CULTURAL CHANGE AND ADAPTATION IN THE CENTRAL ATACAMA DESERT OF NORTHERN CHILE

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In many current anthropological studies, an initial component of a theoretical model for analyzing cultural change is the view of culture as an environmentally adaptive mechanism, with habitat, biome, and culture being systemically interrelated.[1] The environment to which a culture adapts is understood to include other cultures as well as the physical and biotic setting. In addition to its role in this general ecological framework, a culture is further recognized as a holistic structure which is the integration of various subsystems such as socio-political, religious, linguistic, material culture, and economic networks, among others.[2] Such a systems view of culture and environment has been termed cultural ecology.[3]

In order to analyze the adaptive aspect of culture, it can be hypothesized that there are some cultural subsystems or features which will play more active or crucial roles than will others in adaptation to the total environment.[4] With the recognition that the more important variables cannot be determined a priori, analysis requires a sequence of sufficient duration to delineate culture changes, and data that allow delineation of the various subsystems of culture.

Archaeological investigations undertaken in the central portion of the Atacama Desert of northern Chile have allowed the formulation of preliminary conclusions concerning the major variables of cultural ecological adaptation in this region. The time period studied, from the introduction of ceramic technology up to Spanish contact, provided the essential diachronic perspective for isolating the conditions and succession of major cultural changes.[5] Attention was focused on the reconstruction of settlement patterns, with the assumption that such patterns, given the limitations of archaeological data, provide meaningful units for reconstructing past cultural systems, and reliably reflect cultural ecological adaptations.[6]

The Setting

The Atacama Desert lies roughly between 18° and 28° S. latitude, a distance of approximately 1000 kilometers, and extends from the Pacific Ocean to the high cordillera of the Andes, incorporating an area of over 150,000 square kilometers. Northward, it is continued by the Peruvian Coastal Desert the length of Peru. The Río Loa is the only river in northern Chile which carries water to the sea. It traverses the barren, sandy and rocky pampa, which contains abundant copper ores and nitrate deposits. Dry and drying salt lakes are found scattered over the desert.

The climate is marked by an almost complete lack of precipita-

tion. Rainfall records are sporadic but show an annual precipitation of 12 mm. for Antofagasta, 1 mm. for Arica, and none for Calama.[7] However, rare torrential rains, traditionally believed to occur every seven years, have been noted for the region.[8] Inland, the mean temperatures at Calama are 63° F. in January and 46.5° F. in July, but diurnal differences are extreme.[9] Dry, high southwesterly winds are a constant feature over the pampa. During the summer these winds begin in late morning and continue into evening; in winter they develop in mid-afternoon.

Soils suitable for cultivation are particularly scarce owing to the extreme arid climate, slow weathering, lack of vegetation for humus production, and high salinity of most water sources. Shallow sandy alluvial soils can be found along the Río Loa and its tributaries, and in the highland zone above 2700 meters elevation. Non-oasis vegetation reaches a maximum at 3000-3500 m. and is characterized by scattered xerophytic and halophytic species. Of the few native trees, chañar (Gourliea decorticans) and algarrobo (Prosopis chilensis) are now scarce, but historic accounts indicate former abundance of at least algarrobo.[10] The fruit of both species were utilized as food sources during pre- and post-hispanic times.[11] The limited areas which support vegetation are characteristically low and swampy grounds with scattered grass and scrub. Such areas, common along the Río Loa and its tributaries, are henceforth referred to as vega.

Few native animals can be found in the region today. Wild chinchillas were last seen on Chilean Andean slopes in 1955,[12] and the puma, often depicted in petroglyphs, is extinct in the area. Wild vicuñas and guanacos have been all but hunted to extinction in the highlands, and present herds of llamas and alpacas appear to be dwindling. Condors, ducks, and rheas are still sighted in the highlands, as are flamingos, but the latter are rapidly disappearing.

The middle Río Loa area of Antofagasta Province comprises what is usually considered to be the geographical center of the Atacameño culture which extended northward into Tarapacá Province, southward into Atacama Province, and eastward over the Puna de Atacama. The term "Atacameño" has been used to signify any and all of the indigenous, prehispanic, ceramic stage agriculturalists, herders, and hunters.[13]

Previous archaeological research in this region has provided little in the way of a comprehensive diachronic study of settlement and cultural ecology. Investigations have concentrated upon cemetery excavations[14] and late village ruin descriptions,[15] with only an occasional attempt to order the limited available data with regard to time and space.[16]

Research for the present study was confined to the central desert region along the Río Loa from Calama to just north of Lasana, a distance of about 50 km., and included an intensive-survey area of approximately 450 sq. km. (fig. 1). Other areas included in the survey were the localities of Turi and Topaín near the precordillera to the east of the Río Loa.

Delineation of the Culture Sequence

More than 100 ceramic stage sites were recorded and studied within the surveyed area. The majority of these are quite small, spatially distinct, and represent single-unit occupation. In most cases cultural deposition consisted of little more than surface concentrations of artifacts, primarily potsherds. Collections were taken from most sites, and test excavations were conducted at sites which appeared to have possible refuse accumulation, and for which excavation permission was obtainable. Non-ceramic artifacts, other than lithic material, constituted a small portion of the original artifact assemblages and therefore contributed relatively little to the total context of site analysis.[17]

A chronological ordering of the ceramic material has been done by Edward P. Lanning.[18] Lacking culturally stratified sites, this ordering was necessarily achieved primarily by similiary seriation based on the continuity of features and variation in themes,[19] which was supplemented by petrographic analysis of all sherds brought to the U.S. This latter technique proved to be especially valuable in forming hypotheses about transhumance and sedentariness through identification of clays and tempers from different zones within the region. Ceramic comparison with the fairly well established sequence at San Pedro de Atacama also provided clues for ordering the new collections from the middle Loa region.

Lanning's seriation distinguishes three ceramic complexes, designated Vega Alta, Loa, and Lasana. Each of these is composed of several stylistic phases, as shown in Table 1. At present, dating of the phases of the sequence is tentative and partly relies on comparisons with dated materials from nearby regions. Four new radiocarbon measurements have been obtained from the Río Loa region for the ceramic stage. The earliest is associated with a Late Vega Alta pithouse site: 200 B.C. ± 95 years (I-5400). This date is here accepted as the terminal one of the Vega Alta Complex, Phase II. A later measurement of A.D. 105 ± 105 years (GX-1644) was obtained from a sample of llama wool and skin excavated from a Late Loa village site. A measurement of A.D. 1250 ± 90 years (I-5399) for an isolated house site falls within the second phase of the Lasana culture complex. The fourth measurement, A.D. 15 ± 110 years (GX-1643), was derived from a small sample of charcoal excavated from just below present ground level at an Early Vega Alta site, and is much younger than expected when considering the date for the Late Vega Alta phase and the large number of phases between Early Vega Alta and Late Loa. The sample may have been contaminated by modern rootlets, and an estimated beginning date of 800 B.C. is tentatively assigned to Early Vega Alta ceramics.[20] Further discussion of the radiocarbon determinations is given in the appendix.

The ceramic seriation and C 14 measurements provided a basic chronological ordering of the archaeological sites found in the survey. By analyzing site form, content, and distribution through time, I have distinguished three sequential culture complexes, each subdivided into

at least two phases of development. The degree of correspondence between ceramic changes and changes in other aspects of culture, such as settlement patterns, is implicit in the sequence chart of Table 1; each culture phase is basically distinguished by its pattern of settlement. Since settlement patterns often do not change as rapidly as the pottery, the time interval of two ceramic phases may correspond to one culture phase; as larger units of integration, the ceramic and the culture complexes are comparable. For simplicity, I have applied the name of each ceramic complex to its corresponding culture complex (i.e., Vega Alta, Loa, and Lasana). For distinction, phase subdivisions of each culture complex are sequentially labelled with Roman numerals (Loa I, Loa II, Lasana I, etc.). The more familiar list of Peruvian periods, also shown in Table 1, is given for comparative reference.

By "culture complex" I mean the "...total of cultural forms (artifact assemblage, settlement pattern, food economy, etc.) characteristic of a particular region and time span."[21] The ceramic stage culture complexes of the middle Loa region are summarized and discussed below.

