Unfortunately, because the other three groups are known only through mortuary excavations and surface scatters, their subsistence strategies can only be inferred from site locations and reasonable but speculative analogies to the better-known groups. Future analyses of the grave goods found in burials containing Osmore Multicolor and Ilo Multicolor pottery at Chiribaya Alta (Williams and Buikstra n.d.) and San Geronimo (Jessup 1990a,b, 1991) will probably support the claim that these groups used resources and technologies similar to those of the Algarrobal phase Chiribaya. Inferences about subsistence based on mortuary evidence other than the human remains themselves are rarely conclusive, however, and the analyses themselves are not yet available.

The most general indication that the Chiribaya and the Ilo-Tumilaca/Cabuza people shared the same resource base is that their settlements are located in the same types of places and are intimately intermixed along the whole length of the coastal Osmore valley (Figure 7-2). Most sites of both groups are found close to the valley bottom, often on quaternary river terraces slightly above the floodplain, but also on artificial terraces constructed on slopes of up to about 30 degrees. Survey on ridgelines, peaks, quebrada bottoms, flats, and moderate slopes more distant from the river found virtually no evidence of human occupation away from the valley margins except on the coastal pampas that were probably used for hunting and pasture when the *lomas* fog vegetation was more extensive. Except for the relatively few sites located near the mouth of the river or with convenient access to the coastal pampas, all the sites of all the groups in the valley clearly were placed in order to be close to the river and/or the valley bottom. As the settlement pattern map indicates, neither Chiribaya nor Ilo-Tumilaca/Cabuza sites cluster differentially in any section of the valley. This relatively uniform distribution of sites, similar for both groups, suggests that either both exploited generally the same valley bottom resources, or the resources that they exploited were similarly distributed all along the valley.

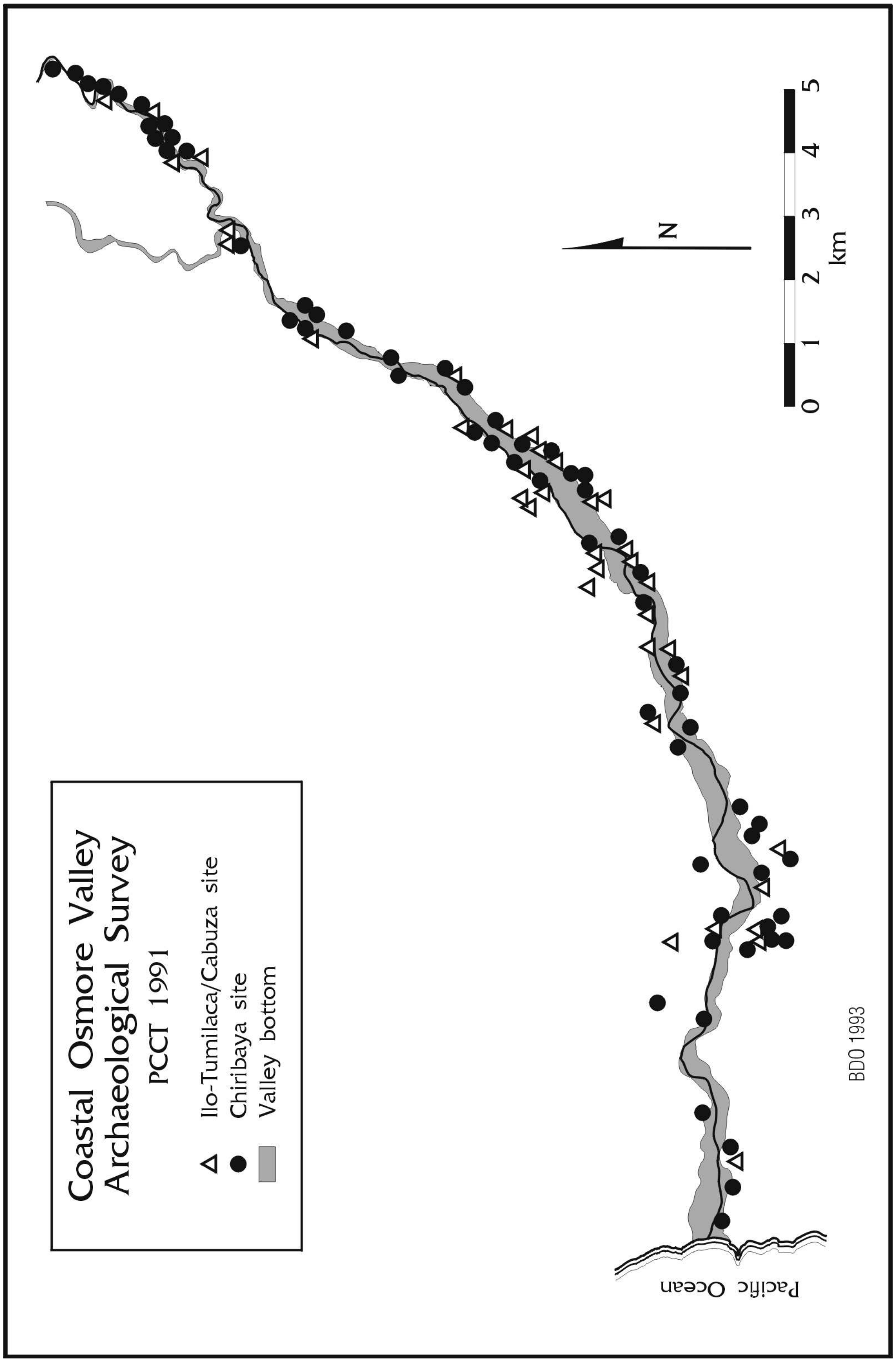

Figure 7-2. Late Intermediate Period sites.

The intimately intermixed settlement pattern also indicates that whatever resources the two groups both exploited would have at least potentially come from the very same sources. To demonstrate the possibility of competition, it is not sufficient to show that two groups both exploited resource A; both groups have to have had access to the same particular source of resource A, as well. The settlement pattern in the coastal Osmore leaves no doubt that if both groups did use some of the same types of resources, and I show below that they did, they would have been in positions to vie for access to the same sources of those resources, as well.

There are two unusual site types, however, which might tend to indicate differences in subsistence practices between the two groups. First, Chiribaya Alta is an unusual site for many reasons, but is important here because it is located outside the valley proper, on the edge of the coastal pampa. Jessup (1990b, 1991) suggested that Chiribaya Alta may have played an important role in herding camelids, since until recently the part of the pampa that it occupies was used as a resting place for animals being moved from the valley floor to the *lomas* areas further south along the coastline. Chiribaya Alta was clearly a central site of some ritual or political importance, so its location may also have been chosen for reasons apart from subsistence concerns. In any case, although the habitation areas have not been excavated, at least the cemeteries were used by both Chiribaya and Ilo-Tumilaca people (Williams and Buikstra n.d.; Jessup 1990b, 1991). In the absence of detailed group affiliation evidence and contrasting subsistence data from the domestic area of the site, Chiribaya Alta in itself does not necessarily imply any subsistence differences between the two groups.

The second type of site is more problematic. These sites are composed of numerous small stone-faced terraces that run up the bottoms of steep quebradas in the valley wall like steps in a staircase. They are found only on the northern wall of the valley, and only above areas of fields built on river terraces watered by the long coastal Osmore canal (Appendix F). The prototypical example is the site of Loreto Alto, which was extensively test excavated by PCCT (Appendix A) and proved to be a single-component residential site occupied only by people using Ilo-Tumilaca/Cabuza pottery. I suspect that the other, similar sites nearby also pertain to the Ilo-Tumilaca/Cabuza group, although all of these sites tend to have virtually no ceramics on the surface. Because the locations and layout of this type of site are so different from those of most Chiribaya and Ilo-Tumilaca/Cabuza sites, there is no reason to assume that the activities carried out at these sites and the resources used there would be the same as at the more typical sites. On the contrary, they might reasonably be expected to differ, and if so, to suggest differences in the subsistence strategies of the Ilo-Tumilaca/Cabuza people, who used this type of site, and the Chiribaya, who did not.

Because Loreto Alto was the only single-component Ilo-Tumilaca/Cabuza site excavated, this anomalous site provides all of the excavated data about Ilo-Tumilaca/Cabuza subsistence. The Chiribaya domestic excavation data all come from the more typical river terrace sites of El Algodonal and Loreto Viejo (Appendix A). Because the excavated subsistence data for each group come principally from different types of sites, the data are potentially biased towards indicating differences in the subsistence bases of the two groups. Any differences observed might be due either to general differences between the groups, or differences due only to the unique activities carried out at the few anomalous sites. On the other hand, to the extent that the two samples of midden debris are found to be similar, the argument that the Loreto Alto-type sites indicate differences in subsistence strategies between the two groups is rejected. The implication is that the subsistence patterns are so consistent and similar that the same resources and practices are used by both groups even at markedly different types of sites.

All the sites on which this analysis is based are located in a single two-km segment of the river valley, about twelve km inland from the mouth of the river, near the middle of the length of the arable coastal valley. This tight spatial clustering of the sample effectively rules out gross spatial differences that might weaken the comparability of the samples of each group. On the other hand, it means that the samples may not represent all the variability of the social groups' subsistence strategies. For example, the Chiribaya site of San Geronimo, only some 100 m from the coastline, clearly has a dramatically higher content of shell in its domestic deposits than the Chiribaya sites sampled here (Jessup 1990a; pers. obs.). Sites of both groups were probably variably focussed on marine resources, *lomas* resources, or valley floor agriculture, depending on their specific locations. The data that follow can only stand for a subset of Chiribaya and Ilo-Tumilaca/Cabuza occupations, although this subset is probably typical of the bulk of the valley settlements.

The major components of domestic midden from good Ilo-Tumilaca/Cabuza and Chiribaya contexts are summarized and compared in Table 7-1. More detailed data are presented in Appendix E, but for the purpose of grossly assessing the degree to which the two groups competed for resources, I will consider only those general categories of remains that comprised at least one tenth of a percent of the total mass of midden material from one or both groups. Given that the dry and salty conditions allowed the common preservation of such normally perishable materials as animal soft tissue and the plant refuse that comprises about one quarter of the total midden mass, it is

Midden component	Ilo-Tumilaca/Cabuza % of mass	Chiribaya % of mass	Signif. more in:
Animal bone and tissue, mostly large land mammals (camelids)	20.8	15.9	I-T/C
Marine shell	19.3	16.0	same
Fish bone and tissue	1.3	2.5	Ch
Corn cobs, husks, kernels	0.1	2.8	Ch
Tubers, mostly yuca (*Manihot*)	0.7	0.1	same
Bean pods and seeds	0.1	0.3	same
Pacay (*Inga*) pods and seeds	0.4	0.2	same
Molle (*Schinus*) seeds	0.0	0.4	Ch
Lucuma (*Lucuma*) seeds, husks	0.0	0.3	Ch
Squash (*Cucurbita*) seeds	0.0	0.1	I-T/C
Freshwater crayfish shells	0.1	0.0	I-T/C
Cotton bolls, fiber, husks	0.1	0.2	same?
Sticks, stalks, etc.	7.4	8.9	same?
Bark	3.6	0.5	same
Wood and cut wood chips	8.4	0.4	I-T/C
Charcoal	2.9	0.9	I-T/C
Other botanical refuse, mostly leaves of cane and/or corn	4.0	11.7	-
Camelid feces	2.2	2.3	same
Cuy (*Cavia*) feces	0.0	3.6	Ch
Other and unidentified feces	0.8	3.8	-
Ceramics	19.9	25.6	same
Flaked stone	1.3	0.1	same
Small ground stone (<300 g)	0.0	0.2	same
Textile fragments and fibers	3.1	1.1	same
Other crafts- botanical material	2.0	0.5	-
Other crafts- other material	0.6	0.6	-
Other	0.7	1.2	-
Total	99.8	100.2	-

Table 7-1. Major components of domestic midden (see Appendix E).

unlikely that this restriction will cause major resources to be overlooked. The table lists for each material category the percentage it represents of the total mass of midden material recovered from 100% 1/4 inch screening of unmixed, undisturbed domestic contexts each comprising at least 15 liters of soil with at least 3 grams of midden material per liter. Single items weighing over 300 grams, such as grinding stones and structural posts, are excluded from the calculations in order to avoid skewing the results. Results are reported as percentages of total midden mass because extreme variability in the amount of material per liter of soil, apparently due to variable patterns of use and deposition at different sites, made standardizing by excavated volume impractical. Percentage data have the drawback that an increase in one category necessarily decreases the others, even if they represent functionally unrelated activities. Unfortunately, no suitable value external to the midden material itself by which to standardize the data is available. I compensate as far as possible for the this weakness of percentage data by running significance tests on percentage data based on various different subsets of the material in question, standardized by various partially independent measures within the midden material, that is, not only on percentages of the total midden mass, but also on percentages of the mass of botanical material, of diagnostic botanical material, of shell, and so on as appropriate to the particular category. These methods are elaborated further in Appendix E.

The third column of the table summarizes the results of the many Wilcoxon rank-sum tests reported in Appendix E, in many cases for various measures of the same material. For example, the result for tubers summarizes tests on the ratios of tuber roots and peels to all midden material, tuber roots only to all botanical material, tuber peels only to all identified botanical material, and so on, each calculated separately for each stratigraphic context excavated. When a rank-sum test is significant, it means that the fraction of the contexts in one category that had values higher than values in the other category is greater than would be expected by chance if the categories had the same median value. Only the rank order of the values is considered; the magnitudes of the values are ignored, which makes the test resistant to rare extreme values. One result is that the total percentage mass of squash seeds, for example, is actually higher in the Chiribaya material because of a small number of stratigraphic contexts that had relatively large amounts of squash, while the overall pattern is exactly the opposite: in most Ilo-Tumilaca/Cabuza contexts, squash seeds generally comprise a larger fraction of the total midden mass than in most Chiribaya contexts. Differences were considered significant if the rank-sum test probability was less than .10, but the results would have been almost the same with a significance level of .05; the only in-between cases are fish remains (p=.05), wood and cut wood chips (p=.01 to .06, depending on the measure used), and those marked "same?", which for some measures are different at a .10 level, but are always the same at a .05 level. The relatively lenient .10 criterion for significant difference reduces the risk of committing a statistical type II error, that is, of claiming that the groups are the same when they are not. Since the condition for applying the competitive exclusion effect is that the groups exploit the same resources, a lenient significance level actually poses a more stringent requirement for using the model, since the hypothesis that the two groups are the same is more easily rejected.

