

CORBEL VAULTED SOD STRUCTURES IN THE CONTEXT OF LAKE TITICACA BASIN SETTLEMENT PATTERNS

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Introduction

This article is an introduction to the study of a specific kind of corbel vaulted structure known as *putuku* or *phullu uta*, and a variation of this called *taklla putuku*.¹ The corbel vaulted design and the use of sod (*ch'ampa*) as building material employed in its construction provide an excellent alternative to the use of timber for beams in this environment where appropriate trees are absent, and allows an efficient response to the persistent and severe climatic conditions of this region.

1. Although our informants in the region say the word *putuku* is Quechua, no such word is found in relevant dictionaries and may not be a Runasimi (Quechua) expression. Mesa and Gisbert (1966:492-493) and Gisbert (1988: 124-125 and figures on pp. 132, 140) report similar corbel vaulted structures also known as *putuku*, belonging to rural Chipaya in Oruro, Bolivia. These one-room structures, however, are circular in plan rather than rectangular as found in the northern portion of the Titicaca Basin. The closest architectural term similar to the word *putuku* is *phutu*, reported to be an Aymara word meaning "niche" (Gasparini and Margolies 1980:133, 343), or *phuthu* meaning "a hole" (Apaza Suca *et al.* 1984:166). Bertonio's 1612 Aymara vocabulary glosses *putu* as "edificio de bobeda" ("vaulted building") (Bertonio 1956 [1612]:120). However, Guaman Poma de Ayala in his Second and Third Ages of Indians describes and illustrates a vaulted structure called *pucullo*, which he defines as "a house" ("*cacitas que parece horno*"); and elsewhere also as funerary constructions, and burials for Indians of the Colla Suyos (Guaman Poma 1936 [1615]:53, 54, 56, 59, 69, 188, 259, 289-291, 296, and 298).

On the other hand, the second term mentioned by our informants that also refers to the corbel vaulted structures is *phullu uta*. This composite term is defined by Apaza Suca *et al.* (1984:237) as Aymara meaning:

Phullu. Manta pequeña para la espalda (prenda de mujeres).

Uta. Casa.

Utachaña. 1. Construir una casa. 2. Techar una casa.

Utachayaña. Hacer construir o techar casa. Repajar una casa.

Utachkataña. Construir una casa junto a otra.

The present-day distribution of these little-known structures in the northern Lake Titicaca Basin of Peru includes the Province of Huancané in the Department of Puno, for example along the Taraco-Huancané road where this investigation was conducted (Figure 1). Two settlements were selected within this area, the town of Taraco, capital of the District of Taraco, and the community of Yanaoqo, permitting comparison between the kinds of *putuku* found in an urban and in a rural setting, respectively. Both sites lie within the same altiplano environment and are about 16 km apart. Since 1968, while conducting archaeological reconnaissance and excavations in the area with Karen Mohr Chávez, the author has investigated *putuku*, their materials, and the present-day settlement patterns of which they are an integral part. In July, 1985, and again in August, 1988, more detailed investigations were conducted and interviews were made, including with builders, such as the one observed in the process of constructing a *putuku*.

Aside from presenting a description of the different architectural attributes, tools and building materials employed in construction, and the different uses given to these one-room structures, interpretations are proposed aimed at understanding: (a) the relationship between environmental conditions (for example, lack of trees, topography, low soil absorption, and rainy season inundation) and the presence of corbel vaulted *putuku* using local resources; and (b) how differences in building materials (stone, *tapia*, adobe, and *ch'ampa*), in form, in function, and frequencies of *putuku* and other structures provide architectural indicators of status, whether social, economic, and/or political, in a nucleated urban settlement (Taraco) and in a dispersed rural one (Yanaoqo). Finally, comparisons are made with a different kind of corbel vaulted sod structure in the southern end of the basin, and the historic and

prehistoric background is given, along with a discussion of archaeological implications for the region.

The Use of Stone, *Tapia*, Adobe, and Ch'ampa as Basic Local Building Materials

Stone

Stone in Taraco is not only extensively employed for house foundations where it is required, but also is utilized to cover patios, as door portals or jambs, for the curbing of some streets, and in the large steps and platform in front of the church. Stone is accessible both because of the economic ability of the residents of Taraco to obtain and transport it, and because of its relative abundance at or near Taraco itself. For example, worked and unworked slabs and blocks of different shapes and sizes belonging to prehistoric occupations have been found at or near the surface in Taraco and are reused today.² Furthermore, there are also stonecutters (*picapedreros*) in Taraco (Martínez 1962:62; Ghersi and Arquinio 1966:38).

In contrast, the use of stone in Yanaoqo is limited to the very few people who can afford to have stone foundations in their gabled one-roomed adobe structures. Rarely, unworked stones are also used as layers at the base of corrals built of sod blocks called *ch'ampa* (Figures 19-20). We also observed a household cluster near Taraco with three *putuku* enclosed within four *tapia* walls, that had three courses of stone at their base (Figure 2). Stone is rare and expensive here. The only major quarry nearby is a hill called Cupisco just north of Yanaoqo, where a kind of pinkish banded quartzite is commercially exploited, making the material beyond the economic reach of most Yanaoqo residents.

2. See, for example, Kidder (1943:17). Archaeological research carried out by us in Taraco indicates a long sequence of occupations going back to at least 600 B.C., and many of the carved slabs, stelae, and statues relate to the Yaya-Mama and Pucara styles (Kidder 1943:16-18, plates III-V; S. Chávez and K. Chávez 1970:32-36; K. Chávez 1977:9, 263-264, 1026, 1064, 1091).

*Tapia*³

Tapia, as our informant at Taraco indicated, is an economical alternative to adobe, requiring less labor and time. The elaboration of *tapia* begins with the preparation of earth using shovel and pick, to which water is added to form mud. This first step requires a few days of soaking which is carried out near the site where the *tapia* will be used. With a shovel, the soaked earth is then mixed to achieve a homogeneous mass of mud. Subsequently, this mud fills and is tamped into a long rectangular wooden mold having the thickness of the wall. The mold is already situated directly on the wall under construction. As the first *tapia* block is drying, the mold is taken apart and rebuilt to continue with the horizontal layer. The same operation is repeated, with each new layer resting directly on top of the previous one without mortar. We observed one case in Taraco in which medium-sized stones were unevenly distributed between each horizontal row of *tapia*, and only at the inner and outer surfaces of the wall (Figure 23).⁴

The use of *tapia* blocks in Taraco is extensive in enclosure walls (*cercos*) that delimit individual property lots and streets (Figures 22-23), and in the lower portions of some *putuku* (Figures 24, 28). In Yanaoqo, especially in places along the road to Huancané, *tapia* is also used in walls enclosing household clusters (Figure 2). These walls, however, appear to be built more frequently of adobe and *ch'ampa* blocks (Figures 9, 20), and as far as we can confirm, *tapia* is never used in Yanaoqo to build *putuku* or gabled structures.