Many of the recorded sites, and their associated sherds, could not be seriated due to the scarcity of diagnostic artifacts and decorated sherds. However, this fact did not significantly prevent our obtaining a fairly reliable picture of the course of cultural development. In brief, the sequence demonstrates a progression from hunting and gathering campsites to fortified villages based on llama herding and irrigation agriculture.

Vega Alta Complex

Fourteen sites are assigned to the first phase of this complex. Open campsites are characteristic and are found primarily within the limited zone of scattered grass and scrub vegetation beside the river at an elevation of ca. 2500 meters. All campsites were located within 5 km. of the confluence of the Río Loa and its tributary, the Río Salado, and within 400 meters of the river. Site size ranged from 375-2400 sq. m., with no evidence of structures and no significant depth of deposit. Stone cairn burial sites, also believed to be characteristic of this phase, are found on barren higher ground at the edge of the river vega. One hundred and forty-seven individual piles of irregular stones were recorded (4 sites) but none were found intact, with only fragmentary human bones remaining.

Surface collections from the open campsites yielded coarse-temper sherds from cooking and storage jars, stemmed and concave-base projectile points, micro-perforators (diagnostic of this phase), stone flake knives, scrapers, notched tools, irregular cores, stone and shell beads, and retouched, utilized, and waste flakes. Also present in the assemblage are ovoid and trapezoidal tabular porphyritic rocks, bifacially flaked on the edges. These are believed to have been hafted as shovel blades, similar to the more spade-shaped tabular stones of the later culture complexes. Mortars and pestles, common in late preceramic

sites, are present, and unifacial and bifacial manos and flat milling stones make their first appearance in the sequence. The lithic artifacts reflect the use of several stone types: cherts, malachite, silicified tuffs, quartzite, felsites, and basalts, including small quantities of obsidian. The cherts and tuffs are found locally, but the other materials had to have been brought from highland regions to the east or north, a distance of 50-75 km. Small quantities of seashell are also present, apparently traded in from the coast, at least 200 km. distant.

The open campsites are interpreted as being the temporary occupation sites of small hunting and gathering groups, probably of no more than 25 persons, which followed seasonal rounds into highland regions, primarily up the Río Salado. Animal bone and vegetable material are lacking at the shallow Vega Alta I sites, but subsistence is likely to have centered on wild guanaco and vicuña, supplemented with various plant resources. Edible rhizomes, common in late preceramic middens, and algarrobo pods may have been ground on the milling stones and mortars. Algarrobo flour and paste have been found in later prehispanic burials in northern Chile.[22]

The second phase of the Vega Alta Complex is represented by ten sites. The settlement pattern is now characterized by small, semi-permanent settlements with a central base of habitation located on barren ground near and above the river; smaller, temporary encampments were located near specifically exploitable resources.

Two sequential settlements, each with an estimated population of 40-60 persons, were centered in the vega-oasis locality of Chiu Chiu beside the Río Loa. The earlier of these (RAnL 88), tentatively classified as a semi-permanent village, yielded Vega Alta II artifacts within an area 100 by 200 meters. However, the same area had been later utilized as a Lasana III cemetery and has since been totally destroyed by looters. Thus there is little way of determining whether structures were originally associated with the Vega Alta II component. Material collected from the surface, including 40 manos and 10 broken milling stones, does suggest a relatively substantial occupation. Four temporary campsites may have been related to the main habitation site. Three of these are found immediately adjacent to the river, within or overlooking the band of vegetation, and within 5 km. of the main site. Each of these sites lacks midden associations, but their locations suggest affiliation with hunting, gathering and possibly herding activities. The fourth, located at the edge of the Salar de Talabre, 13 km. west-southwest of Chiu Chiu, was a small lithic workshop near abundant chert outcrops. Only 5 sherds were recovered, but they clearly date this site to the early part of Vega Alta II. Here, test excavations provided the first tangible evidence of human diet: small quantities of algarrobo seeds, rhizomes, cactus buttons (tentatively identified), Lama sp. wool, and poorly preserved feathers.

The later settlement of this phase focused at a semi-permanent village (RAnL 273A) of at least ten circular pithouses, recognized as shallow surface depressions 4.5-6.5 meters in diameter on barren ground

above the river.[23] Excavation of one of the structures revealed an oval pithouse 1.7 m. deep with an average floor diameter of 3 meters. The upper perimeter of the pit had been lined with several courses of large, flat limestone rocks (fig. 2). No entrance was discernible and the roof, judged from fragmentary remains, is believed to have been made of cortadera stems bound with cord braided from junquillo.[24] The structure contained no interior hearth. The mixed and unstratified fill yielded a large quantity of material, including the following: sloughed-in perimeter rocks, one mano, 4 stemmed projectile points, 24 stone and bone beads, 34 retouched flakes, worked and unworked seashell, sherds of 9 ceramic vessels, 7 poorly preserved coiled baskets, worked bone (spatulas and a spear thrower) and wood, gourd fragments (Lagenaria sp.), primarily lower extremity Lama sp. bones representing at least seven animals, and partial disarticulated human skeletal remains of four adults. All of this material is believed to represent secondary burial deposition within the pithouse. Burial pits at an adjacent, associated cemetery appear to have been the original loci of interment, with their contents later transferred to the house structure(s).

It is suggested that subsistence activities during Vega Alta II continued to center on hunting and gathering, and that domesticated Lama sp. (llama and/or alpaca) may not have been introduced into the region until this time.[25] While direct supportive evidence for the introduction of domestic Lama sp. is presently lacking, such an economic shift would have made possible the larger and more permanent settlements of this period.

Loa Complex

The nine sites assigned to the first phase of this complex include three major habitation sites classified as small villages of semi-sedentary occupation by 15-40 individuals. All three are found on barren terrain on the west side of the Río Loa, within 500 meters of the river. Each had remnants of rectangular and/or circular, above ground, dry laid stone structures, presumably dwellings, but most of the stones had been removed and utilized in constructions of nearby Lasana Complex ceremonial sites. The ceramic seriation does not suggest that more than two villages were occupied simultaneously.

Two of the villages represent the earliest ceramic stage sites at Lasana, nine kilometers north of Chiu Chiu; both are atop the steep canyon walls of the river. The remains of one site (RAnL 338A) include five roughly circular structures 2.0-2.4 m. in diameter, and a light surface concentration of artifacts, primarily sherds, within an area 20 by 80 meters. The second site (RAnL 343), 12 by 50 m. in area, contains 15 circular and rectangular structures, the largest of which is 2.2 by 4.0 meters (fig. 3). One particularly small unit may have been used as a storage bin. The few associated artifacts (18 sherds and 2 manos) provide little information as to site activities. The third village site (RAnL 261) is found at Chiu Chiu. Later utilization of the site almost totally obliterated the Loa I structures, but a relatively heavy artifact

concentration delimited the site as approximately 30 by 45 meters. The artifacts suggest a range of activities that include food preparation, artifact manufacture, and some hunting. The lithic material exhibits the same diversity of sources, from the Salar de Talabre to the precordillera, that characterized Vega Alta stonework.

Another site of this phase is a small cemetery at Chiu Chiu consisting of eight burial niches dug into the eroded face of limestone marls adjacent to the river; all niches had been looted, leaving only a few handfuls of identifiable sherds. There are also five campsites, two of which are located at sources of silicified tuff; another, comprising a few sherds, appears to have been a transit stop at the Salar de Talabre; the final two, immediately adjacent to each other at the edge of the Chiu Chiu vega, covered areas as large as those of the village sites and yielded large quantities of sherds but lacked associated structures.

Compared to Vega Alta II, settlements are now more numerous, but each is only about half the size of a late Vega Alta settlement, and they are found more widely distributed. Loa I villages represent a shift to above ground structures rather than the continued use of pithouses. As was concluded for Vega Alta II, it is postulated that herding, food gathering, and hunting provided the bases of subsistence, although no bones or vegetable remains are preserved at any Loa I site. Increased sedentariness at this time is suggested by petrographic analyses showing that nearly all of the Loa I ceramics were locally made. By contrast, ca. 66% of the earlier Vega Alta II ceramics at Chiu Chiu were of non-local wares.[26]

The emergence of fully sedentary village life sustained by the development of maize agriculture marks the second phase of the Loa Complex beginning ca. A.D. 100. The seven sites of this phase, all found at the locality of Chiu Chiu, include one village, two isolated house sites, two platform shelters, one small temporary campsite, and an isolated cemetery of six looted niche burials; all of these may have been contemporary and units of a single settlement.