The percentages and tests shown in Table 7-1 indicate that the Ilo-Tumilaca/Cabuza group and the Chiribaya group used many of the same resources, but differed in the relative amounts of each. For example, while the midden analysis suggests a relatively greater focus on camelid consumption at the Ilo-Tumilaca/Cabuza settlements than at the Chiribaya ones, both groups clearly consumed considerable amounts of camelid meat, so both must have needed access to pastures for their animals. As noted earlier, some of these differences may be due to the differences in the type and location of the sites excavated for each group, but the extent to which the same resources are indicated even at different types of sites suggests that the two groups depended upon a substantially similar resource base.

Several of the midden categories require comment. Most surprising is the statistically significant ($p<.01$ for numerous measures) and large (300% to 5500%) difference in remains of corn (*Zea mays*) in Chiribaya midden compared to Ilo-Tumilaca/Cabuza midden. The difference is strong when standardizing by various values including total midden mass, total botanical mass, and total mass of identified botanical material, and it holds not only for cobs, kernels, and husks separately and in combination, but also for corn flowers and probably for corn stalks and leaves as well, although the stalks and leaves cannot be quantified because they were not reliably separated from those of other plant species. According to the midden data, both compared to Chiribaya people and absolutely, Ilo-Tumilaca/Cabuza people appear neither to have processed nor eaten much corn. As noted earlier, most of the Ilo-Tumilaca/Cabuza data come from Loreto Alto, which, like all the sites of its type, is located immediately above reclaimed fields irrigated by the coastal Osmore canal and might have been supplied by the produce from these fields to an unusual degree. If the fields were used for growing crops other than corn, perhaps beans, yuca, and the squash that is significantly more common in the Ilo-Tumilaca/Cabuza sample, then the diet and resulting midden at Loreto Alto might not be representative of other Ilo-Tumilaca/Cabuza sites that would have depended more on other types of farmland. This hypothesis cannot be evaluated with the currently available data, but if true, it would suggest that coastal Osmore sites had extremely localized farming territories and did not exchange significant quantities of staples even over sub-km distances and where clear imbalances of supply and demand can be inferred. Because corn has traditionally held a specially high position in domestic and ritual preferences in the Andes, the apparently marked concentration of coastal Osmore corn in the hands of the Chiribaya may indicate important differences in group prestige, rights to preferred farmland, or other value-laden features that may be difficult to assess archaeologically.

A preliminary study of human bone isotopic composition suggests a dramatically different reconstruction of the diets of the two groups (Sandness 1992). As part of a larger project, Sandness analyzed the carbon and nitrogen isotopic composition of human bones from six Ilo-Tumilaca/Cabuza and two Chiribaya burials. These results are plotted in Figure 7-3, which shows a tight clustering of $\delta^{13}C$ values near the high end of the normal range of values. Naively interpreted, this result in itself suggests that corn was a large part of the diets of both groups, and that there was no notable difference in the amount of corn consumed by members of the two groups. The ovals and unshaded boxes in Figure 7-3 indicate the reference values used by Sandness, according to which the $\delta^{13}C$ observations indicate a diet of perhaps 65% C4 plants, presumably corn. The reference values shown as shaded boxes are from Hastorf (1990), and suggest that the observations indicate an even greater proportion of corn in the diet. Neither result corresponds to the midden evidence that suggests corn was only a minor component in the Chiribaya diet, and an extremely small component of the Ilo-Tumilaca/Cabuza diet.

Two factors make such a naive interpretation of the isotopic data for corn problematic, however. First, the $\delta^{15}N$ values for all but one of the individuals for whom $\delta^{15}N$ could be measured fall in the range that indicates a diet largely composed

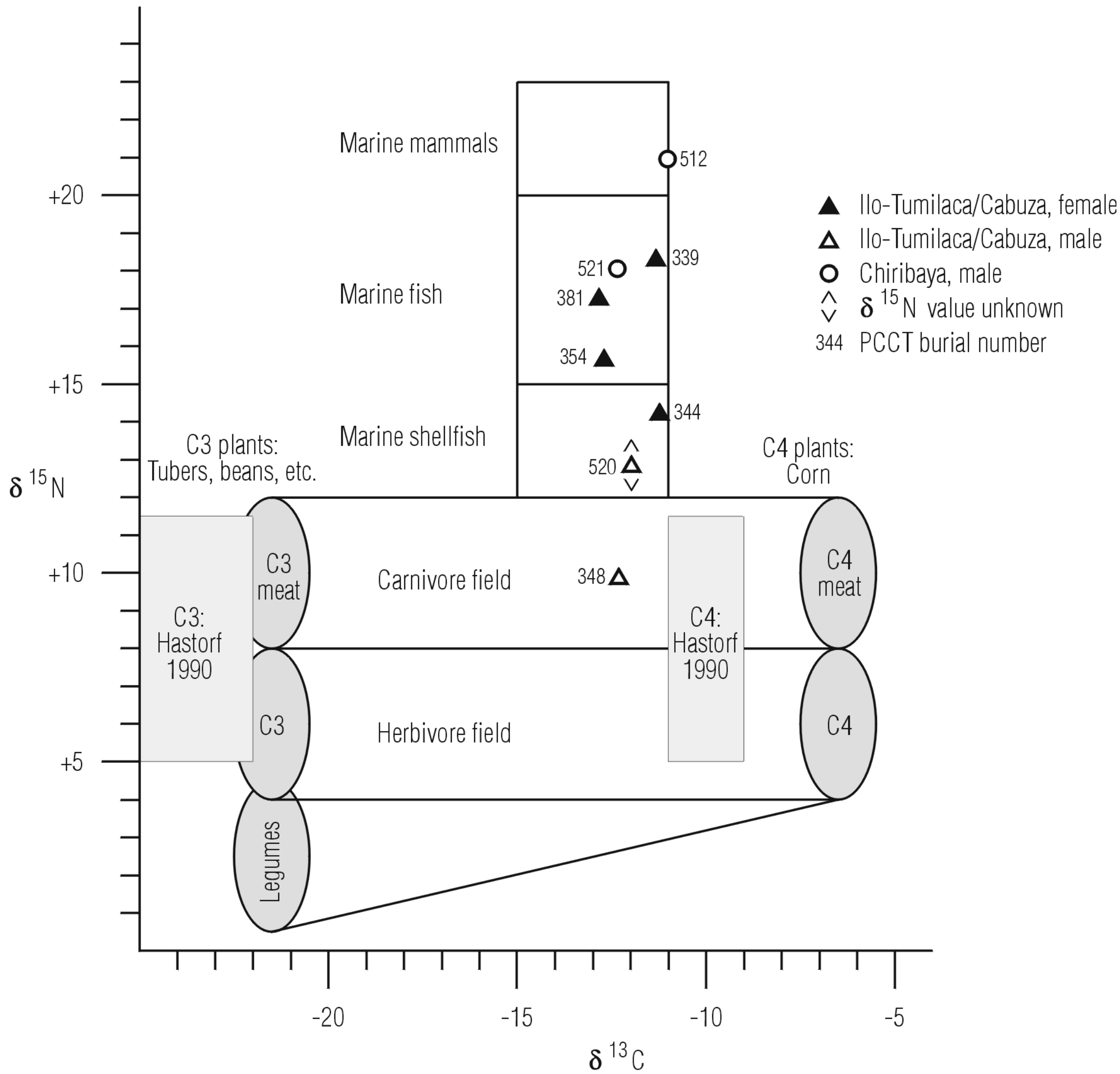

Figure 7-3. Carbon and nitrogen isotopic composition of human bone, data from Sandness (1992).

of marine resources. As indicated by the boxes representing marine subsistence on Figure 7-3, such a diet tends to have a relatively restricted range of $\delta^{13}C$ values, and one that by itself would indicate a relatively high consumption of corn. The marine component of the diet could be masking the relatively small and differential contributions of corn to both groups. Sandness (pers. com) has suggested, however, that the high $\delta^{15}N$ values might result in part from intensive use of marine guano as fertilizer, a practice well documented in the ethnohistorical record. It is also possible that coastal camelids ate marine plants or algae such that their meat had high $\delta^{15}N$ values. In either case, the relative contribution of marine foods to the diet and their effect on on the C4 plant estimates remains undefined. Second, four ^{13}C measurements run on camelid wool from textiles in Ilo-Tumilaca/Cabuza tombs in connection with radiocarbon dating (see Appendix C) indicate that coastal Osmore camelids ate large quantities of C4 plants, either corn or other coastal desert plants that might use the same C4 metabolic pathway. The $\delta^{13}C$ values of human bone might reflect primarily the consumption of high ^{13}C camelid meat, rather than corn. Since the amount of bone in the midden suggests that camelid meat was a relatively important part of the diet and corn was relatively minor, the differences in corn consumption and its overall small contribution to the diet might be overwhelmed by the effect of the camelid meat. For both of these reasons, the isotopic data do not lead to a clear conclusion on the consumption of corn, and the midden contents should be considered more reliable on this point: corn was probably a minor component of the diet of both groups, and much more important among the Chiribaya than the Ilo-Tumilaca/Cabuza people.

Another unexpected result of the midden analysis is the total absence of any bones or feces of cuyes (*Cavia*; guinea pig) in the Ilo-Tumilaca/Cabuza material. By contrast, cuy feces are a significant component of Chiribaya midden, and despite the small size of the bones comprise almost 0.4% of the mass of animal remains in Chiribaya refuse. Cuyes are not exotic to the region; their feces and bones are present in middens of the much earlier Algodonal Early Ceramic times in amounts comparable to the Chiribaya midden (feces: 0.2% of midden mass; bone: 5% of animal remains mass). The domestic refuse suggests that the Ilo-Tumilaca/Cabuza people neither raised nor ate cuyes, yet whole cuyes were found among the grave goods in several Ilo-Tumilaca/Cabuza tombs. Cuyes today are prized for special meals and celebrations, and may have played some similarly privileged role in Ilo-Tumilaca/Cabuza society such that they found their way more often into tombs than into the refuse of the living. Alternatively, the absence of cuyes may be due to some special feature of the site of Loreto Alto, perhaps the relatively greater effort that would be required to carry food for them up to the site. (It is modern practice in rural domestic settings to feed cuyes both on kitchen scraps and specifically gathered greens.) Even if cuyes were not raised at Loreto Alto, however, one might expect the residents to have procured at least small numbers of them by exchange with people from other sites. The lack of cuyes, like the lack of corn, at Loreto Alto hints that inter-site exchange may have been minimal. As for the competitive exclusion effect, however, cuyes do not require very specific conditions or food, and their absence probably does not imply such a drastic difference in subsistence patterns that the two groups would not have tended to compete for many of the same resources.

The Chiribaya also seem to have had greater access to most tree crops than the Ilo-Tumilaca/Cabuza group. Enough of the Chiribaya midden contexts contain seeds and husks of lucuma (*Lucuma bifera*) fruit, which is completely absent from Ilo-Tumilaca/Cabuza contexts, that the difference is statistically significant. Lucuma is common among Chiribaya grave goods as well (Appendix D; John Dendy, pers. com.), but has not been found in any Ilo-Tumilaca/Cabuza burials. Molle (*Schinus molle*) seeds, possibly used in *chicha* beer production or to ward off insects, are also significantly more common in Chiribaya midden. Molle branches and leaves are also common in midden contexts, but cannot be quantified because they were not separated from other species. Guava (*Psidium guajava*) fruit and seeds comprise only .04% of

Chiribaya midden mass, but are significantly more common than in Ilo-Tumilaca/Cabuza contexts where they are never found. By some measures, pods and seeds of the leguminous algarrobo (*Prosopis chilensis*) tree are more common in Chiribaya contexts, but by others there is no significant difference. The only identified tree crop that is evidently not more common in Chiribaya contexts is pacay (*Inga sp.*). Whether the molle and algarrobo represent resources that were in demand or common, casually collected items of little value is unknown. The Chiribaya's apparently exclusive control of two of the three undoubtedly prized fruits in the valley, however, coincides with the patterns of corn and cuyes to suggest an unbalanced prestige or resource tenure relationship between the two groups, as well as the likelihood that exchange between sites or social groups was severely limited.

The Ilo-Tumilaca/Cabuza midden, especially that from Loreto Alto, contains significantly more wood and wood chips than does the Chiribaya midden sample. Wood was loosely defined as any woody material that lacked bark and was large enough not to be considered a twig; much of this material is split or otherwise modified from a purely natural form, but generally has no clear cutmarks. Wood chips were defined as thin wood fragments with definite cutmarks, mostly apparently resulting from discrete blows with a sharp axe or adze-like tool. Both forms of wood may represent fuel, construction material, or craft production material. The ends of the structural posts found *in situ* in the Ilo-Tumilaca/Cabuza units at El Algodonal had been rather neatly cut with a sharp axe or similar tool, which would have produced many wood chips and fragments such as those in the midden at Loreto Alto. Although no finished or uncompleted wooden craft goods that would have resulted in this type of byproduct were found in domestic contexts, wooden spoons and one wooden *kero* (cup) that might have left wood fragments and chips as byproducts of their production were found in Ilo-Tumilaca/Cabuza funerary contexts at El Algodonal. These artifacts are also common in Chiribaya tombs, however, so in themselves they do not explain the quantities of wood in Ilo-Tumilaca/Cabuza refuse. Charcoal was also significantly more common in Ilo-Tumilaca/Cabuza midden, which suggests that some of the additional wood might have been intended as fuel. It is curious that the Chiribaya seem to have had much greater access to tree crops, while the Ilo-Tumilaca/Cabuza people had much greater access to tree trunks or large branches. The wood might reflect the use of different tree species, or perhaps debris washed downstream by the river. Unless most of the wood was scavenged from flotsam of the river, both groups would have needed access to areas along the river where trees would flourish, if not to the very same trees.

