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Erickson, C. L. (1977). Domestication and Subsistence Implications of Plant and Animal Utilization in the Titicaca Basin. Retrieved from http://repository.upenn.edu/anthro_papers/19

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Domestication and Subsistence Implications of Plant and Animal Utilization in the Titicaca Basin

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Unpublished manuscript.

DOMESTICATION AND SUBSISTENCE IMPLICATIONS OF
PLANT AND ANIMAL UTILIZATION IN THE TITICACA BASIN

MS 1977

INTRODUCTION

The origins of agricultural systems and the beginnings of sedentary life and its implications for the evolution of cultural complexity have been a major focus of archaeological investigation in the Southern American Andes, particularly within the last few years. Actual plant and animal remains together with indirect evidence for certain aspects of agricultural systems have been recovered from a number of spatial and temporal contexts throughout the Andean area. The most complete data have been taken from special situations where conditions of preservation have been unique or atypical, primarily from dry coastal sites in Peru and Chile (Towle 1961, Lanning 1967, Lumbreras 1974, Nunez 1974) and from protected caves in the highlands (e.g., Macneish 1969, Macneish et al. 1970).

However, the development and implementation of more sophisticated recovery techniques such as water and chemical flotation separation, palynology, and opal phytolith analysis, in addition to traditional means of retrieving macro-plant and animal remains, a wider data base is potentially available. We now have the ability to garner a more complete picture of the prehistoric utilization of plants and animals in addition to building more accurate environmental reconstructions based on information from previously unproductive open sites.

(247)

This paper discusses the results of analysis of botanical and faunal remains recovered, in part utilizing a water flotation technique, from the pre-mound levels (1300 BC-1000 BC) of Chiripa, a site in the Titicaca Basin of the Bolivian Altiplano. Our analysis reveals a previously unrecognized dimension of Andean Highland subsistence, namely the intensive use of lacustrine resources. After describing the evidence for this aspect of prehistoric economy, we will discuss some of the possible ramifications it has in the development of complex culture in the area.

GENERAL ECOLOGICAL SETTING: ALTIPLANO & TITICACA BASIN

The Titicaca Basin is located in the Puna Boliviana or Altiplano. As the name implies, the Altiplano is a high plain ranging in elevation from about 3500 to 4500 meters (Hill 1959:790). It extends from just north of Lake Titicaca to northwestern Argentina -- a distance of approximately 800 kilometers. It is defined by the Cordillera Oriental on the East and the Cordillera Occidental on the West, a distance varying from 50-160 km (Carter 1971:7).

In contrast to other Andean regions, the altiplano can be characterized as a single large macro-zone. Climatically the altiplano is semi-arid with irregularly occurring rainfall (both seasonally and cyclically), fluctuating daily temperature, frequent subfreezing, throughout the year frequent hail, and occasional high velocity winds. These factors, together with

(248)

the soil conditions and high altitude naturally affect the indigenous vegetation. Cardenas (1968:7) has commented on the diverse and drastic adaptations that the plant communities have made to Altiplano climate and soils noting that most of the altiplano species adapt to the environment by having a habit of low, prostrate, many branched, cushion and rosetta form which tends to protect the plant by providing insulation by moderating the temperature changes, and by limiting excessive transpiration.

Characteristic Altiplano vegetation consists of stiff bunch grasses (Festuca spp., Stipa spp., and others) various tola strubs (Lepidophyllum spp., Baccharis spp.), and small, stunted trees (Polylepis spp., Buddleia spp.). Of course, the composition of the animal community is determined by the natural vegetation, so it is not surprising that scrubbrush and grassland adapted species are the predominant types found on the altiplano. Rodents (Cavies and Ctenomys), Camelids, and Cervids (Hippocamelus, Mazama, and perhaps Odocolleus) are the most numerous occurring mammals. Mammalian predators include puma and fox. Avifauna found in the Altiplano include various types of doves, quail, woodpeckers, sparrows, hawks, falcons, vultures.

Thus far we have described the Altiplano as a single, if somewhat large, macrozone. However, the altiplano can be divided into various subzones on the basis of differential latitude, temperature, soil conditions, and rainfall (but not altitude). For example, Bolsi (1963) divides the Altiplano into

(244)

four sub-areas: (1) "la puna planicie central" to the south, characterized by flat relief, vast salt flats, isolated mountain ranges, less rainfall, dendritic drainage, poor vegetation and an annual rainfall between 50 mm to 350 mm; (2) "valles intermontanas del Este", with a folded mesa relief, numerous valleys, and a vegetation consisting mainly of grasses and small trees and an annual rainfall of 350-550 mm; (3) "Lago Titicaca" and adjacent areas (Titicaca Basin) and (4) "franja de transition", the area between the "planicie central" and the Titicaca Basin, consisting of wide mesetas and plains of different altitudes interspersed with low mountains and a grass predominated vegetation with 300-600 mm of rainfall.

