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Chiripa Ethnobotanical Report: Flotation-Recovered Archaeological Remains from an Early Settled Village on the Altiplano of Bolivia.

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CHIRIPA ETHNOBOTANICAL REPORT:
Flotation-Recovered Archeological Remains from
an Early Settled Village on the Altiplano of
Bolivia

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April 2, 1976

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ABSTRACT

The flotation water separation recovery technique for botanical remains was applied during excavation of undisturbed stratigraphic lower levels of the site of Chiripa, Bolivia, in the 1974-75 field seasons. The flora and fauna represented in the sample of recovered material are carbonized seeds of Chenopodium spp., Amaranthus sp., Scirpus sp. (probably S. tatora), Carex sp., Juncus sp., Opuntia sp., Stipa spp. and Festuca spp.; various tola and native tree remains; possible tuber fragments; and a large quantity of fish scale and fish bone. These levels date from approximately 1260 B.C. to 350 B.C.. Analysis of the data indicates the probability of the cultivation of wild or weedy species of Chenopodium, but not necessarily the cultivation of the domesticates Chenopodium quinoa or Chenopodium pallidicaule. No major shifts of economic plant usage were shown in the data within this time sequence. Possible economic uses and importance of the various botanical remains are surveyed. Also, ecological aspects of the site's location are discussed.

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INTRODUCTION

During the field seasons of 1974 and 1975, a joint project of Washington University and El Centro de Investigaciones Arqueológicas en Tiwanaku (CIAT) conducted excavation at the site of Chiripa, Bolivia. Chiripa is located on the Taraco Peninsula (Province Ingavi, Department of La Paz) which projects out into the southern portion of Lake Titicaca at 3804 meters above sea level in the Bolivian Altiplano. Specific emphasis was placed on the recovery of economic data, primarily subsistence in the form of archeobotanical and archeozoological data. The water separation technique of flotation for the recovery of carbonized archeological flora and fauna, ^{which is becoming a} an almost standard procedure in many New World excavations, has rarely been applied to Andean excavations. Most prehistoric dietary information has been obtained from various coastal sites where desert environmental conditions provide excellent preservation of all types of floral remains. Usually, reported material is from grave sites with poor provenience. Although much information on plant usage and domestication has been gained from the study of coastal archeobotanical remains, the coast is generally recognized as not being the original area for domestication of the most important prehistoric food staples, which are of highland and jungle origins (Pickersgill 1969:60; Heiser 1973:10; Flannery 1973:302; and others). As Towle observes, "the climate of all the Andean highland areas is not conducive to the preservation of vegetable remains and we have only scant evidence of the plants--either wild or cultivated that were used" (1961:136). Most of the known information is based on vegetable material depicted on ceramics and textiles, and ethnohistorical accounts (such as Yacovleff and Herrera 1934-35). Other floral remains have been recovered from protected dry sites located within caves and rockshelters (MacNeish 1969; MacNeish et al. 1970). Because protected sites are rare and

located only in certain geological areas, the "typical" highland sites tend to be "open" sites with poor preservation. Most of the floral data from non-protected sites has been due to discovery of large caches of carbonized material. The application of the flotation technique allows recovery of even the smallest carbonized floral remains and also small faunal remains such as fish bone, fish scale, mammal and reptile bone, and snails. These remains are at times invisible to the naked eye when within the soil matrix, and are thus missed even with the most careful excavation techniques.

Lake Titicaca and vicinity (Bolivia and Peru) has been the focus for much prehistoric activity, from early settled villages to the time of contact with the Spanish. In regard to subsistence and the domestication of highland Andean crops, Cutler (1968) and others have commented on the importance of the Lake Titicaca area. Cutler states:

The region around Lake Titicaca brings to mind Carl Sauer's suggestion that "sedentary fishing peoples perhaps commenced the cultivation of plants and became the first domesticators of plants and animals." Around the Lake is centered a tremendous diversity in several crops with edible underground parts: potatoes, oca (Oxalis tuberosa), ulluco or papa lisa (Ullucus tuberosus), and mashua or añu (Tropaeolum tuberosum), a tuber bearing nasturtium). Here is also a center for the important highland seed crops, quinoa (Chenopodium quinoa), cañihua (Chenopodium pallidicaule), and tarwi (Lupinus mutabilis). Cañihua is almost restricted to the drainage area of the Lake. . . . These facts suggest that this region may have been an ancient and perhaps independent center for agriculture. Unfortunately, we lack good archaeological material of early man, of plants, and of animals to support this (1968:13).

The site of Chiripa (16°26' S, 68°50' W), located on the shore of Lake Titicaca in its southern extension ("Lago Pequeño"), appeared to be an excellent place to test various economically oriented hypotheses on the origins of agriculture, subsistence strategies, diet, environmental and cultural ecology. The site is composed of villages built on a stratified mound (approximately 50 x 50 x 5 meters), of midden and purposely added earth, with two subterranean temples (one on top of the other) in the center of the mound. Radiocarbon dates and ceramics show an almost continual sequence from ca. 1250 B.C. to the historic period.

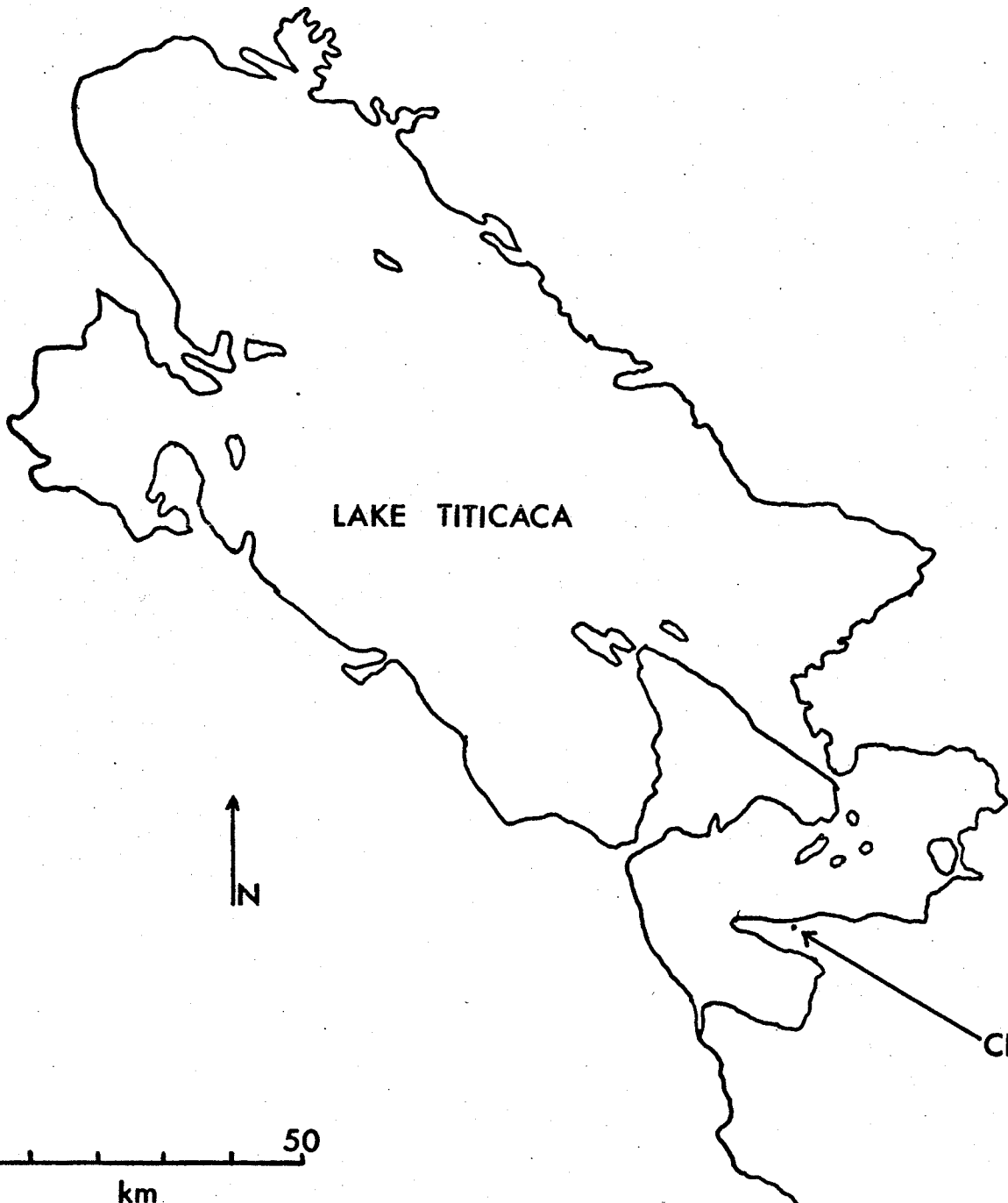
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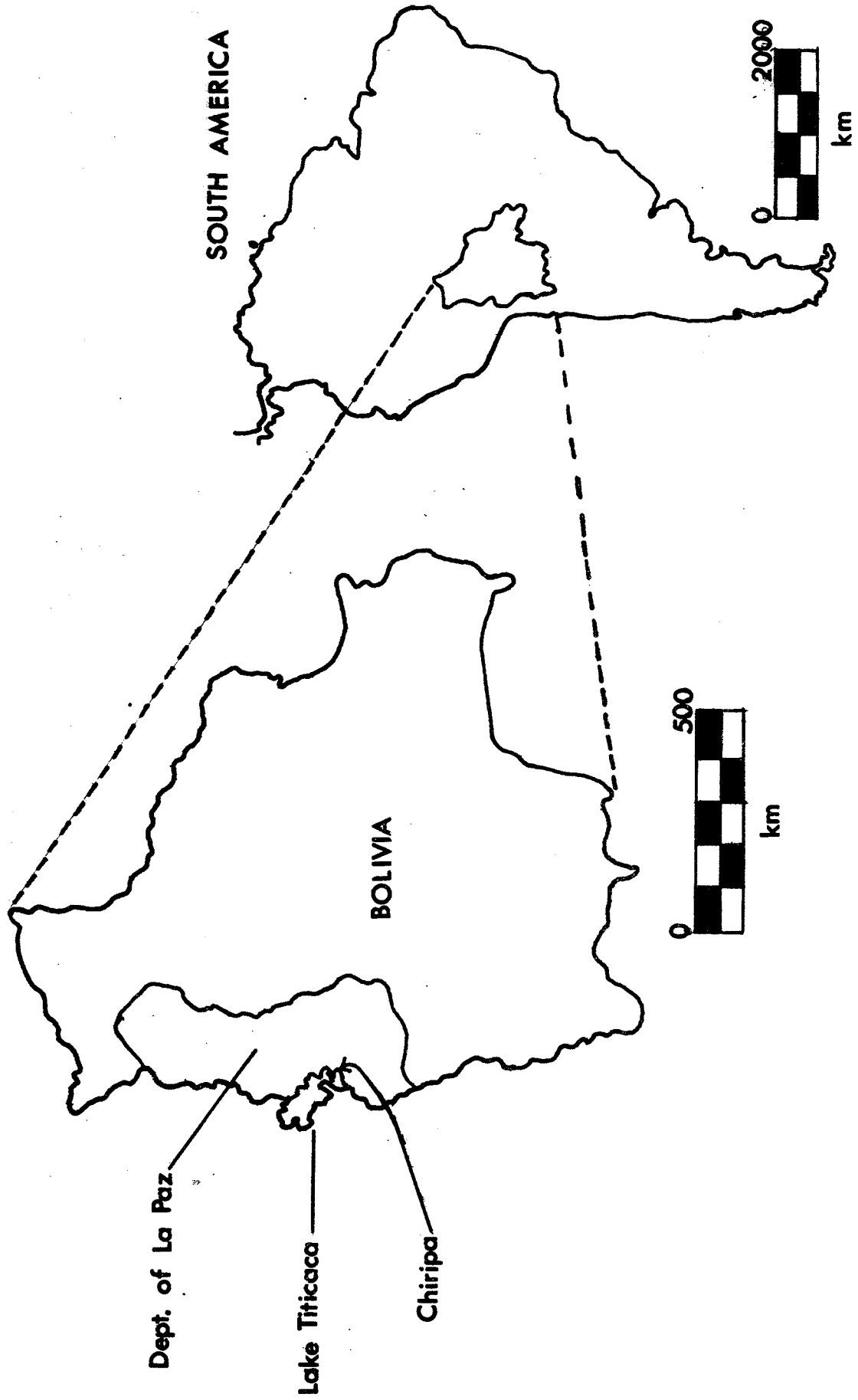


— 16°



0 50

km



The site has been well known through time. Precolumbian stone robbing, adobe quarrying, and "pothunting" by "huaceros" have been well documented by the 1974-75 excavations, especially within the temple area. Controlled excavation began in 1935 when Wendell C. Bennett (1936) examined this site, also several other Bolivian sites. Bennett reported a stone-lined subterranean temple, mound facing walls, and a series of double walled houses with "storage bins" situated in a circular pattern around the temple. Part of the temple and two of the houses examined yielded ceramics, burials, bone (worked and unworked), lithics, and carbonized botanical remains (two types of "quinoa"). Another area sampled revealed what Bennett called a "pre-mound level" dating to the earliest occupation of the site. In 1955, Alfred Kidder II (1956), in an effort to expand on Bennett's information, excavated two older house structures below Bennett's circle of houses. In addition, he excavated several double-walled houses and verified the subterranean temple. In one of the "storage bins" within the double walls of a house, he recovered a large cache of charred plant remains. A substantial amount of carbonized "quinoa" and 12 specimens of "tuber" material, possibly two or more different varieties of tubers, were identified by Margaret Towle (1957, 1961: 86). Charred fragments of basketry and cordage were also present (Towle 1961:136). The tubers resembled both unprocessed and processed (freeze-dried) types, some possibly potatoes (Towle 1961:86). The houses from which the botanical material was taken have been dated between 600 B.C. and 22 B.C. (Ralph 1959:56-7).

In 1974, two test excavation pits were dug by a Washington University crew for the recovery of stratified material in undisturbed levels, with specific concentration on the lower strata of the mound and the "pre-mound." Excavation pit F10 (2 x 5 meters) was located near the center of the northern face of the mound and in this pit, several house wall foundations, fire hearths, a stone paved floor, and a lower mound facing wall of fieldstone and mud were excavated. Sterile soil was encountered at cm below datum. Excavation pit H7 was located in the northwest corner of the mound. This pit

was placed in the floor of one of Alfred Kidder's 1955 excavation pits and was excavated to ___ cm below datum before severe weather conditions interrupted and ended the 1974 field season. Three house walls were encountered, ^{AS WELL AS} numerous packed clay "floors", and two baked clay lense-shaped semi-circular fire hearths.