Given both the domestic midden evidence and the common inclusion of camelid remains in burials and apparent offering contexts, both groups clearly made extensive use of camelids for wool and meat, and probably for transport and ritual purposes as well. Although camelid meat was important for both groups, the Ilo-Tumilaca/Cabuza diet seems to have included more camelid meat than did the Chiribaya. Whether this meat was as important to the diet as the mass of camelid bones superficially implies is unknown, since reconstructing the dietary contributions implied by remains as different as large mammal bone, fish bone, shell, and varied plant remains is a complex project that will not be attempted here. Unlike the observed differences in use of corn, cuyes, and fruits, the difference in the amounts of camelid meat consumed by the two groups may have less to do with relative status, since both groups had access to large amounts of camelid meat. These large amounts suggest that they would have competed for resources related to camelid herding. The difference in camelid meat consumption might be an indirect effect of differences in the numbers of camelids kept for other purposes, specifically packing cargo. Two possible bridles were found in domestic contexts, one at the Ilo-Tumilaca/Cabuza site of Loreto Alto and the other in a Chiribaya midden at Loreto Viejo. These bridles would have been used on llamas working as pack animals, suggesting that both groups might have been involved in the transport of goods by llama caravans.

One hint about the relative importance of camelid meat is contained in the high $\delta^{15}N$ values of the human bone shown in Figure 7-3. These values principally suggest that marine resources may have been major parts of the diet, but the consumption of terrestrial meat would also contribute to elevating the $\delta^{15}N$ values above the range typical for primarily agricultural diets. Unfortunately, these $\delta^{15}N$ values are so high that the standard interpretation indicated by the reference values in Figure 7-3 may be suspect. Both the inland location of the sites and the moderate representation of shell and fish remains in the midden suggest that the local diet could not have been as heavily focussed on marine resources as the isotopic data alone suggest unless the people were living and eating away from the sites a lot of the time. There may be other effects of living in coastal regions that confound the simple interpretation of $\delta^{15}N$ values (Sillen et al. 1989); as noted above, the use of guano as fertilizer might be one such confounding factor.

The Ilo-Tumilaca/Cabuza midden also includes significantly more freshwater crayfish shell than does Chiribaya midden. These *camarones* are prized delicacies in the Andes today, but then as now they would have comprised a minuscule fraction of the diet.

Although both groups dumped about the same amount of marine shell in their refuse and exploited many of the same species, the mixes of species they used were

Shellfish variety	Habitat	Ilo-Tumilaca/Cabuza % of mass	Chiribaya % of mass	Signif. more in:
Choromytilus mussel	SS	83.6	31.8	I-T/C
Crepipatella slipper shell	RS	2.5	0.1	I-T/C
Chiton chiton	RI	0.8	29.5	Ch
Semele clam	SS	0.0	8.5	Ch
Donax small surf clam	SI	0.1	4.3	Ch
Tegula snail	RI	0.0	1.7	Ch
Aulacomya mussel	RS	0.0	0.9	Ch
Perumytilus small mussel	RI	0.0	0.3	Ch
Fissurella keyhole limpet	RI	1.8	15.7	same
Echinoidia sea urchin	RI*	5.5	0.3	same
Concholepas false abalone	RI	0.6	1.9	same
Balanus barnacle	RI*	0.1	0.1	same
Oliva olive shell	SI,SS	0.0	0.1	same
Other and unidentified	-	5.0	4.8	-
Total	-	100.0	100.0	-

SS: Sandy Subtidal; RS: Rocky Subtidal; SI: Sandy Intertidal; RI: Rocky Intertidal

After Sandweiss et al. 1989, except RI* by personal observation.

Table 7-2. Marine shell from domestic midden.

markedly different. Table 7-2 breaks down the shellfish species by percentage of total shell mass in the midden samples and shows the significant differences, calculated in the same way as in the previous table. The significance test results are identical when the shell mass is standardized by total midden mass, but the relationships between varieties are slightly less obvious. Some of this shell is burned, but the potential differences in preparation techniques that might be implied by the distribution of burning across species, sites, and social groups are not analyzed here.

The Ilo-Tumilaca/Cabuza shell assemblage is heavily concentrated on a single species, *Choromytilus* (purple mussel), while the Chiribaya assemblage is more diverse. Moreover, both of the shellfish that are significantly more common in the Ilo-

Tumilaca/Cabuza material are from the subtidal zone of the littoral, while most of the varieties that are significantly more common in the Chiribaya material are from the intertidal zone. Neither group apparently controlled any of the four categories of shellfish habitats, and only a few minor shellfish varieties were exclusively used by one group. Nevertheless, the Ilo-Tumilaca/Cabuza group got the great bulk of their shellfish from the deeper subtidal zones where swimming and diving would have been necessary, while the Chiribaya exploited the more accessible intertidal zone much more extensively. Since both the intertidal and subtidal zones may be relatively safe or dangerous to work in, depending on how rocky and exposed the location is, it will take more detailed study to assess the significance of the two groups' different shellfish collecting practices.

There seem to be two superimposed patterns in the resources used by the two social groups. The more general pattern is that many resources were heavily used by both groups. These are the resources for which the groups most obviously would have had cause to compete with each other. They include water for human consumption, pasture and water for camelids, access to the littoral for shellfish collecting and fishing, water and appropriate land for crops such as yuca, beans, and cotton, and access to groves of pacay and possibly other trees. The completely intermixed settlement pattern suggests that both groups would have been physically close to the same sources of these resources. This considerable degree of potential overlap in resources used seems to offer sufficient possibilities for competition to satisfy that condition for using the competitive exclusion effect.

The other pattern is of markedly different use of specific resources, which could indicate either areas of non-overlapping demand, or the diametric opposite, areas of drastically unmet demand on the part of the group with relatively reduced access to the resource. In the first case, these resources would have played little part in any competition between the two groups, because only one group would have had much demand for them. In the second, they would be the focus of the most intense competition of all. The only resources that the Ilo-Tumilaca/Cabuza group seems to have had special access to, or interest in, were camelid meat, *Choromytilus* mussels and *Crepipatella* shellfish, crayfish, and wood. They seemingly spent more time chopping or cutting wood than Chiribaya people, and since there is no notable difference in their assemblages of wooden artifacts, the Ilo-Tumilaca/Cabuza people were most likely using it either for fuel or construction to a greater degree than the Chiribaya. Although the difference in camelid meat is significant, the Chiribaya also consumed a great deal of it, leaving little reason to suspect that their access to the necessary resources for camelids was notably restricted. The special focus on two shellfish species is hard to assess at the moment. The Chiribaya group, on the other hand, had much greater access to, or interest in, corn, cuyes, and several tree fruits including lucuma, guava, and molle seeds that may have been used, like the corn, to make *chicha* beer (Hastorf and Johannessen 1993). Most or all of these were probably especially prized resources which were charged with symbolic value, relished as luxury foods, or both. Moreover, the Chiribaya group had greater access to the intertidal zone for shellfish gathering, which may have been preferable because it could be exploited without diving. The greater use of fish among the Chiribaya may support the same conclusion, since good shore fishing spots tend to be located in or near the same rocky intertidal zones where they collected the shellfish. In every case except that of the possibly unimportant crayfish, wherever the Ilo-Tumilaca/Cabuza and Chiribaya groups differed in access to particularly valued resources, the Chiribaya seem to have gotten the better end of the bargain.

Whether this result implies that Loreto Alto was a particularly disadvantaged site or that the entire Ilo-Tumilaca/Cabuza group had relatively limited access to the most prized resources compared to the Chiribaya cannot be addressed with the current data. However, even if the present sample of Ilo-Tumilaca/Cabuza material represents an unusually poor segment of the Ilo-Tumilaca/Cabuza community, it still without any doubt indicates that the Chiribaya and Ilo-Tumilaca/Cabuza had plenty of resources to compete over.

Competition between the groups: Inferences from population estimates

The second condition for applying the competitive exclusion effect is that there be some evidence that competition actually took place or that conditions were such that competition would be expected to have taken place. Several categories of evidence for competition will be considered in turn, starting with arguments based on population estimates, continuing through a variety of indicators of stress or shortage of resources, and concluding with evidence of various cultural responses to competitive circumstances.

One direct approach is to estimate the population of the region, calculate its subsistence needs, and compare those needs to the total productive capacity of the area. If the demand approaches or exceeds the potential supply, there must have been competition for the scarce resources. As appealing as this approach may be, in practice the uncertainties involved throughout the calculations compound to the point that the comparison between demand and supply is meaningless. Productivity varies drastically not only from region to region, but from crop to crop. Setting aside the distortion involved in using data based on modern technology and plant varieties, the average production of corn on the Peruvian coast from 1966 to 1979 was 3201 kg/ha, while in the same period and setting, the average production of yuca was 10,587 kg/ha, and the average production of potatoes was 15,702 kg/ha (Maletta et al. 1984). In order to reconstruct prehistoric productivity per hectare, then, one has to estimate the mix of foods in the diet. The relative contribution of marine resources, hunting, pastoralism, and so on are even more difficult to reconstruct with any certainty. Historical analogies are problematic, since, for example, consumption figures for 1947 suggest that roughly equal weights of corn and potatoes were consumed per capita in Perú, while by 1975, the mix had shifted to almost four times as much potato as corn in the average diet (Maletta et al. 1984). Ethnographic analogies will be no less affected by historical changes ranging from the availability of cheap rice, to the introduction of cattle, new varieties of corn, and technology such as iron hoe blades, guns, and fishline. It will be no small task to reconstruct a prehistoric diet mix, and the uncertainty will necessarily be large; as a guess, I doubt that any honest uncertainty term for people supported per hectare could be less than plus or minus 100 or 200 percent. In the case of the coastal Osmore valley, there must also be some uncertainty about the total cultivated area. The river must have flowed at least most of the year in order to support the irrigation and drinking water needs of the inhabitants and their animals. If the more reliable flow was accompanied by greater flow volume as well, it is unclear how wide the river bed would have been, and more important, how much of the presently arable land would have been consistently threatened by flooding. On the other hand, the river flow could have been reliable but small, in which case the scarcity of water might have prevented the entire floodplain from being optimally exploited.

Estimating the total demand is no less problematic, and perhaps more so. There is ample evidence that many sites have been partially buried or eroded away, and others no doubt have been completely hidden or destroyed, so the total occupied area is underestimated to some unknown degree. Many sites probably had occupations that were not recognized because diagnostic ceramics were rare, so the total occupied area per phase is further underestimated. On the other hand, the occupations may not all be contemporaneous, so the total area occupied at any given moment is probably overestimated by some unknown amount. Moreover, the entire area of any given site may not have been occupied all at once, further overestimating the total occupied area. The density of people per unit area was probably different at different sites. Reasonable estimates of population density within sites range from 100 to 600 individuals per hectare (Earle et al. 1987), introducing another 600% uncertainty in the population estimates. The population density estimate could be refined with extensive archaeological work at a number of different site types, but such information is not presently available.

The net result of all these uncertainties is that estimates for both total demand and total production in the coastal Osmore valley produce overlapping ranges with known uncertainties of over an order of magnitude. For example, depending on the ceramic criteria for identifying Ilo-Tumilaca/Cabuza sites, 27.4 to 43.3 ha of Ilo-Tumilaca/Cabuza habitation area were recognized during the survey of the coastal valley (Appendix F). Estimating 100 to 600 individuals per hectare, the maximum Ilo-Tumilaca/Cabuza population would be 2,740 to 25,980 individuals plus or minus the unknown (possibly large) additional uncertainty to account for lost or unrecognized sites, non-contemporaneous occupations, occupations that did not cover the entire area of a site, and so on. The estimates of Chiribaya population and total agricultural productivity are similarly uncertain, while the proportion of the diet from non-agricultural sources and the productivities of non-agricultural resource sources are even more uncertain. The uncertainties of the demand and supply estimates are so large that scenarios ranging from a tiny population wallowing in a paradise of plentiful food to a huge population in cutthroat competition for inadequate food to fend off starvation are all possible outcomes.

A more productive approach to estimating demand is to consider population only, on a purely relative scale. Unless resources are so abundant that productivity is limited only by labor, increasing population increases demand without increasing supply proportionally, so increasing population suggests increasing competition. Similarly, if population is at unusually high levels, then it is probably safe to infer that competition is unusually high, and probably absolutely high, as well. Because these measures are all relative, there is no need to introduce many of the factors and associated large uncertainties used in calculating absolute populations from site areas. Instead, as a first approximation, we can reasonably assume that habitation density, degree of contemporaneous occupation, and so on were comparable for various social groups and time periods, and let the site area itself stand for population. Later in this chapter, we will improve on this assumption by correcting for the denser and deeper cultural remains per unit area on Chiribaya versus Ilo-Tumilaca/Cabuza sites; introducing this correction here would make the results come out even stronger, but for the moment the data speak strongly enough for themselves without any additional manipulation. When we use total site area as a proxy for population, only the errors in estimating contemporaneous site area per phase are left, and these need not be severe because we can also reasonably assume that site preservation and identification problems have roughly the same impact on all the social groups and time periods. Although absolute population estimates tend to have enormous uncertainties, relative populations based on total site areas can be assessed with much more confidence.

One analytical approach to site areas is to treat the total area as a maximum that could have been occupied at one time. This approach assumes that all the sites were occupied contemporaneously at some point during the time period, near the end if population was rising, near the beginning if it was falling, or somewhere in the middle if it population peaked during the time period. The total site area in this "maximum" model stands for the maximum population at some time during the period, and the duration of the period is irrelevant.

An alternative approach to site areas is to assume that only a fraction of the sites were occupied at the same time, and that they were founded and abandoned at comparable rates. Under this "average" model, the best proxy for population is the total area occupied per year, which can be considered an index of the average population over the entire time period. The "maximum" model concentrates the population as much as is logically possible, while the "average" model spreads it out as evenly as is logically possible. The reality should be somewhere in between the two models. By considering the data with both analytical models, we can determine the extremes imposed by the analytical methods themselves, and infer that the best interpretation of the data is intermediate between these extremes.