The village site, located on barren ground adjacent to the river, includes several sections: a Loa II cemetery of 43 looted, bell-shaped burial pits, refuse deposits, abandoned agricultural terraces and irrigation ditches, and ruins of a historic period house. Sherds dating to the Loa II occupation were found on all sections of the site, but were concentrated in an area of 8000 sq. m. which excluded most of the abandoned fields. The area of heavy sherd concentration is the sector of the original habitation, but any structures it may have contained were obliterated by the historic occupation. A general surface collection provided 1506 sherds, 161 shovel blade fragments, and a few chipped tools. Nineteen manos and eight milling stones were also collected but it is estimated that at least three times this number were present on the site.

The most important finds were provided by a 1.0 by 2.5 m. test excavation into a low refuse mound measuring roughly 15 by 20 meters

(RAnL 100, test cut 1). Five distinct but culturally homogeneous refuse layers were excavated, the bottom of the fifth layer being as much as 55 cm. below ground surface. The cut yielded nearly 600 sherds and a variety of other artifacts, but the most important items related to human diet: a large quantity of algarrobo seeds (some found within a human coprolite), 4 fish vertebrae, a few large feather quills, llama wool and over 400 Lama sp. bones or fragments,[27] and, for the first time, maize cobs (Zea mays). Seventeen intact maize cobs and 17 fragments were recovered, and were of two types, neither of which shows introgression by tripsacum.[28] One is clearly a cultivated form and shows resemblances to the modern race Capio. Of special interest are four of the ten specimens from the bottom layer. These are small primitive cobs of low kernel row number (10 and 12 rows), 2.6-3.0 cm. in length, and are quite similar to the prehistoric wild corn from Tehuacán, Mexico.[29] This evidence supports the position that maize agriculture was not present along the middle Río Loa before the middle of the Loa Complex. The radiocarbon measurement of A.D. 105 ± 105 years (1845 ± 105 years B.P.) was obtained from organic material from the bottom layer of the excavation. I here accept this date as the beginning of maize and irrigation agriculture in the middle Loa region. Two of the small, primitive Chilean cobs are shown in fig. 4.

The other Loa II sites are found along the river within 3 km. of the village site. Of these, the two isolated houses represent a new type in the sequence. One (RAnL 248C), located at the Río Loa/Río Salado confluence, had an associated corral large enough to have contained 30-40 llamas, and may have been a base for maintaining and grazing a domestic herd along the river vega. Two platform shelters are found within 100 m. of this house site. Each had been briefly occupied, yielded only a few sherds, and provided an extensive view of vega where herds would have grazed. The "platform" consisted of a small flat area protected from the wind by the short vertical face of an eroded marl formation above and along the Río Loa and its vega.

The human population of the Loa II village settlement is estimated to have been at least twice that of any preceding ceramic stage settlement. Herding and gathering continued as important subsistence activities in addition to the development of the reliable and high yield domestic food plant, maize.

Lasana Complex

More than 75% of the 92 recorded Lasana Complex sites could not be assigned to a particular one of the three Lasana culture phases owing to their association with few and undiagnostic artifacts. However, changes in settlement distribution and complexity are reflected in the chronological ordering of several major sites which include five villages.

The six major site types of this complex are categorized as agglutinated villages (5 sites), 11 isolated houses, 18 platform shelters, 17 open (herding?) campsites, 24 cemeteries, and, for the first time, ceremonial sites (17 sites). Agricultural terraces and irrigation systems

were not given site designation. A brief description of each site type is warranted.

The village sites consist of several types of structures: single and multiple-room dwellings, rectangular and circular storage bins which may be interior or exterior to dwellings, corrals, and usually a defensive exterior wall surrounding all or part of the habitation concentration. Buildings are constructed of limestone or basalt blocks, with or without the use of mortar, and usually adjoin one another with alleyways traversing the site. No interior hearths were recognized. One of the villages, the Pukara de Lasana (RAnL 1, fig. 5), was described in detail by Rydén in 1944. Except where abused by vandalism and modern settlement, village ruins are well preserved and reconstructable. A typical Lasana Complex settlement consists of an agglutinated village situated on a promontory or other site offering at least partial natural defense, with agricultural and grazing lands beginning close by. Subsidiary activity sites are found within or along the edge of grazing areas, and major burial grounds and ceremonial sites are at a distance from the village.

Isolated house sites are found within vega areas and on barren ground near or away from areas with vegetation. Most are believed to have been associated with herding activities, although at least one appears to have been a stop-over point between settlements. All of the supposed herding house sites are at least two kilometers from their associated village.

Platform shelters are similar to those of the Loa II phase, and occasionally exhibit a low irregular wall as wind protection. This site type is confined to favored localities beside the Río Loa overlooking the vega.

All but one of the structureless open campsites are found within or at the edge of vega areas, and are interpreted as having been temporary camps of herders. Average site size is 800 sq. m., with a low yield of sherds and lithic artifacts. A small camp at the Salar de Talabre appears to have been another stopover site, probably between the localities of Chiu Chiu and Calama.

Cemeteries include six major grave types: niche burials; pit burials, with or without a constricted aperture; cairn burials; rectangular stone lined graves; storage bin burials; and multicompartment chambers with an entrance ramp. Niche and pit burials often have multiple compartments and can be found together in the same cemetery. All types, except cairns, are frequently found within village confines. The 24 cemeteries recorded for the localities of Chiu Chiu and Lasana represent over 800 graves, all of which had been previously looted or excavated. Most graves probably served for multiple burials. Sherds of vessels were all that remained to date these sites to the Lasana Complex.

Ceremonial sites are found on high barren ground, usually well away from main habitation structures. There are two major types, both of which are small and unimpressive. One type, apacheta, consists

of one or more piles of irregular stones, forming cairns 1.0-2.0 m. in diameter and 0.5-1.0 m. high. Associated artifacts usually consist of a few bowl sherds and a light scatter of crushed malachite. These sites may have been simple shrines at which travelers made offerings to insure safe journey.[30] The second type of site is more common; it is the type which I call the "wall-and-box" site. Typically, a ceremonial unit consists of a low dry laid stone wall, 30-50 cm. high, paralleled on one side by one or more rectangular "boxes" set well into the ground. Each box is formed by four tabular stones which project 3-5 cm. above ground surface; box size varies, but usually is ca. 10 by 20 cm. A site may consist of anywhere from 1 to 30 units, with walls 1.5 to 30.0 m. long. Sites may have associated apachetas and, rarely, llama burials. Common artifacts include sherds, shovel blade fragments, and scattered crushed malachite. Occasional llama bone finds, plus ethnographic information from northern Chile[31] suggest the conclusion that these sites were associated with llama sacrifice, and that part of the slain animal's blood was deposited within the stone boxes. I have considered the evidence for this conclusion in detail elsewhere.[32]

The ceramic seriation indicates that each of the six major site types is represented in each of the three Lasana Complex phases. As defined here, the types constitute basic identifiable units of whole settlements. Briefly, Phase I represents the formation of a new village at Chiu Chiu (RAnL 3), now obliterated by the present town, followed by population expansion and the establishment of a village settlement at Lasana (RAnL 1), nine kilometers north on the Río Loa. The early part of Phase II is distinguished by the construction of the first permanent village settlement in the highland vega 50 km. to the east of Chiu Chiu, at an elevation of 3000 meters. This is the Pukara de Topaín (RAnL 299), defensively situated on a basalt hill rising from the vega. At some point during Phase II, this site appears to have been abandoned, possibly due to a drying up of the springs which supplied water for irrigation. Another village (RAnL 300), at Turi eight km. to the south, was established in the same region during this phase. Finally, this phase also saw the erection of a new village at Chiu Chiu (RAnL 99), possibly supplanting the former habitation center at this locality. The third culture phase, Lasana III, coincides with the expansion of the Inca Empire into northern Chile in about 1473.[33] The observable effects in the middle Loa region include the presence of Late Horizon Inca sherds at a Chiu Chiu cemetery and ceremonial site, and the construction of a large adobe Inca tambo within the village confines at Turi (administrative center?). The cohesion of these various village localities as a single region of settlement is demonstrated by petrographic analysis of the collected sherds. All of the local utilitarian ceramic vessels at Chiu Chiu, Lasana, Topaín, and Turi, of the Lasana Complex, were made from clays found only at Chiu Chiu and Lasana.