During the 1975 field season, Washington University continued excavation in pit H7 until sterile soil was encountered ___ cm below datum. Several midden concentrations and numerous thin clay "floors" were the major cultural features of the pit.

Excavation pit C8 was placed within the temple walls on the temple floor and continued until culturally sterile soil was encountered ___ cm below the datum. Various building and deposition features of the mound and temples were delineated.

PHYSICAL AND HUMAN ENVIRONMENT:
PHYSIOGRAPHY, CLIMATE, AND VEGETATION

In order to understand the prehistoric economic strategies and adaptations of the inhabitants of Chiripa, one must examine in detail the various aspects of the natural environment within which man must act. The most important aspects are the physiography (hydrology, geology, geomorphology, soils, altitude, etc.), the climate (rainfall patterns, latitude, seasonality, etc.), the vegetation (natural and crop), and the interactions between each. The unique characteristics of the high Andes of the Bolivian Altiplano are largely a result of the combination of very high altitude and tropical/sub-tropical location. The human environment (man, his crops and animals, and their activity) has not only been affected by the non-human environment, but has in return greatly altered the non-human environment. The mechanisms involved in the interaction of the human and non-human environments has received little attention by the various ethnographers who have studied the indigenous groups of the Altiplano (the Aymara, Quechua, Uru, and Chipaya). This interaction has only been recently considered in cultural ecological terms. The prehistoric man-nature relationships have been almost completely ignored, especially in ecological concepts.

By using present day data and observations of the modern environment and the human adaptations to and modifications of this environment, speculation can be directed towards interpretation and explanation of prehistoric man-nature relationships on the Altiplano of Bolivia.

THE ALTIPLANO

The Taraco Peninsula is within the altitudinal zone called the Altiplano ("High Plain") or Puna Boliviana. Studies in other areas of the Andes have all stressed the vertical environmental zonality based on altitude, soils, vegetation, climate, etc. of a particular area or region and the various adaptations that have been made by the inhabitants of such areas. These distinctions could be considered "macro" zones as defined by Pulgar Vidal (1946), Tosi (1960), Weberbauer(1945a; 1945b), and most recently, Brush (1974). Each distinct zone exists within close proximity to the others due to steep valley and basin cuts in which they exist, creating extensive vertical altitudinal differences. In contrast, the Altiplano at 3500-4500 meters (Hill 1959:790; Bolsi 1968:58 says 3300-4300 meters) exists as a single large macro-zone that also has great diversity due to climatic differences within the Altiplano, rather than drastic altitudinal differences. The Altiplano ^{extends from} lies ~~between~~ north of Lake Titicaca ^{to} and Northwestern Argentina (approximately 800 km) and between the Cordillera Oriental to the East and the Cordillera Occidental to the West, a distance varying from 50-160 km (Carter 1971:7). Geologically, the Altiplano is a high alluvium-lacustrine plateau of Tertiary sediments, primarily red sandstone, clay, conglomerates, gravel, and volcanic ash, covered with fine, wind-blown sediment subject to erosion (Carter 1964:15; 1971:7; Weil 1974:51; Newell 1948:18-20). The soil texture is generally loose and spongy, with little humic-organic topsoil, and has a tendency to absorb water quickly, leaving the topsoil parched or waterlogged in lower areas, thus resulting in land too dry or too wet (Carter 1964:15; 1971:7, Weil 1971:51). Many areas have high concentrations of salts and alkalines.

The semi-arid climate tends to be harsh on natural vegetation

and agricultural vegetation because of irregular rains (seasonally and cyclically), fluctuating daily temperature, frequent freezing temperatures throughout the year, distinct wet and dry season contrasts, frequent hail, and at times high velocity winds. Cardenas (1968:7) has commented on the diverse and drastic adaptations that the plant communities have made to Altiplano climate and soils. Most of the high altitude vegetation, according to Cardenas, consists of dwarf phanerophytes, chamaephytes, hemicryptophytes, and geophytes, with most of the Altiplano species being hemicryptophytes that adapt to the harsh climate 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. Other plants adapt by sending long tap roots deep into the soil to obtain moisture in the dry seasons and to avoid the surface salts. Reduced leaf size and resin impregnation within the plant also help protect some plants from the elements. The plants themselves create micro-climates. Grasses, predominantly Stipa and Festuca, make up the major vegetation of the Altiplano (Cardenas 1968:6-7).

The same harsh climate that effects the natural vegetation also effects man and his cultivated crops. Due to factors such as infrequent and irregular rainfall, frequent freezing, and hail, the practice of agriculture is difficult. Weil states, "Irregularity of rainfall and freezing temperatures, even around Lake Titicaca, are said to result in the almost total loss of a crop on the average of once every five years and a loss so appreciable during three years that only a single crop during the five-year period is considered a really good one" (1974:54). Weil (1974:54) points to the 1956-7 drought in which almost all crops on the Altiplano were lost. But in spite of this, the Altiplano is put to productive use. Statistics for 1970 show that 50% of Bolivia's population lives there, 43% of all land under cultivation in Bolivia is on the Altiplano, and 34% of the total agricultural production comes from the Altiplano, even though the agriculturally rich lowlands have been opened up to the

East (Weil 1974:292-3). The crops grown on the Altiplano by the Aymara and Quechua are highly adapted to the high altitude, harsh climate, and poor soil. Human and natural selective processes have operated over long periods of time on the crop plants. Some specific adaptations would be drought and frost resistant, short-growing-season plants that can thrive in poor, unfertile, or exhausted, often saline or alkaline soils, and under short day lengths and short growing seasons. The predominant indigenous Andean crops grown on the Altiplano are "quinoa" or "hupa" (Chenopodium quinoa), "cañihua" (Chenopodium pallidicaule), "papa" or the potato (Solanum spp.), "oca" (Oxalis tuberosa), "mashua", "isañu", or "añu" (Tropaeolum tuberosum), "papa lisa" or "ollucus" (Ullucus tuberosus), + "tarhui" (Lupinus mutabilis). In special, climatically suited areas such as the shores of Lake Titicaca, maize can be grown (Zea mays, "Altiplano" race--Cutler 1946:281-2; or "comfite puneño"--Ramirez et al. 1960:46-7). Introduced crops such as wheat, barley, broad beans (Vicia fabia), onions, garlic, and other crops adapted to the Altiplano also play an important economic role.

As noted above, the Altiplano can be subdivided into various distinct sub-zones based primarily on temperature, rainfall, and soil differences, not altitudinal differences. Cardenas (1968:5-6) sub-divides the Altiplano into two major zones 1) the North with higher rainfall and alkaline soil containing carbonate of soda, and 2) the South, with less rainfall and saline, sandy soil. Bolsi (1968:58) divides the Altiplano into four sub-areas 1) "la puna planicie central" to the South, characterized by flat relief, vast salt flats, isolated mountain ranges, dendritic drainage, poor vegetation, and an annual rainfall between 50 mm to 350 mm; 2) "valles intermontañas del Este" characterized by folded mesa relief, numerous valleys, and a vegetation consisting mainly of grasses and small trees, with annual rainfall of 350-550 mm; 3) "Lago Titicaca" and adjacent areas; and 4) "franja de transition" the area between the "planicie central" and "Lago Titicaca" zones, consisting of wide mesetas and plains of different altitudes interspersed with low mountains and a grass

RAINFALL

predominated vegetation with 300-600 mm.^v Wennergren and Whitaker (1975:84-5) divide the Altiplano into three major eco-zones corresponding with Bolsi's sub-areas 1, 3, and 4. The distinctions are based on rainfall and temperature differences with the North Altiplano having an annual average rainfall of 650 mm and temperature of 12°C, the Central Altiplano having an annual average rainfall of 350 mm and a temperature of 10°C, and the Southern Altiplano having much less rainfall, 250 mm annually and a colder average temperature of 8.5°C.

Chiripa is situated within the Lake Titicaca sub-area (or North Altiplano). The importance of Lake Titicaca as a major moderating factor on Altiplano climate has been noted by many (Ogilvie 1922; Coker 1911; Bolsi 1968; Weil 1974; Hill 1959; Smith et al. 1968:356; McEwen 1969; and others). The Lake is geologically called the "Titicaca Trough", a syncline structure, and the basin area has been described as "rolling mature topography of moderate relief" (Newell 1949:13). The Titicaca Basin drains 42,000 km² of Altiplano and higher mountain peaks (Hill 1959:790). The Lake itself at 3803 meters above sea level is estimated to cover between 8000 km² and 8600 km² (Hill 1959:790-1) and is 281 meters deep in places (Newell 1949:14). In winter, the easterly trade winds from the Atlantic carry dry, stable air which is blocked at the Cordillera Oriental by Pacific air systems; thus, there is no precipitation and the result is the dry season from May to October. In summer, the moist unstable eastern winds "spill over" the Cordilleras and pass over the northern Altiplano in irregular patterns bringing precipitation in the form of rain and hail^{AND} resulting in the wet season from October to May (Hill 1959:790). Bolsi (1968:41) believes that during the summer Lake Titicaca acts as a zone of attraction for winds by drawing air from the lower moist areas to the east of the Altiplano. Studies of Lake water temperature show a stable fluctuation between 10-11°C with little seasonal or depth variation, which is considered warm for a high altitude lake (Coker 1911:76, 180).

Although irregular and fluctuating cyclically (a seven year cycle--Ogilvie 1922:98), the annual rainfall in the Titicaca sub-area is much higher than^{IN} the Central and Southern Altiplano.

The annual average has been reported to be 600 mm between 1914 and 1950 with a range of 500-700 mm at least 50% of the time (Hill 1959:793), 650 mm (Wennergren and Whitaker 1975:84), and 600 to more than 800 mm (Newell 1949:14; Bolsi 1968:58). A recent study has shown that a maximum of 1150 mm of annual precipitation occurs in the northern part of Lake Titicaca (Kessler and Monheim 1968:275). The average temperature also is higher than the other Altiplano areas, reported as 12°C (Wennergren and Whitaker 1975:84), but diurnal-nocturnal variation is great, often with nightly freezing temperatures occurring any time of the year. Much of the data on the Lake varies greatly (see Smith et al. 1968:356).

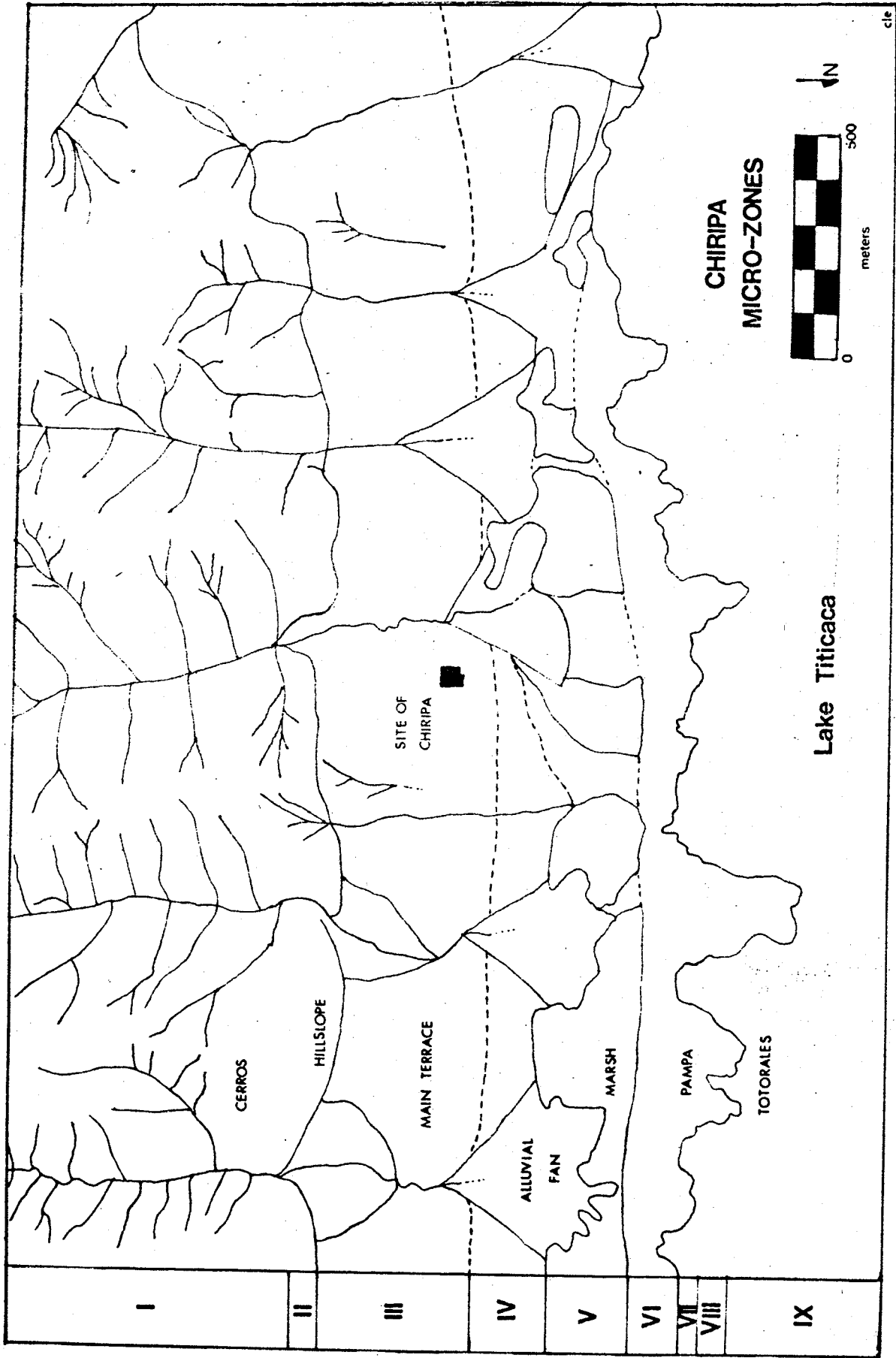
Soils and geology vary throughout the Titicaca area, but soils are generally fine textured, fertile and rich in organic matter in comparison to the poor soil of the rest of the Altiplano. The soil, considered with the moderated climate and higher rainfall, has a great effect on the carrying capacity of the Lake-associated agricultural lands. The immediate effect on agriculture is that cropping is much more intense in some areas, without the need for extensive fallowing systems employed elsewhere on the Altiplano in order to maintain fertility. Buechler (1969:184) notes that some Titicaca fields can be cropped twice in one year. The carrying capacity has been noted by several as being the highest of the Altiplano. Reports have averaged 80 inhabitants per km² (Bolsi 1968:43,50; Ogilvie 1922; Tschopik 1948:502-3; McEwen 1969:247). Crop yields are higher near the Lake and a crop such as maize, not grown in other Altiplano areas, can be grown in sheltered areas around the shores of Lake Titicaca. In regard to crop surplus, the dry season with its intense sun and low humidity, enables the farmers to dry the surplus and the drastic diurnal-nocturnal fluctuations in temperature allows the application of "freeze-drying" techniques for the preservation of potatoes and other tubers. The Lake itself provides a rich lacustrine resource in the form of fish and bird life, possibly available for exploitation throughout the year, although few studies have been made on the animal life of Lake Titicaca to determine if seasonal patterns exist.