3. *Tapia* is a prepared mix of mud, straw, and water rammed into molds to make walls..

4. In Cajamarca (north highland Peru), Karen L. Mohr Chávez noted in July, 1985 the frequent occurrence of *tapia* structures with rows of medium-sized stones between each layer as illustrated by Muelle (1978: figures 5-6); Muelle's figure 6 clearly shows that stones are positioned at the outer wall surfaces only.

Adobe

The initial steps in the preparation of adobe are similar to those described above for *tapia*. As the mud is ready, however, straw is added by dispersing it onto the surface and walking over it to mix the two. The kind of straw used is a native grass called *chilliwa*, which is cut into segments of about 20 cm long. Subsequently, this mixture of mud and straw is put into a single, four-sided rectangular wooden mold (*adobera*), and the upper surface is evened out by hand. As this process is repeated for each adobe, the wooden mold is constantly dipped in water to prevent the next adobe from sticking to it. Additional time, space, and periodical turning over of the adobe are required to dry them and ready them for use. During the construction of permanent structures, each horizontal course of adobe has to be leveled and aligned, and mud mortar must be applied between each course. Finally, walls are plastered with mud, a process which is periodically repeated over the years. Adobe is considered to be the most expensive building material, compared to *tapia* or *ch'ampa*, because it requires more time, space, and labor in the manufacturing process.

Most of the buildings in Taraco, including the church of San Táraco, are made of adobe (Figure 22); in very few cases adobe is also used in wall enclosures. Furthermore, there are some *putuku* which are either built entirely of adobe or in combination with *tapia* (Figure 26).

In contrast, all of the gabled one-room structures in Yanaoqo are built entirely of adobe (Figures 8, 10), and none of the *putuku* we visited were of adobe. Instead, the *putuku* is made entirely of sod blocks or *ch'ampa*. In addition, adobe is also employed in walls and enclosures, although always between the uppermost and lowermost course of *ch'ampa* (Figure 9).

Ch'ampa

Ch'ampa refers to a rectangular block of sod characteristically containing sod of a specific kind of low-growing native grass (called

kimillu or *dimillu*), with long and profusely distributed roots, or sometimes also having *grama* and *layu* grasses, the latter a variety of high-altitude *ichu*. Terrains where this type of grass grows are highly valued because they have to be flat (located on a pampa), undisturbed, and must possess a homogeneous and lush growth on rich dark farming soil (hence harvesting *ch'ampa* is in potential conflict with agriculture). Such an area exists south of Yanaoqo and was the source for the *ch'ampa* the master-builder was using in the new *putuku* (see information on Yanaoqo, below).

Informants in the community of Collana (north of Taraco) mention a test which is sometimes carried out to determine the quality of *ch'ampa*. This test involves soaking a sample in water for about four days, followed by drying it for four additional days, at which time the *ch'ampa* block will crumble when its quality is not appropriate or suitable for construction. This low quality *ch'ampa* is associated with sandy soils, little top soil, and/or contains mostly *grama* grass.

The labor needed to extract the sod blocks is still obtained through the traditional *mink'a* system used on communal lands (K. Chávez 1987:179-180). Once a specific location is chosen, the *maestro* marks on the ground the length and width of each block of *ch'ampa* to be removed. He uses string and two measuring sticks cut from the straight stems of the domestic *kiwña* plant; one stick is for the length and the other is for the width of the blocks. The tool used to cut out the blocks is the traditional foot-plow (*chaki-taklla*), that is inserted obliquely into the ground by hand, rather than by foot (Figure 4). Blocks are cut in parallel adjacent rows. As each block is removed, the underside is evened out with the foot-plow, and the block is turned over (Figures 5-6). The moisture then begins to evaporate and the block quickly dries in the characteristic high solar radiation of the region. The end result is a series of heavy rectangular blocks having a consistent size and trapezoidal cross-section (Figures 7-8). The dimensions of *ch'ampa* blocks we observed during construction in Yanaoqo were about 53 by 42 by

13 cm, and two larger blocks, to be used as a lintel were 70 by 41 by 13 cm.

The importance and effective use of *ch'ampa* have not been properly documented, and to some extent *ch'ampa* has been ignored in the literature where more attention has been given to adobe and stone as traditional building materials. Our observations in Yanaoqo (and to some extent in other areas of the altiplano), however, indicate that *ch'ampa* is efficiently and extensively used to solve many structural problems that include the following:

(1) The construction of enclosures of sizes varying from 1 m to 1.50 m high (Figure 19), and longer walls marking land boundaries.

(2) *Ch'ampa* may be used in combination with adobe for added protection against rain and ground moisture. A large wall 2 m high enclosing the school at Yanaoqo was built by first laying down four successive layers of *ch'ampa* on the ground, then adding eight layers of adobe and mortar, and finally placing two layers of *ch'ampa* on top (Figures 9, 20). The placement of *ch'ampa* layers above and below adobe ones protects the entire structure from the annual rain and floods. *Ch'ampa* is more resistant to such persistent conditions, and hence is better than adobe alone. We also observed that, unlike adobe structures, *ch'ampa* ones do not always require plastering of the exterior. Furthermore, exposure to rain and floods actually helps in some way to settle firmly and to seal the layers, and sometimes encourages the green regrowth of naturally occurring grass in the sod at the first course of *ch'ampa* near the ground (Figure 3).⁵

(3) *Ch'ampa* is used as an economic alternative in the building of the corbel vaulted *putuku* (Figures 12-18), as well as one-room thatched and gabled structures and smaller ones for keeping dogs and chickens. Further-

more, when our informant in Yanaoqo was questioned about the differences between adobe and *ch'ampa* structures, he indicated that although the use of adobe allows a larger interior space, a *ch'ampa*-made *putuku* is better because it will last longer, resist severe flooding better, and provide a far more comfortable interior environment during extreme variations of temperature.⁶

(4) *Ch'ampa* is used to elevate terrain prior to the construction of rooms, to level the floors within structures, to create causeways between household clusters in temporarily inundated areas so that communication is maintained (Figure 3), and to build large causeways in flooded areas as in prehistoric times (Julien 1989:53-54, figure 11).

(5) Water canals can be banked with *ch'ampa*, which are also used to form the fill of convex surfaced raised field planting platforms (Erickson 1989:14, figures 6, 9).