The full development of intensive agriculture combined with llama herding was perhaps the most important feature of cultural ecological adaptation that occurred during the Lasana Complex. At least two races of maize were developed, and other crops included beans[34] (Phaseolus sp.?), quinoa[35] (Chenopodium quinoa), chili peppers (Capsicum sp.), gourds (at

least Lagenaria sp.), and near the end of the sequence potatoes[36] (Solanum sp.). As more land was brought under cultivation, the human population continued to grow and establish new settlements near irrigable land. Soil along rivers and on hill slopes was terraced into plots which could be irrigated by canals drawing from the river or springs. For the second phase of the Loa Complex, it is estimated that approximately 72 hectares were cultivated in the locality of Chiu Chiu/Lasana, irrigated by one major canal. By the end of the Lasana Complex, the amount of cultivated land in the same locality had risen to roughly 375 hectares irrigated by at least ten canals. For the later part of the Lasana Complex, village populations are estimated to have been in the range of 300-500 persons, although the Turi settlement (RAnL 300) may have contained nearly 1000 individuals.[37]

The role of village fortification, exemplified by defensive walls and strategic locations of villages, is far from clear. There is some evidence of a "trophy head cult" in the desert region, but its age and magnitude have not been determined. Grave excavations by Le Paige and Mostny[38] document the existence of burials with heads separated from bodies, and a few carved artifacts show a head held by human or god figures. Weapons and leather chest armor have also been described.[39]

Changing Complexity of the Cultural System

The preceding discussions of the Vega Alta, Loa, and Lasana Complexes summarized basic data relevant to artifact assemblages, levels of technological development, subsistence activities, settlement patterns, and population estimates. These data directly reflect the material culture and economic subsystems for major periods of the culture sequence. To the extent that religious or ceremonial activities are manifested in material culture, this subsystem is reflected as well.

Economy during the first half of the Vega Alta Complex was a continuation of hunting and gathering practices from preceramic times, and was correlated with open campsites within areas of vegetation. Flat milling stones and manos, a new means of food preparation, were added to the artifact assemblage. For the second phase of the complex, economic expansion to include herding of domestic llamas is postulated. This expansion, if it in fact occurred at this time, is correlated with a new settlement pattern based on larger settlements with pithouse structures on barren terrain, but no significant increase in regional population size is apparent.

The economic and technological base during the first phase of the Loa Complex appears to have been the same as that of Vega Alta II, but settlements were more numerous, more widely dispersed, and characterized by above ground structures. Again, regional population appears to have remained constant, but more localized. Further economic expansion during Loa II was shown by the addition of maize agriculture with artificial irrigation. A major permanent village was characteristic, along with added specialized activity sites. Settlement population was at

least twice that of any earlier community.

The Lasana Complex witnessed the development of its agricultural component with new and improved cultigens and expansion of irrigated fields. Village settlements increased in size and number, and were located on defensible terrain or were built with defensive walls. Specialized sites for ceremonial activities are found for the first time in association with settlements of this complex.

Conclusions concerning changes in the sociopolitical subsystem are based on inferences drawn from evaluation of artifacts, settlement patterns, demographic data, the levels of techno-economic development, and the opportunities and limitations of the physical environment. For example, for both the Vega Alta and Loa Complexes, no item in the artifact assemblages would necessarily have been manufactured or utilized only by special status individuals, and none of the inferred activities involved in the use of the artifacts suggests differentiation other than by age and sex. Settlements, at least through Loa I, were temporary and quite small (possibly limited by available food resources) and probably required no fixed positions of leadership for the few cooperative activities that may have been pursued. Even with the advent of maize and irrigation agriculture in Loa II, new group activities appear to have been on a small scale with no necessity for social ranking. Also, present evidences of burial practices, although limited, imply no rigid social differentiation. Sociopolitical organization up through Loa II is therefore best characterized as that of simple or egalitarian societies.[40]

I suggest that Lasana I and II witnessed the emergence of social ranking and that social stratification was only secondarily established by the presence of the Inca and their state structure during Lasana III. Several lines of evidence can be considered. Data on many aspects of burial practices are lacking, but there is a diversity of physical grave types and locations which imply social ranking. The intensive agriculture of the Lasana Complex, including land terracing and moderate scale irrigation systems, probably required a degree of central management authority at each major settlement. With regard to warfare and ceremonial activities, the nature of leadership rank and status is problematical and requires further data on the level of these activities before meaningful evaluation can be made, but the presence of specialized ceremonial sites during the Lasana Complex suggests an elaboration of the religious subsystem above that of previous complexes for which no ceremonial sites are recognizable. Within villages, differences can be distinguished as to dwelling size, location, and storage provision; the larger multi-roomed dwellings tend to be found in the central and best-protected sections of the village, and generally have larger food storage facilities. Social differentiation is implied, although far from being demonstrated, and appears to have been at the level of ranked society. Inca administration of the region, suggested by the tambo structure at the Turi settlement, imposed social stratification upon the indigenous populations.

A Model of Cultural Development

In an ongoing cultural system there is a high degree of reinforcing and modifying interaction (feedback) among the system's various units, or subsystems. When this interaction is in the form of repeated positive feedback over a relatively short period of time, wherein changes which occur in one or more subsystems are amplified through the responses of other subsystems, it becomes difficult to separate particular cause and effect relationships. Yet, given a systems view of culture and environment, this problem must be faced in the attempt to deal with processes of cultural development.

Given the limitations of archaeological data and present analytical techniques, not all cultural subsystems for the middle Río Loa sequence could be reconstructed, particularly the psychological and linguistic subsystems. Thus the evolutionary impact of changes that may have occurred in these aspects cannot be evaluated. However, tentative conclusions regarding the process of cultural change in prehispanic northern Chile are now presented. It should be clear that these conclusions are formulated as hypotheses, and that they will hopefully be tested by additional research in northern Chile and by further analysis of available data. My objective is to provide an interpretation of the sequence of changes which have been reconstructed, for it is through an attempt to explain past cultural development that archaeological data may meaningfully contribute to anthropology in general. At the very least, problem areas for future research are outlined, with the added hope that a search for more complete or more accurate explanation will be undertaken. A basic consideration in the formulation of the model presented here is the marginality of this desert region in terms of its relative isolation from the more prominent centers of Andean culture development, as well as the relatively low population density the region appears to have been able to support in preindustrial times.

I propose that shift in economy (including the technology of production) and population growth were two major factors which determined alteration of basic characteristics of settlement pattern and sociopolitical complexity. These two factors are seen as closely interrelated dynamic features of the cultural system, within which they stimulated, and were stimulated by, other components of the total system, including the environmental setting. Efficient utilization of the limited and dispersed subsistence resources favored a pattern of shifting hunting and gathering settlements as evidenced through Vega Alta II. Here I assume that gradual population growth,[41] although not demonstrated in the archaeological record, brought pressure upon regional human carrying capacity, with the postulated response that the herding of domesticated llamas began by the second phase of the Vega Alta Complex. With minimal disruption of the previous way of life, the addition of this more dependable resource may have initially allowed the slight increase in population density per settlement revealed in the new settlement pattern for this phase. Given the already extreme marginality of the Atacama, segmentation and partial movement out of the region by late Vega Alta I

groups is rejected as a likely alternative response to population growth. Further adjustment occurred by the subsequent Loa I phase, however, during which settlements were smaller, more numerous, more dispersed, and possibly more sedentary. In the marginal environment this arrangement may have been more efficient because it provided greater immediate access to herding areas and other subsistence resources. Assuming continued population growth at the now more numerous settlements, pressure would again build on the available resources. This population pressure is therefore viewed as a demand on subsistence resources resulting from the density of population and the level of technology in relation to the given environment.[42] Insofar as the conditions of population pressure precluded reduction in the degree of sedentariness as a viable cultural response, the development of an expanded and more localized subsistence base of greater productive potential can be seen as a logical, consistent, and expected alternative.[43] In northern Chile, this type of response is evidenced by the initial acceptance of maize agriculture and irrigation technology during Loa Phase II, and is viewed as indicative of the emergence of a fully sedentary pattern of residence.