CHIRIPA

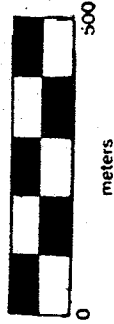
No climatic records exist for Chiripa or the Taraco Peninsula, but data has been regularly kept nearby at the town of Copacabana, approximately 20 km directly north of Chiripa. Bolsi (1968:41) reports that irregular precipitation averages 670.4 mm per year with most falling between two periods, September to November, and February to April, with May to August being the dry season. The temperature averages 9°C (6.2° - 10.8°C) (lower than the estimate given by Wennergren and Whittaker 1975:84), with a 15 - 20°C diurnal-nocturnal variation. January is the coldest month of the year. The winds are generally from the west and northeast from January to July, August is calm. September has wind from the west and northeast, and during the rest of the year (October-December), winds are from the southwest or northwest bringing in the moist air. The sun is obscured approximately 24 days out of the year. The Pueblo of Tiwanaku (located on the site of Tiwanaku) has much the same climate. During the May to August field seasons of 1974-75 in Chiripa, total precipitation occurred in the form of two short rainstorms, one hailstorm, a light snowstorm/sleet fall, and a week long snowstorm. The remainder of the time, there was no precipitation whatsoever.

The Taraco Peninsula is located on what has been called the "Taraco Formation" by Newell with "extensive conglomerates from deposits derived from erosion of old rock of the Cordillera Real" (1949:78) consisting mainly of gravel some 2000 meters thick with "buff to drab sandstone" (1949:pl.#18). The peninsula is bordered on the south and northeast by Quaternary "undifferentiated fluvial, lacustrine, and fluvio-glacial deposits" (Newell 1949:pl.#18). In common to all the Lake Titicaca shoreline areas, many micro-zone distinctions can be made within the generalized macro-zone of the Titicaca sub-area. Nine distinct zones can be delineated at Chiripa, based on soil types, hydrology, vegetation, and economic usage, all of which are interrelated (See figure and). All the micro-zones are within a 20 minute walk from any point on the peninsula.

The zones are as follows:



**CHIRIPA
MICRO-ZONES**



Lake Titicaca

cle

North

CHIRIPA MICRO-ZONES



South

IX

VIII
solerole

VII

VI
pampa

V
marsh

IV
terrace

III
main terrace

II
hilllope

I
cerros

Site of
Chiripa

Los 6 Terraces

ZONE I: "Los cerros"

Through the middle of the Taraco Peninsula runs a low series of hills, cut by numerous dissected, dry valleys due to fine dendritic drainage and erosion patterns. The soil is clayish mainly light colored, mixed with very little topsoil with a high percentage of stones and pebbles (most approximately 10cm in diameter). An extensive fallow system is practiced here due to the poor fertility and inaccessibility with most of the land lying fallow (50-60% fallow on the northern edge and 80-90% fallow to the south). This land ^{vse} would fit into Wolf's classification as "long term fallowing system" (1966:19-21). The fields in use tend to be concentrated on the rounded tops of the cerros and on saddles between the cerros. Many farmers who live in zones III and IV have "extra" fields in this area, much of which is considered communal land with no individual ownership. Some habitation complexes are located in the larger north-south valleys that are cut into the ridge of hills, but this would be technically considered another zone. With the exception of these valley farms, no habitation is seen on the cerros. The natural ^(Plant Community) vegetation consists mainly of the grasses "ichu" (Stipa spp.), "sicuya" (Festuca spp.), and "tola" (various Compositacea of the genera Lepidophyllum and Baccharis), with some scattered clumps of globular cacti (Opuntia sp., sub-genus Tephrocactus) and wild lupins. The crops grown in this area are mainly wheat, barley, "habas" (Vicia fabia), "tarhui" (Lupinus mutabilis), "ocas" (Oxalis tuberosa) and potatoes. Since the area is poor farmland, its major economic use is for sheep pasturage.

ZONE II: "Hillslope"

This zone is immediately to the north of zone I and is characterized by steep slopes, lack of topsoil (except at the base of the slopes), stone and pebbles throughout the soil. This could be compared to Tschopik's "hillside fields" (1948:513). Most of the zone lies fallow due to the steepness and lack of topsoil. Another possible problem could be ^{THE} poor drainage associated with hillsides in the Andes. This is counteracted by the Aymara technique of vertical, anti-contour plowing to aid the drainage. The bases

of the slopes have a talus of accumulated topsoil that extends into the next zone. The natural vegetation consists mainly of Stipa ("ichu" and "sewienka", a tall Stipa among the fieldstone piles at the base of the slope), and Festuca spp. The crops are mainly wheat and barley. At the base of the slope, a series of springs can be found, roughly on the same contour, probably emanating from a sedimentary level that outcrops in the zone. The water is used by the farmsteads below and is collected in man-made ditches for "tunta" freeze-drying and water processing of tubers for preservation.

ZONE III: "Main Terrace"

This is the zone of major habitation and excellent farmland, which could be placed into Wolf's "permanent cultivation of favored spots" category (1966:19-21) or Tschopik's "valley bottom land" (1948:513). The agricultural system used is characterized by intensive cropping with little or no fallow being incorporated (5% at most is fallow) into the system. The only areas that are not under cultivation are the stone piles from the field clearing, house complexes, threshing grounds, chuño processing areas, and storage areas. Few areas exist on the Altiplano where intensive agriculture can be used. The soil has dark rich color with humus. The intensive use of the land for a long period of time is indicated by large fieldstone piles, accumulated through years of clearing fields. Present habitation is located within this zone and the zone was probably preferred in prehistoric times due to the numerous sites in addition to Chiripa that are located ^{WITHIN} in the same zone. The natural vegetation consists of Stipa spp., Festuca spp., Poa sp., tola, Capsela sp., various composites, Opuntia sp., and "weeds" associated with Altiplano crops such as "anu cara" and "apara hupa" (both Chenopodium spp.) and also wild ^{OR PERA} potatoes (Solanum sp.). The crops grown in this zone are potatoes, ocas, papa lisas, wheat, barley, quinoa, habas, onions and some maize. Introduced eucalyptus trees have been planted along the east-west road that cuts the northern end of the zone and in a series of stands on the hillside and near the Chapel. The fields receive little intentional fertilization,

but do get incidental garbage, sheep, burro, and cow manure (although most is collected, dried, and used for cooking fuel¹), ash from cooking fires and human "night soil". In addition to the large fields, some farmsteads have small gardens located near habitation complexes. In these gardens, onions and garlic are grown and tended with care. Besides the economic use of this zone for agriculture, the plowed fields after harvest serve as areas for rooting pigs, providing their subsistence of missed tubers, roots, and garbage.

ZONE IV:

This zone is much like Zone III, but is on a lower contour. The economic uses are much the same as Zone III, but fewer modern farmsteads are located here. Several important springs emerge between Zone III and IV and provide the major water sources of the Comunidad of Chiripa. This zone extends up some of the major seasonal wash/valleys that come out of the cerros from above.

ZONE V: "Marsh"

This zone is characterized as a ^{WATERLOGGED} low-lying flat area with a high water table, much of which is covered by stagnant, shallow water, even in the dry season. No agriculture is practiced in this zone due to the high water table, but the zone has an economic use that takes advantage of the high water table. A series of ditches and canals have been dug to hold water for "tunta" processing of potatoes and other tubers. The old hacendado of the comunidad built a huge concrete-lined pit with sluices for mass production of tunta, but this is not used today to any great extent. Low-lying areas similar to this zone are found all around the Lake, especially on the eastern and northern edges. In prehistoric times, many of these huge expanses of high water table land had been "reclaimed" for agriculture through ^{MASSIVE} construction of "ridged fields" by the inhabitants of the area. There are no such fields at Chiripa, but they do exist in large number to the east of Chiripa near Aygachi (see Smith et al. 1968 for a summary of the data on Lake Titicaca ridged fields). New ridged fields were discovered covering a small area near the site of Iwawe Grande a few kilometers to the southwest of Chiripa on the Taraco Peninsula during surface survey undertaken in 1975.

The areas of marsh are cut by alluvial fans, consisting mostly of pebbles and gravel. Some houses have been built on these fans, but the soil is poor for cultivation. These fans act as broad pathways for access to the lake shore from the habitation sites above. Clumps of Stipa and Festuca are the major vegetation on these fans along with a few scattered Opuntia and Compositaceae. Some dark green, low, mat-like plants grow within the standing water of the low spots.

ZONE VI: "Pampa"

The "pampa" is the low-lying flat area along the shore of Lake Titicaca. This land is cultivated, but not as intensively as Zone III and IV. Approximately 40-50% of the land lies fallow, which would place the land into a use pattern Wolf would call "short term fallowing" or "sectorial fallowing" (1966:19-21). The very fine-textured soil appears to be very rich with organic humus and nutrients due to the frequent inundation by ^{fishing} Lake Titicaca. Very few pebbles and stone common in other zones are present in this zone. The limited use of the rich soil appears to be due to the high water table, the frequent flooding (seasonal and cyclical), and distance from the habitation sites. With the high water table, thin patches of salt or alkaline incrustations can be seen in some areas. Evidence of the changing lake levels can be seen in the plow marks that extend out into areas now underwater. The shoreline variation normally is affected only by an average lake level variation of 60 cm, but fluctuation has been measured as much as 4.6 meters (Hill 1959:789) and a change as great as this would drastically alter this zone. At low water, the area would be excellent agricultural land; but if high, much of this zone would disappear under water and be rendered useless for agriculture.

ZONE VII:

Zone VIII is a narrow band that includes the shallow water from the shore to the beginning of the totorales (thick totora stands). This shallow water contains a rich carpet of water plants that provide a major part of the diet of the burros and cattle that are

kept by the inhabitants of Zone III. The cattle wade ^{or swim} into the water and graze. These same plants are collected by the Aymara and carried to the habitation sites for fodder. Several types are used, and Aymara informants gave the following names for three distinct genera: "sawsee", "upoopo" (an alga), and "lema" (Darwin Horn: personal communication 1975). These plants are also called "lima", and "canku" by Labarre (1948:19). Coker (1911:178) lists several water weeds of this zone, giving their names as Myriophyllum titicacense ("the water milfoil"), Chara sp. ("the luxuriant stonewort"...forms a thick carpet of bright green floating over the bottom"), a species of grass, the "floating duckweed" (called "laqo" by Labarre 1948:18), and a "filamentous green alga" (probably the same as "upoopo"), Azolla magellanica, Casalea bonariensis, Potamogeton, Cladophora, Elodea, and diatoms. The common Aymara names have not been keyed to the proper Latin names by any of the various works on Lake Titicaca, thus confusion results. The bottom consists of a fine green-black mud, thick with decaying plant parts. The shallow water is warm.

ZONE VIII: "Las totorales"

In a distinct band offshore in approximately 1-2 meters of water, thick stands of totora reed exist. Two distinct types of "totora" are present. One, Scirpus tatora Kunth (called Malacochaete totora by Labarre 1948:18 and Coker 1911:178, called Scirpus riparius Presl. by Cardenas 1969:80-1, all of which are considered synonymous by Beetle 1941:698) is used economically as fodder, roofing thatch, mat material, & food (the inner pulp of the root called "saq'a" and the pulp of the stem called "čulu", also called "k'auri", "saka", "chullu", and "ccauri" in a listing by Labarre 1948:54). Coker adds that it has been used for weirs and for bridges and pontoons (1911:178). The second type of "totora" reed is a Juncus that grows scattered in thick clumps within the Scirpus tatora. The major economic aspect of this type of totora is that the dense clumps are used as nesting areas for the numerous bird population of the zone; the Aymara collect the eggs from the nests and trap and kill the birds for food. This

zone and Zone III probably contain the highest percentage of floral and faunal biomass of the Lake. The various indigenous fish also seem to be present in large quantity within Zone VIII. The Aymara pole their boats out and set up nets within the totorales ^{zone} and on the northern edge of Zone VIII. The concentration of organic life in the bays and shallows and the absence of organic life in the deeper areas of the Lake is noted by Coker (1911:179-80). He also states that fishing is better in the lower Lake south of the Copacabana Peninsula (1911:176), the part of Lake Titicaca in which the Taraco Peninsula is located.

ZONE IX: "Open water"

Deeper water lies beyond the totorales. Fish nets are dense within the first 10-20 meters but few are placed beyond as the Lake gets even deeper. The only visible vegetation is isolated totora.

The various economic-ecological zones of Chiripa show great diversity of soil types, moisture content, and land usage. In the Altiplano, this zonal diversity is found in such close proximity only in areas around Lake Titicaca. The natural vegetation of the peninsula is by no means a "pristine" plant environment. All the vegetation of the peninsula has been greatly tampered with by man and his economic activities. Cultivation has removed much of the tola shrub and grasses, and the "disturbed habitat" created by plowing has encouraged various ^{AGGRESSIVE} weed species to flourish (such as Chenopodium spp., Solanum sp., etc.), encouraged by the Aymara practice of not keeping "clean fields". All farmable land on the peninsula has been plowed within 20 years, and the favored fields located in Zone III and VI are plowed ^{FEN} more frequently, some continuously. Since ^{FEW} no native indigenous ^{TOURISTS} trees ("kehua"-- Polylepis incana or P. racemosa, and "kishura"-- Buddleia coriacea), nor the resinous umbellifereae "yareta" (Azorella spp.) exist today on the north or south shore of the peninsula, all fuel for cooking and other activities is supplied by the introduced eucalyptus trees, ^{CATTLE} dung, and the various ^{SHRUBS} tolas. The absence of these genera,

which are utilized as fuel, is probably due to overexploitation because they do grow in other Altiplano areas. Camelid and deer populations of prehistoric and historic times may have also had a great impact on the natural vegetation, especially the pasturing of llamas and alpacas. The Spanish introduced sheep to the area and herding of these animals even into the remote areas of the Taraco Peninsula must have had a great effect in the past as well as in the present in determining the existing vegetation. Pigs also have an impact due to their "rooting" habits which destroy even the subsurface plant parts. Another direct human impact, in addition to cultivation, is that during certain fiestas and celebrations (San Pedro in particular) children and adults set fire to any burnable vegetation they can get their hands on. This may actually be beneficial to the plant communities in the area by burning off the dried, dead plants allowing regeneration of new plants.