Table 7-3 summarizes the total identified areas of all types of sites occupied or used in various time periods in the coastal Osmore valley (see Appendix F for methods used and more detail). These are the data needed for the "maximum" analytical model. The first column totals sites occupied in the Early Ceramic periods, which serves as a

Quality of Cultural Attribution	Algodonal Early Ceramic and BR Early Ceramic		Algarrobal phase Chiribaya and Ilo-Tumilaca		Post-Algarrobal phase Chiribaya and Ilo-Cabuza		All Chiribaya and Ilo-Tumilaca/Cabuza	
	Sites	Area	Sites	Area	Sites	Area	Sites	Area
Definite	18	27.0	17	34.6	28	53.0	68	93.8
Probable	45	47.8	30	49.5	33	64.1	82	103.0

Table 7-3. Total site areas by time period, as a proxy for relative population estimates.

baseline for comparisons. The Algodonal Early Ceramic and the BR Early Ceramic styles are lumped in this analysis to reduce the problems of site identification and the uncertain chronological positions of the two styles. The length of time represented by these sites is not well known, but it probably ran from perhaps 100 BC to AD 950 or later, for a highly speculative total of 1050 years (see Appendix C). The total population represented by these sites was probably not evenly spread over time, but rather was concentrated in the earlier Algodonal Early Ceramic times, tentatively dated from 100 BC to maybe AD 600, while only a small fraction of the population represented by these sites lived during the BR Early Ceramic. This uneven distribution of population over time adds some uncertainty to the relative estimates. Since the duration of this period is much greater than any of the subsequent temporal phases, the total relative "population" in Early Ceramic times will tend to be more overestimated due to non-contemporaneous occupations than are the estimates for later periods. On the other hand, these early sites are clearly more buried and eroded than the later ones, and the ceramics are less diagnostic, so the total area will also be more under-estimated due poorer site preservation and recognition. The magnitude of these uncertainties is difficult to estimate.

The second column totals sites known to have been in use during the initial occupation of the coastal valley after the collapse of Tiwanaku, that is, the early Late

Intermediate Period, marked by sites with Ilo-Tumilaca and Algarrobal phase Chiribaya pottery. The total areas are comparable to the totals for the preceding Early Ceramic period, but the total time represented is far shorter, probably under 200 years (Figure 1-5). Under the "maximum" model, the maximum population during the early Late Intermediate Period was about the same as the maximum population during the Early Ceramic Period, and competition would not have been unusually high. On the other hand, the data discussed in Chapter 4 suggest that most of the Early Ceramic population lived during Algodonal Early Ceramic, and that population had declined drastically by the BR Early Ceramic. In that case, even though competition under the "maximum" model may not have been absolutely high in the early Late Intermediate Period, it would nevertheless have risen markedly compared to the preceding period.

Because the two time periods are of such different lengths, although the total site areas are similar, the site area per unit time in the early Late Intermediate Period would have been about five times as large as in the Early Ceramic. The "average" analytical model addresses this disparity in the lengths of the periods, and the data necessary for the "average" model are shown in Table 7-4. The poorer preservation and recognition of the Early Ceramic sites certainly account for some of the difference in site area per century, and since many of the Early Ceramic sites have deep deposits that suggest long occupations compared to the Late Intermediate Period sites, some more of the difference is probably due to differences in rates of site founding and abandonment between the different time periods. Nevertheless, using the "average" model, the evidence suggests that the early Late Intermediate population of the valley was probably much larger than it had been in the preceding periods. The increase in population suggests that competition was relatively higher, and the high population compared to the previous norm suggests that competition may have been absolutely

Quality of Phase Attribution	Algodonal Early Ceramic and BR Early Ceramic	Algarrobal phase Chiribaya and Ilo-Tumilaca	Post-Algarrobal phase Chiribaya and Ilo-Cabuza	All Chiribaya and Ilo-Tumilaca/Cabuza
	Area/100 years	Area/100 years	Area/100 years	Area/100 years
Definite	2.6	17.3	15.1	23.5
Probable	4.6	24.8	18.3	25.8
Duration	1050	200	350	400

Table 7-4. Total site areas per 100 years by time period.

high, as well. The truth probably lies somewhere between the "maximum" and the "average" analytical models, implying some degree of competition even during the initial occupation of the coastal valley by early Late Intermediate Period groups.

The third column in both tables totals sites known to have been in use slightly later, in the Middle Late Intermediate Period, as indicated by Ilo-Cabuza and Post-Algarrobal phase Chiribaya ceramics. The total site areas shown in Table 7-3 are slightly higher, but the total time represented is also almost twice as long as the preceding period, lasting some 350 years. The total area per year shown in Table 7-4 for the middle Late Intermediate Period is lower than in the early Late Intermediate Period, but is still far above the value for the Early Ceramic period. The "average" model suggests that the total population of the valley declined in the middle Late Intermediate Period, but was still much higher than in the Early Ceramic period. Using the "maximum" analytical model, the maximum population during the middle Late Intermediate Period would have been well above the maximum population in any of the preceding periods, suggesting that the population rose throughout the period. Again, the truth probably lies between these two models, suggesting continuing or increasing competition in the middle Late Intermediate Period.

The last column in both tables indicates the total site areas of all Late Intermediate

Period sites. These totals are higher than those in the other Late Intermediate Period columns, because many sites could not be specifically assigned to one or the other subdivision of the Ilo-Tumilaca/Cabuza or Chiribaya styles. When the totals in this column are compared to the Early Ceramic values, it is clear that under either analytical model, the population in the early to middle Late Intermediate Period was far larger than it had been in the Early Ceramic. Although the finer temporal definition of the previous two columns is lost, the broader trend is better defined: population soared in the Late Intermediate Period, reaching heights unprecedented in the coastal valley. There is every reason to expect that competition would intensify under such circumstances.

Competition between the groups: Indicators of stress and shortages

Another general approach to documenting competition is to document shortages of certain resources or subsistence resources in general. When demand outstrips supply to the extent that people are physically stressed or they are pressed into using less-preferred alternative resources or more labor-intensive methods of capturing resources, then it is reasonable to infer that people competed with each other for access to the insufficient supply that was available.

The most direct indicators of stress are traces of lifestyle-related diseases and mortality patterns in human remains. Based on a study of pathologies on skeletal remains of 568 Chiribaya individuals, Burgess (1991:9) concluded that "disadvantaged health status for Chiribaya is indicated by an overall high prevalence of cribra orbitalia and porotic hyperostosis when compared to other pre-Columbian skeletal populations from North and South America". In a later study, Burgess (1992) found that a sample of 51 individuals from the Ilo-Tumilaca/Cabuza cemetery at El Algodonal did not differ significantly from the Chiribaya population in the frequency of any of the major pathologies she recorded. On-going analysis of coprolites (Reinhard, pers. com.; Burgess 1991, 1992) suggests that these indicators of stress are probably not related to unusual parasite loads, and the seemingly small contribution of corn to the diet noted earlier suggests that the widely cited health disadvantages of diets high in corn are not responsible, either (Burgess 1991). After considering a variety of possible explanations, Burgess concluded that the high incidence of these two conditions probably reflects poor environmental conditions, specifically the presence of infectious respiratory diseases including high frequencies of tuberculosis, poor hygiene and sanitation practices, and poor nutrition. This skeletal evidence suggests that the Late Intermediate Period population was physically stressed, and individuals or groups would presumably have competed for food resources, and possibly for living space and clean water, as well.

Mortality or survivorship patterns reconstructed from the age-at-death of human skeletal remains should also be indicators of overall stress on a population. The ages at death of 67 individuals from the Ilo-Tumilaca/Cabuza cemetery at El Algodonal were estimated by Shelley Burgess and fit to Weiss's (1973) model life table 22.5-50.0 (see Appendix D). The comparable data from the much larger sample of Chiribaya individuals excavated by David Jessup at San Geronimo and by Jane Buikstra's Chiribaya Project at three Osmore drainage sites are not yet available in detail, but Burgess (1992) found no statistically significant difference in age distributions between the large Chiribaya sample and the Ilo-Tumilaca/Cabuza material, so the discussion presented here should be roughly correct for the bulk of the Late Intermediate Period population of the coastal valley. The model life table that best fits the Ilo-Tumilaca/Cabuza sample is towards the high-mortality end of the range of tables prepared by Weiss (1973). A convenient single figure for comparing demographic data is E(15), the life expectancy at age 15. This particular measure is somewhat arbitrarily selected because Weiss provides it for all his real and calculated life table data, and because it avoids the problems associated with life expectancy at birth, which is often skewed by incomplete reporting or poor representation of juveniles in the burial record. Of the fourteen living non-industrial populations that Weiss reports, including Eskimos, Guarani, Tikopia, Tsembaga, Tiwi, and others, only the Yanomamo and Angmagssalik Greenlanders had lower E(15) values than the Ilo-Tumilaca/Cabuza sample. This result suggests that the Ilo-Tumilaca/Cabuza population was relatively stressed compared to these modern populations.

The Ilo-Tumilaca/Cabuza lifestyle does better in comparison to other archaeological populations that Weiss labels "pre-urban," of which 19 of 27 have lower E(15) values. Weiss suspects that the ages at death of archaeological remains are consistently underestimated; the extent to which this would apply to the Ilo-Tumilaca/Cabuza sample as well is unclear. Assuming that all are comparably skewed, the Ilo-Tumilaca/Cabuza fall on the long-lived side of the middle of the distribution of stress among "pre-urban" populations. If (as I suspect) the Ilo-Tumilaca/Cabuza sample is more accurately aged than many of Weiss's reference populations, then it may be even closer to the prehistoric norm. Certainly by modern standards this population was stressed, but the degree of stress was nothing unusual for people in the "pre-urban" past. The prevalence of stress in pre-urban settings does not mean that stress was less likely to cause people to compete for resources, only that it did so more commonly or more intensely. Although it would make a stronger argument for competition if the Ilo-Tumilaca/Cabuza had suffered from unusually severe mortality rates, even being near the middle of the pack in "pre-urban" mortality is probably sufficient to imply stress, unmet demand, and competition for resources.

Another indicator of competition is an increasing use of less-preferred resources. People who cannot meet their demand for the most preferred resources will have relatively less of them and relatively more of their less preferred alternatives. For archaeological societies, the relative esteem in which different resources were held would ideally be demonstrated by comparing assemblages from excavations in households of clearly varying status; the resources most concentrated in the higher-status households would be considered more highly valued or preferred by the inhabitants than those with more uniform distributions or distributions skewed towards lower status households (Owen i.p.). Since the material needed for such a study is not yet available for the coastal Osmore region, the next best alternative is ethnographic analogy, which provides the relative rankings I have alluded to earlier. Table 7-5 shows the proportions of various food resources for which ethnographic analogies suggest possible more or less preferred status, and their relative abundances in Ilo-Tumilaca/Cabuza midden, Chiribaya midden, and Early Ceramic midden. If competition was more intense in the Late Intermediate Period the proportion of preferred resources in the Late Intermediate Period midden samples should have gone down from the earlier Algodonal Early Ceramic period, and the proportion of less preferred resources should have gone up. The figures and significance tests are calculated in the same manner as in the previous tables. Except as shown in the table, the results are the same whether the items are standardized by the mass of all midden materials, or by the mass of only botanical materials, so differences in ceramic and lithic use from the Early Ceramic to the Late Intermediate Period do not materially affect the interpretation.

Item	Early Ceramic	Ilo-Tumilaca/Cabuza	ITC sig. diff? p=	Chiri-baya	Ch sig. diff? p=	Pre-ferred good?	Trend
Corn cob, etc./all mass	19.91	0.15	.19	2.80	.16	yes	down?
Corn cob, etc./plant mass	35.84	0.74	.55	10.89	.02	yes	down
Crayfish/all mass	0.60	0.06	.64	0.03	.02	yes	down
Cuy/all mass	0.02	0.00	.43	0.06	.18	yes	none
Cuy feces/all mass	0.21	0.00	.07	3.65	<.01	yes	up
Guava/all mass	0.01	0.00	.43	0.04	.07	yes	up
Lucuma/all mass	0.00	0.00	-	0.31	<.01	yes	up
Pacay/all mass	0.29	0.53	.44	0.21	.25	yes	none
Pacay/plant mass	0.52	2.65	.03	0.84	<.01	yes	up
Molle seed/all mass	0.004	0.002	.89	0.351	<.01	yes?	up
Algarrobo/all mass	0.001	0.126	.97	0.033	.03	yes?	up
Large mammal (Camelid)/all mass	0.03	4.00	.02	0.90	.07	yes?	up
Large mammal/animal mass	43.17	93.75	<.01	90.41	<.01	yes?	up
Camelid feces/all mass	4.06	2.85	.88	2.21	.58	no	none
Beans/all mass	1.21	0.08	.03	0.31	<.01	no?	down
Tubers/all mass	2.05	0.68	.55	0.13	<.01	no?	down

Table 7-5. Trends in the use of more and less preferred resources.

Most of these data do not conform to the expectations of increasing competition. Corn and crayfish were probably highly valued, and did in fact decline in relative use, while camelid meat may have been a second-choice food and does seem to have increased in relative use. These are the patterns expected for a situation in which competition is increasing. However, a variety of other probably highly valued resources, including cuy, guava, lucuma, pacay, molle seeds, and algarrobo seeds and pods all became more common or at least remained constant in the diet, while the presumably less preferred beans and tubers actually declined. All of these trends suggest that the composition of the diet was changing for the better, hardly an indication of competition for subsistence resources. Perhaps other cultural differences between the local Algodonal Early Ceramic people and the Late Intermediate Period groups such as subsistence technologies, seasonal settlement, traditional values, or other intangibles overwhelm the effect of relatively increased competition on the diet mix. Since so many other lines of evidence, both already noted and still to be discussed, suggest that competition increased to high levels in the Late Intermediate Period, the interpretation of these changes in use of preferred and less preferred resources will be left in abeyance for now.