It was not until after the introduction and development of maize cultivation, during the Lasana Complex, that there was marked increase in population size and density, conflict (between settlements?), and increased sociopolitical complexity. This economic shift to agriculture, combined with llama herding and continually supplemented by gathering and hunting, therefore allowed and eventually promoted further changes in the cultural system. Conflict and village fortification, which may have arisen in competition for favorable agricultural and grazing lands, was probably reinforced by unsuccessful resistence to Inca, and later Spanish, intrusion.

A final major factor was conquest, specifically the incorporation of the Atacameño into the Inca Empire. The Inca conquest of northern Chile was part of a process which originated outside the local culture system. The changes it established, such as socially and politically stratifying the society, do not appear to have been related to indigenous evolutionary trends.

Acknowledging the data limitations, I have suggested economy, population growth, and conquest to be the more crucial features that affected cultural development in the Atacama Desert of prehispanic northern Chile. As interrelated features of the regional cultural system, changes in economy and population growth were postulated as processes which held varying roles of importance at different points in time; such variation of importance is compatible with the theoretical approach I have followed. Archaeological reconstructions of past cultures are not complete, but the systems model of cultural ecology can at least serve to pinpoint deficiencies in our data and possibly lead to further refinements of methodology, for it is through consideration of all possible variables that we may derive a meaningful evaluation of the adaptive aspect of culture.

ACKNOWLEDGEMENTS

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APPENDIX

Radiocarbon Age Determinations

All measurements are based upon the Libby half life of 5570 years for C 14, with the error stated as one standard deviation.

Vega Alta Complex

GX-1643: 1935 ± 110 C 14 years B.P. (A.D. 15). RAnL 216.

Measurement was on a small sample of charcoal fragments excavated from surface level to a depth of ca. 10 cm. in an irregular hearth area of a Vega Alta I open campsite (RAnL 216). Both ash and charcoal were collected, but only the charcoal was used in measurement. The date is much younger than expected, and the sample may have been contaminated by modern rootlets. Locality: Río Loa/Río Salado confluence.

Pretreatment: The finely divided charcoal was concentrated and impurities were picked out. The entire sample was then digested in hot dilute HCl to remove carbonates prior to combustion and analysis. The size and nature of the sample did not permit use of NaOH digestion without great risk of making the sample too small to date reliably.

Measured October 1969.

I-5400: 2150 ± 95 C 14 years B.P. (200 B.C.). RAnL 273A-1.

Measurement was on approximately 20 grams of a 150 gram sample of wood excavated from near the bottom of the unstratified fill within a Vega Alta II pithouse (RAnL 273A-1). Approximate depth below surface was 1.5 m. The date is accepted as the terminal one of the Vega Alta

Complex. Site locality: Chiu Chiu.

Pretreatment: Sample was treated with NaOH solution to remove humic acids and treated with HCl to remove carbonates.

Measured December 1970.

Loa Complex

GX-1644: 1845 ± 105 C 14 years B.P. (A.D. 105). RAnL 100.

Measurement was on approximately 34 grams of llama wool and skin excavated from the bottom refuse layer (layer 5) of test cut 1 at the Loa II village site at Chiu Chiu. Depth from surface was ca. 50 cm. The layer from which the sample derives also contained 4 small primitive maize cobs and 6 cobs of clearly cultivated maize. The date is accepted as representing the beginning of maize and irrigation agriculture along the middle Río Loa.

Pretreatment: The llama wool and skin was digested in hot dilute HCl to remove calcium carbonates and was cleaned ultrasonically to remove any remaining dirt or inorganic material.

Measured October 1969.

Lasana Complex

I-5399: 700 ± 90 C 14 years B.P. (A.D. 1250). RAnL 337-1.

Measurement was on approximately 20 grams of wood taken from sample of over 300 grams. Sample was excavated from a Lasana Complex isolated house site (RAnL 337-1) beside the Río Loa, nine kilometers below the Río Loa/Río Salado confluence. The 3.0 by 3.5 meter marl house foundation contained a maximum of 28 cm. of unstratified refuse.

Pretreatment: Sample was treated with NaOH solution to remove humic acids and treated with HCl to remove carbonates.

Measured December 1970.

NOTES

[1]Steward, 1955, pp. 37-39; Sanders and Price, 1968, pp. 213-224.

[2]Clarke, 1968, p. 83.

[3]Steward, 1955, pp. 36 ff.; Sanders and Price, 1968, p. 213.

[4]Clarke, 1968, pp. 109-110; Trigger, 1971; Sanders and Price, 1968, p. 219; Steward, 1955, p. 37.

[5]The preceramic period was studied in detail as well, but by other researchers.

[6]Trigger, 1971, p. 330; 1968.

[7]C.W. Thornthwaite Associates, 1965, pp. 388-391.

[8]Rudolph, 1963, pp. 3-4.

[9]CORFO, 1965, pp. 35-36.

[10]Frézier, 1717, p. 144; San Román, 1896-1902, vol. 1, p. 191; Plagemann, 1904, p. 17.

[11]Mostny and others, 1954, p. 12; Munizaga and Gunckel, 1958, pp. 7-42.

[12]Rudolph, 1955, p. 169.

[13]The language spoken in this region in prehispanic times appears to have been Kunza (see Bennett, 1946, p. 605, and Mason, 1950, p. 302), but it is poorly known. A grammar for Kunza is given by San Román, 1890, and a limited vocabulary is found in Vaisse, Hoyas, and Echeverría y Reyes, 1895.

[14]e.g., Mostny, 1952; Le Paige, 1964; Spahni, 1963, 1964.

[15]e.g., Mostny, 1949; Rydén, 1944, pp. 21-53.

[16]e.g., Núñez, 1965, 1968; Orellana, 1968; Schaedel, 1957; Tarragó, 1968.

[17]General descriptions of late prehispanic artifact assemblages are found in Latcham, 1938; Rydén, 1944; and Bennett, 1946; however, these descriptions provide inadequate provenience information.

[18]Pollard and Lanning, ms.

[19]Rowe, 1961.

[20]Radiocarbon samples for other phases will soon be processed.

[21]Lanning, 1967, p. 209.

[22]Latcham, 1933, p. 135.

[23]Shallow preceramic house pits have been reported for Tarapacá Province by True, Núñez, and Núñez, 1970, p. 179; and Mostny, 1970, pp. 274-77, describes house pits for the Guatacondo region.

[24]Tentatively identified by Bruce Grove.

[25]The problem of determining domestic species of Lama from faunal remains is far from being resolved. I did a comparative study of the Lama sp. bones (primarily metapodials) from the pithouse excavation (RAnL 273A-1) and eight identified skeletons at the American Museum of Natural History in New York. Preliminary conclusions, based on size and slenderness of the metapodials, are that the smaller domesticate, alpaca (Lama glama pacos), is similar in skeletal morphology to the wild vicuña (Lama vicugna); and the larger domesticate, llama (Lama glama glama), is similar to the wild guanaco (Lama glama guanicoe). I tentatively assume that at least the larger species in the pithouse is domesticated (llama). This question is considered further in Pollard, 1970, pp. 123 ff. See also note 27 below.

[26]By "non-local" I mean not within the general locality of the sites from which the sherds were collected. For example, non-local wares from Vega Alta II sites at the locality of Chiu Chiu were derived from clays found up the Río Salado (Ayquina/Toconce) and/or up the Río Loa as far Conchi and the Río San Pedro. Information on clay type distribution and petrographic analysis was provided by Edward P. Lanning.

[27]Preliminary morphological analysis suggests that at least two Lama sp. were present here as well. A second test cut into Loa II refuse on another part of the same site (probably looter's backdirt) yielded an additional 700 Lama bones or fragments. A few of the metapodials from this second cut, plus specimens from test cut 1, were submitted to Dr. Isabella Drew of the Sackler Laboratory at Columbia University for thin-sectioning and examination under polarized light. This procedure had been utilized with considerable success in distinguishing wild vs. domestic animals from other archaeological deposits (see Drew, Perkins, and Daly, 1971, pp. 280-282, and later discussion by McConnell and Foreman, 1971, pp. 971-973, with a reply by Drew, Perkins, and Daly). The preliminary finding here is that both domestic and wild species are represented in both test cut samples from the village site. Other specimens, as well as bones from the earlier Vega Alta II pithouse (RAnL 273A-1), are now being analyzed.