The intensive use of the land in particular zones that do not require fallowing, as noted above, has implications on demographic patterns and carrying capacity. On the Taraco Peninsula, an almost standardized predictable pattern of prehistoric demography has been delineated. A majority of the major sites of the peninsula are located in Zone III or similar ecological and geomorphological environments. The rich, fertile, well-drained agricultural soil of this zone seems to have been preferred in the past, as it is today, for habitation. In addition to agricultural potential, this zone has the major springs for fresh water, and is centered in the middle of the micro-zone sequence.

FLOTATION METHODOLOGY

During excavation of test units F10, H7, and C8 by the Washington University crew, selected random samples of soil of the undisturbed stratigraphic levels within each unit were taken for the recovery of botanical and faunal remains by the flotation technique. The sample size varied from the 1974 season to the 1975 season. During the 1974 season, small plastic soil bags were utilized holding approximately 5 kg of soil (usually two samples per level). After processing these small samples, a new system was incorporated during the 1974 field season where 13.7kg soil bags were used to hold the samples, in order to increase the recovery of remains and to aid in transportation of the soil to the storage and flotation processing area. Samples were collected using a trowel or shovel to loosen and carefully place the soil into doubled plastic bags. Samples were generally taken from fire hearths, garbage pits, and other likely areas where visible carbon could be seen. Some of the hearths were completely floated. In most of the major levels, samples were taken from the general level (see Table). In the North face of the mound, a tennis court had cut into the mound exposing the stratigraphy from the surface to approximately 4.5 meters below. A 30 cm thick band of almost pure ash and carbon could be seen in a thick zone across the face and could be traced to the northeast corner of the mound. Because of the likelihood of good botanical recovery from this zone and because the zone was an undisturbed strata above the strata excavated in our lower excavation pits, flotation samples were taken in the northwest (J8 and I8) and in the northeast (B11) corner of the mound from this ash/carbon zone. In total, approximately 1000 kg of soil were bagged and floated.

For processing the samples, a 208 liter oil drum was utilized as a "flot tank" and a nearby stream provided the water for the separation of the carbon from the dirt matrix. Fine mesh window screen (1.6 mm openings) welded to the bottom of a metal bucket (with the bottom removed) served to catch the "heavy fraction" of bone, sherds, and lithic material. A hand sieve made of bronze

carburetor screen (.2-.3 mm mesh openings) was used to skim off the carbonized "light fraction." Besides the recovery of botanical remains, flotation is excellent for the recovery of small bones and bone fragments, fish scale and bone, snails, etc. and these will show up in the light fraction. The soil of the site provided several problems which greatly affected our recovery of botanical remains. A high percentage of clay in most of the soil samples caused lumping of the soil, and poor separation of the carbonized botanical remains resulted. In breaking up the lumps and clods, some of the fragile botanical material was crushed and fragmented, especially the larger sized material. Despite this, adequate samples were obtained, even in areas of low carbon concentration. The areas of best recovery were the various midden concentrations and fire hearths. The ash/carbon zone did not yield as good a sample as expected due to the high ash content. Even samples that appeared to be failures in the field due to scant carbon recovery, turned out to consist mostly of identifiable seeds.

In the analysis stage in the laboratory at Washington University, the light fraction was shifted through a series of interlocking screens (size openings of 6.30, 4.00, 2.80, 2.36, 2.00, 1.00, .710, .425, .212 mm) to aid in microscopic viewing and sorting of the material. The shifting and sorting of the light fraction does not seriously affect the condition of the fragile material if carefully done, although some breakage occurs. Precise quantification of the material by weight was not attempted due to the inconsistencies caused by the flotation soil problems and the limited size of each sample floated and the amount of the recovered material. All faunal and floral remains larger than 2 mm were sorted into different components. All seeds larger and smaller than 2 mm were separated and vialled except those in the finest screen (>.425 mm). In the smallest size range, a sample of the seeds was taken, due to the difficulty in recovering the seeds without complete destruction of the identifiable features and also due to time limitations.

Identifications of the material recovered were based on a small comparative collection made in Chiripa, herbarium specimens located in the Missouri Botanical Gardens herbarium, various plant keys,

and comparisons with similar North American genera from comparative collections and photos. Some modern comparative material was carbonized to aid in the identifications.

FLORAL REMAINS

CHENOPODIACEAE:

Chenopodium spp.

Throughout the stratigraphic sequence in all the flotation samples, several distinct types of carbonized Chenopodium were recovered. The state of preservation of these seeds ranged from excellent to badly fragmented. In several levels of H7, extremely desiccated, uncarbonized Chenopodium sp. were recovered, probably preserved by the many clay "floors" throughout the sequence. In total, approximately 9200 carbonized Chenopodium seeds were recovered from H7, F10, C8, and the special midden level flotation samples. Also recovered were fragments of winnowing trash. Most of the carbonized seeds are badly distorted in thickness, having "puffed up" during carbonization, so it could be assumed that the seeds contained at least a minimal level of moisture content at the moment of carbonization. Experimental test carbonization of modern Chenopodium quinoa and Chenopodium spp. showed that exposure of fresh seed from field dried plants and from the markets in La Paz, Bolivia, to high heat caused a "popping" effect, with the embryo and cotyledon expanding greatly (up to 3-6x). A majority of the archeological material showed a moderate heat-induced "popping" which could be interpreted as slower carbonization/heating, or the carbonization of drier seeds. Only a few showed extreme expansion. Few perianths enclosed seeds, thus the seeds appear to have been threshed and winnowed prior to carbonization, indicating preparation for food and/or storage.³

The occurrence of carbonized Chenopodium within the flotation samples in such numerous quantity may be due to several factors. Under the assumption that mature seeds were being utilized for

food, various parching techniques may have been used by the prehistoric inhabitants of Chiripa, causing accidental carbonization of vast quantities of seed. Many of the seeds have embryos that have partially separated from the seed, at first interpreted as sproating seeds, but this seems to almost always happen with parching and carbonization. Little data exists in the literature on Andean practices of parching. The best reference is an account by Safford (1915b:291) in which the elaborate process of parching and washing is described in great detail for a particularly bitter variety of "quinoa." An earthen jar was used over a llama dung fire into which dry seed was added and stirred until parched; then the seeds were placed into another vessel and "danced on" with the feet to free the "husks", the seeds were winnowed in the air. In this case, it would seem that parching aided in threshing and winnowing the trash from the seed. Labarre (1948:64) also mentions the parching of Chenopodium and barley in earthen cooking ollas. The bitter saponin (a glycoside) contained in varying amounts in the various economic and wild chenopods of the Highland Andes may also be a reason for parching. If boiled, an elaborate water changing procedure must be used to leach out the saponin, but it seems that the utilization of parching may destroy the saponin. Gade (1975:77) notes that parching or toasting in large pottery vessels enables quinoa to be consumed "as is" without special boiling and water changes. But in Safford's account above, parching and boiling techniques of preparation were used. My personal experimentation with parching yielded indications that parching does have an effect on the bitter taste of raw quinoa. A market variety of Chenopodium quinoa was subjected to moderate heat and with light browning, the seeds were excellent with no bitter taste such as that encountered with improperly boiled and/or raw quinoa. Also, it should be noted that during parching, it is easy to accidentally burn (carbonize) many seeds, especially when large quantities are being toasted. "Cañihua" (Chenopodium pallidicaule) is reported to have a higher saponin content, and almost all accounts of its preparation for food indicate toasting/parching (Vargas 1938:229; Leon 1964:67; Cardenas 1969:118; Gade 1970:60). Cañihua flour

("pita") is toasted before grinding with no water processing and has no bitter taste. In a fuel-scarce area such as the Altiplano, the shortening of cooking time and fuel use by parching would be an economizing technique. Nelson (1968:70) speculates that the dark-seeded Chenopodium may be highly impermeable to water, which would make the boiling method for cooking difficult.

Other purposes parching may have served could have been to kill the seed germ to prevent sprouting during storage. With moisture, Chenopodium quinoa will sprout almost immediately with no dormancy period, while C. pallidicaule will sprout as soon as three months (Simmonds 1965:228). The heat from parching would tend to dry out the seed, which would tend to prevent spoilage that could result from rotting or fungus growth during storage. Also in regard to moisture content, if seeds are parched dry, grinding into flour would be facilitated.

An alternative explanation for the occurrence of carbonized Chenopodium would be the burning (accidental or intentional) of storage facilities located within storage bins in houses that showed evidence of having been burned. . . But our excavations were in various midden and floor levels containing fire hearths and garbage pits and the occurrence appears due to accidental carbonization during food preparation.

"Quinoa" has been reported from various pre-columbian South American archeological sites, but the ^{ARCH} cultural context with most reported occurrences is often vague and the identifications to the species level of the domesticate Chenopodium quinoa may be incorrect. Safford (1915a:15) reports "quenua" from Arica, associated with highland artifacts and seeds from Argentinian tombs. Bird (in Towle 1961:36) reports "quinoa" in fabrics from Playa Miller and Pichalo, Arica, Chile. Wittmack (in Towle 1961:36) found seeds, leaves, and stems of "quinoa" in mummy bundles at Ancon. Rochebrune (in Towle 1961:36) found cakes and bags of "quinoa" at Ancon. The cakes were made of quinoa and maize flour (although the identification of "quinoa" from a ground flour form would be difficult for most botanists). Hunziker (1943) examined botanical remains from a burial urn near Salta, Argentina, and identified Chenopodium quinoa.

and Chenopodium sp. (probably the weed "apara") associated with two varieties of Amaranthus caudatus, Amaranthus sp., Phaseolus, and Zea mays. The age of the site had not been determined. A more recent discovery near San Rafael, Argentine, has a better archaeological context. Hunziker and Planchuelo (1971) report the identification of Chenopodium quinoa var. quinoa, C. quinoa var. melanospermum, C. hircinum, associated with Amaranthus caudatus and Amaranthus sp. from a basket from a stratigraphic level with radiocarbon dates that indicate an age of "around 2000 years." The Chenopodium quinoa make up 95% of the sample recovered. FROM THIS CAUSE

Highland preservation and archeological recovery of plants has been scarce in the Andes. MacNeish (1969:22, 38) reports "quinoa," amaranth, gourd and possibly chile peppers from the Piki Phase (5500-4300B.C.) of Pikimachay Cave, Ayacucho, Peru, but Pickergill (in Flannery 1973:305) cautions that these are the only "quinoa" seeds from the whole sequence. Whether the seeds are the domesticate or wild species of Chenopodium is not indicated.

Some of the only highland archaeological occurrences of "quinoa" has been from the site of Chiripa. Bennett (1936:424; Bennett and Bird 1948:142) reports a floor covered with ash and charcoal, burnt clay, bone lithics, and ceramics where he found types of seed, "the common quinoa and the small grained variety" (Bennett 1936:424). Kidder recovered a small cache of "quinoa" seeds from the site of Chiripa during his excavation in 1955. (Towle 1961:36). In her report on these remains, Towle (1957) notes that the seeds have a "striking resemblance to Chenopodium quinoa," but states identification as Chenopodium sp.. The botanical remains came from upper level houses dating to approximately 600B.C. to A.D. 22 (Ralph 1959:56-7). ←
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The literature has tended to equate the recovery of "quinoa" to the domesticate Chenopodium quinoa Willd., when in fact, positive identifications have not been made in many cases. Speculation about the domestication of quinoa (Chenopodium quinoa) and cañihua (C. pallidicaule) is generally in agreement that the origins, most likely at an early time period, must be in the Southern Highlands of Peru and the Bolivian Altiplano where the greatest variety and most intensive cultivation is reported (Vargas 1938:228; Cevallos Tovar 1945:10;

Leon 1964:63-71; Cutler 1968:13; Nelson 1968:79; Cardenas 1969:113, Gade 1970:55).

Our data from the lower stratigraphic levels of Chiripa show intensive utilization of Chenopodium spp., but not necessarily the domesticate Chenopodium quinoa or C. pallidicaule. The seeds range from .4 mm to _____ mm with a mean of _____ mm, standard deviation of _____, and a variance of _____ in the flotation sample _____. Several varieties, types, or species seem to be present in the material. Although a few of the seeds resemble the domesticate C. quinoa in basic morphology, the size tends to be much smaller. The majority of the recovered seeds are most like the seeds of the weedy-wild species of Chenopodium that grow on the Altiplano. The morphology is similar, but the seeds of the modern weedy-wild Chenopodium spp. tend to be larger. One key to the identification of the wild vs. the domesticate is the seed thickness-to-diameter ratio and the seed margin (Nelson 1968: 22), which is badly distorted by the popping effect of the carbonization process and thus, is unusable as a characteristic. From the size range and morphological similarity to the weed-wild chenopods of the Altiplano, it could be speculated that a very diverse population of Chenopodium was being exploited at Chiripa in the early levels of the site, possibly ancestral domesticated quinoa.

Although much descriptive data has been accumulated on the various domesticated species of Chenopodium, very little is understood regarding the interaction between the "wild" or "weed" Chenopodium and the domesticated Chenopodium. The variations of Chenopodium quinoa and C. pallidicaule have been commented on and classified by many, mostly on the basis of color variation in the stems, leaves, inflourescences, and the seeds (for C. quinoa--Cevallos Tovar 1945:11; Cardenas 1944; 1969:111, 113; Hunziker 1943; Leon 1964:73-5; Gade 1975:153, Nelson 1968:16-55; and for C. pallidicaule --Vargas 1938:224-6; Leon 1964:65-66; Cardenas 1969:117). A classification by the indigenous populations of highland inhabitants appears to be based on color characteristics and level of saponin content.

Standley (1931) lists 8 different species of Chenopodium that are indigenous to northwest South America. The Missouri Botanical Garden's herbarium contains 18 different species of Andean Chenopodium,

all with small black seeds. Planchuelo (1975) describes 27 wild species that are endemic to Argentina. Weedy-wild varieties of Chenopodium have been noted in the Altiplano, especially in the Lake Titicaca area, in fields associated with the crop C. quinoa and C. pallidicaule that are locally called "ayara", "aara", "ajara", "alko-quinoa", "quinoa del perro" (Cardenas 1944:109; 1969:113,116), "kanawa", "ahara hup'a", "iswala hup'a" (Labarre 1948:54), "jaru" (Cevallos Tovar 1945:12) and "quitacaniqua" (Leon 1964:63). Informants gave me the names "ajara", "apara", and "anu cara" ("anucaro"="dog") for the Chiripa weedy-wild Chenopodium, similar to the names Cardenas gives. The literature indicates a high saponin content for all the highland weedy-wild varieties. The name "paik'o", "pako", or "pacco" is generally associated with Chenopodium ambrosioides, throughout the Andes (Gade 1975:156; Missouri Botanical Gardens herbarium sheet notes; Standley 1931:119; Labarre 1959:61; del Granado 1931:128 and others). C. ambrosioides is noted for its strong odor and medicinal properties. The odor was characteristic of the weedy-wild Chenopodium encountered in Chiripa. All the weedy-wild versions have small to medium size, dark seeds, usually reported as shiny black.