Because of the moderating effects of Lake Titicaca, climatic extremes typical of the other sub-areas are not quite as severe in the Titicaca Basin (Monheim). Here, temperature averages approximately 12°C in contrast to the 8.5°C average in the southern Altiplano. Precipitation is also greater in the Titicaca Basin with yearly averages of 650 mm compared to a 250 mm average in the south. This relatively mild climate allows the cultivation of some crops more typically found at lower altitudes, for example maize (Zea mays L.) which can be grown to a limited extent in some of the more sheltered areas of the Basin (Ramirez et al., 1960:46-47).

It is in the Titicaca Basin that the site of Chiripa is located. Specifically, near the southern shore of Lake Titicaca in the province of Ingavi, Department of La Paz, Bolivia (16°26'S,

(250)

68°50' W). It is located on the north coast of the Taraco Peninsula roughly 18 Km north by northwest of Tiwanaku, at an elevation of 3835 m above seallevel (25 m above the present lake level and 500 m from the shore line).

THE SITE

Chiripa is well cited in the Andean highland archaeological literature (Bennett 1936, Ponce Sangines 1970, Bennett and Bird, 1960). Bennett examined the site in 1935 and reported the presence of a stone-lined Tiwanaku subterranean temple, mound facing walls, and a series of double-walled houses containing "storage bins" which surrounded the subterranean temple plaza. He also investigated numerous burials associated with the temple complex. In 1955 Kidder II excavated several other house structures at the site in addition to examining stratigraphic profiles on the north, east, and west sides of the mound.

Of particular relevance to this report was the recovery of botanical and faunal remains during both of these excavations. Bennett reported that "...two kinds of grain were found, the common quinoa and the small grained variety", (1936:424) from what appeared to have been an occupation floor of one of the double-walled houses. Kidder recovered a small cache of carbonized plant remains which Towle (1961:86-136) identified as "quinoa" and twelve specimens of "tubers" which resembled both processed (freeze-dried) and unprocessed tubers of possibly more than one type or variety. Associated with these remains

were both fish and camelid bones which Kidder interpreted as an indication of a "mixed agricultural, fishing and herding economy" (1964:464). The houses from which these remains were excavated date to between 400 BC and AD 50 (Browman, persl. comm.).

The mound which is some 50 x 50 x 5 meters in dimension consisted of a series of superimposed "villages", occupation debris, and intentionally added earth fill. Excavations conducted by Browman and Cordero in 1974 and 1975 revealed another stone lined semi-subterranean temple underlying the one described by Bennett.

Although investigation was by necessity focused on the Chiripa temples, one of the major goals of the joint Washington University-National Science Foundation and Instituto Nacional de Arqueología de Bolivia project at Chiripa was to implement the flotation technique of water separation for the recovery of botanical and small animal remains from the midden refuse. It was hoped that the application of this technique would provide a long temporal sequence of faunal and botanical data from well-dated contexts that would reveal indications of the economic orientation of the site's inhabitants. We were particularly interested in information from the earliest "pre-mound" levels of the site as defined by Bennett (1936:430-31,445).

To satisfy our curiosity, we placed three test pits through undisturbed portions of the mound. One excavation unit was located in the floor of one of Kidder's 1955 excavations

(52)

(this corresponded with one of Bennett's upper-level double walled houses). Another unit was placed along the north facing wall of the mound. And the third test unit was put in through the floor at the northeast corner of the Tiwanaku period temple.

Each of these test units was excavated under stratigraphically controlled conditions, utilizing natural levels when possible. All deposits were screened and soil samples from each level were subjected to a water flotation process. Additional flotation samples were taken from a thick ashy-carbon zone associated with the lower and/or upper level of house complexes on the north face of the mound. It is the floral and faunal remains recovered from these contexts upon which this paper is based.

BOTANICAL AND FAUNAL REMAINS

Botanical resources of economic importance at Chiripa can be divided into two distinct classes: terrestrial/grassland and aquatic/lacustrine. Terrestrial/grassland floral resources recovered during excavation include Chenopodium sp., Amaranthus sp., Opuntia sp., Stipa sp., Festuca sp., Malvastrum sp., and Plantago sp. Aquatic/Lacustrine resources recovered include Scirpus sp., Juncus sp., and Carex sp.

Faunal resources can be divided into the same classes, with terrestrial/grassland species consisting of camelids, deer, dog or fox, birds in the family Charadriidae (lapwings). Aquatic/lacustrine resources include three species of fish,

Orestias pentlandi Valenciennes, Orestias neveui Pellegrin (topminnows), and Pygidium rivulatum (Cuvier and Valenciennes) a type of small catfish). Species from two families of avifauna, Rallidae (rails and coots) and Podicipedidae (arebes) are represented in the sample as are one Bufo sp. individual and two varieties of aquatic gastropods (Litterindina (L. andecola?) and Taphius, (T. montanus?)).

FLORAL REMAINS

Identifications were made of the following recovered remains: (note: many of the seeds still remain to be identified, although the major, most numerous seeds in the assemblage have been identified):

<u>Chenopodium</u> sp.	food (seeds, greens) medicinal fuel fodder/forrage salts/calcium (ash)
<u>Amaranthus</u> sp.	food (seeds, greens) medicinal fuel fodder/forrage
<u>Scirpus</u> sp. ("totora")	food (inner stalk, root) fodder/forrage technological (fiber, matting, thatch) medicinal
<u>Juncus</u> sp. ("junco reed")	fodder/forrage technological (matting) boats - information evidence Chiripa sites on islands
<u>Carex</u> sp.	fodder/forrage (?)