There are no permanent structures of any kind in Taraco in which *ch'ampa* blocks are used. In the community of Yanaoqo, however, the use of *ch'ampa* is widespread. The following chart summarizes, in order of preference and frequency, the use of these basic local building materials (see also Table 1):

TARACO	YANAOQO
<i>Most frequent to least frequent</i>	
1. Adobe	1. <i>Ch'ampa</i>
2. <i>Tapia</i>	2. Adobe
3. Stone	3. <i>Tapia</i>
	4. Stone

5. Describing the sod houses in Nebraska, Welsch (1973:71) indicates that the heavy walls settled six to eight inches in the first year or two, while at the window and door where the load was much less, settling was only two to three inches. This example provides an independent confirmation of the settling of sod-built structures.

6. Welsch (1973:71) also states, based on interviews with former sod house dwellers in the United States Great Plains, that unlike frame houses, these structures were well suited to severe weather and wind conditions in the prairies, as well as resistant to fire, rot, and damage by rodents and insects. Gabled sod houses, or the earlier dugout dwellings (see for example, Dick 1979: figures facing pages 112 and 116), were also built without mortar, with the grass side facing down, and were plastered on the interior with a mixture of clay and fine sand. Each sod block was about 90 by 60 by 8-10 cm.

Ch'ampa appears to be a word in Runasimi as well as Aymara (Apaza Suca *et al.* 1984:41). The dictionary published in 1608 by Gonçalves Holguín (1952:93, 469) defines and describes the use of *ch'ampa* as follows:

Chhamppa. Sod with roots

Chhamppa chhamppa huaylla. Sod-cutting place.

Chhamppani, o chhamppahuan pirccani. Make a wall or enclosure of sod.

Chhamppani o chhamppaycuni chhamppahuan harcani. Cover a canal with sod [blocks].

Cesped. Turf, and *champani*, Make enclosure walls.⁷

Yanaoqo and its Rural Characteristics⁸

Yanaoqo is one of many communities in the area whose primary activities include agriculture, followed by trade and some craft production. Yanaoqo is on a pampa between two main rivers, the Huancané on the east and the Ramis on the southwest, that eventually join and flow into Lake Titicaca (Figure 1). The pampa, having an elevation of 3810 m, is bordered rather abruptly on the north by Yanaoqo Hill with a maximum elevation of 4145 m. Lagoons and rivers almost entirely surround the pampa, creating peninsulas, marshes, and temporarily inundated places. On the other hand, these water sources provide the inhabitants with resources including fish, *totorá*, and lake algae called *llachu*, as well as with routes of communication. Furthermore, this area possesses a complementary distribution of resources and utilization: the eastern half is mainly cultivated with potatoes, barley, and *kiwña*, and the non-cultivated portions of this half are characteristically covered with native grasses. The western half is an inundated marsh zone adjoining small lakes where cattle feed on *llachu*. People on wooden and *totorá* rafts were observed cutting *totorá* and *llachu*

using a *kinina*, a pole about 4 m long with a metal blade attached to one end. The *totorá* has multiple uses including roof thatching, fuel, and food for people (the last 25 cm near the root constitutes the edible portion called *chullu*). Cutting *totorá* by leaving about 25 cm of the stem encourages regrowth in about one month. Depletion of this resource is also avoided by transplanting it into new or sparsely occupied areas. *Llachu* and a thinner variety called *chinki* are exclusively used as cattle feed. It should be noted that many informants admitted not having seen either llamas or alpacas. Most of the domestic animals are the European-introduced cattle, sheep, pig, donkey, and chicken. Native domesticates observed include guinea pig, muscovy duck, and dog.

An important climatological and hydrological factor in this region is the periodic rise in lake and Ramis River levels, which causes inundation of extensive residential and agricultural areas (see also section on Taraco below). Monheim (1963:19, 101) indicates that according to local Indian informants, major lake inundations occur every 15-20 years, and that when he visited this area in March of 1954, Lake Arapa had temporarily joined Lake Titicaca. In 1986 severe inundation, especially in the Province of Huancané, extended up to 15 km inland and caused 30% loss of the potato, *kiwña*, and barley production and covered roads so that boats were the only mode of transportation (*La Región* 1986: 2, 8, and 9). The rising of lake levels had also displaced the floating islands of the Uru people and covered the *totorá* reed plants (Aquize Jaén 1986). Additional related environmental factors here include the low gradient of the terrain, slow water permeability, and the formation of flat river margins. Furthermore, sporadic droughts also occur. For example, it has been estimated that during the severe drought of 1943, the lake level dropped some 6.30 m.

The settlement pattern here, as well as in similar rural areas, is dispersed, consisting of widely separated household clusters (Figure 21). Sometimes household clusters are adjacent where close relatives are involved. Aside

7. *Chhamppa*. Cesped de tierra con rayzes.

Chhamppa chhamppa huaylla. Lugar para sacar cespedes.

Chhamppani, o chhamppahuan pirccani. Hazer pared de cespedes, o cerca.

Chhamppani o chhamppaycuni chhamppahuan harcani. Tapar acequia con cesped.

Cesped. Champa, y champani, hazer cercas.

8. Due to its close geographical proximity to Taraco, the environmental conditions as well as agricultural production described for Taraco, also apply here.

from lake shores or foothills, the boundaries of these settlements are difficult to determine visually (Figure 21). There are no streets, plazas, or public buildings except for one school. Each household cluster occupies slightly elevated terrain, and sometimes these elevations extend like causeways between households to connect them in the rainy season.

Each household cluster shelters a family unit and is enclosed by four walls about 1.50 m high. There are usually three separate and independent one-roomed structures facing an open courtyard. The backs of the structures may interrupt and form part of the enclosure wall. Household clusters may contain only *putuku* (Figures 15, 16), *putuku* and one story (very rarely two story) gabled structures (Figures 10, 18), or only gabled structures, depending on the socio-economic condition of the occupants.

Of the two kinds of structures, gabled ones require more time and labor to construct and necessitate the use of expensive building materials brought from distant places. They are rectangular in plan and require stone foundations that, when possible, sometimes extend about 40 cm above ground to avoid water damage (Figure 10). The vertical walls are made of adobe bricks with mud mortar. Additional characteristics include: padlocked carpentry-made wooden doors, glass windows, wooden lintels and roof beams, and plastered exterior and interior.

It was observed that the gabled structures may be divided into two groups according to the quality of additional building materials:

(a) those which are constructed mostly of local or nearby resources: these structures are built of adobe, or even *ch'ampa* as observed especially in the district of Platería, south of Chucuito, have thatched roofs of either *ichu* grass or *tatora* secured with woven rope of *ichu* grass, are mud plastered inside and outside (Figure 18), and sometimes have a piece of glass set directly into an opening made in the adobe without a frame. Although the thatched roof repels water and provides a comfortable interior environment, it requires periodical re-

newal. For example, Arquíñiba (1978:601) reports that the *ichu* roof lasts one year, while a roof which is sewn and secured with rope also woven of *ichu* can last two to three years.