A final indicator of unmet demand for resources is the adoption of more labor-intensive means of procuring the resources. In essence, competition drives up the "price" of goods, and the adoption of labor-intensive methods of production reflects the higher "price" people are willing to pay for a scarce commodity. In the coastal Osmore valley, the most obvious example of a labor-intensive technology of production is the system of reclaimed fields on quaternary river terraces above the floodplain, irrigated by a long canal on the north wall of the valley. The scarce commodity involved was arable land, or the agricultural products of it. Perhaps even more importantly, the fields on the elevated river terraces would not have been subject to the flooding that has destroyed farmland and crops within the present generation and against which the present farmers expend tremendous efforts to deflect the flow of the river away from their land. This flooding would probably have been even more of a threat in the past, when the river must have flowed at least most of the year, and with a greater volume, so land that was relatively risk-free may have been highly sought after. The reclaimed fields total (conservatively) 23.2 ha. A modern survey of the agricultural resources of the coastal valley found 378 ha of arable land, of which only 170 ha were considered to have less than "moderate" limitations on its use (ONERN 1976; see Appendix F). Constructing the fields and canal would have increased the good farmland in the coastal valley by about 15%, or perhaps more if the reclaimed fields were in fact valued more highly than much of the floodplain land. Ignoring the quality of the fields altogether, the reclamation project still would have added 7% to the total arable acreage in the valley.

The price for this land was the labor to construct the main canal and feeder canals, and to shape the inclined river terraces into level, rectilinear plots, some of which were supported by stone retaining walls. The main canal is 6.7 km long (I have reported longer figures in previous papers, based on an incorrect determination of the location of the canal's intake). About 2.4 km of the canal's length runs across steep, rocky cliff faces, where the canal is both cut into the bedrock and supported by mortared stone retaining walls. In places, the canal clings to these rock faces as much as nine m above the foot of the cliff. Constructing this canal and the associated fields would have required a considerable effort that would presumably not have been exerted had there not been fierce competition for flood-resistent arable land.

When did this competition occur? Dating the construction of canals is typically difficult, and various detailed arguments are presented in Appendix F. The canal and fields were definitely in use contemporaneously with the Ilo-Tumilaca/Cabuza and Chiribaya occupations of the valley, and they were abandoned apparently slightly before the end of the Chiribaya tradition. The BR Early Ceramic sites, which I suggested in Chapter 4 represent the settlements of the previous occupants of the valley, are all at least five km downriver from the last river terrace irrigable by the canal. For this reason alone, the BR Early Ceramic people are not likely candidates for having built the canal. Algodonal Early Ceramic sites are located in places that make sense for users of the canal, but the sites could also have been selected for their access to the valley bottom. If the canal dates from Algodonal Early Ceramic times, then it was probably abandoned for several hundred years and then restored by the Late Intermediate Period groups, a possible but not very likely scenario. The most likely date for the canal's construction is in the early or middle Late Intermediate Period, when Ilo-Tumilaca/Cabuza and Chiribaya people lived in the valley.

It is most likely that the canal was built early in this period. The simple argument for an Ilo-Tumilaca date is that the site of Loreto Alto is clearly associated with a large area of the reclaimed fields, and presumably would not have been built in its difficult location if the reclaimed fields had not already been present or anticipated. Ilo-Tumilaca ceramics were found at Loreto Alto, so the fields would have been built or in use before the Ilo-Tumilaca style faded away. The more complex argument is that, as we will see later, the Ilo-Tumilaca/Cabuza and Chiribaya groups increasingly diverged over time in population size, relative group prestige, social complexity, and so on. Since both Ilo-Tumilaca/Cabuza and Chiribaya sites are directly associated with the canal, the canal was probably used, and possibly built, by both groups at a time when their relative positions of power and legitimacy were not too far from equal, that is, relatively early in their joint occupation of the valley.

If this dating is correct, then the construction of the canal suggests that competition for flood-resistent arable land in the coastal Osmore reached unprecedented heights not long after the two (or perhaps all five) social groups had established themselves in the valley. Since the reclamation project did not add a great amount of land to the total available, but the population of the valley continued to grow, the rising demand for land was probably satisfied only briefly at best, and competition for farmland probably continued to grow after the canal and field system was finished.

Despite the probably increasing unmet demand for farmland, no major additional canals were built, perhaps because the few remaining river terraces were already settled, or were too small, too high, or too remote to profitably irrigate with a canal. (Appendix F notes a smaller canal of unknown but probably prehistoric date, and a sizable canal near the valley mouth that is said to have been built in the 1940's.) Strangely enough, it appears that some areas of the river terraces that could have been watered by the canal were never terraced off into fields. This seemingly incomplete use of the available reclaimed land might indicate that the demand for arable fields was indeed satisfied by the reclamation project to the point that there was excess capacity that was never used, but it is more likely that some other scarce resource such as the amount of water that could be delivered by the canal became the limiting factor on arable land area. If so, the competition would have shifted its object from land itself to water rights, and in so doing become invisible in the archaeological record.

Competition between the groups: Evidence of social responses

Competition can be inferred from evidence of social responses to it, most notably the responses of real or threatened warfare, and, albeit more ambiguously, strong social boundary marking. Interestingly enough, there is little evidence of warfare in the coastal Osmore valley. Settlements were mostly located on slopes and open river terraces near the valley floor, with residential areas and cemeteries of different groups completely intermixed and in very close proximity to each other. Some sites have ceramics of more than one style, suggesting either that they were occupied by different groups in succession, or that individuals or families of different groups lived together on the same sites. Another explanation would be that decorated, stylistically distinct ceramics were traded fairly freely between people of different groups, but both the logic of social group boundary marking and the midden evidence noted above suggest that exchange between the groups was quite limited. The habitation sites show no evidence of walls, ditches, or other defensive features other than the often steep slopes behind them. Even these slopes would have been a mixed blessing in active hostilities, since although they would have made attack from the rear difficult, it would have been easy to roll boulders down them or start landslides that could have been disastrous for the defenders below.

The only sites with possibly defensive features are Chiribaya Alta and the Loreto Alto-type sites. Chiribaya Alta is located on a projecting corner of the level pampa above the southern lip of the valley, such that about half of its perimeter is naturally protected by a high, steep, and loose talus and gravel scarp dropping down to the valley floor below (Williams and Buikstra n.d.; Jessup 1990b, 1991; Ghersi 1956). The pampa side of the habitation area of the site is completely protected by a mound originally perhaps two m high and a parallel borrow ditch just outside it. A second mound and ditch separated from the first by a broad uninhabited no-man's land was started but never brought all the way around the pampa side of the site. Unfortunately, the mound has been too badly damaged by looters to ascertain whether it was surmounted by a palisade (unlikely on the nearly treeless coast) or perhaps a thick cane wall. More than half of the heavily looted cemeteries of Chiribaya Alta are located outside the inner mound and ditch. Great quantities of shell, plant material, grinding stones, and the stubs of cane walls outlining rectangular multiroomed structures indicate that the interior of the site was densely inhabited in addition to being the site of many rich burials. Nevertheless, only a small fraction of the Chiribaya population of the valley could have taken refuge inside Chiribaya Alta, and it is unlikely that Chiribaya people living over twenty km up the coastal valley would have seen the site as useful for their own defense. Moreover, inhabitants of Chiribaya Alta would have had to leave the site and climb down to the valley floor to get drinking water, so the site would have been vulnerable to even a short siege. Although Chiribaya Alta looks imposing as a defensible site, and a great deal of effort was expended to make it so, it would have served to protect only a small fraction of the valley's population, and principally from brief raids rather than protracted conflicts. The tensions implied by the site, then, are relatively small scale, and the fortifications may reflect visible boundary marking by a status or ethnic group more than responses to real threats of war. Most people apparently saw no reason to even symbolically protect their settlements.

The other potentially defensible sites are Loreto Alto and several smaller concentrations of similar little terraces in the bottoms of steep ravines high up on the northern wall of the valley. These sites are somewhat defensible because of their locations, but have no additional walls or other structures other than a few possible lookout points that might reinforce the impression that they were placed for defensive purposes. In fact, the habitation terraces at these sites are located in the bottoms of steep ravines, where they are vulnerable to attack from the ridgelines on either side, as well as the next terrace above. These ridgelines are easily accessible from the lip of the valley. I suspect that despite their daunting locations up on the valley wall, these sites were selected primarily for some reason other than defensibility, and would not have made even the symbolic statement of defensibility that Chiribaya Alta probably did.

Another category of evidence for warfare is a large number of weapons and related equipment. Weapons are known from some Chiribaya burials, but based on the published examples and my personal observations, they are not found in great quantities, nor in clear concentrations that might indicate "warrior" burials. The full documentation of the hundreds of Chiribaya grave lots excavated by Jessup (1990a,b, 1991) and Buikstra's Chiribaya Project (Williams and Buikstra n.d.) will better define the prevalence of weapons in Chiribaya burials. No weapons at all have been found in Ilo-Tumilaca/Cabuza burials. Chiribaya weapons include bows and arrows that could have been used either for hunting or warfare, and axes that were probably at least symbolically weapons. These axes have ground stone, copper or bronze, or even functionless wooden bits, and generally are not very sharp (Jessup 1990a,b, 1991). One looted example in a private collection is an elaborately cast copper alloy piece with a gilded surface and decorative relief details that was clearly intended only for display. These axes may allude to real weapons, and may hint that some element of force was involved in the high social status of the evidently wealthy individuals they were buried with, but they do not suggest extensive actual warfare. A few ground stone "doughnut stones" very similar to Moche maceheads have been found by collectors in the coastal Osmore valley. Virtually identical artifacts have also been identified as agricultural "clod breakers" (Russell 1988), so these items may not be related to warfare at all. A fragment of a "doughnut stone" was encountered on the surface at Loreto Alto, and pieces that might have been another that broke in an early stage of manufacture were also surface collected there. The central, probably highest-status terraces at Loreto Alto had an unusual density of otherwise typical projectile points on the deflated surface, which could conceivably relate to a battle at the core of the site. Like the doughnut stones, however, these points could also be traces of peaceful pursuits. Even in the unlikely event that every artifact known from the coastal valley that might have been a weapon was in fact used as such, weapons still would have been a very minor part of the artifact assemblage and would indicate a relatively minor impact of armed conflict on daily life in the valley.

Raids and warfare can also be expected to show up in osteological remains as high frequencies of traumatic injuries, or as elevated mortality rates for males of fighting age. Neither is the case in the coastal Osmore valley. Burgess (1991, 1992) found that only 8.9% of the Ilo-Tumilaca/Cabuza individuals and 6.6% of the Chiribaya individuals that she examined had suffered pre-mortem traumatic fractures; she notes that these frequencies are low compared to other preindustrial populations. Depressed fractures of the cranium are particularly diagnostic of conflict, but all three cases (two Chiribaya and one Ilo-Tumilaca/Cabuza) are females, and Burgess suggests that they may be more indicative of domestic violence than of warfare. Finally, the mortality patterns of both groups are smooth and typical. Neither group appears to be missing any age or sex group such as warriors who might have fallen in battle and not been recovered, and neither group shows any unusual elevation of mortality for individuals who might have been involved in warfare (Burgess 1991,1992; Appendix D).

Wobst (1977) and Hodder (1979) have suggested that competition between groups may encourage increased emphasis on marking the boundaries between them. This boundary marking might involve visible symbols such as walls that physically separate the groups, decorated clothing or ceramics, or ritual differences such as burial practices. To the extent that the boundary marking actually limits contact between the groups in certain spheres of activity, boundary maintenance may be indirectly reflected by limited exchange of goods between the groups, or limited exchange of knowledge and skills that leads to random "isochrestic variation" (Sackett 1982), that is, divergence of "style" in areas that are not direct expressions of group identity nor practical function such as choice of ceramic temper and paste constituents. Competition is not the only explanation for pronounced boundary maintenance, but evidence of boundary maintenance tends to corroborate other indicators of competition.

The mound and ditch surrounding Chiribaya Alta, as noted earlier, may be just such a symbolic boundary marker. These constructions probably would not have been very effective at actually keeping fighters out of the site, but they very visibly delimit the site from the rest of the world. The symbolic use of nominally defensive architecture is not unusual in the Andes; it has been suggested for the much more imposing Inka "fortresses" of Sacsawaman and Ollantaytambo, as well. Moreover, the impressive site of Chiribaya Alta does not seem to have been originally intended to be walled. The mound covers earlier Chiribaya burials, and is composed of redeposited domestic midden, largely shell, which indicates that it must have been built after the site had already been occupied for a considerable period of time. Whether the mound and ditch were meant as literal defenses or symbolic divisions of social space, the pressures that lead to their construction seemingly arose or intensified after both the Chiribaya and Ilo-Tumilaca/Cabuza groups had shared the coastal valley for some time, specifically during Jessup's Yaral (middle) Chiribaya phase (Jessup 1990b, 1991), which I include in Post-Algarrobal phase Chiribaya.

Another form of boundary marking that apparently increased over time is expressed in the decorated ceramics of the two principal social groups (see Appendix

B for systematic descriptions of the ceramic styles). In the early portion of their joint tenure in the coastal valley, the Ilo-Tumilaca and Algarrobal phase Chiribaya styles were decoratively distinct, but executed with very similar ceramic technologies. The most common pastes and tempers are the same in both styles. Most vessels of both styles used the same or similar overall thin, slightly transparent red slip on the exterior of vessels, with just a band along the rim slipped inside. Both tended to use watery paints, especially black for lines, and many examples are not burnished or only cursorily burnished, resulting in a uniform matte or dusty-looking finish. The range of quality of execution of forms, slipping, and painting is similar for most examples of both styles. The Ilo-Tumilaca style is more variable in quality, though, such that some of the finest Ilo-Tumilaca pieces are substantially better made, with thicker, more opaque slips and paints and thorough burnishing, and a few are noticeably more poorly formed, slipped, painted, and fired, but these are unusual. The two styles share some, but not all, vessel forms, including *tazones* (everted straight-sided bowls) and globular jars with handled, flaring necks, but they differ in others, such as the rounded bowls that are found in Algarrobal phase Chiribaya style but not Ilo-Tumilaca style and the flaring *keros* (cups), often with raised bands around the waist, that are found in Ilo-Tumilaca style but not Algarrobal phase Chiribaya. The two styles differ most clearly in painted motifs. Algarrobal phase Chiribaya vessels, especially the highly diagnostic bowls, are often decorated with bow tie ("mariposa") motifs, eight-pointed stars, and a characteristic two or three pointed double sawtooth design, none of which are ever found on Ilo-Tumilaca vessels. Ilo-Tumilaca motifs include simplified black line drawings of flamingos, outlined stairsteps, circles with central dots, and a variety of other motifs, some of which are never found on Chiribaya ceramics, and others of which are extremely rare or executed differently in the Chiribaya style. The Ilo-

Tumilaca designs are clearly derived from or identical to Chen Chen phase (Tiwanaku V) and Tumilaca phase motifs and design canons in the middle valley, while the Algarrobal phase Chiribaya designs, although probably related, are already quite distinct and in many cases have no obvious direct precursors in the Tiwanaku tradition.