(254)

<u>Opuntia</u> sp. ("cactus")	food (fruit) technological (dye, needles, pins) medicinal
<u>Stipa</u> spp. ("ichu")	fodder/forrage
<u>Festuca</u> spp. ("paja brava", "sicuya")	technological (fiber, pottery temper, thatch) medicinal
<u>Malvastrum</u> sp.	medicinal
<u>Plantago</u> sp. ("llanten") various wood and tola	medicinal

STATUS OF BOTANICAL REMAINS -- DOMESTIC OR WILD?

FLORA

Of major concern is whether or not the recovered plant genera represent wild, cultivated, or fully domesticated plants. Of prime concern are the Chenopodium sp. and the tubers, believed to have been domesticated by this time period and important as a highland economic complex with pastoralism. The seeds of Chenopodium (Ca. to 9200 seeds from all proven) range from approximately .4-1.3 mm with most averaging .8-1 mm in diameter. Precise measurements are difficult due to morphological distortion and surface alterations caused by the carbonization process. The size range of the modern day domesticate Chenopodium quinoa Wild ("quinoa", "quinua") varies greatly, but most of the seed measurements published and the author's own measurements of local cultigens of the Taraco Peninsula generally fall between 1.5 and 2.5 mm. The cultigen Chenopodium pallidicaule Aellen ("canahua", "Canihua") is closer in size range, but still

appears larger than the means for the archaeological material.

	<u>Chenopodium quinoa</u>	<u>C. pallidicaule</u>
Leon 1964:73	1.0-1.5 mm	1.0-2.0 mm
Planchuelo 1975:546	1.5-2.2 mm (2.6)	1.2-1.4 mm
Hunziker 1943:147	1.5-2.5 mm	1.0-1.2 mm
Nelson 1968:17	1.3-2.5 mm	---

On the basis of morphological criteria the archaeologically recovered Chenopodium differ from the cultivated varieties. Although distortion has occurred as a result of carbonization, especially in regard to seed thickness and the circular embryo, both of which are critical diagnostic features for identification, the archaeological seeds have a more or less obtuse, rounded margin; whereas, the modern domesticates tend to approach a more truncated margin (perpendicular to the sides). Both have lens-shaped, convex dorsal and ventral surfaces, although the modern domesticates have somewhat flatter surfaces. Both the archaeological and modern cultigens show reticulate surfaces (minute pitting of the testes coat). The cultigens tend to have a more pronounced embryo; whereas, in the archaeological material, the embryo is much less pronounced except where carbonization has "puffed" or "popped" the embryo or separated it from the seed (sometimes the distortion is 4x in thickness). The archaeological material has a thickness of at least 1/2 of the diameter of the seed, while the cultigens tend to be thinner in proportion to the diameter. The seed morphology of C. pallidicaule tends to be more elliptical in the published material while the carbonized seeds are nearly circular.

When the archaeological material is compared to the modern weedy-wild (referred to in the literature as "foral", "escapees", "wild", etc.) species of Chenopodium of the Altiplano of Bolivia (locally called "apara", "ajara", "anu cara"), the similarity of form and size is striking. Local varieties of Chenopodium are associated with the cultivated forms of quinoa as weeds and have been noted throughout the Andes, although the taxonomic status of most of these and their relationship to the cultigens are not well understood (for some of the literature on the subject, see Planchelo 1975, Cardenas 1969, Nelson 1968, Simmonds 1965, Hunziker 1943). Much crossing between the cultivated species and the weedy-wild varieties has been noted. In some instances, these serve economic functions as fodder, forage, human food, medicine, and at times these Chenopodium are even cultivated. Common characteristics of these Chenopodium are black or brown seeds, bitter seeds (due to high levels of saponin), strong aromatic odors (especially C. ambrosioides L.) and a "weedy" nature, found usually in such disturbed habitat areas as cleared fields. Seeds, although much smaller than the cultigens, are produced in large quantities and the prostrate nature of these plants would tend to protect them from the harsh climatic elements. The size of the archaeological seeds is well within the range of the various "weedy-wild" Chenopodium spp. present throughout the Altiplano (herbarium sheets -- Missouri Botanical Gardens, St. Louis MO) and those collected by one of the authors on the Taraco Peninsula. The archaeological seeds do not closely resemble modern varieties now cultivated in

the Altiplano.

Seeds of Amaranthus sp. were recovered from the upper levels of our excavation and from samples taken from the sidewall of an exposed cut on the north face of the mound, possibly contemporaneous with either the upper or lower circle of house structures. The seeds are small (1 mm in diameter or less) and do not appear to be the Andean cultigen Amaranthus caudatus L., neither with regard to size or morphology, but probably represent one of the various wild species of Amaranthus common throughout Bolivia and Peru.