(b) Gabled structures that use more expensive and distant materials: these structures have corrugated iron ("tin") roofs and glass windows set into welded metal frames; only these structures may have two stories and may be painted white or light green, with blue window frames and doors (Figures 10, 18).

Furthermore, we were informed that these "tin" roofed houses are not well adapted to the climate of the region, because they tend to absorb the sun's heat during the day and are cold at night. The roofs produce noise from rain and hail, and can also rust, requiring eventual replacement. Within this basically subsistence economy, however, the price of metal roofs is very high, and hence their presence is associated with, or reflects, the family's high social and economic status within the community.⁹ We observed that some of these gabled rooms were used to store bicycles, machine-made clothing, *ch'arki* (dried meat) hung from a rope line, grains in pottery vessels, and varieties of freeze-dried *oqa*, *ulluku*, and potatoes kept in cylindrical containers called *seje* that are made from *tatora* mats.

The structure known as *putuku* is designed for multiple uses (see the section below, A Household Cluster in Use). It requires only readily available local resources. This unique architectural solution to the lack of timber in the altiplano has a reputation among the natives of the region as producing a more stable structure well adapted to the severe climatic conditions.

The *putuku*, made entirely of sod called *ch'ampa*, consists of two superimposed shapes (Figure 17). The lower half has a rectangular plan and four inwardly slanted walls. Each is hence trapezoidal in elevation. The upper half is a conical corbeled vault. The small trape-

9. Héctor Martínez (1962:78) also observed in 1957-1958 that metal roofs were just being introduced into these rural areas, and that their use indicated prestige, economic capacity, and acculturation.

zoidal door is elevated above the floor and is enclosed by an additional entryway that extends to ground level. This entryway is added to the exterior of the door and may also be trapezoidal. The inner door is not secured, other than by a piece of sheet metal nailed down to a wooden frame, or by a piece of cloth hanging as a curtain, for protection against the winds at night, or to keep out domestic animals. However, elsewhere in this region we have observed the use of doors made of wood and cow hide. Interior ventilation is achieved by the following architectural attributes: two small smoke vents opposite one another at the apex, small vents through the upper conical vaulted portion of the structure, and small vents in the trapezoidal walls usually near the floor. On the lower portion of the structure there are also one or two niches or recesses carved into the wall and some wooden pegs for hanging things. The interior walls are mud-plastered on the rectangular lower portion only.

Without exception in the corbel vaulted structures we observed at Yanaoqo, there was a consistent arrangement of the bed, oven, and grinding stone areas. As one enters the *putuku*, the bed is to the right of the door, the earthen or pottery oven (*q'oncha*) to the left of the door, and the rocker mill (*maran*, or flat base, and *tunau*, or hand-held rocker) on the left side of the wall opposite the door.

Construction Technique of Corbel Vaulted Structures in a Rural Setting

The information in this section derives from an intensive interview conducted with Mariano Quispe Bautista, one of two master builders of *putuku* in the community of Yanaoqo. We were fortunate to observe him and three of his assistants constructing a *putuku* on July 17, 1985, allowing us to document and ask pertinent questions about the building process (Figures 10, 12-14).

The number of *ch'ampa* blocks used in the *putuku* we observed being built was about 600. According to Mariano, a *putuku* may have as many as 1000 *ch'ampa*, indicating that such a structure could be almost double the

size of the one described here.¹⁰ Removal of the approximately 600 blocks was accomplished in three days with four people working. The transportation of these blocks to the site where the *putuku* was to be built required three trips by truck. We were informed that according to the distance involved, donkeys can also be used, although each would carry only two blocks at a time. Both males and females can carry blocks by themselves or by using a wheelbarrow.

Faustino Huanca Cusi, owner of a household cluster situated west of the school and on the road to Huanacáné, wanted to add a *putuku* to the cluster (Figure 10). Through the *mink'a* system he requested the service of Mariano who, as a master builder, was to receive 15,000 soles (the dollar at that time was about 12,100 soles) for constructing the new *putuku*. In addition, Faustino and two younger workmen (Jesús Mamani Huanca and Jorge Caira Bautista) helped Mariano during the entire building process which lasted one day.

The tools used include the foot-plow (*chaki-taklla* in Runasimi, and *wiri* in Aymara), an adze (*rawk'ana* in Runasimi, and *lijwana* in Aymara), a sharp-edged shovel, a small pick, and rope. Using these tools, the men begin the building process by compacting, filling holes, and evening out the surface of the ground, an area that is already elevated. The locations of the corners for the rectangular plan are marked by placing a stake at each of the four corners connected by a string at about 90 degree angles, and the lengths of the sides (3.53 by 3.1 by 3.43 by 3.18 m) are measured by outspread arms.

The first layer rests directly on the surface of the ground without foundation. The rectangular blocks of *ch'ampa* are laid face down without mortar in this and each successive layer so that the surface of the next block on top rests directly on the underside of the one below. During the entire construction, blocks are laid down so that the vertical joints between blocks of one course occur over the centers of the blocks of the course just below,

10. Such a large *putuku* composed of some 39 layers of *ch'ampa* can be seen in Belaúnde Terry (1961).

known as isodomic construction (*aparejo isodomo*, Mesa 1978:13). Where necessary, this technique is achieved by further reducing the size of blocks and accommodating them to fit using the small pick and shovel. The base of the doorway or entrance begins after the second row of *ch'ampa*. Doorways are placed to avoid the prevailing winds, and, in this case, the door was oriented to the northeast. The door is trapezoidal and measured 56 cm wide at the bottom and 42 cm at the top, and was 1.22 m high. At the conclusion of raising the walls flanking the space for the doorway (Figure 14), two small wooden supports about 4 to 5 cm in diameter and made of the native *gewña* tree, were set across the top of the doorway. The only large *ch'ampa* measuring 70 by 41 by 13 cm, was then placed as a lintel over them. Gradually each block and layer in this lower portion were placed slightly towards the interior so that the four walls, of 15 layers when complete, have an inclination of about 8 degrees and were about 1.72 m in height. During the construction of this lower portion, several temporary long wooden boards were used to brace each wall at different locations on the interior, one end of each board on the floor and the other about half way and higher up the wall. In preparation for the upper conical vault a small *gewña* wood branch or corner brace about 4 cm in diameter and 40 cm long was permanently embedded in the last layer diagonally across each of the four corners. About 20 cm of the length of the horizontally positioned sticks was exposed on the inside at each corner. These corner braces, which presumably served to reinforce the corner joints, have also been reported on several stone-adobe Inca structures of Cusco (Moorehead 1978:73, 84-85, 91, figures 6, 9, 13, and 27). Finally, a small rectangular vent (10 by 11 cm) was left open within the ninth layer at about 55 cm to the right of the door jamb, as viewed from the exterior (Figure 14).¹¹