The Chenopodium are notorious "camp followers" in the truest sense of the term, known for their ability to spontaneously appear in almost any disturbed habitat such as alongside the cultivated crops, especially grain crops. Since the Aymara and Quechua do not practice "clean field" agriculture, weeds tend to be tolerated and actually serve economic purposes. Nelson (1968:55) believes that the Andean weedy-wild variety is not found truly in the wild state, but always is associated with ^{CULTIVATED} man's fields. In contrast to their ^(THE AYMARA SAW IT IN BOTH FIELDS + NON-CULT.) careful selection of seed tubers, the Aymara and Quechua do not select seeds carefully for quinoa cultivation and all color varieties are mixed (Tschopik 1948:517; Leon 1964:74; Gade 1975:45, 47-48). After harvest, some selection is done regarding seed size in the process of winnowing where the smaller black bitter seeded varieties are somewhat separated from the larger light colored seeds (H. Cutler: Personal communication 1976). The genetics involved in the Andean Chenopodium is not completely understood, but Simmonds (1965:230, also Nelson 1968:35-6) has determined that

all are predominantly inbreeders with much mixture of inbred lines; occasionally outbreeding occurs, especially in the Altiplano varieties of quinoa. Nelson (1968:40) showed experimentally that hybridization occurs freely between the wild/spontaneous and the cultivated varieties of quinoa. He considers all the weedy-wild Chenopodium to be Chenopodium quinoa var. melanospermum, a subspecies of the domesticate (1968:44).

There are distinctive differences between the weedy-wild Chenopodium, the domesticate/semi-domesticate Chenopodium pallidicaule, and the domesticate C. quinoa. The habit of the wild species and C. pallidicaule is a low, prostrate, many branched plant, whereas C. quinoa tends to be taller (up to 2-3 meters in the Cochabamba Valley of Bolivia) and much less branched. Seed colors vary, but the weedy-wild tend to be black. Simmonds (1965:229) and Nelson (1968:68) point out that C. quinoa can be harvested without too much loss due to shattering of the perianth (a common human selected trait in crops), whereas the perianth enclosing the seed is freely shed in C. pallidicaule, as in the weedy-wild Chenopodium. This may not necessarily be the case with all the weedy-wild because observations of several ^{DESICATED} dried up Chenopodium spp. ("anu cara" and "apara") in Chiripa (1975) showed that most of the seeds and perianths still clung to the plant even many months after the plant had dried up and died. Individual cañihua plants do not mature at the same time, characteristic of crops that have not been bred for simultaneous harvest (Gade 1970:59), in contrast to quinoa (Nelson 1968:68). The seeds of the domesticate are generally larger, but as Gade notes, number of seeds is more important to the Andean farmer than the size of the seeds (1975:45).

Chromosome studies have helped shed light on the domestication problems. Studies have shown that cañihua (C. pallidicaule) is diploid (2n:18), normal for the Chenopodium genera and that quinoa (C. quinoa) is tetraploid (2n:36) (Leon 1964:76; Cardenas 1969:113; Simmonds 1965:234; Cardenas and Hawkes 1948:31; Giusti 1970:101). But problems exist with the so-called weedy-wild Chenopodium because many have the same tetraploid 2n:36 that the domesticate has, considered a sign of "advancement" (Cardenas 1944:109; Cardenas

and Hawkes 1948:31-32; Leon 1964:76; Cardenas 1969:113; Giusti 1970:101-2). The question then becomes as Leon (1964:71) and Simmonds (1965:230) have pointed out, are the wild species escaped cultigens or the ancestral wild species or species that are totally distinct?

If cañihua is a "rustic" cultigen retaining many wild characteristics --resists frost, drought, salty soil, and pests; requires little care; matures fast (95-150 days);^{AND} has high protein and amino-acid balance (Gade 1970)--the weedy-wild Chenopodium may be similar. Cañihua appears to have better high altitude natural climatic protection, more protein content, and a faster maturity rate than quinoa (Gade 1970; 1975:156), although quinoa generally has a higher seed production rate and a lower saponin content (ie: less bitterness). *NOTE TO CLYBURN*

Quinoa's economic utilization as a staple food seed crop in the Andean Highlands has been well documented (Leon 1964:80-81; Cevallos Tovar 1945:17-18; Gade 1975:115; Eiselen 1956:332-3; Cardenas 1968:114-5). The most common methods of preparation are boiling with several changes of water for soups and stews, and parching for immediate eating or for storage or for grinding into flour to be used in "bread" and mush dishes. Beverages such as fermented and unfermented "chicha" is also made from sprouted quinoa. Cañihua seed has similar uses, but is usually only found in the ground flour form of "pita" (Cardenas 1969:118-9; Vargas 1938:229; Leon 1964:67; Gade 1970:56, 60-61; 1975:156; Labarre 1948:64).

Both quinoa and cañihua seeds are well known for their nutritional makeup. Many studies have been made on the protein content and results fluctuate between 10-20% protein, with 13-15% most frequently reported for quinoa (Leon 1964:81-3; Simmonds 1965:231; Eiseler 1956). Cañihua appears to have a higher protein content than quinoa in some studies (13.8%-cañihua and 12.5%-quinoa, Gade 1970:55). Both plants are better providers of the essential amino-acids and vitamins than the other cereals, but are lower in carbohydrates (Eiselen 1956:331; Leon 1964:67).

The plants are also used in the fresh green state as potherbs (Eiselen 1956:332-3; Gade 1975:155; Labarre 1948:64; Leon 1964:80).

The plants make excellent forage for cattle and other animals in the fresh state (Cevallos Tovar 1945:17; Gade 1975:115) and in the stored dry state (Leon 1964:81; Gade 1970:60). Leon (1964:67) reports that the protein content of green cañihua varies between 23-30% protein depending on the age of the plant, and is also high in vitamins (Gade 1975:115).

Non-food uses of chenopod stalks and leaves are for making alkaline ash for coca chewing (Cevallos Tovar 1945:17, Eiselen 1956:332-3; Leon 1964:81; Gade 1970:60; 1975:155), for field border "living fence" material for crop protection (Gade 1975:155), for quick, hot burning fuel (Gade 1975:156; Eiselen 1956:332-3), and the cooking water for soap (Yacovleff and Herrera 1934:155). In level C8#9, excavation recovered a small lump of grey-white "kella", the alkaline ash used for coca chewing, most likely chenopod ash. The identification of the fragment was verified by a local inhabitant of Chiripa who uses the similar alkaline every day for coca chewing. This was the only evidence of prehistoric coca chewing at the site of Chiripa.

The medicinal uses are diverse and seem to be related to the bitter saponins contained in the seeds from which infusions are made by soaking or boiling the seeds. Some of the various medicinal uses are as a diuretic, purgative, emetic, "vomitant", stimulant, "refrigerant"; and many other uses are recorded (Forbes 1870:281; Vargas 1938:230; del Granado 1931:27-28; Cevallos Tovar 1945:17; Labarre 1959:61; Bristol 1968:611; and others).

While the importance of the cultivated Chenopodium has been stressed in the literature, the utilization of the weedy-wild species of Chenopodium in the Highland Andes often goes unnoticed. Labarre (1948:54, 57) notes that all types of wild Chenopodium are eaten by the Aymara. Gade (1975:155) comments on the use of C. petolaré as an important potherb by the Quechua of the Vilcanote Valley. Others have noted the utilization of C. ambrosioides ("paicco") (Cardenas 1969:361; Standley 1931:119; Martinez 1968:611; Bristol 1968:593; Labarre 1959:61).

In regard to the use of Chenopodium spp. seeds as a food

resource at Chiripa, a small fire-blackened bowl (fragmented) was recovered in situ in excavation pit F10# against the sidewall which was filled with fish bone and carbon. A small special flotation sample was taken from this material and Chenopodium seeds were recovered in association with the fish bone and fish scale in a possible cooking vessel. THIS COULD POSSIBLY REPRESENT A MEAL OF CHOW-FISH STOW

Chenopodium seeds are an excellent storable food resource, as long as the seeds are kept dry. Flour and hardtack-like biscuits made from parched and ground cañihua and quinoa is known ethnohistorically as excellent nutritious, light weight "trail food" for long journeys in the Andes (Vargas 1938:229; Leon 1964:80, 67). Labarre (1948:64) states that quinoa leaves are boiled with special herbs and dried for storage. Dried stalks are stored during the winter for forage for animals.

In summary, the cultivation of Chenopodium spp. and collection of the weedy-wild have many implications on the lives of the ^{INDIGENOUS} Highland ^{PEOPLES} Indians. The plants adapt well to the harsh environmental conditions, have a high yield (up to 1 ton of seed per acre for quinoa--Eiselen 1956:331), require little care, resist or have few insect or fungus pests, provide storable surplus, have an excellent nutritional make-up, and have medicinal uses. As Gade (1970:56) notes, cañihua has different soil requirements than tubers, thus the plants can be planted directly after tubers without the need for fallow. This characteristic may also be true of the other chenopods.

AMARANTHACEAE: (Amaranth family)

Amaranthus sp.

In the upper levels from which flotation samples were taken , Amaranthus sp. seeds were recovered (124 total). Identification to species level at this time is not possible. The seeds do not have the distinctive morphology, dull color, or size that is characteristic of "millmi" (Amaranthus caudatus), the Andean domesticate "grain amaranth". (Called A. edulis by Hunziker, but A. edulis is considered only a variation of A. caudatus by Sauer 1967) . The seeds of "jatacco" (A. quitensis), a weedy type, are similar, but the archeological seeds appear smaller and have a distinct notch in the border, similar to many other native Andean Amaranthus.

Amaranthus spp. have been reported twice archeologically from Argentina. Near Salta, Argentina, Amaranthus caudatus var. leucospermus, A. caudatus var. alopecurus, and Amaranthus sp. (possibly A. quitensis) were identified, associated with Zea mays, Phaseolus sp. , and Chenopodium quinoa in an undated tomb (Hunziker 1943). Another tomb dated to "around 2000 years old" produced Amaranthus caudatus, Amaranthus sp., associated with C. quinoa var. quinoa, C. quinoa var. melanospermum, and C. hircinum (Hunziker and Planchuelo 1971). In the Andean Highlands, the only reported occurrence of Amaranthus has been from the Piki Phase (5500-4300B.C.) of the Pikimachay Cave, Ayacucho, Peru, where "some amaranth" was found (MacNeish 1969:22). Towle remarks on ethnohistoric data and speculation on the age of "bledos" (Amaranthus caudatus), but no archeological material is reported (1961:36-7).

Amaranthus is a widespread genera with 60 species native to the Americas (Sauer 1967:103). The Andean species have been shown to be short-day-length species (Fuller 1949), a typical trait of Andean plants, but little is known about the distribution in the Andes of the wild and cultivated species. Amaranthus seems to favor temperate valleys. Cevallos Tovar (1945:19) states that the domesticate grows only in the temperate valleys and not on the Puna. Vallejo E. (1940:165) states that the altitude range is 2000-3000 meters for A. edulis. Leon (1964:6) says the range for A. caudatus is 1000-3000

meters. Gade (1975:156) records the altitudinal range for A. caudatus in the Vilcanota Valley to be 2000-3000 meters. Del Granado (1931:129) states that it only occurs in the temperate valleys up to 2600 meters. But conflicting data exists in reports of A. caudatus in Puno, Peru, at 3805 meters (Sauer 1950:46), and wild species have been reported at 3200-3400 meters and 3450 meters in the Urubamba area (Herrera 1940:231-2). Thus, it would be possible that a species could be grown as high as the Altiplano, which is within the range given by Sauer of A. caudatus (1967:128).

Sauer notes that the genera thrives in open, disturbed habitats and volunteers readily, thus is "preadapted" for success in man's habitats. Certain traits such as "monoecious habit, the dehiscent utricle allowing easy threshing and winnowing, and the large compound inflorescences producing enormous quantities of seed" have made the domesticated section of Amaranthus successful (Sauer 1967:103-5). "Domestication" could probably be replaced by "cultivation" because there seems to be a vague line between the domesticates and the weedy-wild species in regard to occurrence in fields. Black seeded weeds are common in the fields of A. caudatus (Sauer 1950:46; 1967:129, 110; Safford 1915b:295; Cardenas 1969:120). The domesticate A. caudatus is known to exist in the wild or "escaped" state (Vallejo E. 1940:166; Gade 1975:156) and the weedy-wild "jatacco" (A. quitensis) is cultivated at times (Sauer 1967:109; Heiser 1964). Chromosome studies show that the weedy-wild species often have the same chromosome number as the domesticates (2n:34) (Cardenas and Hawkes 1948:31; Leon 1964:89; Cardenas 1969:121). Variation within the species is great (Leon 1964:87; Cardenas 1969:120; Hunziker 1943) and the species are known to hybridize (Leon 1964:89). Sauer (1967:110) believes that the common weed/semi-cultivated "jatacco" (A. quitensis) may be a hybrid due to backcrossing of weeds and domesticates.

The uses of Amaranthus spp. is as diverse as those of Chenopodium. Although the seeds are minute, seed production is very high (up to 500,000 seeds per plant--Sauer 1967:105). The most common method of preparation as food is parching and generally grinding the seed into a flour or "popping" (Safford 1915b; Sauer 1950:46;

Sauer 1967:129; Gade 1975:77). Others report its use as a potherb (Sauer 1967:129; Gade 1975:156, and most of the cultivation in Mexico is for greens, not seed (Sauer 1950:11). The weedy-wild species seem to be used for food ^{as} commonly as the domesticate is used for food (Gade 1975:156; Herrera 1940:230; Cardenas 1969:121). The seeds are storable, and ground Amaranth seeds have been used as an excellent "trail food" (Leon 1964:90). Amaranthus as forage for animals is recorded by Martinez (1968:611) and Sauer (1967:104). Weedy amaranth is also cultivated as an ornamental due to the bright red leaves (Heiser 1964; Hunziker 1943:150), for a red dye (Heiser 1964), and burned for calcium ash used in coca chewing (Gade 1975:196).

Nutritionally, Amaranthus caudatus is comparable to quinoa and cañihua, with a high protein content ("16%"--Leon 1964:90), and is superior in carbohydrates and fats (Sauer 1967:104). ^{WITHOUT SAPONIN PROBLEM} Although no nutritional data is known on the Andean weedy-wild amaranths, they may be similar to the domesticate. Another advantage that Amaranthus has over the chenopods is the absence of the bitter saponins (Sauer 1967:127-8). Ground seed as mush is easily digested by children and invalids (del Granado 1931:129; Safford 1915b:286).