In levels dating to approximately 800-500 BC in the lower temple fill of Unit C-8, two carbonized tuber fragments (fragmented by 3/4 complete) were recovered which resemble freeze-dried potatoes ("chuno", or "tunta") in structure and density. Identifications of the carbonized material to the potato genus Solanum has not been verified yet, but appear to be the correct identification for at least one of the tubers. In addition, in a majority of the flotation samples, there occur small fragmented pieces of what appears to be tuber (light, porous, slightly glossy carbonized material). Further work on the positive identification of these fragments will utilize scanning electron microscopy at the University of Illinois. If the identifications of cultivated Solanum tubers recovered by Kidder from the upper level double-walled Chiripa houses (400 BC-AD 500) are correct, then the use of Solanum or at least one of the highland tuber crops (ullucos, isanu, arrachcha, oca, etc) at that time period

(258)

is documented.

In addition to the direct evidence of carbonized botanical remains, indirect evidence of cultivation has been recovered in the form of numerous cultivation tools, food preparation implements, and sophisticated storage facilities. The cultivation tools represented are "hoes", and "hoe-adzes" (Bennett 1936:445, material on display in the National Museum in La Paz from the Kidder excavation and material recovered in our excavation). Pre-mound food preparation implements have been found throughout the site in the form of ground stone "manos" and "metates", stone bowls, and various ground stone pestle-like artifacts. Complex storage systems are represented in the form of double-walled houses in the Chiripa upper circle of houses (400 BC-50 AD). Function of these "bins" as storage units is attested by Kidder's recovery of carbonized botanical remains from the double-wall bins of a burned structure (Kidder, 1967) and similar ethnographic evidence. The lower houses of the site excavated by Kidder and our excavation did not have the double-walled bins of the upper houses, but numerous deep circular pits filled with midden debris may have originally served as storage pits. The well designed and well constructed bins of the upper level houses would tend to support arguments of surplus accumulation probably through some sort of cultivation of chenopods and tubers.

FAUNAL REMAINS

Although over 10,000 bones and bone fragments were recovered

from the excavation units . . . because of the practice of intensive bone fracturing during the butchering process, the total minimum number of individuals of 269 is somewhat less impressive.

The Chiripa faunal assemblage is composed of the ubiquitous camelid, at least one species of deer, and perhaps two or three, one unidentified and three identified types of fish, at least three families of birds, as well as one individual dog or fox and one amphibian. In addition, several small mammals and gastropods were also identified.

Camelids		fresh meat, charki, fat, wool, bones, hides, dung, bezoar stones
	Lama glama Lama pacos Vicugna vicugna Lama guanicoe	
Deer		fresh meat, charki, fat, bones, hides, antlers
	hippocamelus odicoeleus huamal	
Canid)
Birds		fresh meat, charki, eggs, feathers
	Chirocinidae Podicepsidae Rallidae	
Fish		fresh meat, charki
	orestias peutlandi valenciennes orestias nevayi Pellegrin Pygidium rivulatum (Cuvier and Valenciennes)	
Amphibian	Bufo sp.	(?)
Snails	Planorbidae spp. Hydrobiidae spp.	
CAMELIDS		

Although the main thrust of highland faunal analysis has

(66)

concerned the identification of Lama glama (Llama), Lama pacos (Alpaca), Vicugna vicugna (Vicuna), and Lama guanicoe (Guanaco), unfortunately, no technique for confidently distinguishing between these four species has been entirely worked out. For the purpose of this preliminary report no attempt to differentiate these species has been made. They have been lumped as simply camelids.

The camelids are represented by a minimum number of 20 individuals, or about 7 percent of the total assemblage.

By analyzing the characteristic bone breaks and butcher marks and by utilizing ethnographic analogies, it was possible to reconstruct the method by which the camelids were butchered (Horn 1978). This analysis indicates that the carcass was processed by stripping off the major muscle masses and then thoroughly smashing the bones in order to facilitate the utilization of marrow and fat. The long bones were usually broken in such a fashion that characteristically long splinters were produced which could be used as handy perforating tools, as indicated ^{is indicated by} ~~inclusion of~~ *cerametics*.

It was observed that the high degree of bone fracturing was especially apparent in the sample of cranial elements. The implication of this was finally realized upon purchasing a llama skull which had been processed for sale in the Tiahuanaco marketplace. This skull had been prepared for drying by removing the braincap and brain, and then systematically smashing strategic skull bones so that the head could be ^{preserved}. This

production technique, by greatly increasing the surface area of the head and thus allowing more exposure to the air, facilitated the desiccation of the flesh and its transformation into charki (sun-dried meat).

After macerating the purchased skull, it was observed that the remaining skeletal material was identical in size, shape, and fracture characteristics to the archaeologically recovered skull fragments. Since there are no notable differences in degree of fracture at Chiripa through time, it is inferred that the preservation of meat was a known and practiced activity in the Titicaca Basin by at least 1300 BC.

CERVIDAE

A minimum number of eight deer (or a little under 3 percent of the sample) were identified, but this may not be an accurate impression of their food value, as several of these individuals are represented only by the occurrence of highly modified antler fragments. At least one individual is an Odocoileus and the rest of the sample may include Hippocamelus and/or Mazama individuals (brocket and/or huemal).

Unfortunately, the sample of cervids is not complete enough to make inferences about the manner in which they were butchered.