Once the last layer of the lower portion has been concluded, the upper corbel vaulted

structure begins. The first course of *ch'ampa* rests almost entirely on the flat horizontal surface of the rectangular lower portion that measures about 3 by 2.72 m. This first layer of the vault follows a circular to slightly oval plan, leaving only four small triangles of the lower walls exposed on the exterior at the four corners. The blocks of *ch'ampa* used are also placed face-down without mortar and require additional reshaping of each rectangular block into trapezoidal forms (Figure 11). Using the foot-plow but without the aid of his foot, the master builder strikes each rectangular block vertically to remove two corners from the same longer edge, achieving a roughly trapezoidal form. No measuring device is used.

Subsequently, the master builder climbs up the structure and receives each block which has been tied to a rope (Figure 12). As the person above pulls up the rope, the workmen below lift the block in a synchronized manner to avoid rubbing or damaging it against the existing walls. The blocks, which are constantly evened out at the edges with the small pick and shovel to achieve the desired fit, are also placed with staggered joints. The conical vault is gradually achieved as each successive circular course is reduced in diameter by corbeling. The width and length of blocks in each subsequent layer are also reduced by removing additional portions at the four sides and rounding the faces of the blocks that will form the curved exterior and interior surfaces of the vault. This process gradually makes the wall thinner in the upper portions.

As the corbel vault is being erected, three small rectangular vents are placed in the following locations: one 15 by 9 cm within the second course directly opposite the door, and two vents (10 by 11 cm) within the third and ninth layers, respectively, in a line directly above the door (Figure 14). Furthermore, in the nineteenth row, close to the apex, two smoke vents are made opposite one another. The last block which closes the structure is a circular *ch'ampa*.

The last and final step made by the master builder is to shave and even out the exterior of the entire corbeled portion, using a shovel

11. Although the vents are called *ventanitas* (small windows), they provide a very small field of vision and little light, due to the wall thickness. A more appropriate term might be air vents, and they function as additional smoke vents.

(Figure 13). He then leaves and assigns the remaining tasks to the three workmen who will complete them in one additional day. At this point the entire structure is composed of 35 layers of *ch'ampa* (15 layers on the lower rectangular portion, and 20 layers on the upper conical vault portion including the last circular *ch'ampa* at the apex), and has a maximum interior height of 3.80 m.

When the main structure has been finished, the three workmen remove the long temporary wooden supports from inside and clean the debris accumulated there during construction. Subsequently, the interior floor as well as the trapezoidal walls are scraped and evened out in preparation for plastering with mud. The entire floor is then covered with a single layer of tightly fitted *ch'ampa* also laid face down, and an additional layer is added on the right side (as one enters the room) occupying about one third of the interior space to form a platform for use as a bed (*p'atjati*). Furthermore, as we were informed and were able to observe in some other *putuku*, a niche (*t'ojo*) is carved out on the interior above the bed. One final architectural attribute, an enclosed entryway, is attached to the trapezoidal door on the exterior (Figures 17-18). It is also built with *ch'ampa* and its lintel similarly rests on two *qewña* wood supports. The mud plastering is then applied to the floor, bed, and interior walls of the lower rectangular portion only. As the walls are being plastered, some small wooden pegs are inserted into the walls to use for hanging things.

Additional Observations and Informant's Comments

This section summarizes our additional observations and comments made by Mariano Quispe Bautista and other informants in communities between Yanaoqo and Taraco, concerning variations in technology, design, location, duration, and ceremony associated with a new *putuku*.

With respect to the shape of corbeled vaults, Mariano indicated that the conical vault may also be slightly convex-walled, depending on individual preference. While

documenting the settlements nearby, we saw a household cluster with both a *putuku* having a convex-walled vault formed by a total of 20 courses of *ch'ampa*, and one next to it with a straight-walled vault formed by 22 rows (Figure 16).

Likewise, depending on individual preference, the total number of vents (without counting the two smoke vents at the apex which are always present) in most cases is three or four, but can be as many as 10 as observed in Mariano's own *putuku*. The last single circular *ch'ampa* at the apex may alternatively include two circular *ch'ampa* (Figure 17). Furthermore, Mariano indicated that other builders do not include the permanent wooden "braces" at the four wall corners prior to building the conical vault. We were also informed that some people plaster the entire exterior with fine/sifted mud mixed with cut *ch'illiwa ichu* grass. Although we did not observe many cases of exterior plastering in Yanaoqo, informants indicate that this procedure helps maintain the structure and can be repeated every 5-15 years to make the structure last longer.

Regarding the total number of layers or courses of *ch'ampa* employed in the construction of *putuku*, and the proportions used in each of the two portions, we have a sample indicating the following distribution:¹²

Sample	Upper portion	Lower portion	Total	Ratio upper: lower portion
1	17	15	32	1.1:1
2	20	12	32	1.7:1
3	21	12	33	1.8:1
4	20	13	33	1.5:1
5	20	15	35	1.3:1
6	22	14	36	1.6:1
7	24	15	39	1.6:1
8	26	15	41	1.7:1
Range	17-26	12-15	32-41	1.1:1-1.8:1
Average	21.25	13.88	35.13	1.5:1

In one case we observed a *putuku* having 35 layers in the upper portion and 16 in the lower, totaling 51 layers. The upper portion always

12. For ease of reference, we consider even the last single circular block of *ch'ampa* at the apex as a layer. This sample was not selected probabilistically.

has more courses than the lower, and has a broader range of variability in numbers of courses than the lower.

A variation of the typical *putuku* is the *taklla putuku* (Figure 29), that is built for larger families. Although it has the same inclined walls of the lower portion and same relatively small trapezoidal doorway (about 1.10 by 0.60 by 0.45 m in one case), it is more oblong in its rectangular plan. The upper corbeled portion forms a sub-rectangular or ovoidal shape approximating or imitating a gabled structure with four slopes. Furthermore, the portion at the apex and just under the last row of *ch'ampa*, requires the support of long straight beams (usually from the recently introduced eucalyptus tree) across the length of the "roof." In addition, beams are placed at several points along the width about halfway down the "roof" on the corbeled portion.