Painted motifs are probably the most easily and obviously changed features of decorated ceramics, while the materials, finishing, and even forms may require more risk and experimentation to alter successfully, and may face more resistance from the established preferences among the people who use the vessels. For this reason, it is precisely the painted motifs that are most available for manipulation for purposes such as boundary marking. The Ilo-Tumilaca and Algarrobal phase Chiribaya styles evidently share a common technological and decorative heritage, but have been adjusted in exactly the way that produces the most easily recognizable visual differences. These differences can reasonably be considered to be intentionally created and consciously recognized markers of ethnic identity and distinctness among the users of the ceramics, just as pottery designs are today in the central Andes.

As the two ceramic traditions developed and the later Ilo-Cabuza and Post-Algarrobal phase Chiribaya styles emerged, the differences between the pottery used by the two social groups increased dramatically. While less-diagnostic sherds or even some minimally decorated whole vessels of the plainer Ilo-Tumilaca and Algarrobal phase Chiribaya styles are occasionally hard to distinguish, even the smallest sherd of a slipped Post-Algarrobal phase Chiribaya vessel can be distinguished with certainty from the Ilo-Cabuza style, and any Ilo-Cabuza style sherd with even a tiny fragment of painted design can be distinguished from the Post-Algarrobal phase Chiribaya without any doubt. Post-Algarrobal phase Chiribaya decorated wares, which are relatively common even in domestic refuse, have a distinctive dense, dark red slip, overall careful burnishing, and are almost always made from a distinctive coarse-tempered paste with large white inclusions. The invariably polychrome painted designs are highly standardized and completely distinct from any motifs in the Tiwanaku or Ilo-Tumilaca/Cabuza tradition. They are so uniform and expertly made that they probably imply at least part-time, if not full-time specialist potters working in a relatively limited number of shops.

Ilo-Cabuza style ceramics evolved in exactly the opposite sense. The overall red slip became so watery that it is often difficult to detect, and may have sometimes been omitted altogether. What burnishing had been done before was largely abandoned, and the resulting vessels tend not only to lack a burnished luster, but also to be somewhat lumpy and irregular in surface contour. The forms themselves become irregular, with wavy rims and oblong, asymmetrically sagging bowl shapes. The occasional polychrome painting of the Ilo-Tumilaca style disappears, leaving only black line designs in a paint that becomes so fugitive that in places it is visible only as a difference in surface texture. The black line designs themselves include only a few simple motifs, rather than the variety and complexity of motifs in both the Chiribaya tradition and the earlier Ilo-Tumilaca style. These few motifs are executed in a sloppy, cursive manner, with lines that obviously extend beyond where they were intended, accidental drag marks and drips, and miscalculated angles and design spacing resulting in apparently unintended asymmetries. There is virtually no overlap in paste, temper, slip, paints, or burnishing between decorated Ilo-Cabuza and Post-Algarrobal phase Chiribaya ceramics; the sources of materials and/or details of their use appear to have completely diverged. While the Ilo-Cabuza ceramics might be the work of specialized potters, they vessels do not suggest a great deal of expertise, care, or investment in the work.

If the differences in the decoration of the Ilo-Tumilaca and Algarrobal phase Chiribaya styles reflected intentional boundary marking, then the dramatically greater decorative differences between the Ilo-Cabuza and Post-Algarrobal phase Chiribaya styles probably indicate an increasing effort to mark the social boundaries between the two groups, and so may indicate increasingly intense competition between the groups, as well. The divergence of the technology of the two pottery traditions may reflect the accumulation of inconspicuous or invisible, presumably culturally irrelevant variations in technology ("isochrestic" variations [Sackett 1982]) caused by a lack of exchange of technical information between potters of the two groups. The use of two completely different dyes to achieve the same red color in Ilo-Tumilaca/Cabuza and Chiribaya textiles (Boytner and Wallert 1993) may be another case of such invisible, isochrestic variation, although Boytner and Wallert suggest that it may have had symbolic significance (see Lechtman 1976 for the same argument concerning tin versus arsenic in Andean bronzes). If these differences are in fact isochrestic, they imply a lack of communication that in turn indicates that the efforts to keep the two groups separate were in fact successful.

Probably the premier arena for boundary marking symbols is clothing and personal ornamentation (Wobst 1977; Hodder 1982; Maurer 1979). Even today, males and females of different ethnic groups in the Andes tend to identify themselves with distinctive hats, shawls, belts, and other items of apparel, and this practice was noted in early colonial times, as well (Guaman Poma c. 1600 [1978]:53). Chapter 6 discussed some of the decorative differences between Chiribaya and Ilo-Tumilaca/Cabuza textiles, including the Ilo-Tumilaca/Cabuza use of loopstitched bands (cf. Rodman 1992), large areas of narrow multicolored stripes of variable width, stripes broken by supplementary-warp bars, and the greater frequency of green and blue colors, and the Chiribaya white floating warp figural designs, round knotted hats, faja-bolsas, and so on. Many of these textiles are highly diagnostic, although as Boytner (1992a,b) notes, they can often be categorized only after inspection at a relatively close distance, suggesting that members of the different groups did not fear to approach each other. The important point here is that the technology and function of the textiles of both groups was quite similar. Both used camelid wool almost exclusively, even though cotton textiles were made in small quantities. Both made virtually all their cloth with the same simple warp-faced structure. Both made shirts and bags of basically the same form and construction. The differences are almost all decorative, suggesting that the textiles were vehicles for stylistic variation that marked group identity. Although the current state of research does not allow a reconstruction of the chronological development of the two textile traditions that might indicate relatively increasing or decreasing stylistic distinctness over time, at a gross level at least they suggest sufficient competition between the two groups to warrant clear boundary marking with textiles.

While textiles, and possibly to a lesser extent ceramics, would have served to distinguish group membership in public situations and situations of contact between group members, ritual practices such as those relating to burials would presumably have reinforced solidarity principally within the social group. Funerary rites are boundary markers for internal consumption. In addition, when group boundaries are well marked, few individuals will have detailed knowledge of the within-group activities of the other group, so these practices will be relatively independent and free to diverge through the accumulation of random or directed variations. Chapter 6 noted some of the differences between Chiribaya and Ilo-Tumilaca/Cabuza burial practices, which may indicate intentional boundary marking encouraged by competitive conditions, much the same as the ceramics and textiles may.

Like the ceramic styles, the tomb forms and possibly other mortuary practices of the two groups seem to have diverged over time. My observations of looted burials, tombs excavated by PCCT at El Algodonal and Loreto Viejo, and work in progress by various Programa Contisuyu projects will have to be confirmed by systematic studies of larger samples of excavated Chiribaya burials (Jessup 1990a,b, 1991; Williams and Buikstra n.d.). Nevertheless, I believe that cylindrical stone-lined tombs are typically early in the Chiribaya sequence; all the cylindrical Chiribaya tombs excavated by PCCT contained Algarrobal phase or Yaral phase Chiribaya ceramics. This cylindrical form is the only one known for Ilo-Tumilaca/Cabuza stone-lined tombs. The later Post-Algarrobal phase Chiribaya tombs, on the other hand, tend to be rectangular, with masonry only on the two long sides of the chamber. None of the examples excavated by PCCT contained Algarrobal phase Chiribaya ceramics, and most contained San Geronimo phase Chiribaya ceramics. Although this divergence is only in a single trait, it is one that may have been charged with supernatural significance, that seems to run consistently through virtually all Chiribaya and Ilo-Tumilaca/Cabuza sites, and that was executed repeatedly and at the cost of some considerable effort. The divergence of tomb forms, then, may suggest either increasing intentional social boundary marking or accumulating variation due to restricted flow of information between groups. Either interpretation may in turn suggest competition between the two groups, possibly of an increasing intensity over time.

Finally, I suggested earlier that the highly differential and even exclusive distributions of corn, cuyes, and several tree fruits in the domestic midden of the two groups might indicate severely restricted exchange of valued goods between sites or social groups even in close proximity to each other. One possible interpretation of such limited exchange is that it directly reflects competition between the groups for those goods. If access to them was seen as a group, rather than individual, issue, then the group that controlled the products would not have been inclined to trade them away. Alternatively, the limited exchange could indirectly reflect group competition through the action of generally restricted contact and interaction between members of the different groups. If competition and boundary marking were excessively successful at differentiating group members, then contact and hence exchange between them might have been limited. Of course, there are many examples of highly differentiated groups that nevertheless trade, or even that appear to mark their boundaries sharply for reasons closely tied to the trade that brings them into contact (Barth 1969). In the case of the coastal Osmore valley, however, the extremely and obviously limited resources may have lead to a more competitive, rather than symbiotic, relationship between the groups, and given the resulting social boundaries a more exclusive character that would correspond to the suggested limitations in contact and exchange.

Changes in group size and number over time

The third major criterion for applying the competitive exclusion effect to an observed case is that the balance of population must have shifted such that one or a few groups grew in size, others shrank, and ultimately some groups disappeared and the group number declined. Earlier in this chapter, I took a cautious approach to relative population estimates that lead to a clear conclusion that population had increased dramatically in the early and middle Late Intermediate Period. In order to show the shifting relative sizes of the social groups within this time period, the sites must be more narrowly dated, the analysis will have to make a few more assumptions, and the results will be less precise. Nevertheless, the trends in the data are so strong the general pattern can be established with some certainty, and it satisfies the condition for using the competitive exclusion effect.

First let us set aside relative group sizes, and consider only group number. As we saw in Chapter 6, during the early Late Intermediate Period there were as many as five distinct social groups in the coastal Osmore valley, marked by their pottery styles: Algarrobal phase Chiribaya, Ilo-Tumilaca, Osmore Multicolor, Ilo Multicolor, and Viboras. Both Osmore Multicolor and Ilo Multicolor seem to be associated exclusively with pottery of the Algarrobal phase Chiribaya and Ilo-Tumilaca styles. As these styles were replaced, respectively, by Post-Algarrobal phase Chiribaya and Ilo-Cabuza, the Osmore Multicolor and Ilo Multicolor styles apparently disappeared. The social groups that made those styles presumably left the valley or went extinct through any of the many possible mechanisms of boundary porosity, demographic failure, or group fusion. The Viboras style is less well dated, but because it is similar to Ilo-Tumilaca models but has some Ilo-Cabuza traits as well, it can be tentatively said to disappear with the last of the Ilo-Tumilaca style or a little later. By the middle Late Intermediate Period, starting perhaps around AD 1100 or 1150, only Post-Algarrobal phase Chiribaya and Ilo-Cabuza style ceramics remained in the valley. The group number had apparently dropped from five to two. The timing of the end of the Ilo-Cabuza style is also a bit vague, but the style probably went out of use around AD 1250, leaving only the Post-Algarrobal phase Chiribaya in the valley. The group number had finally dropped to one, just as it is expected to under the influence of intense competitive exclusion.

Estimating the relative populations of the various groups is more difficult. Since virtually no data are available on the groups that made the three minor pottery styles, only the Ilo-Tumilaca/Cabuza group and the Chiribaya group will be considered here. For each of these groups, we have the close to the bare minimum of chronological control needed to assess the relative changes in their populations: data for an early period, data for a late period, and the knowledge that neither was present before or after these times. If we consider simply the number of sites occupied by each group in their early and late periods, respectively, the trend is immediately apparent. Table 7-6 shows that the number of sites occupied by the Ilo-Tumilaca/Cabuza group declined dramatically over time, while the number of sites occupied by the Chiribaya group increased slightly or enormously, depending on the measure used. As before, the true pattern probably lies between the extremes shown in the table, and as a rough guide to the general trend, we can take a mean of the changes in the four measures for each group and conclude that the number of sites used by Ilo-Tumilaca/Cabuza people in their later period was less than half what it had been previously (42%), while the number of sites used by Chiribaya people more than tripled (333%). This shifting balance of settlements is precisely what would be expected if the Chiribaya group had been competitively excluding the Ilo-Tumilaca/Cabuza group, as the group number data suggest. Note that the figures cited here and in the following tables do not sum simply to those listed earlier in this chapter, because here multi-component sites are counted separately for each pottery style that was found on the site, while in the lumped figures used earlier they are counted only once for each time period.

The logic of simply counting sites assumes that the total number of sites is significant in itself, regardless of the relative lengths of the time periods, essentially as

Site type, Certainty	Ilo-Tumilaca Sites	Ilo-Cabuza Sites	Percent Change	Algarrobal Chiribaya sites	Post-Algarrobal Chiribaya sites	Percent Change
All sites, Definite	11	4	36%	7	25	357%
All sites, Probable	14	7	50%	24	27	113%
Domestic, Definite	6	3	50%	2	15	750%
Domestic, Probable	9	3	33%	15	17	113%

Table 7-6. Total number of sites by group and time period, and changes over time.

we did earlier with the "maximum" analytical model. Table 7-7 presents the total site areas by pottery style and the changes in them over time, which are also to be interpreted with the "maximum" model. The pattern is even stronger here than with the site number data. The total area, which the "maximum" model takes as an index of the maximum population in the period, of Ilo-Cabuza sites is only about 16% of the total area occupied in the preceding Ilo-Tumilaca times. The later Chiribaya sites, on the other hand, total from half again as much area to fourteen times as much area as the early Chiribaya sites, depending on the measure used. The mean of the various measures of change in total Chiribaya site area is a huge 616% increase.