FISH

Large quantities of fish remains were recovered through

the utilization (implementation) of flotation techniques for micro-remains. At least 215 fish individuals were identified in the collection. Most of these individuals have been identified as Orestias pentlandi Valenciennes, or "Q'esi" which is a small lake fish averaging about 12 cm in length. The next most common species represented is the closely related and somewhat smaller Orestias neveui Pellegrin or Qaraci which is about 8 cm in length. Pygidium rivalatum (Cuvier and Valenciennes), one of the parasitic catfishes which averages about 9 cm in length, contributed less than 1 percent of the total number of fish individuals. One other unidentified individual was also encountered. All three of the identified species are sold in modern Bolivian market places and the first two now supplement the present day Chiripa campesino diet.

These fish are found almost exclusively in the shallow parts of the lake near thick strands of totora coker (1910). Early travelers such as Bandelier (1910) report that almost no fish are to be found in the deeper parts of the lake, but are common in the shallower sections of lake, especially the south portion of the lake. Today these fish are procured for market sale with seine and trawler type nets from balsas and wooden gaff-rigged sail boats. Fish for family consumption are generally caught by wading into the shallows and using a rectangular dip net (La Barre 1948, ¹⁹⁴¹ Tschepik 1948).

AVIFAUNA

The Chiripa avifaunal remains, which contribute about 9

(263)

percent of the total number of animals, consist of 24 individuals from at least three families: Charadriidae, or lapwings and plovers, Podicipedidae, or grebes, and the most numerously represented, Rallidae, or coots and rails. The latter two families are composed of species which inhabit marshy lake shores where they feed upon lake vegetation (coots and rails) and small fish and other aquatic animals (grebes). When not feeding, these birds are usually found in the protective cover offered by such vegetation as stands of totora where they sleep and nest. The lapwings are more of an upland bird and during harvest time near the modern community of Chiripa, can be observed foraging in the fields for grubs and other insects.

While the sample size of the bird collection is admittedly small, it does seem to indicate a definite orientation toward the exploitation of marshland birds. That is, more than 94 percent of the identified species are those preferring marshy environments whereas less than 6 percent are non-aquatic.

OTHER FAUNA

One dog-like individual is indicated by a presence of a canine tooth and a few fragments of cranium. Unfortunately, the remains are not complete enough for us to determine whether the individual was a fox or a dog.

A Bufo or toad was identified in one of the flotation samples. The bones of this individual were charred leading one

(264)

to suspect that it had in fact been eaten, although the relatively minor contribution that this animal makes to the overall Chiripa faunal assemblage may mean that they were not customarily utilized as a food resource.

Several individuals of small mammals were identified in the collection. These were at first believed to represent the Cavia sp., or guinea pigs which were expected to occur at the site. However, on the basis of dentition, these have been identified as Ctenomys sp., or tuco-tucos. Tuco-tucos are small, burrowing rodents resembling the North American pocket gophers in size and behavior and which still inhabit the vicinity of the Chiripa mound. Because there was stratigraphic evidence of rodent activity in some of the test pit levels, and because most of the remains were whole and none exhibited any obvious evidence of exposure to fire, these animals probably represent non-economic, intrusive species. Contrary to initial expectations, no Cavia sp. individuals were identified in the Chiripa collection.

671 gastropods identified in the faunal collection. 24 were species, or a species, in the family Hydrobiidae. The rest, 647, are from species in the Planorbiidae family. Both of these families are predominately composed of aquatic species. The few species which are not purely aquatic are confined to tropical rainforest environs and so would not be expected to be found indigenously to the altiplano.

Species from both of these families are commonly found

(265)

clinging to masses of lake vegetation. Thompson (1968), when collecting specimens of Hydrobiidae in Floridian lakes and ponds, found that the most efficient method of procurement involved rinsing out mats of vegetation into a container of water. The clinging gastropods would fall off the plant material and could then be easily gathered.

Since these animals are relatively small (less than 5 mm in length) and their food value is probably minimal, they do not, in all likelihood, constitute a intentionally exploited species. A more reasonable explanation for their inclusion in the faunal materials would be that the Formative Chiripans gathered lake vegetation and that these gastropods clung to this, eventually to be incorporated into the site midden. Modern Aymara campesinos have been observed collecting thick mats of a watercress-like plant from the lake which they now use as a supplementary livestock fodder. Although informants denied that this vegetation is fit for human consumption, this is probably not true. (The Uru living near the Rio Desaguadero have been reported to gather and eat lake vegetation.) This material is also currently utilized as a medium for storing fresh fish.

It is believed that the gastropods found in the Chiripa faunal assemblage reflect the gathering of lake zone vegetation for animal or human consumption, or for some other reason, and therefore, are not an example of a species which was directly exploited. For this reason, they will not be considered as an important component of the economic faunal assem-

266

blage. Their presence does, however, suggest an important additional strategy of lacustrine resource exploitation.