This kind of structure is relatively rare in the region and is associated with well-to-do *campesinos*. A walled household cluster composed entirely of three *taklla putuku* was documented in the community of Pataskachi west of Yanaoqo. These structures face an open patio and are surrounded or flanked by a corral. Within the household enclosure is a smaller *putuku* for chickens and dogs as well as a small enclosure to keep piles of harvested *kinua*. The largest *taklla putuku* measured 7 by 3.10 m in plan, had 40 cm wall thicknesses and was 3.50 m in total height. It was built of 18 rows of *ch'ampa* in the lower rectangular portion (to a height of 2 m) and 17 layers in the corbeled portion (to a height of 1.60 m). In addition, this structure was large enough to have a partition wall that separated a bedroom, measuring 3.30 by 2.25 m, from a kitchen, each with its own doorway to the outside. The number of beams in this case was three along the length, and eight along the width. One of the other *taklla putuku* was used for storage and the other as a bedroom. This example shows that a well-to-do family has *putuku* built for special functions rather than having a single multiple function *putuku* as in Yanaoqo (see section below).

Small-sized *putuku* are also built with *ch'ampa* and plastered on the exterior. They are located within household clusters, and are specifically used to keep pigs, chickens, or sheep and cow dung for cooking fuel.

Inquiring as to why *putuku* are not found outside this region, we were told that their absence was due to the lack of good *ch'ampa*, and that such *ch'ampa*-producing fields are destroyed by farming. On the other hand, the appropriate location to build a *putuku* must meet the following criteria: it must be a warmer area (*zona abrigada*), on solid high ground to avoid inundation, and be surrounded by, or near, good soils and pasturage. Likewise, the best time to construct a *putuku* is within the months of September and October when the weather is mild. The addition of a new *putuku* is directly related to increased family size, and the formation of a new household cluster occurs when offspring marry and move elsewhere. Furthermore, some older informants indicated that before the influence of Adventists and Evangelists, people used to avoid "wrong" places inhabited by ancient spirits or *gentiles*.

At the conclusion of building a *putuku* a ceremony or *pago* is performed. Although we have not witnessed these, many informants in the region indicate two kinds of associated *pagos* which can be carried out by the builder himself, or a *yatiri* (indigenous priest): one involves splashing sheep or llama blood onto walls, and the other is burying a small pot containing subsistence items in the middle of the *putuku*. These *pagos* are performed to avoid the collapse of the structure which could "eat" the people in it, and to ensure a long life for the *putuku*.

The *putuku*, sometimes present with other kinds of structures (see Household Cluster in Use), are grouped together, forming household clusters as protection against the prevailing winds. The four most severe climatic conditions present in this region include rain, water, wind, and cold. According to informants, the corbel vaulted structure allows a more efficient response to these conditions in terms of building material and form. For the former,

ch'ampa blocks provide thick lower walls of about 50 cm that are slightly thinner at the upper portion, as well as high resistance to water filtration at the base. In form, the well-shaved exterior walls (sometimes plastered) and the approximately 8 degrees inclination of the lower rectangular portion protect the structure and allow fast rain water run-off. A single relatively small, trapezoidal door that is oriented towards the sun or against the prevailing winds, helps maintain interior heat. Likewise, the additional enclosed entryway framing the doorway, as well as the wooden or cowhide door, serve to protect the interior from rain, dust, and cold.

When a household cluster is abandoned, as we observed in some cases in Yanaoqo, the doors are closed with *ch'ampa* blocks (Figure 15). In old and deserted structures the first portions to collapse are the layers at the apex and the entryway (Figure 15). Asked how long a *putuku* would last, Mariano indicated that a *putuku* will last much longer than a structure built of adobe and corrugated iron, and speculated that it could survive from 80 to 100 years. In this regard, Martínez (1962:76) reports that many of the still habitable ones had already been in existence for perhaps three generations. Furthermore, La Barre (1948:95) reports the presence of many *ch'ampa*-built *chullpa* (prehistoric burial towers) south of Lake Titicaca. Unfortunately he does not mention the shape, size, or content of these tombs that could help determine their relative age. We know these burial structures to have been built at least in Inca times. Conservatively, La Barre's *ch'ampa chullpas* may be 400 years old, but may be later or even earlier.¹³ Several informants indicated that the origin of the *putuku* is very old, and referred to the Inca, Qolla, and Lupaca peoples as their ancestors who might have originated the *putuku*.

Finally, we also learned that there is a basic division of labor by sex in the process of building *putuku*. Only men can build *putuku*

because "women cannot lift *ch'ampa*." However, women can help to make and prepare *ch'ampa* in the fields.

Similar structures, but entirely circular in plan, have been reported from Bolivia, pertaining to the Chipaya ethnic group in the Department of Oruro (e.g., Mesa and Gisbert 1966), and also from the district of Desaguadero in the province of Chucuito in Peru (see Comparisons and Distribution). We therefore asked our informant and builder in Yanaoqo whether a *putuku* having a circular plan could be built. His response was simple and definite, "it cannot be done."

A Household Cluster in Use

This household cluster belongs to Mariano Quispe Bautista who is married to Paula Caira Larico, and they have a son (then 22) and a daughter (25) who now reside in Arequipa. Their main subsistence activities include the cultivation of potatoes, *kiwña*, and barley, as well as the herding of a small flock of sheep. In addition, Mariano fishes along the nearby lake shores, using a kind of fishnet he manufactures called a *karuña*, and through the *mink'a* system he cuts *ch'ampa* and is a well-known *putuku* builder in the community.

Mariano's household is situated just south of the Taraco-Huancané road, adjacent to two other household clusters on the north and east. A wall enclosure delimits a rectangular area oriented north-south, with its entrance in the southeast corner. The north and south walls of the enclosure are made of eight layers of adobe combined with one layer of *ch'ampa* at the top to a maximum height of 1.40 m (Figures 19-20). However, on the east (adjacent to his brother's property) and south, the walls are lower and of uneven height, and are entirely made of *ch'ampa*.

In the southwest corner there is a gabled room made out of adobe and mortar that is roofed with *totorá* brought from the nearby shores (Figure 18). Two of its sides form part of the enclosure wall. This structure has a carpentry-made padlocked door and a single sheet of glass set directly in the adobe window

13. Welsch (1973:71) documents sod houses still in use in the north central states of the United States dating to the 1800s and early 1900s (see also Dick 1979: *passim*, and figures facing pages 112 and 116).

opening. It is used to store agricultural products and as a temporary bedroom.