[28]All maize specimens were kindly analyzed by Paul C. Mangelsdorf.

[29]See Mangelsdorf, MacNeish, and Galinat, 1967.

[30]Similar Indian practices have been noted in historic times in northern Chile. See Bowman, 1924, p. 306.

[31]Unpublished data, personal communication from Jorge Checura, Director of the Universidad del Norte's Regional Museum in Iquique.

[32]Pollard, 1970, pp. 279-281.

[33]Rowe, 1945, p. 277.

[34]Focacci Aste, 1961.

[35]Latcham, 1933, p. 135; Oyarzún, 1933.

[36]Bennett, 1946, p. 606; Bird, 1943, p. 231.

[37]Estimates were based primarily on number of living rooms times five persons per room, with the assumption that single room dwellings each housed a nuclear family, as is common in present village settlements of the region.

[38]Le Paige, 1964; Mostny, 1952.

[39]Rydén, 1944, pp. 94-120.

[40]See Fried, 1967, for discussion of egalitarian, ranked, and stratified societies.

[41]Regarding the assumption of population growth, compare Binford, 1968, p. 325 ff.; Birdsell, 1968, pp. 229-230; Boserup, 1965, pp. 11, 14; Harner, 1970, pp. 67-71; Patterson, 1971, p. 200.

[42]Harner, 1970, p. 68.

[43]c.f., Flannery, 1969, pp. 78-79.

BIBLIOGRAPHY

Bennett, Wendell Clark
1946 The Atacameño. Handbook of South American Indians, Smithsonian Institution, Bureau of American Ethnology, Bulletin 143, vol. 2, pp. 599-618. Washington, D.C.

Binford, Lewis R.
1968 Post-Pleistocene adaptations. New perspectives in archeology, edited by Sally R. Binford and Lewis R. Binford, pp. 313-341. Aldine Publishing Co., Chicago.

Bird, Junius Bouton
1943 Excavations in northern Chile. Anthropological Papers of the American Museum of Natural History, vol. XXXVIII, part IV,

pp. [i-ii] 171-318. New York.

Birdsell, Joseph Benjamin
1968 Some predictions for the Pleistocene based on equilibrium systems among recent hunter-gatherers. Man the hunter, edited by Richard B. Lee and Irven DeVore, with the assistance of Jill Nash, pp. 229-240. Aldine Publishing Co., Chicago.

Boserup, Ester
1965 The conditions of agricultural growth; the economics of agrarian change under population pressure. Aldine Publishing Co., Chicago.

Bowman, Isaiah
1924 Desert trails of Atacama. American Geographical Society, Special Publication no. 5. New York.

C. W. Thornthwaite Associates
1965 Average climatic water balance data of the continents, part VIII, South America. Publications in Climatology, vol. XVIII, no. 2. Elmer, New Jersey.

Clarke, David L.
1968 Analytical archaeology. Methuen and Co., Ltd., London.

CORFO
1965 Geografía económica de Chile. Texto refundido. Corporación de Fomento de la Producción, Santiago.

Drew, Isabella M., Perkins, Dexter, and Daly, Patricia
1971 Prehistoric domestication of animals: effects on bone structure. Science, vol. 171, no. 3968, January 22, pp. 280-282. Washington, D.C.

Flannery, Kent Vaughn
1969 Origins and ecological effects of early domestication in Iran and the Near East. The domestication and exploitation of plants and animals, edited by Peter J. Ucko and G.W. Dimbleby, pp. 73-100. Aldine Publishing Co., Chicago.

Focacci Aste, Guillermo
1961 Descripción de un cementerio inca en el valle de Azapa. Trabajos presentados al Encuentro Arqueológico Internacional de Arica y cuadro cronológico del área andina meridional. Museo Regional de Arica (Chile).

Frêzier, Amédée François
1717 A voyage to the South Sea, and along the coasts of Chili and Peru, in the years 1712, 1713, and 1714. Printed for Jonah Bowyer, London.

Fried, Morton Herbert
1967 The evolution of political society: an essay in political anthropology. Random House, Studies in Anthropology, AS 7. New York.

Harner, Michael James
1970 Population pressure and the social evolution of agriculturalists. Southwestern Journal of Anthropology, vol. 26, no. 1, Spring, pp. 67-86. Albuquerque.

Lanning, Edward Putnam
1967 Peru before the Incas. A Spectrum Book, S-156, Prentice-Hall, Inc., Englewood Cliffs.

Latcham, Ricardo Eduardo
1933 Notas preliminares de un viaje arqueológico a Quillagua. Revista Chilena de Historia Natural, Año XXXVI, pp. 130-138. Santiago.

1938 Arqueología de la región atacameña. Prensas de la Universidad de Chile, Santiago.

Le Paige, Gustavo
1964 El precerámico en la cordillera atacameña y los cementerios del período agro-alfarero de San Pedro de Atacama. Anales de la Universidad del Norte, no. 3 [whole number], Antofagasta, Chile.

Mangelsdorf, Paul Christoph, MacNeish, Richard Stockton, and Galinat, Walton Clarence
1967 Prehistoric wild and cultivated maize. The prehistory of the Tehuacán Valley, vol. 1, edited by Douglas S. Byers, pp. 178-200. University of Texas Press, Austin.

Mason, John Alden
1950 The languages of South American Indians. Handbook of South American Indians, Smithsonian Institution, Bureau of American Ethnology, Bulletin 143, vol. 6, pp. 157-317. Washington, D.C.

McConnell, Duncan, and Foreman, Dennis W. Jr.
1971 Texture and composition of bone. Science, vol. 172, no. 3986, May 28, pp. 971-973. Washington, D.C.

Mostny, Greta
1949 Ciudades atacameñas. Boletín del Museo Nacional de Historia Natural, Tomo XXIV, 1948, pp. 125-204. Santiago.

1952 Una tumba de Chiu Chiu. Boletín del Museo Nacional de Historia Natural, Tomo XXVI, no. 1, pp. 1-55. Santiago.

1970 La subárea arqueológica de Guatacondo. Boletín del Museo Nacional de Historia Natural, Tomo XXIX, no. 16, pp. 271-287. Santiago.

Mostny, Greta and others
1954 Peine, un pueblo atacameño. Greta Mostny, Fidel Jeldes, Raúl Gonzales, F. Oberhauser. Publicación no. 4 del Instituto de Geografía, Facultad de Filosofía, Universidad de Chile, Santiago.

Núñez, Lautaro
1965 Desarrollo cultural prehispánico del norte de Chile. Estudios Arqueológicos, no. 1, pp. 37-106. Universidad de Chile, Antofagasta.

1968 Subárea Loa-costa Chilena desde Copiapó a Pisagua. XXXVII Congreso Internacional de Americanistas, República Argentina - 1966, Actas y Memorias, vol. II, pp. 145-209. Buenos Aires.

Orellana, Mario
1968 Tipos alfareros en la zona del Río Salado. Boletín de Prehistoria de Chile, Año 1, no. 1, pp. 3-31. Universidad de Chile, Santiago.

Oyarzún, Aureliano
1933 La quinoa. Revista Chilena de Historia y Geografía, tomo LXXIV, no. 78, enero-abril, pp. 65-67. Santiago.

Patterson, Thomas Carl
1971 The emergence of food production in central Peru. Prehistoric agriculture, edited by Stuart Struever, pp. 181-207. American Museum Sourcebooks in Anthropology Q15. The American Museum of Natural History, Natural History Press, Garden City, New York.

Plagemann, Alberto
1904 Der Chilesaltpeter. Der Saaten-, Dünger- und Futtermarkt, Berlin.

Pollard, Gordon Clark
1970 The cultural ecology of ceramic-stage settlement in the Atacama Desert. Ph.D. dissertation, Department of Anthropology, Columbia University, N.Y. University Microfilms (71-6239), Ann Arbor.

Pollard, Gordon Clark, and Lanning, Edward Putnam
ms. Prehistory and desert adaptation in northern Chile: the ceramic stage of the middle Río Loa region. Part II, The Artifacts. In preparation.