In addition to food and technological use, ^(OF AMARANTH) Amaranthus biltum, a wild species, is used by the Aymara of the Altiplano for medicinal purposes (LaBarre 1959:62).

TUBERS:

SOLANACEAE: (Nightshade family)

Solanum spp. (?)

In most excavation levels, carbonized "tuberous" material was recovered by flotation. The sample is made up of several types of porous, non-woody membrane of various densities. All are badly fragmented with no visible outside surface to give identification clues. Possible tubers that could be in the sample are potato (Solanum spp.), "oca" (Oxalis tuberosa), "isañu" (Tropaeolum tuberosum), & "papa lisa" or "ollucu" (Ullucus tuberosus). The "'racacha", (Arracacia xanthorrhiza), another tuber eaten commonly by the Aymara today, grows only in lower altitudes from 1000-2500 meters (Leon 1964:54), thus is probably not a possibility. Many fragments of the "tubers" are glossy, very porous, light weight, low-density material that compares favorably with carbonized freeze-dried chuño and tunta and the dried "papa seca", all of which are made from Solanum spp. . Samples have been sent to Dr. J.G. Hawkes in England for verification of the identification.

In Kidder's excavation at Chiripa in 1955, a cache of 12 carbonized "tubers" was recovered from a storage bin within the double-walled houses of the upper stratigraphic levels of the mound (Towle 1957; 1961:86). The material was examined by M. Towle and she specifically states that they are "in all probability tubers" (1961:86), indicating that identification to genus level was not possible. She also notes that several of the tubers may have been processed by the freeze-drying technique. Radiocarbon dates for these houses range from 600 B.C. to A.D. 22 (Ralph 1959:56-7). The occurrence of "tubers" at Chiripa has often been interpreted as the domesticate Solanum tuberosum which may not be the case. Besides the possibility of being one of the other Andean tubers or wild Solanum, experimental carbonization of llama dung pellets collected from the St. Louis Zoo produced what could be mistaken for small tubers unless broken open. Evidence of the drying of potatoes for food storage has been reported at the Tiwanaku site (southeast of Chiripa) in Early Horizon levels (Ponce Sangines 1961). Towle (1961:86-7

reports on ceramic representations of tubers from the Moche period on the coast and actual specimens in central coastal areas such as at Pachacamac, but at much later time periods.

The poor recovery and low frequency occurrence of "tuber" remains at Chiripa could be due to several factors: 1) the clayish soil caused [during the flotation process] fragmentation of the carbonized remains, 2) the generally poor preservation of tuberous material, and/or 3) the limited use of tubers by the prehistoric inhabitants of Chiripa. The most probable explanation would be the first and second possibilities due to the recovery of a carbonized cache of whole tubers in the upper levels by Kidder. Experimentation with the carbonization of modern tunta and chuño showed that they carbonize readily, but they quickly ashify unless they fall through the fire and out of the heat. Due to the extremely fragile nature of the resulting carbonized material, it is easily crushed beyond recognition.

The species of tuber bearing highland Solanum are numerous. Towle (1961:84) states that there are approximately 150 species of tuber bearing Solanum. Aymara classification of potatoes seems endless (Labarre 1947:85-6; Loza Balsa 1972:71-6; Vincente Ballivian and Cevallos Tovar 1941). Labarre's study (1947) lists over 200 names for potatoes and added one hundred more names that others recorded. Chromosome studies have also indicated the complexity among the domesticated potatoes (Leon 1964:8; Ugent 1970:1162-3; Cardenas 1969:33).

The Lake Titicaca area is considered to be the focus of the diversity or "gene center" for the tuber bearing Solanum (Ugent 1970:118). Cardenas (1944:27-38) and Vargas (1943b) have described some of the numerous wild species of the Bolivian/Peruvian area and show the great diversity. The wild potatoes were probably "camp followers" as Ugent (1970:1165) notes, readily volunteering in disturbed habitats created by man. We may be dealing with this situation in the lower levels of Chiripa. [Later in the upper levels, true domesticated Solanum and other tubers may be present.

Fresh potatoes and other tubers can be stored in sealed bins of adobe and stone for insulation. Tschopik (1948:527) records

use of an herb called "muna" as a potato preservative. But the most efficient method of storage is freeze-drying. If Towle is correct on the identification of freeze-dried tubers at Chiripa, then the technique was known and in use in the upper levels of the site (Early Intermediate Period). Although we lack the data, it is possible that the process was used in the lower levels. The technique of freeze-drying can be quite a complex process (especially in the case of "tunta"), but the basic principle could easily be "discovered" by accident since the extreme diurnal-nocturnal temperature differences must have existed in the earlier time periods. Potatoes often freeze before arriving at maturity (Forbes 1870:245) and the utilization of such potatoes or potatoes that had been improperly insulated could give rise to the process. Simple drying of cut up potatoes after boiling is reported on the Altiplano (Tschopik 1948:527), called "papa seca" in the Dept. of Cuzco (Alejandro Camino: personal communication 1976).

Freeze-drying and regular boiling/drying of tubers serves to preserve surplus indefinitely, reduce the bulk and weight, reduce the toxic bitterness of some of the high altitude potato varieties, and concentrate the carbohydrates. According to Meneses Rodriguez (1974:32), the process creates a more digestible food.

Modern Aymara and Quechua diets show high percentages of potato consumption (fresh and freeze-dried) (Mazess and Baker 1964), as high as 68% of the food weight in the Aymara community of Irpa Chico on the Altiplano, as opposed to 18% grain products and 4% meat and miscellaneous products (Carter 1964:23-4). Potato and other tubers, although ^{ADANLW}low in protein content, provide the missing carbohydrates that Chenopodium and Amaranthus do not provide; thus, they are excellent compliments to each other.

CYPERACEAE: (Sedge family)

Scirpus sp.

In many levels, carbonized Scirpus sp. achenes were recovered by flotation (61 total). At least two distinct types of "totora" presently grow offshore Chiripa. One is definitely a Scirpus

(the most common--90%--and most utilized economically) which stands 1-4 meters tall in the thick bands of totorales encircling Lake Titicaca. The other type appears to be Juncus sp. (Juncaceae). The "totoras" have been discussed by many botanists and the result has been much confusion. The Aymara term "totora" has been applied to many plants that grow in water, regardless of genera and species (Towle 1961:26-7). Most likely the major Titicaca species we are dealing with is Scirpus tatora Kunth.. Cardenas (1969:80-1) and Yacovleff and Herrera (1934:294) mention S. riparius Presl. as the Titicaca species, but the name has been changed to S. tatora because the name had been applied elsewhere (Heiser 1974:23; Beetle 1941:698). MacBride (1936:290) considers S. tatora to be synonymous with S. californicus, the common sedge of North and South America, but Beetle (1941:698; 1945:2) believes that the Titicaca species is distinct. Labarre (1948:18), Coker (1911:178), and del Granado (1931:44) state that the totora of Lake Titicaca is Malacochaete totora, but this is considered archaic by Beetle (1941:698).

At Copacabana, Bolsi (1968:41) reports S. atacamensis.

The "totora" is one of the most important plants to the Aymara and lake-dwelling Urus, serving many economic functions in their everyday lives. Labarre (1941:513) considers the totora reed to be the single most important aspect of Uru subsistence. As food, the totora roots and stalk ("saq'a" and "çulu", respectively, also called "k'auri", "saka", "chullu", and "ccauri"--Labarre 1948:54) are relished by the Aymara and Uru. The spongy inner white pith is eaten raw as a snack, having a slightly wet, sweetish taste. The totora as food in this manner is hard to keep very long before it loses its freshness, but the almost inexhaustible supply growing in the Lake is exploitable year round. Huge piles of many thousands of stem segments are sold weekly in each of the various market towns surrounding the Lake, some of which is transported inland to other markets. For the inhabitants of the Lake, totora, along with the various water plants that grow offshore, serves as a major fodder source for cattle and burros and must make up a good percentage of the animal diet. The cattle of Lake Titicaca countryside definitely have a much healthier appearance than inland Altiplano cattle and this

is probably due to the virtually unlimited, replenishable fodder and forage resource provided by Lake Titicaca. Although few llamas and alpacas are seen on the Taraco Peninsula today, it could be expected that they could have been fed totora as fodder in prehistoric times. Stacks of the stalks are piled weekly at farmsteads for fodder purposes.

As non-food use, totora has many applications. The famous reed boats ("balsas") of Lake Titicaca are primary examples of the use of totora. Even the sails can be made of totora. The boats themselves serve many subsistence purposes such as for fishing, bird egg collecting, hunting, and fodder collecting.* ↓Coker (1911:178) mentions the construction of totora pontoon bridges and weirs on Lake Titicaca. Roofing thatch in lakeside house construction has traditionally been totora reed and large quantities are incorporated as roofing material. Del Granado (1931:46) and Labarre (1941:513) mention the construction of totora reed mattresses and mats by the lakeshore dwellers and Tschopik (1948:527) adds that grain is often stored in totora reed open-ended cylinders. Kidder (1967) has speculated that reed matting framed with sticks was used in the "sliding door niches" of the upper level houses that he excavated at Chiripa. Ethnographic work among the Uru reports doors made of totora (Labarre 1941:513). Where wood is not available for rafters, bunches of totora reed are utilized (Labarre 1941:513). Medicinal application of totora roots has been reported by del Granado (1931:47). Totora as fuel has been reported by Beetle (1950:137), although it would not produce much heat.

A major economic aspect of totora is that it provides protection and nesting grounds for a dense bird population. The seed is also eaten by land oriented birds, ducks, and geese (Beetle 1950:132-8). Within the totorales, the Aymara often hunt birds for meat and eggs. Totora boats are poled up to nests within the clumps of totora that form small "islands" and the eggs are regularly and systematically "harvested". The Uru of the Lake construct artificial nesting platforms out of totora to attract birds (Labarre 1941:513).

Scirpus spp. reproduces naturally by seed and vegetatively, but cases of Aymara cultivation of the Lake totoras has been reported.

* PROOF OF USE OF BOATS AT CHIRIPA
(COLLECTED ISLANDS IN LAKE
(SINCE 1970))

Buechler (1969:184) states:

...the growing of totora, or lake reed, as a cultivated plant has often been overlooked. Totora grows wild in many parts of the lake, but since the level of the lake rises and falls, the strips of totora growing along the lakeshore are often submerged or left on dry land. Therefore, in order to have a constant supply of totora for livestock, for thatching roofs, and for building small boats, or balsas, it has to be planted. Totora roots may be obtained by digging from places where the reed grows wild, or by thinning out previously planted totora.

Usually, the roots are cut into pieces about 4 inches long and planted under shallow water by pushing them down into the mud, one step apart, where the reed soon grows into a dense network. More rarely, totora reed is broadcast on the lakeshore in August. During the rainy season, a few months later, the lake rises and the reed soon grows even more densely than when transplanted. Totora can be harvested at any time and is generally cut at about four-month intervals, except when it is to be used for house-thatching or boat building, then it is cut only after going to seed (1969:184).

On the coast of Peru, dense stands of totora are cultivated for harvest in the sunken gardens ("mahamaes" or "pukios") for construction of "caballitos" (small totora reed boats) (Richard Woods: ^{PERSONAL} communication 1976). Heiser (1974:23) also notes that a species is cultivated on the coast of Peru for mats and boats and he speculates that cultivation could have occurred in prehistoric times. Beedle (1950:135) mentions that Scirpus transplants easily, thus ^{is} a natural potential cultigen. + semi-domestic

Carex sp. (?)

In flotation levels H7#26 and H7#30, achènes of a sedge, most likely Carex sp., were identified (2 total). Also, in , a desiccated uncarbonized Carex seed spiklet fragment was found. The Carex of Lake Titicaca are poorly known, but Bolsi (1968:41) notes that Carex nebulorum grows in lowland and moist soils near Copacabana, the peninsula directly north of Chiripa. Possible uses could be ^{for} forage and mat-making material.

JUNCACEAE:

Juncus sp.

In many flotation levels, seeds of non-sedge "totora" were tentatively identified. These seeds resemble a comparative collection of seeds from a Juncus sp. "totora" that grows off-shore Chiripa. This plant is not as common as the Scirpus and forms the thick clumps that are used as bird nesting spots and supports the large bird population of the lake.

The Juncus sp. is used as an inferior quality forage in Peru (Yacovleff and Herrera 1934:295). Bertónio ^{look up or write} (in Labarre 1959: 55) states that a short totora "es la comida de los Vros" and Labarre has recorded diuretic medicinal usage of the same plant Juncus acutis.

In summary, the water flora of Lake Titicaca appears to have been utilized by the inhabitants of the site of Chiripa, but to what extent we cannot tell. Missing from the components are the various "water weeds" (see page 14), but this is only to be expected due to the improbability of preservation or identification of the various water weeds. It could be safely speculated that these were used for fodder as intensely as they are utilized today.

CACTACEAE: (Cactus family)

Opuntia sp.

In most excavation levels, carbonized seeds of Opuntia (Tribe Opuntieae, genus Opuntia, sub-genus Tephrocactus--Britton and Rose 1919:84; also considered genus Tephrocactus by Rauh 1958:195-226) were recovered (43 total). The seeds are distinct and compare in size and morphology to the seeds of a small (10-30cm), globular, high altitude Altiplano Opuntia sp. that generally grows wild in the upper zones of Chiripa. Cardenas mentions Tephrocactus bolivianus which may be the same cactus (1969:9). The major use of the cactaceae of South America is the eating of the mature fruit. The fruits have a sweet, juicy inner pulp with many inedible seeds which are commonly referred to by the general term "tuna"

by the Aymara, but "tuna" is usually applied by botanists to the species from Mexico (Cardenas 1969:224-5). No mention is made in the literature of the fermenting of the juice of the Andean Opuntia fruits for "chicha", but the high sugar content could possibly be utilized for such purposes. Labarre(1938:225) notes that beer is made from the Mexican Opuntia fruits. The fruits of the Chiripa Opuntia are eaten and called "k'illa."

Non-food uses of the plants are centered on the stiff spines that are used for needles, combs, and pins (Towle 1961:69, 100), and have been reported in an archeological context used as fishhooks (Bird in Towle 1969:69). Other use of the fruits of a species of cactus is for making a dye for textiles and food (Gade 1975:190-2). The Chiripa cactus fruits collected during 1975 stained the hands red. Labarre (1959:48, 57) reports the medicinal use of various Opuntia pulps for treating various diseases and notes that possible effective medicinal values are well based due to the occurrence of strychnine-like alkaloids (Labarre 1957:93; 1948:57). The inner pulp can be used to clear sediment in water (del Granado 1931:108).