To the north there is an old *putuku* that had been built by Mariano's father (Figure 18). Mariano was in the process of taking it apart in order to rebuild it, reusing the old *ch'ampa* blocks. Near the northwest corner there are two small, mud plastered structures made of *ch'ampa* used as chicken coops, and in the northwest corner there is a rectangular corral (*kancha*) for sheep. The two walls that abut against the enclosure walls to form the corral are made using two layers of irregular stones at the bottom and 6-7 layers of *ch'ampa*, to a height of about 1.20 m (Figures 19-20). Cow dung for use as cooking fuel was being dried on top of the corral wall. In the northeast corner, an introduced cypress tree grows inside a *ch'ampa* enclosure which protects it from frost.

Finally, on the east wall, near the entrance, there is a *putuku* with its back wall forming part of the enclosure wall (Figure 17). In the middle of its north wall there is a small square exterior extension about 70 by 70 by 30 cm. The *putuku* has a simple door, oriented to the west, that is made out of a piece of metal nailed onto a wooden frame. Nine small vents are distributed around the conical vault,¹⁴ in addition to two smoke vents at the apex and one small vent to the left of the doorway.

The use and distribution of interior living space for sleeping, cooking, and eating in the *putuku* here is the same as in others we observed. In fact the arrangement was remarkably uniform. In the corner left of the door, formed by the north and west walls, there is a fired clay stove (*q'oncha*) with three openings. The fuel used is cattle and sheep dung (*toqra wanu*) and occasionally eucalyptus firewood brought from the nearby places called Kirichaya, Qaqocha and Qaparaya. The small extension built in the middle of the north wall is used to store the pottery vessels for the kitchen. The corner formed by the north and

east walls is designated for the rocker mill brought from a hill called Timoray. Inserted into the lower rectangular portion of the east wall are wooden pegs, and a niche (*t'oyo*) is carved into the middle of the south wall. Finally, the platform used as a bed is located along the entire south wall, measuring about 1 m wide and 18 cm above the ground. We were informed that four people could sleep on this bed. The sheep wool blankets used in the bed had colorful bands on black or brown backgrounds, and were all woven by Mariano.

Additional kitchen implements found in the space between the stove and grinding stones include pottery vessels made near Putina such as the *q'ocho* (bowl), *tachu*, *manka* or *hayku* (cooking pots) and *llata* (shallow bowl). In addition, there was a glazed pottery bowl from Pucara called *p'uku*, a plastic bowl, and spoon called *wishlla* made from the *qewña* wood in Putina, silverware, aluminum vessels, and tin buckets.

Outside and near the *putuku* we observed one large square stone vessel as well as other round stone vessels that are used as wash basins and as containers to feed pigs (Figure 17). These stone vessels are made and distributed by the inhabitants of the Island of Amantaní in Lake Titicaca, who, during the month of August, arrive in rafts at the bridge over the Ramis River and barter these vessels for food. Mariano exchanged these vessels for barley and potatoes. In recent years, bartering (rather than buying) has been emphasized in many regions of the south highlands.

Taraco and its Urban Characteristics

The town of Taraco is the capital of the district of Taraco, in the province of Huanacané, department of Puno (Figure 1). The urban population in the province is 12,209 and the rural is 96,904; while the population in the district of Taraco is 14,970 (Perú: Censos Nacionales 1981). The topography of the district is relatively flat (between about 3800-3850 m elevation) with some isolated hills of low elevation, and one more prominent chain (with Cerro Imarucos at 4085 m) to the southwest of Taraco itself. The terrain is slightly inclined

14. We observed here that the exteriors of most of the vents located at the conical vault were blackened from smoke. Consequently, these air vents also function as additional smoke vents.

with a gradient which usually ranges from 0.5% to 1%, and rarely from 2% to 5% (Gherzi and Arquinio 1966:26). There are basically two seasons: a cold and frosty period from May to October when there are strong winds (especially from July to September) and low temperatures that may fall to 0 degrees Celsius; and the period of abundant rain from November to April. At any given time during the year one can feel a high contrast in temperature between the sun and shade. The annual precipitation ranges from 425 mm to 1121 mm, and the annual average temperatures vary as follows:

Maximum: 14°C in January, and 21.1°C in October
 Minimum: 3.8°C in January, and 4.7°C in June
 Median: 4°C in June, and 8°C in November/April
 (Gherzi and Arquinio 1966:4).

One of the major problems in this region is flooding of lakes and rivers that occurs during some years, creating disastrous consequences for local populations as huge agricultural and residential areas become inundated (e.g., Cuentas Gamarra 1971:60). For example, the Ramis River, which flows from west to east and is at its river bed only 1.76 m above the level of Lake Titicaca, increases in depth from 2 m to 4 or 5 m in the rainy season; in some years it even overflows (e.g., Gilson 1939:9). Furthermore, this area is only approximately 18 m above the level of Lake Titicaca, and the soils are characterized by slow permeability and are resistant to water erosion (Martínez 1962:4-5, Gherzi and Arquinio 1966: 26-27).

In addition to the Ramis River, there are also a number of small and temporary rivers formed in the rainy season called *mishi*, that maintain pastoral lands and facilitate cultivation. Cattle, sheep, pigs, and small quantities of horses and donkeys are raised. The absence of camelids in this region is noticeable; for example, Gherzi and Arquinio (1966:34) report only one or two kept as ornamental animals. The most important cultivated plants include potato, *kiwña*, and barley; other plants grown in smaller quantities include *kañiwa*, peas, broad beans, *ulluku*, *oqa*, *tarwi*, and a small variety of corn called *maíz confite* grown in sheltered areas.

The town of Taraco, having a population of 535 inhabitants (according to the census of 1981), is composed of a predominantly mestizo population speaking Spanish, Runasimi, and some Aymara. The people possess a higher socio-economic status in relation to those in rural areas (e.g., Martínez 1962: 95-104 and chart on page 26). The clustered settlement pattern here (Figures 21-22) stands out in contrast to the dispersed rural settlements such as Yanaoqo. According to the classification of urban settlements proposed by John H. Rowe (1963:3-4), Taraco is a small synchoritic city. There are streets forming blocks and a main square (Plaza de Armas) in the center ornamented with trees and prehispanic stone sculptures. There are public buildings such as the church, schools, municipal building, police station, medical post, technical school (Centro de Formación Profesional de Taraco), post office, stores, and recently, a public telephone service. Taraco has electricity as well as water (from a water tower) and sewage, and a weekly market on Thursdays (Gherzi and Arquinio 1966: *passim*). Some Taraco residents own land nearby, but have others work it. Building materials used in Taraco include plastered adobe and mortar, *tapia*, brick, and cement. *Ch'ampa* blocks are absent. Roofs are mainly corrugated iron, but some are thatched with *ichu* grass, and tile occurs only on a very few houses and on the church of San Táraco.