Rowe, John Howland
1945 Absolute chronology in the Andean area. American Antiquity, vol. X, no. 3, January, pp. 265-84. Salt Lake City.

1961 Stratigraphy and seriation. American Antiquity, vol. 26, no. 3, January, pp. 324-30. Salt Lake City.

Rudolph, William E.
1955 Lincancabur: mountain of the Atacameños. Geographical Review, vol. XLV, no. 2, April, pp. 151-171. New York.

1963 Vanishing trails of Atacama. American Geographical Society, Research Series no. 24. New York.

Rydén, Stig
1944 Contributions to the archaeology of the Río Loa region. Elanders Boktryckeri Aktiebolag, Göteborg.

San Román, Francisco J.
1890 La lengua Cunza de los naturales de Atacama. Revista de la Dirección de Obras Públicas (Sección Geográfica), entrega V. Santiago de Chile.

1896-1902 Desierto i cordilleras de Atacama. Imprenta Nacional, Santiago de Chile. 3 vols.

Sanders, William Timothy, and Price, Barbara J.
1968 Mesoamerica; the evolution of a civilization. Studies in Anthropology, AS 9, Random House, New York.

Schaedel, Richard Paul, editor
1957 Arqueología Chilena; contribuciones al estudio de la región comprendida entre Arica y La Serena. Universidad de Chile, Centro de Estudios Antropológicos, Santiago.

Spahni, Jean-Christian
1963 Tombes inédites du cimetière atacamênien de Chiu Chiu (Chili). Société Suisse des Américanistes, Bulletin no. 26, septembre, pp. 2-9. Genève.

1964 Fóuilles archéologiques dans deux cimetières indigènes de Turi, Désert d'Atacama (Chili). Société Suisse des Américanistes, Bulletin no. 27, mars, pp. 2-20. Genève.

Steward, Julian Haynes
1955 Theory of culture change; the methodology of multilinear evolution. University of Illinois Press, Urbana.

Tarragó, Myriam
1968 Secuencias culturales de la etapa agroalfarera de San Pedro de Atacama (Chile). XXXVII Congreso Internacional de Americanistas, República Argentina - 1966. Actas y Memorias, vol. II, pp. 119-144. Buenos Aires.

Trigger, Bruce Graham
1968 The determinants of settlement patterns. Settlement archaeology, edited and with an introduction by K.C. Chang, pp. 53-78. National Press Books, Palo Alto.

Trigger, Bruce Graham
1971 Archaeology and ecology. World Archaeology, vol. 2, no. 3, pp. 321-336. Routledge and Kegan Paul Ltd., Oxfordshire, England.

True, Delbert L., Núñez, Lautaro, and Núñez, Patricio
1970 Archaeological investigations in northern Chile: project Tarapacá - preceramic resources. American Antiquity, vol. 35, no. 2, April, pp. 170-184. Salt Lake City.

Vaisse, Emilio, Hoyos, Félix S., and Echeverría y Reyes, Aníbal
1895 Glosario de la lengua atacameña. Anales de la Universidad de Chile, Vol. XCI, pp. 39-56. Santiago.

KEY TO ILLUSTRATIONS

Plate XXIV

Fig. 4. Three cobs at left: examples of the Polulo race of maize, excavated from a Lasana Complex isolated house (RAnL 337-1). Two cobs at right: very primitive cobs from the Loa II village site excavation (RAnL 100, test cut 1, layer 5). Photo courtesy of Paul Mangelsdorf.

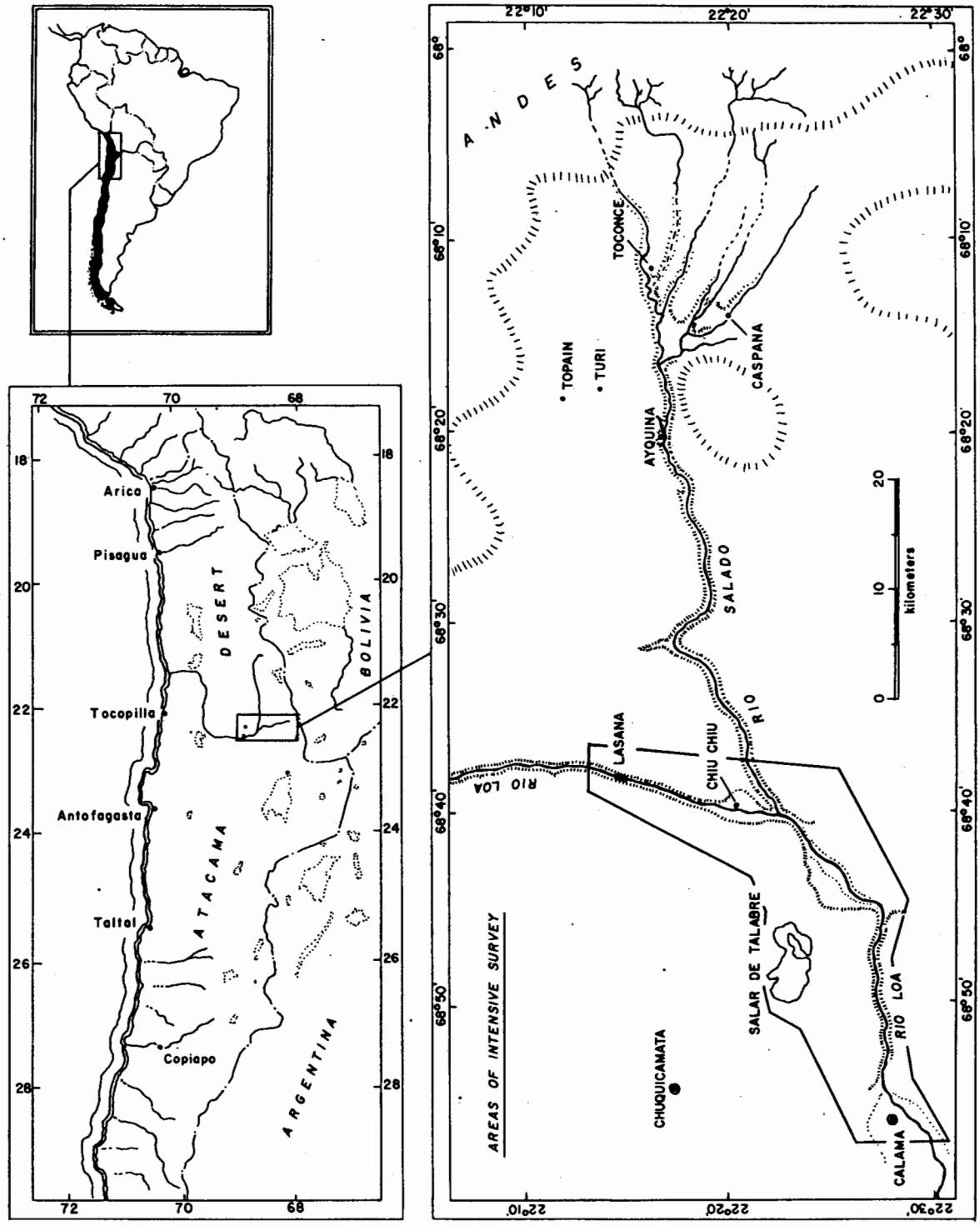
Fig. 5. A Lasana Complex village within the Río Loa canyon. Photo was taken from atop the west edge of the canyon.

TABLE I

THE MIDDLE LOA SEQUENCE
A COMPARISON OF CERAMIC AND CULTURE COMPLEXES
AND PERUVIAN PERIODS

	MIDDLE LOA REGION CERAMIC COMPLEXES AND PHASES	MIDDLE LOA REGION CULTURE COMPLEXES AND PHASES	PERUVIAN PERIODS
1830	COLONIAL	COLONIAL	
1535	LASANA 5	LASANA III	LATE HORIZON
1473	LASANA 4	LASANA II	LATE INTERMEDIATE
	LASANA 3		MIDDLE HORIZON
800	LASANA 2	LASANA I	
	LASANA 1		EARLY INTERMEDIATE
400	LATE LOA	LOA II	
100			
AD/BC ---	EARLY LOA 2	LOA I	
	EARLY LOA 1		
200	LATE VEGA ALTA	VEGA ALTA II	EARLY HORIZON
	MIDDLE VEGA ALTA		
500	EARLY VEGA ALTA	VEGA ALTA I	
800	*PRECERAMIC* ↓	*PRECERAMIC* ↓	INITIAL PERIOD
			PRECERAMIC

Plate XXI.