INDICATIONS OF ENVIRONMENTAL ZONE USE

The identified floral and ~~micro~~-fauna remains ^{reveals an} ~~give some~~ indication of diverse micro-environmental zone utilization by the inhabitants of the site. Within a one kilometer "catchment" radius of the site nine distinct micro-environmental zones would have been available to the inhabitants (see Erickson 1976 for the divisions). Most interesting is the evidence for the use of terrestrial and lacustrine resources. Botanical lake resources are represented by Scirpus sp. (totora), Juncus sp. (Junco), Carex sp. (reed), and shore dwelling gastropods (Littoridina sp. and Taphius sp.). Bufo, bird, totora and juncus reeds are present in the lake littoral -- a wide band around the lake in approximately .5-2 meters depth of water.

The majority of the recovered plant material represents typical floral components of the Altiplano ecology of the Taraco Peninsula. A majority of the plant material indicates disturbed habitat colonists (Chenopodium and Amaranthus) and major grass genera (Stipa sp. -- "ichu" and Festuca spp. -- "paja brava", "sicuya"). The carbonized wood and "tola" tree/shrub material have not been identified to definite generic level, but the diameter of cross-section indicates extensive use of small shrubs as fuel. The Opuntia sp (a cactus) is found in all the well-drained micro-zones of Chiripa today except the lowlying stream cuts and marshy shore-line. They

(267)

are found in relative abundance on the upper slope and hill tops and around modern and prehistoric domestic habitation sites of the peninsula. Malvastrum and Plantago would have probably been collected in the middle zone.

No evidence of "verticality" or exploitation of other macro-environmental zones (the "yungsa/montana", "selva", or coast) is indicated by the flotation data. All the identified genera are well within their ecological range (altitudinally and spacially), ^{As the flora} Other non-botanical ^{as Sauer} data from Chiripa indicates long distance contacts (David Browman: personal communication). The represented flora ^{give} indications of maximization and integration of micro-zones for self-sufficiency, analogous to subsystems discussed by Orlove (1977) in the Puno and others in regard to the ethnographic present in the Andes.

INDICATIONS OF CHANGING SUBSISTENCE THROUGH TIME

Flora's

^{botanical} The recovered flotation remains do not show any significant change of subsistence through time. Amaranthus sp. is added in to the complex of remains in H-7 #12 (ca. 850-500 BC) but is represented only by one seed at this level. Later levels contain more seeds of Amaranthus. In comparison with the recovered Chenopodium sp. seeds, the number of Amaranthus sp. seeds remain at a very low frequency, and were probably or marginal economic importance. Traditionally, this plant is important as a green potherb (Sauer 1967), which may explain the low frequency of seed recovery. The seed size range of

(268)

the Chenopodium from all the stratigraphic flotation samples does not change throughout the flotation sequence; some of the largest seeds are found in the oldest levels. The absence of numerous identifiable, complete tubers from the "pre-mound" levels of the site and the recovery of tubers by Kidder from later levels may indicate the time of their incorporation into the subsistence strategy, but the fragmented tuber-like material in some of the older levels of the site indicate possible use during the first occupation of the site, although the tuber may not necessarily represent domesticated species.

odd ground seeds

COMPARISONS TO OTHER EARLY RECOVERED ARCHAEOLOGICAL REMAINS

Flora

Reported occurrences of Chenopodium and Amaranthus from sound early archaeological contexts have been rare in the Andean Highlands. Towle (1961) and Lanning (1967) have summarized the data from the coast and most occurrences appear to be from relatively late or poorly dated contexts. MacNeish (1969:22,38; MacNeish et al. 1970) reports recovery of "quinoa" seeds with "amaranthus", "gouri", and "possibly chili peppers" from the Piki Phase (5500-4300 BC) of Pikimachay Cave in Ayacucho, Peru, but until the final botanical analysis, we will not know whether this "quinoa" is the domesticate or a wild form.

Hunziker (1943) examined the contents of a burial urn from near Salta, Argentina, and identified G. quinoa and another species of Chenopodium (probably the weed "apara") in association with Amaranthus caudatus, Amaranthus sp., Phaseolus, and Zea mays. From a better archaeological context, Hunziker and

(269)

Planchuelo (1971) have identified two variations of C. caudatus, C. hircinum, A. caudatus and Amaranthus sp. which has been dated to "around 2000 years ago".

Hunez A. (1974:135-7) reports early "quinoa" form ceramic "pre-Tiahuanaco" sites in northern Child (Tarapaco-40-A) although the specific species (domesticated or wild) is not indicated.

Pearsall (1977) reports an almost identical assemblage to the Chiripa assemblage of carbonized floral remains from the Pachamachay Cave near Lake Junin, Peru. The lacustrine/puna environment of Junin is much the same as the lacustrine/alti-plano environment of Chiripa, although the occupation of the cave appears to cover a much earlier time period. The major difference between the Chiripa and the Pachamachay cave carbonized floral remains is a higher frequency of Chenopodium sp. at Chiripa in comparison with other recovered seeds. This may indicate an increased emphasis on collection and/or cultivation of Chenopodium at Chiripa. Pearsall notes a slight increase in Chenopodium seed size between the preceramic and the ceramic levels of the site. Opuntia cactus (probably the fruits as food) are present at both Chiripa and Pachamachay Cave.