The "maximum" model essentially assumes that all the sites were occupied contemporaneously at some point so that the differing durations of the time periods do not matter, but that is an extreme position, and part of the changes in total site areas probably does in fact relate to non-contemporaneous occupations across the differing amounts of time represented. Table 7-8 shows the same site area data corrected for differing period lengths by dividing the total area by the number of centuries represented by each period, as appropriate for the "average" analytical model. Adjusting the data in this way makes the decline in Ilo-Tumilaca/Cabuza population

Site type, Certainty	Ilo-Tumilaca Area	Ilo-Cabuza Area	Percent Change	Algarrobal Chiribaya area	Post-Algarrobal Chiribaya area	Percent Change
All sites, Definite	28.9	4.3	15%	7.0	50.8	726%
All sites, Probable	37.0	5.5	15%	40.7	60.7	149%
Domestic, Definite	22.3	4.2	19%	3.2	45.8	1431%
Domestic, Probable	32.1	4.2	13%	35.3	55.6	158%
Mean change	-	-	16%	-	-	616%

Table 7-7. Total site areas by group and time period, with percent change over time.

look even more precipitous, while the Chiribaya population either dwindles slightly or expands considerably, depending on the measure used. The mean of the four measures is a 311% increase. Since the "maximum" and "average" analytical models themselves are extreme cases, either concentrating the occupation as much as logically possible or spreading it out as evenly as logically possible, the truth is probably in between them. The Ilo-Tumilaca/Cabuza population seems to have declined drastically and finally disappeared, while the Chiribaya population increased probably by several times and persisted after the Ilo-Tumilaca/Cabuza group was gone. Although the figures vary somewhat depending on the selection of data and analytical models used, the condition for applying the competitive exclusion effect is clearly met.

The relative patterns of group sizes can be specified and illustrated a bit more clearly in order to give a better impression of the population history of the coastal valley, but at the price of implying a degree of precision that is not actually present in the data. The tables and graphs that follow are illustrative, then, but represent increasingly arguable departures from the original data. Let us continue presenting

Site type, Certainty	Ilo-Tumilaca Area/ 100 years	Ilo-Cabuza Area/ 100 years	Percent Change	Algarrobal Chiribaya Area/100 years	Post-Algarrobal Chiribaya Area/100 years	Percent Change
All sites, Definite	28.9	1.7	6%	4.7	16.9	360%
All sites, Probable	37.0	2.2	6%	27.1	20.2	75%
Domestic, Definite	22.3	1.7	8%	2.1	15.3	729%
Domestic, Probable	32.1	1.7	5%	23.5	18.5	79%
Duration in years	100	250	-	150	300	-
Mean change	-	-	6%	-	-	311%

Table 7-8. Total site areas per 100 years by social group and time period, with percent change over time.

both the "maximum" and the "average" model, in order to get some idea of the range of uncertainty imposed by the analytical methods themselves. We have already calculated mean estimates of the changes in total site area and total site area per year for each of the two social groups, as indices of population changes. If we arbitrarily set the Post-Algarrobal phase Chiribaya group "population" to 100 units, then we can calculate backwards to the Algarrobal phase Chiribaya "population" by dividing 100 by the mean change in Chiribaya "population" in each model. Setting the Ilo-Tumilaca/Cabuza "population" on the same scale is more problematic. We cannot standardize the area figures directly, because the areas and conversion factors vary depending on whether or not cemeteries are included in the area, and whether the sites attributions are limited to definitely identified sites, or probable sites are also included. Since we have to choose some link from the arbitrary scale based on the change in Chiribaya site area to the Ilo-Tumilaca/Cabuza areas, let us assume that site

Site type, Certainty	"Maximum" analytical model			"Average" analytical model		
	Ilo-Tumilaca Area	Post-Algarrobal Chiribaya Area	Ratio	Ilo-Tumilaca area/100 yr	Post-Algarrobal Chiribaya area/100 yr	Ratio
All sites, Definite	28.9	50.8	57%	28.9	16.9	171%
All sites, Probable	37.0	60.7	61%	37.0	20.2	183%
Domestic, Definite	22.3	45.8	49%	22.3	15.3	146%
Domestic, Probable	32.1	55.6	58%	32.1	18.5	174%
Mean ratio	-	-	56%	-	-	169%

Table 7-9. Ratios of total Ilo-Tumilaca site area to total Post-Algarrobal phase Chiribaya site area under "maximum" and "average" analytical models.

recognition is best when the material is most plentiful, and so select the Post-Algarrobal phase Chiribaya and the Ilo-Tumilaca as probably the best representatives of the true relative site areas of the two traditions. We then calculate the ratio of Ilo-Tumilaca to Post-Algarrobal phase Chiribaya site areas for each of the four selections of sites, and for each model. Table 7-9 shows these calculations for all the site selection criteria. The ratio of Ilo-Tumilaca site area to Post-Algarrobal phase Chiribaya site area is about the same within each set of site selection criteria for each analytical model, which allows us to set the Ilo-Tumilaca "population" as the mean of these ratios for each analytical model. Finally, we calculate the Ilo-Cabuza "population" from the mean change from the Ilo-Tumilaca area observed earlier.

The midden deposits at Chiribaya sites are consistently and obviously much deeper and denser than those at Ilo-Tumilaca/Cabuza sites. Most of the Chiribaya sites were probably occupied much longer or more densely than their Ilo-Tumilaca/Cabuza counterparts. The domestic architecture of the two groups tends to corroborate this impression. As noted in Chapter 6, only Chiribaya residences have heavy compound perimeter walls, which suggests both a need to keep neighbors out and a greater investment and permanence in the construction itself, both of which in turn suggest denser and longer-lasting occupations. The large posts characteristic of Chiribaya compounds also may indicate more substantial constructions intended for denser or longer lasting occupations. Moreover, the entire area of each site is included in the total area figures, even though in cases such as some cemeteries at Chiribaya Alta, the Chiribaya component covers the entire site area and the Ilo-Tumilaca/Cabuza component covers only part of it. Both the apparently greater population represented per unit area and the more complete occupation of the areas tallied for the Chiribaya sites cause the raw site area totals to overrepresent the Ilo-Tumilaca/Cabuza population relative to the Chiribaya population. In an effort to correct for this overrepresentation, we can cut the Ilo-Tumilaca/Cabuza "populations" in half relative to the Chiribaya indices. This adjustment is actually conservative given the differences in artifact distributions and cultural deposits noted during excavation and survey; Ilo-Tumilaca/Cabuza sites in general could easily prove to contain only one quarter as much, or even less, cultural material per unit area as do Chiribaya sites. Table 7-10 shows the standardized "population" indices for both the "maximum" and "average" analytical models, both simply calculated from total site areas and conservatively adjusted for the difference in apparent density and/or duration of occupation at the sites.

Finally, Figures 7-4 and 7-5 are graphical illustrations of the adjusted population indices over time, in order to give a visual impression of the relative populations of the two groups and how they changed over time. Figure 7-4 shows the "maximum" model data, in which the data points represent the maximum "population" during a given time

Model	Ilo-Tumilaca "Population"	Ilo-Cabuza "Population"	Percent Change	Algarrobal Chiribaya "Population"	Post-Algarrobal Chiribaya "Population"	Percent Change
"Maximum", Raw areas	56	9	16%	16	100	616%
"Maximum", Adjusted	28	5	16%	16	100	616%
"Average", Raw areas	169	10	6%	32	100	311%
"Average", Adjusted	85	5	6%	32	100	311%

Table 7-10. Relative "population" indices for each group and time period, using "maximum" and "average" models, each with raw and adjusted site area totals.

period. This maximum is placed near the beginning of the time period if the population is known to have declined, and near the end if it is known to have increased. This procedure produces the least irregular possible combination of growth and shrinkage rates except at the beginning of the Ilo-Tumilaca period, when immigration into the valley could reasonably explain a rapid jump in population, and the end of the Post-Algarrobal phase Chiribaya, which Moseley, Tapia, Satterlee, and their colleagues (Moseley and Feldman 1992; Moseley and Tapia 1991; Satterlee 1991, 1992) suggest came to a sudden end during and immediately after a major El Niño event. Figure 7-5 shows the "average" model data, in which the data value represents an average "population" present during the entire time period. The "average" model is best depicted as a bar chart rather than a line graph. Since the "average" model includes both the total site area and the duration of the period in the plotted values, the relative "populations" should be visually gauged not simply by the height of the bars, but rather by their area. That is, the total number of Post-Algarrobal phase Chiribaya people who ever lived in the valley is shown as being several times the total number of Ilo-Tumilaca people, even though the bars are of comparable

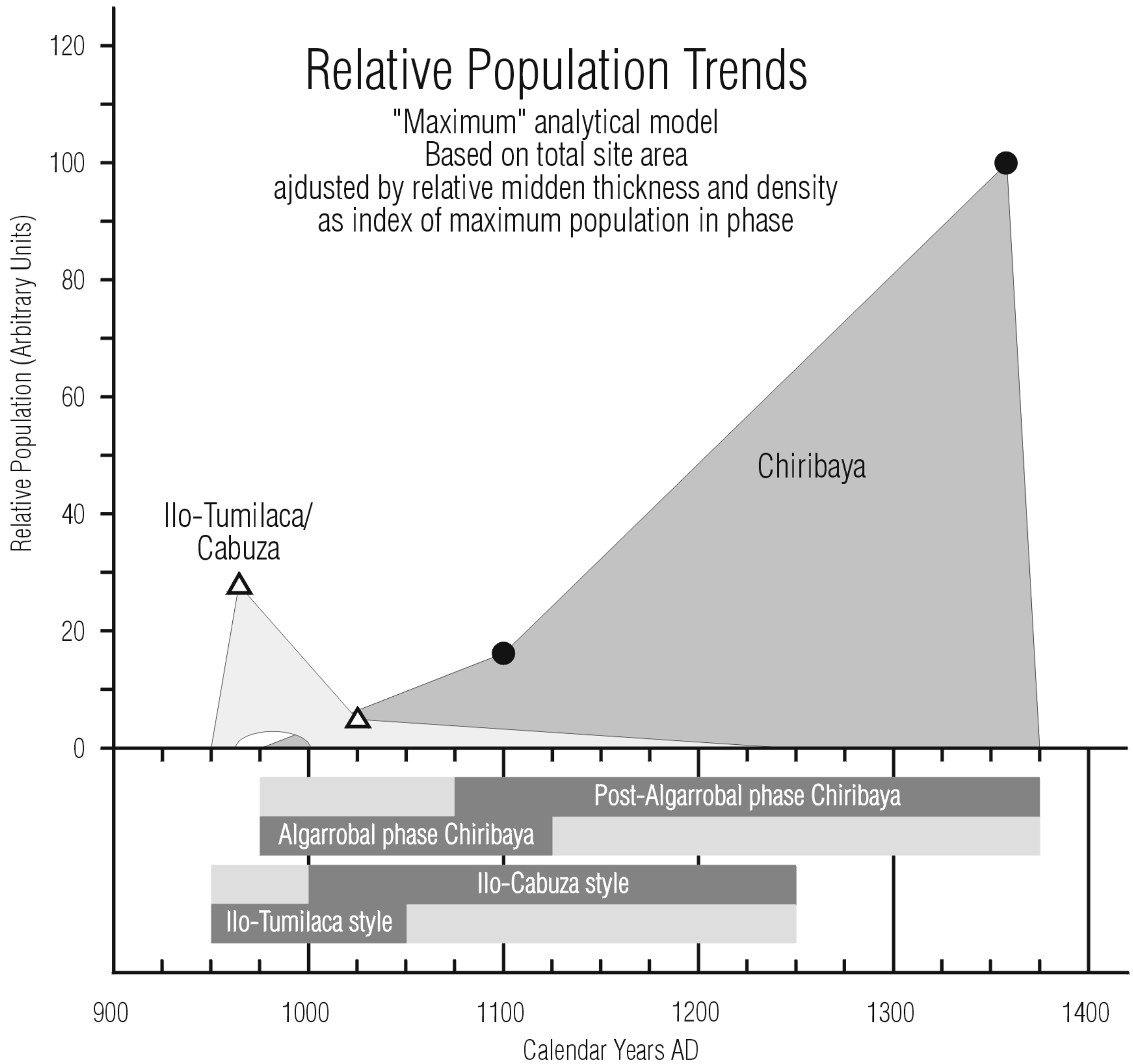

Figure 7-4. Relative population trends based on the "maximum" analytical model.

height, because the Post-Algarrobal phase Chiribaya time period lasted much longer.