1

Plate XXII. Fig. 1, northern Chile: areas of intensive survey.

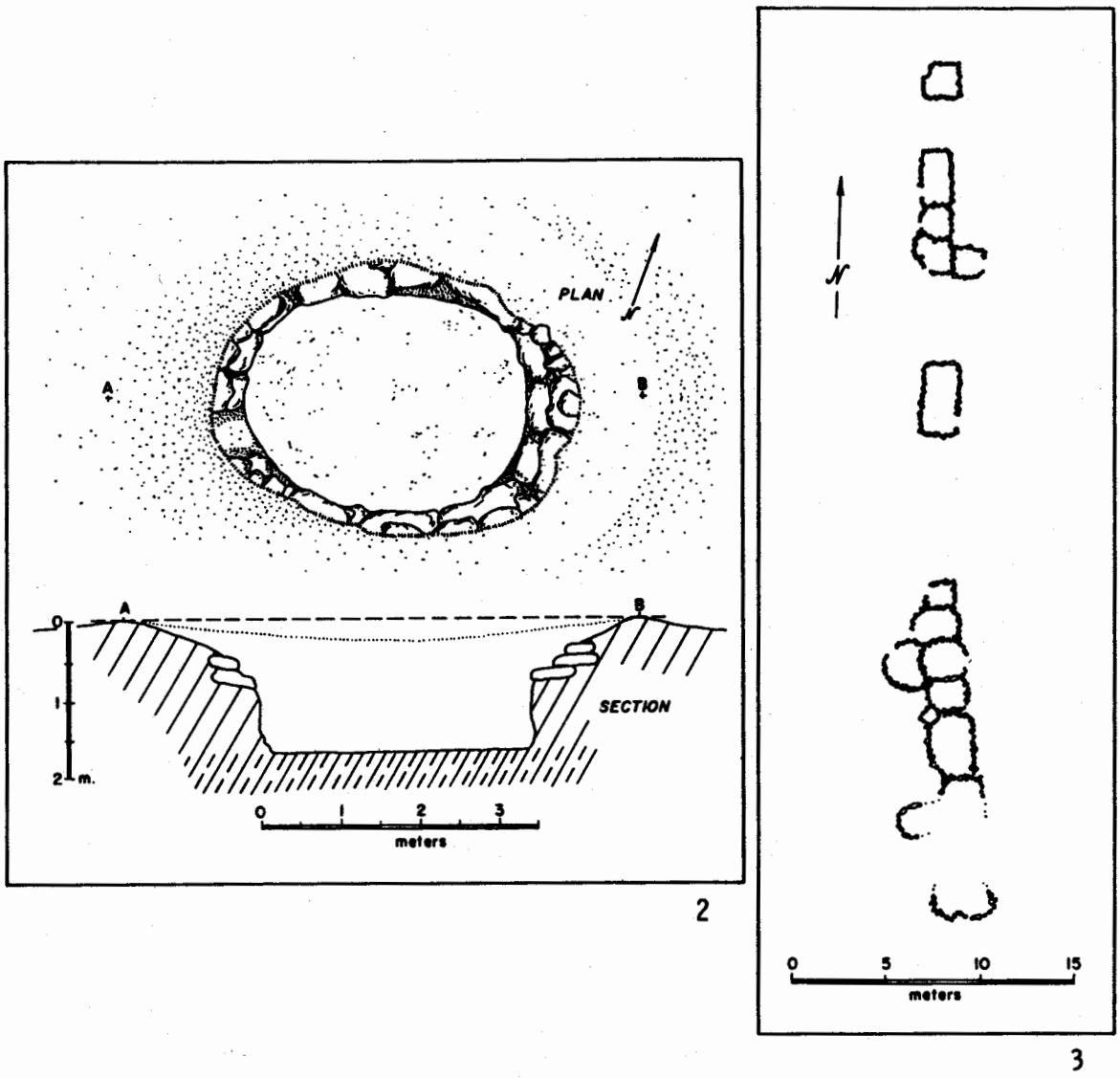
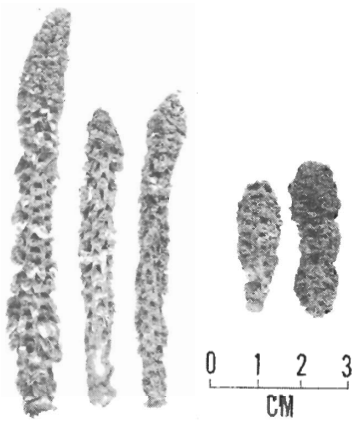


Plate XXIII. Fig. 2, plan and section of a Vega Alta II pithouse structure after excavation, site RAnL 273A-1; fig. 3, Loa I village site (RAnL 343), plan of structural remains.



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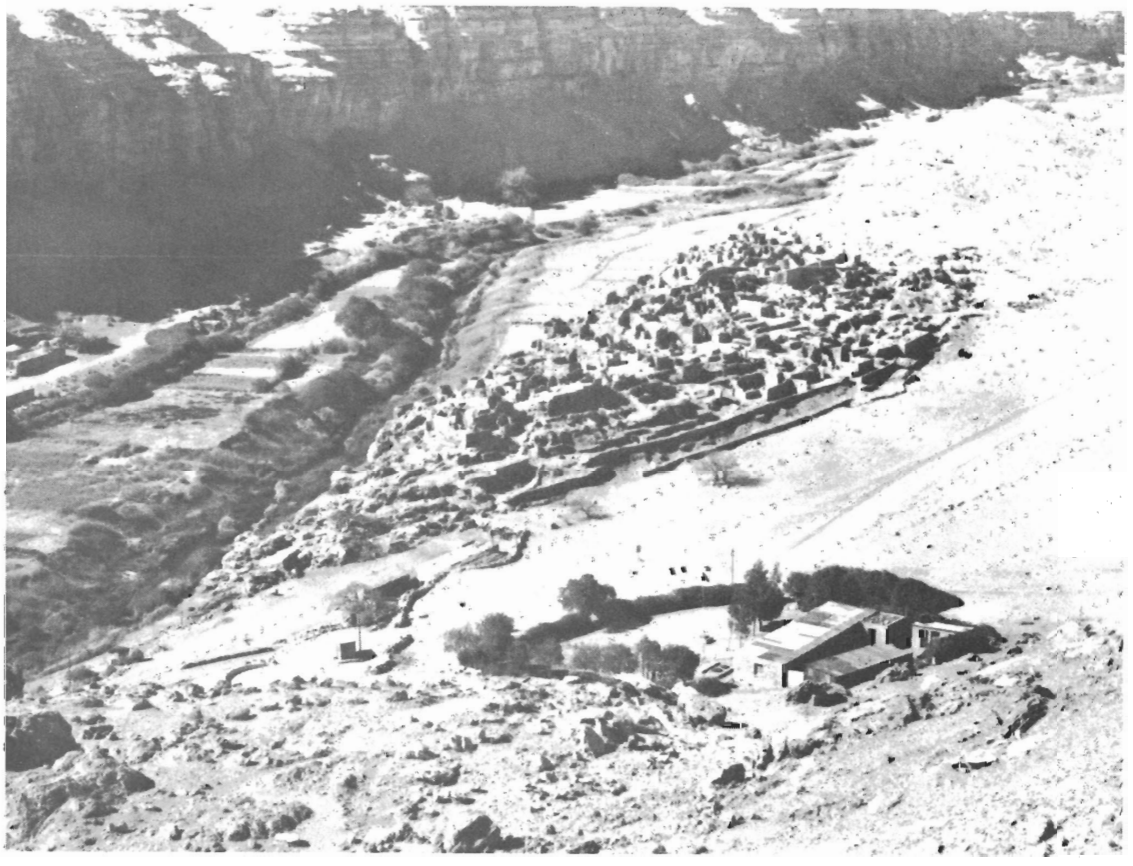

5

Plate XXIV. Fig. 4, prehistoric maize from northern Chile; fig. 5, Pukara de Lasana (RAnL 1). See Key to Illustrations.