Although the various cacti of South America are wild, there is evidence of cultivation at times by inhabitants of the Highlands of Peru and Bolivia. In the Vilcanota Valley of Peru, various species are planted around settlements as living fences, on walls and around fields to "deter entry" (Gade 1975:190-2). On the Altiplano of Bolivia, Labarre (1948:205) reports various cacti being placed on rooftops to keep lightning away. Around Chiripa today, the Opuntia is seen planted on adobe walls, ^{AND} near habitation areas, and the fruits are utilized when mature. Cardenas (1969:226) reports that two species are cultivated for the fruits in Cochabamba and La Paz, Bolivia. According to del Granado (1931:108), the tuna cacti of Bolivia generally reproduce vegetatively, rarely by seed, so man's cultivation of the plant would be easy.

GRAMINACEAE: (Grass family)

In most excavation levels, various carbonized grass seeds were recovered by flotation. The variations are in morphology and size, reflecting genus and species differences. Because of the great variation of genus and species of the grasses that grow in the Andes at high altitudes, much confusion exists in the literature on Gramineae. The major genera that presently grow in Chiripa today are Stipa and Festuca. Both stiff-leaved, bunch grasses are common throughout the Andes, each highly adapted to the high altitude, resisting low temperature, frost, and the wind. In some areas, extensive, dense communities called "pajonales" can be seen on the Altiplano. The various grasses also protect other high altitude flora that grows sheltered within the clumps or in close proximity (Goodspeed 1961:88). On the Taraco Peninsula, the plants grow in isolated clumps, much affected by grazing and field cultivation. Each plant produces great quantities of seed; thus, its occurrence within the flotation samples would be expected.

Stipa spp. "ichu", "hichu"

In most excavation levels, Stipa spp. seeds were recovered. Hitchcock (1927) lists in his key 89 species of Stipa that have been recorded from South America, but most botanists state that Stipa ichu (R. and P.) Kunth. is the predominant species (Hitchcock 1927:297 and others). In the flotation remains, several different size variations occur, possibly due to maturity (developed or undeveloped seeds), but most likely several species or varieties of Stipa are present. Two distinct Stipa are present at Chiripa. One most likely is Stipa ichu which stands 30-70cm tall. The other Stipa, called "seweinka", is much taller (2-3 meters) and grows in the dry washes (possibly a high water table) and around field-clearing stone piles.

Stipa spp. have many economic uses. This plant provides a major source of forage for sheep, llama, and alpaca. Although ichu is a tough stiff plant, it tends to be more flexible, softer, more succulent than Festuca, possibly easier for animals to digest during the dry season when in the dry state. As forage, Roseveare (1948: 75) states that the grass of the grasslands of Peru is "rich in

sugars and carbohydrates, but poor in proteins."

Non-food uses of ichu include the use in making rope, mats, bags, baskets, various ^{OTHER} containers, brooms, and as fuel, as a thatch material (especially in areas away from Lake Titicaca), as an adobe binder, wall protection, and as insulation lining for crop storage. Towle reports the recovery of cordage and basketry from Kidder's excavation at Chiripa (1961:136) and the material most likely would have been made of Stipa.

Festuca spp. "paja brava", "sicuya", "irru ichu"

In most excavation levels, carbonized seeds of Festuca spp. were recovered by flotation. Two major species of Festuca grow on the Taraco Peninsula. One is a low common type that stands in small clumps 30-40 cm tall and the other (20-60 cm tall) fits the description of Festuca orthophylla Pilg. called "irru ichu" by the local inhabitants. Both are tough, stiff-leaved, non-resilient bunch grasses, F. orthophylla moreso. F. orthophylla presently grows southeast of Chiripa near Iwawe Grande.

The primary economic uses of Festuca are as broom material, for thatch, mats and fuel, much the same as Stipa. The Aymara prefer to use Stipa sp. for ropemaking and basketry because of its flexibility. Also, it could be speculated that Stipa is also the preferred forage for animal.

Another interesting use of the various grasses by the inhabitants of the site of Chiripa WAS as a fiber temper for pottery. Its use for this purpose occurs in the time period that has been dated between 850 B.C. to 500 B.C.. Within the ceramics, many hollow impressions and actual carbonized short fragments of grass stems and leaf material are present. Within the temple fill excavated in 1974 and 1975, fragments of ceramic "trumpets" were recovered from excavation. Bennett (1936:442-3) also reported "trumpets" from his excavations at Chiripa. All appear to have been shaped by forming pottery clay around bunches of grass stem and leaves tied with thin twine, which when fired, left the impression of the tied grass in the hollow center of the tube.

Bennett (1936) excavated tombs at Chiripa that he states were

lined with "straw", probably Festuca or Stipa. Since no reference was given to carbonization of this material, preservation at Chiripa is good for a highland site.

A possible alternative explanation for why carbonized seeds of grass are present could be that they were present in the llama and alpaca dung speculated to have been used at the site as an important fuel.

"WOOD":

In almost all excavation levels, a high percentage of small fragments of carbonized wood were recovered. Much of this was recovered through flotation and the rest by hand in situ for purposes of radiocarbon dating of the various stratigraphic levels. Also, a more herbaceous type of stem fragment was recovered. Each had the appearance of the various high altitude "tola" shrubs and native trees due to the stem fragment characteristics of small diameter, ^{AND} twisted, knotty, woody grain structure. Although identification at this time is not secure, the material is most likely that of the tolas Lepidophyllum spp. and Baccharis spp., and the trees Polylepis spp. and Buddleia spp. due to the limited number of genera of shrub-trees that grow on the Altiplano and in the Lake Titicaca area. It is interesting to note that many varieties of tola grow around the Chiripa area today, but the native trees that grow in other areas of Lake Titicaca have been exploited out of existence at Chiripa.

Some of the material identified as "wood" could easily be quinoa stems which are dense, almost woody when dry and are known as a fuel source.

COMPOSITAE:

Lepidophyllum spp. (?) Various tola shrubs of the Altiplano
Baccharis spp. (?)

The main economic use of tola by the Aymara is as a fuel. Labarre (1948:204) notes five different types of tola. The resinous, almost woody composites, according to Cardenas (1969:302) and others,

make excellent fuels, burning with a very hot flame. L. quadrangulare will burn even when green, much hotter than the organic sods that are used for fuel (Goodspeed 1961:88, Ogilvie 1922:115). Due to the limitations of high altitude, little fuel is produced by vegetation that is available in lower altitudes. The umbellifereae "yareta" (Azolla spp.) is another important high altitude fuel source, but no evidence of its use was recovered by Flotation, nor does it grow in Chiripa today. The tola plant only grows in high altitudes (3500-4500 meters) and can flourish despite little moisture, low temperature, and damaging frosts (del Granado 1931:35).

Other uses of tola by the indigenous population are for food, dye, and medicinal purposes. Cardenas (1969:364) notes that L. quadrangulare and B. genistelliodes are used medicinally. Labarre (1948:53) states that tola roots ("kuni" or "amanoq'o") are commonly eaten by the Aymara during the wet season, [as well as the tola fruits] and that the resins of Baccharis sp. are utilized medicinally for many purposes (1959:87). Others have noted the use of tola flowers of some species for dyeing purposes (Labarre 1948:55; Towle 1961:95).

ROSACEAE:

Polylepis spp. (?)

LONGANIACEAE:

Buddleia spp. (?)

The various high altitude (3000-4900 meters) shrub-trees of the Andes provide fuel, supply charcoal makers with high quality raw material (Cardenas 1969:301), and can be used for building materials where introduced eucalytus trees or wood from the lowlands are not available. The leaves and flowers of Buddleia apparently have narcotic properties that are used as medicine in various ways.

UNIDENTIFIABLE SEEDS:

In most of the flotation samples, several types of unidentified seeds were encountered, although the types are diverse, a majority are of a single type which is found in almost every sample. Continued work is in progress to identify the unknowns.

FAUNAL REMAINS

The flotation technique, primarily applied for recovery of botanical remains, is excellent for the recovery of small bones and shell. Large quantities of fish bone and scale were recovered by flotation in both the light and heavy fractions. Most came from flotation samples taken from various hearths and midden areas, but the occurrence of the fish bone and scales is spread throughout the lower level sequence of the site. Bennett and Kidder had both excavated at Chiripa and neither reported any fish bone from the site. Tentative identification shows the occurrence of at least one of the most common Lake Titicaca fish ("carachi"). The importance of fish utilization at Chiripa is being examined by Darwin Horn and will be reported ~~at a later date~~ ^{LATER}. The occurrence of fish bone and scale in such large quantities indicates the importance of fish in the diet of prehistoric inhabitants of the site.

Other small bones and fragments were recovered in the flotation, but at much lower frequency than the fish. A majority of the material ^{CONSISTED} of badly fragmented pieces and splinters of larger dense bone, possibly due to practices used to extract marrow or produce tools. Other fragments include bones of small mammals, possibly birds, rodents, and guinea pigs (Darwin Horn: personal communication 1976).

Throughout the flotation sequence, 2 types of small gastropods (.5-3 mm long) were recovered in the light and heavy fractions (approximately from the light fractions). Most of the gastropods were recovered from midden concentrations. Hass (1955) reports similar gastropods from Lake Titicaca. One of the gastropods is of the genus Littoridina (possibly L. andecola) and the other is of the genus Taphius (possibly T. montanus). Although some appear to have been burned, the gastropods would not have had any human food value due to their very small size. Both of the species appear to be lacustrine in habit, associated with the mud and various water weeds of the Lake Titicaca shoreline. If the various water weeds (reported above) were being utilized by the inhabitants of Chiripa, the clinging snails would be carried and deposited in the site. If the plant material was utilized as fodder, the hard shell material could be

passed through the digestive system and be collected with the dung for fuel. As fodder, the plants may have been stored at the site with the snails attached. Further research on the Titicaca gastropods is in progress by D. Horn and C. Erickson.

MISCELLANEOUS

Fragmented lumps of ashy, semi-carbonized material were recovered in many levels. Due to the inclusion of what appeared to be grass stems and leaves within the material, it has been identified as dung. Due to the scarcity of abundant plant fuels on the Altiplano, it is very likely that llama or alpaca dung was being used as fuel for cooking, firing ceramics, and possibly for smelting ores and metals.

Small fragments of poorly fired and semi-fired "clay" with random impressions of grass stems and leaves were also recovered in many levels. These could be possible fragments of adobe brick or earthen ovens in which grass was used as a binder. Other fragments of fire-blackened lithic-like material were found, possibly "clinker stones" or slag by-products of firing or smelting.

In level H7#12, a small shell bead fragment and in level F10# , a segmented bone bead were recovered in the light fraction.

PLANT ASSOCIATED ARTIFACTS

In addition to the carbonized plant material, many plant-associated artifacts were excavated and recovered from surface reconnaissance at Chiripa. Basic categories would include cultivation tools, food preparation implements, and storage facilities. Bennett (1936:445) recovered a "chipped stone hoe". Excavated material on display in the National Museum in La Paz, Bolivia, from Kidder's excavation contains many biface "adz/hoes". Our excavation in 1974 and 1975

illustrate
some of the
finds (1975)

recovered a total of one large and 6 small adz/hoes, most from the site and from the disturbed upper levels of the Tiwanaku-age temple. Surface survey of other archeological sites on the Taraco Peninsula yielded a bifacially chipped quartzite adz/hoes at Piquire (2 km east of Chiripa) and 2 smaller adz/hoes (basalt and quartzite) at Cala-Cala (4 km east of Chiripa).

It could be speculated that the cultivation implements recovered do not represent a good sample. Digging sticks are commonly used in Bolivia, Peru, and Ecuador as the main tool for cultivating fields. These are generally made with wood and leather thongs, thus would not be preserved in the archeological remains. Broken wooden tools could have been used for fuel due to the scarcity of this resource. Smith and Young (1972:20) speculate that agricultural implements tend to ^{be} discarded or get lost in the fields, thus are less likely to be recovered. Few camelid scapula were recovered in the archeological excavation (Darwin Horn : personal communication 1976), and this may be due to their having been utilized as hoe blades and discarded away from the site. Scapula hoe blades hafted to handles the same way that stone and metal hoes are ~~hafter~~ hafted have been reported in ethnographic accounts (Forbes 1870:182; Tschopik 1948:515).

Food preparation implements have been found throughout the site. Bennett recovered four "hand grindstones", four "muller shaped grindstones" and two "large metate grindstones" (1936:445). In our ^{excavation}, ~~two~~ two-sided milling stones, two small and two large single-sided milling stones, and three stone bowls were recovered, most from the disturbed temple fill. The National Museum exhibit of Chiripa artifacts from Kidder's excavation ~~includes~~ many small hand grinding stones ("tops"), and during the 1974 and 1975 excavation, seven of the same type were recovered. Other items of food processing technology recovered by excavation were three flat, oblong grindstones, three round hand "pestles" and three cylinder-shaped "pestles". Most of the shallow metate-like milling stones and bowls have low sides and flat bottoms, a type that would be excellent for processing seed from various of the "psuedo-cereals" such as Chenopodium and Amaranthus.

Surplus storage systems in the form of double-walled houses enclosing "storage bins" appear to be elaborate in the upper circle of houses (ca 400B.C.-A.D. 22) that surround the Chiripa temple (Bennett 1936; Bennett and Bird 1948:142; Kidder 1967). The probable function of these spaces as storage facilities is supported by the recovery of the carbonized "tubers" and "quinoa" from several of the bins. In the lower level houses, no double-walled bins were present, only small niches. The numerous pits encountered in excavation of H7 could have served storage function. Storage practices used today in Chiripa, such as hanging surplus from the rafters, temporary grass shelters, temporary adobe storage bins sealed over with mud, outdoor stacks protected by thatch, ceramic vessels, and ichu-grass baskets, could not easily be determined archeologically.

The presence of cultivation implements, abundant food processing artifacts, and storage facilities would indicate a relatively sedentary lifestyle. Cultivation of seed plants such as Chenopodium, possibly Amaranthus, and tubers would require little more than light working of the soil with small hoes and/or digging sticks. Harvest of the seed crops is done by hand and requires no tools at all. Hoes would be used for tubers. The food preparation implements would be necessary in order to grind seed products. The storage facilities could be used for both seed and tuber products. Extensive storage systems for produce surplus could have many social, economic, and political implications. In summary, the plant-related artifacts provide much additional data on the use and importance of plants at the site of Chiripa.