Fauna

Most zooarchaeological investigation of highland assemblages in the Andean Highlands have emphasized the use of terrestrial animals, particularly those inhabiting grassland ecozones. For example, John Rick () and Jane Wheeler's (Wheeler Pires-Ferreira, et al.

(270)

1976) investigations of animal utilization at preceramic sites located in the puna around Lake Junin indicate that lacustrine resources did not contribute to the subsistence regime. They suggest that the development of specialized camelid hunting stimulated sedentism and that domestication occurred as a consequence to this.

Recently, the analysis of faunal materials recovered from a number of highland sites situated in a variety of ecozones has indicated a somewhat more complicated pattern of animal utilization in the central Andes than was previously recognized. Analysis, conducted by Wing (1977, 1974, and various) demonstrates that while in puna sites (above 4000 m) grassland species were utilized to the virtual exclusion of any other type, in the valleys, the subsistence pattern did include the exploitation of aquatic species. For example, at Minaspata, excavated by Edward Dwyer, 9% of the faunal materials analyzed consisted of grebes, ducks, rails, and bufos. Similarly, at Pikicallepata aquatic species contributed 8.5% of the total faunal assemblage.

Wing has interpreted this as indicating no more than the reflection of the utilization of localized micro-environments. And given the fact that no major bodies of water are located near these sites, her interpretation is certainly plausible. However, this pattern also suggests that prehistoric highlanders were much more eclectic in their food preferences than is commonly believed, and that they exploited a broad

(271)

range of resources when available. The ecological setting at Chiripa is different from the setting of the sites analyzed by Wing. Far from being merely a localized resource, at Chiripa, the lacustrine ecozone constituted a major resource. Our analysis demonstrates that by 1300 BC the exploitation of lake resources was a major contributor to the subsistence regime. ^{As shown by the} This emphasis is to be expected when the relative value of grassland and lacustrine ecozones are considered.

SEASONALITY AND SCHEDULING

Year round occupation shows some indications of seasonality and scheduling of economic activities may be inferred from the data, although more identifications of the unidentified material and additional ecological data are needed before secure inferences can be made. The seeds of Chenopodium, Amaranthus, Opuntia, Plantago, Malvastrum (and to a lesser degree, Scripus, Carex, Stipa, and Festuca) would indicate use of economic plants at least at the end of the wet season and/or during the dry season (approximately May to September) when these seeds are fully mature. The presence of structures (or foundations of what appear to be structures) in the earliest levels of the site (1300-900 BC) would argue for a potentially sedentary life. The lake resources would certainly be available and abundant throughout the year, offsetting any seasonality of the Altiplano natural and crop vegetation. The totora, juncus and various water plants of Lake Titicaca (which remain green year round), fish, and possibly birds were available year round, ^{in addition to deer and camelids.}

(272)

POTENTIAL OF SITE CATCHMENT AREA

The agricultural potential and carrying capacity of the Taraco Peninsula and Lake Titicaca is great, even though the altitude and climate limits human crop cultivation as well as the natural vegetation. For the Altiplano, the Titicaca area has the highest population density of farmers with up to 800 inhabitants per square mile as a common figure given in the literature (Bolsi 1968:43,50; Ogilvie 1922; Tschopik 1948:502-3). Crop yields are higher near the Titicaca area (Labarre 1948). Lake Titicaca has a unique rainfall pattern (600 mm annually, 1150 mm maximum), much higher than the surrounding Altiplano (Kessler and Monheim 1968:275, Hill 1959:793) and this is probably due to the moderating effect of the lake. Bolsi (1968:41) attributes this to the lake acting as a zone of attraction by drawing moist air from the montana east of the Altiplano. Buechler (1964:41) notes that in some areas around Titicaca, a double-crop can be harvested in a single year. The soil at Chiripa on the first and second terrace above the lake is extremely rich and only short term fallow is needed today, if at all. Prehistoric "ridged fields" are present east of Chiripa at Aygachi (Smith et al. 1968) and southwest of Chiripa at Iwawe, but none are found in association with the site of Chiripa. If cultivation or full scale intensive agriculture was practiced in the "pre-mound" levels, the potential production would have been great.

273

However, even though permanent settlement at Chiripa is indicated and the potential of intensive agriculture would have been high, we stress that there exists no evidence for the practice of an intensive agricultural regime. Although we believe that some form of agriculture was indeed practiced at the site during the pre-mound period, we believe that the intensive utilization of wild resources, especially aquatic sources, along the Taraco Peninsula could have supported a settlement of the size of the site. The remainder of this discussion deals with the comparative potential of the terrestrial and aquatic resources existing around the site of Chiripa.

In an attempt to avoid the problems inherent in utilizing measures of carrying capacity, we have elected to use measures of primary productivity¹ for our comparison of grassland and lacustrine ecosystems. Figure presents the rates of primary productivity in terms of biomass for several of the world's biozones. For the most part, these have been determined by measuring Northern Hemispheric environments so that it is somewhat difficult to assess their applicability to the Andean Area. It will be assumed, however, that the figures are grossly applicable to the area around Chiripa. It will also be assumed that the figures derived for temperate grasslands approximate the productivity of the altiplano grasslands, although it should be realized that this may be, in fact, an overestimate.