Although these two graphs differ in detail, they lead to the same general conclusions. The Ilo-Tumilaca/Cabuza population was small to moderate in size, declined markedly after an initial boom, and trailed off gradually. The overall size of the Ilo-Tumilaca/Cabuza "population" would be even smaller if more aggressive, and probably more accurate, corrections had been made for the lower depth, density, and

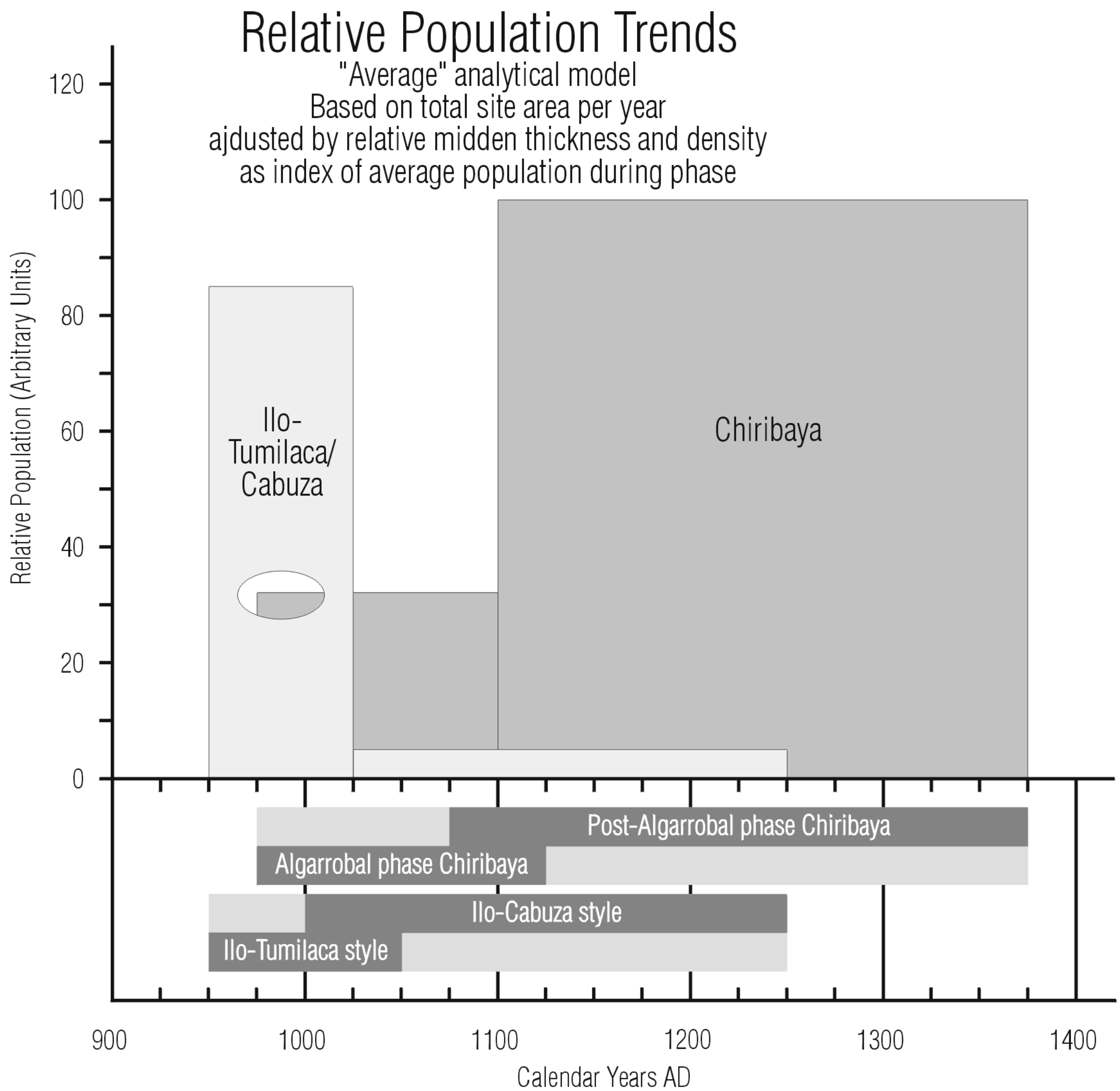

Figure 7-5. Relative population trends using the "average" analytical model.

completeness of coverage per unit area of Ilo-Tumilaca/Cabuza versus Chiribaya sites. The Chiribaya population, on the other hand, grew substantially as time passed, outlasted the small but persistent Ilo-Cabuza group, and by virtue both of large population and long duration left the great bulk of the archaeological remains found in the coastal valley. The only substantial difference between the two analytical models is in the impression of the trend in the total population of the valley, that is, the sum of the populations of the two groups at any given time. Under the "maximum" model, it appears that the total population of the valley increased substantially over time, while the "average" model suggests that the valley's population declined slightly after the Ilo-Tumilaca style disappeared. The actual pattern should lie between the two illustrated extremes, and so most likely would have been a modest to strong increase over time. As already noted, the Ilo-Tumilaca/Cabuza "population" indices are probably still too high due to the conservative correction applied for the shallower, lower density remains at Ilo-Tumilaca/Cabuza sites; if these indices had been more aggressively corrected, both analytical models would show the total valley population increasing. The patterns illustrated in these graphs, like those in the preceding tables, correspond well to the conditions expected under the operation of the competitive exclusion effect.

Group differences in competitive ability

The last characteristic expected of situations in which the competitive exclusion effect acts is that there be a difference in the competitive abilities of the groups involved. Setting aside the problems of logical circularity discussed earlier, we can infer directly from the change in group size and number that the competitive abilities of the groups differed. If all the groups had been equally able, one would not have gained members at the expense of the others.

An essential feature of the competitive exclusion effect is that the competitive exclusion curve is steep. The slope of this curve reflects both the amount of unmet demand for resources and/or members, and the relative difference in the abilities of the various groups to satisfy the demand. Of course, demand is not simply "met" or "unmet"; it is relatively more or less satisfied as the cost of the resources demanded is lower or higher. The scarcer the resource and the more people want it, the higher the "price" and the greater the degree of "unmet" demand in that more people have to do without this or some other resource because it is so expensive. Similarly, social groups are not simply "equal" or "different" in their competitive abilities; they may be relatively more or less well-matched. Either or both of these factors may be important in causing the competitive exclusion curve to be steep.

In the coastal Osmore valley, there is no obvious reason independent of the observed trends in group size and number themselves to suspect that one group was markedly more competitively able than the other. They appear to have had similar subsistence bases, used similar subsistence and craft technologies, and mostly lived in similar sizes, types, and locations of sites. Warfare does not seem to have been a significant factor, so differences in weaponry or tactics would not have lead to large differences in competitive ability. There may have been differences in competitive ability in other arenas, perhaps involving ideology or social organization, but they are not evident archaeologically and so must remain hypothetical.

On the other hand, there is good reason to suspect that demand for resources significantly outstripped supply. Population seems to have risen by several times over not too many generations, reaching unprecedentedly high levels, in a highly restricted environment with severely limited resources. The physical evidence of stress and elevated mortality, while not grossly high, does indicate a scarcity of subsistence resources. Considering that the previous period had seen a much smaller, presumably better-provisioned population in the coastal valley, and presumably well, or at least efficiently, provisioned populations under the Tiwanaku peace and regional administration in the middle valley, people's expectations may have been relatively high, and so could have been badly unsatisfied even if they were getting enough food to survive. The resulting intense competition could have caused even minor differences in the competitive abilities of the various groups to have manifested themselves often and strongly, leading to shifting group sizes and declining group number through the many possible mechanisms of boundary porosity, differential demographic variables, and emigration. That is, the admittedly incomplete evidence suggests that in the coastal Osmore valley case, the competitive exclusion curve may have been steep in large part due to high demand for scarce resources, and less because of marked differences in competitive ability between the groups.

Competitive exclusion in the coastal Osmore valley

In order to apply the competitive exclusion effect to the coastal Osmore case, we had to show that four conditions held true for the observed phenomena in the valley. Since data were available primarily for the Ilo-Tumilaca/Cabuza and Chiribaya traditions, most of the discussion focussed on them. First, the groups had to have occupied overlapping social and ecological niches. Both groups were shown to have exploited many of the same resources, while some other resources were used much more by one group than the other, some by one group exclusively. Whether the non-overlapping resource distributions identify items that were in significant demand only by one group, or items that were most hotly contested by both could not be determined, but sufficient resources were found to be in demand by both groups that the niches clearly overlapped enough to allow competition to be possible.

Second, there had to be some evidence that competition actually occurred or that circumstances were such that it would be reasonable to infer it. The population of the valley was shown to have increased dramatically and reached unprecedentedly high levels during the early and middle Late Intermediate Period, suggesting that competition must have intensified. A variety of indicators of stress suggested that there was significant unmet demand for resources, which implies competition. These indicators included high incidences of pathologies in human skeletal material that suggest poor hygiene and diet; a survivorship pattern suggesting a moderate degree of physical stress, albeit not unusually high for pre-urban populations; and the investment of labor to build an ambitious canal and irrigated field system, which presumably would not have been undertaken unless arable land had been in high demand. Differences in ceramic decoration and technology, textiles, burial rituals, and the construction of the mound and ditch around Chiribaya Alta all suggested increasing emphases on the marking of social boundaries, which may correlate to increasing inter-group competition. A notable lack of evidence of warfare and minimal evidence of the increasing use of less preferred resources tend to contradict the other lines of evidence, but seem to be outweighed by the preponderance of indications that competition increased to high levels in the early and middle Late Intermediate Period.

Third, the balance of population had to have shifted such that one group gained members at the expense of the others until all but the growing group went extinct. Precisely this pattern was demonstrated with the number of groups in the valley, which decreased from five to two to one in successive archaeologically distinguishable periods. The required pattern was also shown in the relative sizes of the Ilo-Tumilaca/Cabuza group, which declined in size over time, and the Chiribaya group, which grew and became the only group in the valley.

Finally, the groups had to be shown to have differed in competitive ability. This condition is acknowledged to be circular, and satisfying the third condition automatically implies the fourth. Nevertheless, a broad view of the evidence suggested that it was probably more the magnitude of the unmet demand for resources than significant differences in the competitive abilities of the groups that caused the competitive exclusion curve to be steep in the coastal Osmore case.

All the conditions are met, and the competitive exclusion effect appears to correspond reasonably well to the reconstruction of events in the coastal Osmore valley during the early and middle Late Intermediate Period. The decline in group number from five to one appears to be an expectable result of the action of strong competition, specifically as represented on a TGN graph by a competitive exclusion curve so steep that the equilibrium group number is one.

What the competitive exclusion effect does not specify is the mechanism by which the surviving group actually garnered the resources and membership of the other groups. The evidence discussed earlier suggests that warfare, raids, and conquest were not the principal mechanisms in this case. The demographic and paleopathological evidence suggests that neither of the two well-studied groups was markedly more prolific or long-lived than the other, although as Hassan (1978) has pointed out, even small differences that would not have been detected in the present samples can have profound effects on population sizes over a relatively small number of generations. Demographic differences within the groups, perhaps relating to differences in marriage or child care practices, cannot be ruled out as mechanisms for the observed changes in group size and number, but neither are they indicated by the data.

The two most likely remaining mechanisms are emigration and the large-scale "osmosis" of individuals through "porous" group boundaries (Barth 1969). The possibility of gradual or wholesale emigration of the declining groups cannot be evaluated without additional detailed data from neighboring and more remote valleys and coastal areas. Emigration is a *deus ex machina* explanation properly regarded with scepticism by many archaeologists, but given that at least some of the Late Intermediate Period groups in the valley had clearly immigrated a few generations earlier, emigration should not be discarded out of hand as a possible mechanism.

I find the mechanisms of boundary porosity to seem the most likely in this case, largely because there seems to have been a significant and increasing difference in the relative status and quality of life between the Chiribaya and Ilo-Tumilaca/Cabuza groups (Barth 1969; Ellemers et al. 1990). The Chiribaya group seemingly increased over time not only in size and resource share, but also in prestige and general desirability of group membership compared to the Ilo-Tumilaca/Cabuza group. The Chiribaya had greater access to various resources that were specially valued not only for their practical utility but also for ritual, social, or quality-of-life reasons, such as corn, cuyes, guava and lucuma fruit, molle seeds possibly used for making *chicha* beer, and possibly preferable seashore areas for shellfish collecting and fishing. This differential access to special resources would have been desirable not only in itself, but also for the relatively elevated status or prestige that it probably implied.

Chiribaya craft goods, most notably their ceramics but also textiles, pyroengraved gourds, metal goods, and so on became increasingly elaborate, some even in apparently common peoples' houses, and would have seemed increasingly preferable to the declining quality and variety of comparable Ilo-Tumilaca/Cabuza products. The trends over time are clearest in the ceramics themselves (Appendix B). While Chiribaya pottery became technically better and homogeneous, Ilo-Tumilaca/Cabuza pottery became increasingly poorly made and plain. The handles of Chiribaya wooden spoons were always decorated with fairly simple silhouette shapes, but Ilo-Tumilaca/Cabuza spoons became simplified from the early varieties with profile llamas on the handles to later ones with the same simple notches as the Chiribaya examples (Appendix D). The temporal development of many of the other craft goods remains to be demonstrated by careful study of grave lots. Regardless of the temporal trends, however, the quantities and quality of many Chiribaya craft items were never approached by the Ilo-Tumilaca/Cabuza equivalents, at least those that are known to date. Chiribaya tombs and midden occasionally contain small metal items such as copper fishhooks, copper composite hook barbs, or silver alloy sheet cutouts that were probably sewn on clothing, but Ilo-Tumilaca/Cabuza people seemingly had no access to metals at all. Pyroengraved gourds are known from Chiribaya contexts, but not from Ilo-Tumilaca ones. Again, the Chiribaya material culture would have been desirable not only in itself, but also for the relatively higher status that it probably connoted.

The Chiribaya also vastly dominated the cemeteries and domestic areas of the clearly most central and impressive site in the coastal valley, Chiribaya Alta. Some Ilo-Tumilaca burials are known from certain cemeteries at Chiribaya Alta (Jessup 1990a,b, 1991; Williams and Buikstra n.d.), but they are rare. Moreover, my impression from unsystematic inspections of the site is that Ilo-Cabuza ceramics are not found there, which may suggest that members of the Ilo-Cabuza group were excluded from what was probably the highest-status burial area in the valley. Finally, a few truly chiefly Chiribaya burials are known, indicating that the Chiribaya had some very wealthy and/or powerful leaders; nothing of the sort is known for the Ilo-Tumilaca/Cabuza group. The Chiribaya as a group probably enjoyed a relatively higher status because they controlled the most important site in the valley, and had the most stratified social structure with the most impressive leaders.

Given these apparent differences in prestige, organization, and quality of life, it would not be surprising if Ilo-Tumilaca/Cabuza people had actively sought ways to become Chiribaya, through marriage, adoption, other forms of fictive kinship or personal alliances, and so on (see Ellemers et al. 1990). As Barth (1969) noted, these processes are known to have lead to shifts in population from one group to another on the order of ten percent per generation, which would be more than sufficient to account for the changes in population and group number observed in the archaeological record. What set the process of diverging group prestige in motion is a question for speculation, but once started, the higher status of the Chiribaya could have been their principal and increasing competitive advantage in the struggle for resources and membership that eventually led to the disappearance of all the other groups in the valley.