DISCUSSION

Unfortunately, statistical comparisons of botanical remains through time and to each other would not be valid in this study. Food values of many of the plants cannot be readily compared to each other, such as a cactus seed (representing a cactus fruit with 20-30 seeds) to an amaranth seed (representing a plant with up to 500,000 seeds). Quantification problems exist in addition. Preservation favors small sized botanical units over larger sized units. Density of the material is also a major factor, with greens and tubers ranking lowest on the scale. Seeds are usually well represented due to more frequent preservation, and certain plants, such as Chenopodium and Amaranthus, produce ^{LARGE} huge quantities of easily preserved seeds, while domesticated potatoes and other tubers reproduce vegetatively, producing little or no seed. Due to larger size in comparison to seeds, tubers are less likely to be lost or misplaced after having been brought to the site (Gail Wagner: personal communication 1976). Certain prehistoric human behavior also would be an important factor, possibly unique to the Andes in certain respects. Ethnographic analogy, using data from present day Chiripa and other Altiplano areas, shows that due to the land quality (ie. generally poor) in many areas and the availability of fertilizers, ash from cooking and other fuel use is commonly and regularly disposed of in the fields closest to the habitation. Such practices would tend to markedly decrease the recoverable remains. Although uniform flotation samples were taken from the excavation levels, some levels, such as the lowest level of H7 and most of C8, produced little or no botanical remains, while others such as the special flotation samples from J8, I8, and B11 produced quantities of botanical material. This was recognized early in the excavation and sampling emphasis switched to distinctive midden zones and hearths. Another uncontrollable factor was that due to the lack of large fragments of botanical remains for radiocarbon dating, much of the botanical sample was used for this purpose. In summary, there are many variables to deal with.

Thus, presence/absence criteria were utilized in examining the data recovered by flotation. Even this has its problems because

in the very small trace samples, plants that are represented in low frequency often do not occur.

In examining the results of analysis of the lower level sequence (1250-500 B.C.) and the upper level strata of B11, J8, and I8, no distinct shifts or changes in economic exploitation of plants is represented except the addition of Amaranthus sp. in level H7#12, for the first time (1 seed only in this level, many more in later levels), between 850 and 500 B.C.. The seed size range of the Chenopodium spp. from all levels does not change throughout the sequence. The possible fragments of Solanum sp. or other "tubers" occur at very early levels (H7#33) through later, upper level houses that Bennett and Kidder excavated. In quantity, the botanical remains seem to increase in the upper levels, possibly indicating more human activity, but this would be hard to demonstrate solely on the basis of botanical remains. Even at early levels, such as H7#24 and #31, good sized, abundant samples were recovered.

IMPLICATIONS FOR AGRICULTURE

In regard to the use of domesticated plants, the practice of true agriculture would be hard to prove with our botanical data. The terms "cultivation" or "horticulture" may be more appropriate terms to apply to the lower stratigraphic sequence represented at Chiripa. The use of wild or weedy tubers, as of now, cannot be ruled out, although it would appear that in the later Chiripa levels of double-walled house construction where Kidder recovered "tubers", fully domesticated plants may have been present and full agriculture may have been practiced.

In regard to Chenopodium, the seed size range is within the size range that is common for the wild or weedy Chenopodium that grow on the Altiplano today, although many of the Chenopodium seeds are smaller. The most important aspect is that the seed size range is very great (from .4 to 1.5 mm), indicating that gathering practices do not seem to concentrate on a single Chenopodium species or variation, but utilize a wide range. If such a diverse range in size is not a naturally occurring phenomena, it could easily represent the

influence of man on the plants, by either 1) bringing together diverse species collected in diverse ecozones, 2) creating habitats in which the diverse species adapted to various ecozones are allowed to thrive or 3) a combination of the above. Both Chenopodium and Amaranthus are well known as "camp followers" and "encouraged weeds" throughout the world, tending to be attracted to human activity areas. Another possibility is that natural mechanisms could be involved in that the plants tend to be "spontaneous" in naturally disturbed habitats due to dispersal by animals and other mechanisms. The diverse dense bird population of Lake Titicaca could have been responsible for the bringing together of very diverse species of plants from particular socialized ecological niches. The moderated temperature and higher rainfall, due to weather patterns and Lake Titicaca itself, plus the rich fertile soil, naturally "disturbed" by the fluctuation of lake level, would allow diverse species of Amaranthus and Chenopodium to thrive naturally. Any one or a combination of the above factors would increase the chances of hybridization between species and result in the observed seed size variation in the archeological material. These same mechanisms could easily lead to domestication when particular genetic traits are indirectly selected by man. These factors may explain much of the speculation that Lake Titicaca is the center of diversity for quite a number of important Andean domesticated plants.

Other data also indicates that cultivation was practiced at Chiripa in the early levels. Hoe blades and the milling stone inventory would support the contention of preparation of the soil and the porcessing of large quantities of seed. The impressive surplus storage systems in the upper levels also indicate cultivation for surplus.

Several plants utilized by the Aymara and Quechua of the Lake Titicaca area today are conspicuous in their absence from the recovered botanical remains. ^{THESE ARE} Maize (Zea mays), lupines such as "tarhui" (Lupinus mutabilis), and coca (Erythroxyllum coca). All have readily identifiable seeds and would have been recognized if

they occurred in the sample. Maize is grown in sheltered areas around Lake Titicaca today, even on the Taraco Peninsula. Lupines are common both as a crop and as a weed. ^{in the area} Coca grows only on the "Ceja de Montaña" and Yungas area in lower altitudes to the east of Lake Titicaca and is utilized only for its leaves, but the seed is commonly found included within the collected leaves when purchased in modern markets. The possibility of carbonization and recovery of coca seeds would be low. The lumps of ash ^{carbon} found in C8 may indicate the usage of coca at the site.

CONCLUSION

Using the flotation data and plant associated artifacts at Chiripa from the "pre mound levels" to the lower level of houses (1250-350 B.C.), data from the previous excavations in the upper level houses (400-350 B.C.), and data from the ash/carbon zone (J8, I8, and B11), a conjecture of plant use through a continuous diachronic sequence can be presented.

In the lowest levels of the site, there is evidence to support speculation that the site was occupied by a sedentary group. The site environment would provide an excellent place for a transition from a hunting and gathering strategy of exploitation and subsistence to a fully sedentary, fully agricultural strategy. Early inhabitants could pursue a completely sedentary life utilizing Lake Titicaca resources with a hunting and gathering exploitation system throughout the year. From the lake margins, fish, birds, bird eggs, and totora (for food, forage, and shelter) could easily be hunted and collected in abundance without any major change in strategy. From the fertile land encircling the Lake, wild Chenopodium greens and seed, cactus fruits (Opuntia sp.), wild potato (Solanum spp.), other tubers, and various weedy herbs could be gathered in season. Flotation analysis shows utilization of all these resources with other minor economic plants such as grasses (Stipa and Festuca) and various shrub tolas and trees even in the earliest levels. During the late summer and early winter, the plant food resources would be abundant. Chenopodium and tubers could have been collected and stored to be supplemented by speculated year-round hunting of birds and other lake-associated

fauna, fishing, and the gathering of Lake Titicaca resources such as totora and bird eggs. Also, the grasses, trees, and tolas would be available for year-round exploitation for fodder, forage, fuel, and technological uses. With such a stable, secure exploitable subsistence base, the transition to sedentarism could be made without the need for intensive agriculture.

Even at low population density, sedentary year-round occupation of the site would rapidly change the plant ecology of the peninsula. Midden buildup of humic, nitrogen-rich soil from occupational debris, fire, over-exploitation of certain scarce resources such as plant fuels, possible grazing of domesticated camelids (if present), the clearing of areas for construction, the collapse of adobe buildings, etc. would definitely affect the makeup of the plant ecology. The result of most of the human activity would create the disturbed habitat that would encourage more of the weedy-wild species of Chenopodium, and possibly Solanum, to hybridize in close proximity to habitation. The "encouraged species" would be tolerated and/or cultivated without much effort or care, more or less in the "wild" state. The seed size range of the Chenopodium recovered by flotation, ^{SEEMS TO} indicate that this happened early in the sequence, and may have been present from the first occupation of the site. As cultivation of Chenopodium expanded and the disturbed habitat grew, Amaranthus sp. probably colonized the area as a "weed" amidst the cultivated Chenopodium, from seeds introduced by man or bird in later levels. Amaranthus seems to have remained a minor economic food plant, maybe only over a short time period, since amaranth was not reported from the upper level caches of "quinoa" excavated by Kidder and Bennett. Possibly, cactus may have been transplanted closer to the habitation sites as it is today. Intensive exploitation of the totora resource of Lake Titicaca and the fluctuation of the Lake level may have required the practice of totora cultivation in order to conserve and maintain a substantial supply for construction of boats, ^{AND} shelter, and as a food resource. Throughout the Early Horizon levels, there was no major shift in economic plant utilization except the possible intensification of cultivation. The lifestyle may have closely

resembled the Lake-dwelling Uru Indians of the western shore of Lake Titicaca who subsist primarily on lake resources (fishing, gathering, and hunting) with the practice of cultivation (potatoes, other tubers, quinoa, and cañihua) as an additional supplementary input to subsistence. LACUS JUNE
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Around 400 B.C., important social, economic, and political changes appear to have occurred. True domesticates such as potato and other tubers may have appeared at this time. Associated with these introductions is the facing of the mound with stone, the construction of a subterranean temple, and the construction of well built houses at Chiripa. Permanent, well designed "storage bin" systems are incorporated in the houses at this period, indicating a substantial amount of surplus production, probably in the form of tubers. Fully domesticated Chenopodium may also have been utilized at this time period, but no solid data backs up this speculation. In any event, the full agricultural component seems to have been added late.

In summary, a sedentary hunting and gathering strategy, adapted to lake-oriented resources (especially fishing), supplemented by the cultivation of Chenopodium remains more or less constant between 1250-350 B.C. without any major subsistence changes. This speculation is based on the flotation-recovered remains. All will have to be verified by the faunal analysis (currently in progress under Darwin Horn) which may show the importance of camelid and guinea pig domestication; the ceramic analysis, lithic analysis, and stratigraphic interpretation (currently in progress under David Browman and Jon Kent). Further refinements in the flotation data will be added, especially in the area of identifications of the unknowns and the species levels of the Chenopodium (if possible), which may help verify or falsify the conjectures made above.

This data only represents a short period of time in the Andean prehistory from a single site. Economically and ecologically oriented investigation utilizing the application of flotation techniques should be applied at other sites in the area with different occupation time periods, because virtually nothing is known about the subsistence strategies and how they change through time. Such study is essential if the social, economic and political developments are to have meaning.

Footnotes:

¹sheep dung was collected from sheep pens, but the dung was never actually seen used as fuel.

²additional plants of Lake Titicaca are: (Bolsi 1968)

Copacabana	<u>Festuca orthophylla</u> <u>Festuca chrysophylla</u> <u>Carex nebularum</u> <u>Scirpus atacamensis</u> <u>Chuquiraga atacamensis</u>
Achacachi	<u>Festuca proxima</u> and other <u>Festuca</u> <u>Tetraglochin cristum</u>
Tiwanaku	<u>Festuca proxima</u> <u>Hordeum andicola</u>

³an alternative explanation for the missing perianths would be that perianths are not easily preserved.

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Chiripa Radiocarbon Determinations: 1974 and 1975 seasons:

lower
case

Cut F10:

290-325 cm	GX-4058	2300 \pm 155 years	350 B.C.
325-350 cm	I-8314	2235 \pm 240	285 B.C. *
325-370 cm	GX-3595	2725 \pm 100	775 B.C.

Cut H7:

197-201 cm	GX-3596	2385 \pm 165	435 B.C.
152-201 cm	RL-491	2900 \pm 140	950 B.C.
211-230 cm	RL-492	2810 \pm 180	860 B.C.
250-265 cm	RL-493	2820 \pm 110	870 B.C.
263-265 cm	RL-494	2850 \pm 110	900 B.C.
268 cm	RL-495	3170 \pm 120	1220 B.C.
310-350 cm	GX-4057	3210 \pm 170	1260 B.C.
350-365 cm	RL-496	3190 \pm 120	1240 B.C.

Cut C8:

300-400 cm	GX-4059	2460 \pm 165	510 B.C.
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*no NaOH pretreatment, sample was too small; hence probably too recent.

CHIRIPA FLOTATION SEQUENCE

<u>Radiocarbon dates</u>	<u>Ceramic units</u>	<u>Flotation units</u>
1250-850b.c.	H7-A 31-33 H7-B 19-30	H7-A 31 & 33 H7-B 19, 20, 22, 24, 26, & 30
850-500b.c.	Sub-phase A [C8-A 17-21 C8-B 15 & 16 Sub-phase B [H7-C 5, 6, 14, & 15 F10-A 12-17 F10-B 10 & 11	C8-A 17 & 18 C8-B 15 H7-C 12, 14, 15, 2, & 3 F10-A 13 (extension cut)
500b.c.-Kidder excavated levels (upper house levels)	A [H7-D 2-4 C8-C 8-14 Sub-phase B [F10-C 5-8 C8-D 3-7 F10-D 2-4 C8-E 1-2	H7-D 1 C8-C 9, 11, & 13 F10-C 5, 6, 7, 8, & 11 C8-D 6 F10-d 1, 2, 3, & 4

CHIRIPA FLOTATION SEQUENCE

(Con't)

<u>Radiocarbon dates</u>	<u>Ceramic units</u>	<u>Flotation units</u>
Upper house levels and/or lower house levels 400b.c. -a.d. 22 (Ralph 1959)	no excavation by Washington University	J8 (from exposed North face of the mound-- I8 a single stratigraphic zone of ash/carbon) B11

Footnotes:

¹ the symbols represent the following:

L=sample from the general level within the excavation pit, usually from the center of the pit.

M=midden zone, usually a pit with rich humic soil.

H=hearth, a distinct fire pit lined with stone or ash lens.

R=rock pile, with a heavy concentration of midden.

T=robber's trench, from a later time period to obtain stone material from the Chiripa temple wall.

Z=stratigraphic ash/carbon zone, approximately 50cm thick, which extends across the exposed areas of the mound on the North face.

² "Wood", "tuber", and "dung/ash": The symbols represent relative abundance of the identifiable components.

A=very abundant

B=abundant

C=moderate

D=scanty

E=scarce

X=trace

the weight of the components range from approximately 2-3 grams for "A" to a few tiny fragments for "X".

(adapted from Yarnell in Watson 1969:42)

³ Gastropod A is a species of Littoridina, possibly L. andecola.

⁴ Gastropod B is a species of Taphius, possibly T. montanus.

⁵ "X"=presence of fish bone and fish scale.

⁶ the counts of Chenopodium are close estimates when the number of the count is high.

⁷ many different seed types are represented in the unidentified seeds. Most are of a single type of seed. ↴

MALVASTRUM SP
PLANTAGO SP