¹ Primary productivity is defined by Reid and Wood (1976:301) as the "...sum total of energy-trapping processes, comprising all photosynthetic and chemosynthetic processes in the system." Unlike the concept of carrying capacity, measures of productivity do not involve theoretical potentials for supporting life systems. Rather, they involve empirically based quantifications of certain biological processes occurring in discrete areas of the biosphere.

274

As the table indicates, a square meter of temperate grassland produces between 200 and 1,500 grams of dry organic plant material per year, whereas the same unit of marshland produces between 800 and 6,000 grams of dry plant biomass per year.

So, in terms of phyto-organism production, the lacustrine littoral is approximately four times more productive than temperate grasslands. Theoretically, this means that marshland systems have the potential for supporting a greater population of energy consumers than do the temperate grasslands.

In addition marshes are not only more productive than grasslands, but the analysis of the nutritional quality of certain marsh plants, particularly in terms of crude protein and caloric content show that they are comparable and often exceed the values of terrestrial forage and food crops (Clegg 1969:1004).

So, in terms of levels and quality of phyto-organism production, the lacustrine littoral appears to possess significantly greater potential to support energy secondary energy consumers than do the grasslands. In quality, this does seem to be the case with marshlands supporting not only larger communities but also more diverse communities of trophic life than do grasslands.

Conclusion

(275)

Conclusion

Traditional models of Highland cultural development have stressed the interaction between the rise of and agricultural subsistence regimes and the rise of settled village life. These models have emphasized the role that the exploitation of grassland resources, both botanical and faunal, has played in the development of domestication and settled villages. Virtually all models, in addition, have placed great emphasis upon the distribution of resources according to elevational zones. quite naturally this has resulted in models in which vertical transhumance occupy a strategic position. We believe that this preoccupation with vertical transhumance and utilization of grassland resources, while appropriate to the regions which have supplied the data for most models, is not appropriate for an understanding of the prehistoric subsistence regime of the Titicaca Basin. This for two basic reasons: 1. elevation is not as an important factor in the distribution of resources as it is in the central Andes, and 2. analysis of the botanical and faunal material from a Basin site indicates that the utilization of non-domestic, non-grassland resources, namely lacustrine resources, contributed significantly to the subsistence regime of the area.

(276)

From our analysis of both botanical and faunal remains recovered from the "pre-mound" levels of Chiripa, no claim for either fully domesticated plants or animals can be made with the available data. Chenopodium appears as a likely candidate for status as a cultigen, possibly at the early stages of genetic manipulation, but its relative importance in the subsistence regime can only be speculated on. The various plant genera identified so far gives an indication of use of a wide range of available resources.

The only possible faunal domesticate in the assemblage are the camelids. Unfortunately, it is not yet possible to determine the status of these individuals. It has become increasingly clear that relatively complex societies, like that of late Formative Chiripa, can support themselves by collecting wild resources, particularly aquatic resources, without recourse to an agricultural economic system. It is therefore not wise to assume the presence of domestic camelids in these components of Chiripa even though we would expect to find them in the area and at this time.

In terms of the relative abundance of individuals by species, the pattern of animal use indicates a definite orien-

(777)

tation toward the exploitation of lacustrine resources. Almost 90 percent of the individuals represented in the faunal materials are species which inhabit marshy lake shores. In addition, the incidence of gastropods in the collection may imply the practice of water plant gathering, thus indicating another dimension of marshland utilization.

A strong relationship between the exploitation of aquatic resources and the development of sedentary village life, and in some cases, the domestication of plants and animals has often been argued (e.g., Sauer 1952:63, Binford 1968). It has also been suggested by Gilmore (1950), Cutler (1968), and others that the Titicaca Basin may have been an early center of domestication. If the latter idea is correct, then the pattern of resource utilization observed at Formative Chiripa would support the contention of an important interrelationship between the two phenomena.

While we hesitate to make grand statements about cultural evolution in the Andes on the basis of materials from one site, the data do indicate a heavy reliance upon fish and other aquatic resources -- a reliance that has not been reported from highland sites outside the Titicaca Basin. We suggest that the intensive exploitation of wild resources, around Chiripa, particularly the highly productive lacustrine resources was sufficient to support a sedentary population and that a predominantly agricultural lifestyle was implemented at a later date.

(778)

TABLE I: Comparative levels of Primary Production (grams of dry weight plant material)

ECOSYSTEM TYPE	NORMAL RANGE G/M ² /year	MEAN G/M ² /year
tundra and alpine	10-400	140
lake and stream	100-1500	400
temperate grassland	200-1500	600
cultivated land	100-4000	650
temperate deciduous forest	600-2500	1200
swamp and marsh	800-6000	3000

These figures show that the mean productivity of marshes and swamps is 2.5 times greater than temperate deciduous forests, 4-5 times more than cultivated fields, 5 times more than temperate grasslands, and 7-8 more than lakes and streams. Finally, swamps and marshes are more than 20 times more productive than tundras and alpine grasslands.

~~TABLE I: Comparative levels of Primary Production (grams of dry weight plant material)~~

ILLUSTRATIONS

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(279)

(280)