The fronts of the houses in Taraco are at the edge of the street and form part of the *tapia* walls that enclose the entire lot. Some of these *tapia*-made enclosures, especially those towards the river, are large enough to be used for cultivation. The houses include one- and two-story gabled structures (*a dos aguas*), and some with the roof inclined in only one direction (*a una agua*) towards the inside of the house or patio, giving the false impression of having a flat roof (or *azotea*) when seen from the street (Figure 22). Behind the houses and within the enclosure walls are some straw-thatched, one-room rectangular structures, and sometimes an ornamental tree is grown such as the small native *qolli* and the introduced cypress. Finally, inconspicuously situated in the enclosures well behind some houses, espe-

cially those near the river, are corbel vaulted structures of a different kind from those found in rural areas (Figure 22). Unlike the ones found in the nearby rural communities such as Yanaoqo, this kind of *putuku* is built entirely of adobe and mortar or combines both with *tapia*, may or may not have vents, and possesses a rectangular door jamb. Another major difference is the design of the upper corbel vaulted portion; four surfaces incline towards a straight summit, the opposing broad sides of which have a trapezoidal silhouette while the narrow sides form isosceles triangles, similar to the *ch'ampa*-built *taklla putuku* (Figure 26). Furthermore, based on direct observations and information provided by our informant, these one-room structures are only used to store harvested products, keep pigs and sheep, and rarely for cooking.

Construction Technique of Corbel Vaulted Structures in an Urban Setting

Our main informant here was Francisco Palomino Olivera, a long time resident of Taraco who, around 1974, built a large *putuku* in addition to the small one already present on his property near the bank of the Ramis River. This site is called Aldonates Patamayu, an area of higher ground due to the presence of intensive prehispanic occupation there, and was the location we excavated in 1973. Two of these structures face each other within a rectangular *tapia* wall enclosure about 14 by 9 m and 1 to 1.50 m in height (Figure 23). The large *putuku* occupies the middle of one wall, and the small one is near a corner and the entrance. In turn, the rectangular wall enclosure forms part of and is located in the middle of the central wall of a larger, three-walled *tapia* enclosure which limits a block size area. This large enclosure has walls bordered by three streets and is open toward the river bank on the north.

The first step in the construction is the preparation of a flat rectangular plan about 3.67 by 2.90 m. The four superimposed layers of *tapia* are built, always avoiding the junctures of previous layers (isodomic construc-

tion).¹⁵ At this point, the basal portion is about 2 m high. Each of the four walls has an inclination of about 5 degrees and forms a trapezoidal surface (Figure 24). The rectangular door jamb which is oriented towards the river to avoid the winds, measures 1.25 m in height and 60 cm in width; it is about 20 cm above the floor, with two wooden beams to support the *tapia* lintel.

The second, upper, portion rests directly on the last *tapia* layer, and is built entirely of 19 courses of adobe and mortar. The first two layers of adobe follow the same inclination and rectangular shape of the previous *tapia* layer of the lower portion, after which the subsequent horizontal courses of adobe are gradually corbelled. The corners are rounded by placing adobes transversely across them, and adobes are placed polygonally in each course to form a more ovoid plan (Figure 25). Furthermore, the last three out of the 19 courses of adobe have a different arrangement: courses 17 and 18, having eight and six adobes respectively, no longer form polygons; instead they form rectangles. The last course at the summit consists of three parallel adobes; their widths close the length of the rectangular opening. The stepped exterior is then smoothed by scraping with a small pick and shovel, but the interior of the structure remains stepped, with the adobes left protruding one-third to one-fourth of their width.

As the main structure is concluded to a maximum height of 4.65 m, an entryway is built at the door with *tapia*, and the entire exterior is plastered with mud for a thickness of 5 cm. The interior of the structure is also mud-plastered, but only on the lower *tapia* wall portion, and there are no vents of any kind. The only additional element on the inside is a wooden pole about 6 cm in diameter set into and spanning the north and south walls at a height of about 2 m, to be used for hanging things. Finally, a layer of mud is also placed onto the interior floor. On the exterior, at the bases of the front and back, soil is shov-

15. The construction of this *putuku* was not observed by us. Consequently, this information is based only on the memory of the builder at the time we interviewed him.

eled to a height of approximately 40 cm, creating an inclined plane. It should be noted that, unlike other such structures we have seen in Taraco, this one has a more ovoidal or subrectangular vault in which the four corners and summit were purposefully rounded, but still give the impression of having a four sided "roof" when seen from a distance.

The building of this structure required the labor of four people for five days (three days for the *tapia* portion and two days for the rest, not including the time used in making adobes). This *putuku* was built to store products Francisco cultivates, and when we visited in July of 1985 all of his broad bean harvest was housed inside. Before this structure was built, the small *putuku* had also been used for the same purpose.

Abandoned Corbel Vaulted Structures

On the east, near Francisco Palomino's property, there is a *tapia*-walled area with two abandoned *putuku* now used as public toilets (Figure 26). We measured and documented these structures to illustrate additional variations in shape, size, building material, and function, as well as the initial process of decay following their abandonment. One *putuku* is very large (maximum height 4.30 m) with the door facing south, and the other, adjacent one is medium-sized (maximum remaining height 3.60 m) with a door facing west.

The lower portion of the large *putuku* is built of three layers of *tapia* to a height just below the door lintel, and the upper portion consists of 18 layers of adobe with mortar (Figure 28). The rectangular plan measures 5.30 by 3.50 m. The four walls are 1.40 m in height and are inclined approximately 5 degrees. The upper portion of the structure rests directly on top of the *tapia* walls which form a rectangle measuring 5 by 3.30 m. The corbel vault has four well-defined sides, two narrow ones forming isosceles triangles, and two wide sides forming trapezoids, constituting what may be called a four-sided corbeled vault with a 2.30 m-long ridge at the top. Unlike the polygonal, ovoid disposition of layers on the *putuku* described above, the entire corbel vault

here is achieved by layers forming rectangles in which the four corners are maintained, similar to what Mesa (1978:21) calls *bóveda por tajadas* (like that in Figure 27).

The rectangular door jamb measures 1.26 m high and 80 cm wide, and is about 25 cm above the ground. A wooden beam supports the lintel which is formed by the first layer of adobe. There was no evidence for a covered entryway, although this might have collapsed; and the area in front of the door was elevated almost up to the door sill. Furthermore, there were indications that at least the lower *tapia* walls had once been plastered on the exterior, and the upper adobe portion was now exposed and beginning to erode.

The interior was also mud-plastered up to the top of the *tapia* walls. At about 1 m above the plaster, and to a height of about the upstretched hand, three poles spaced 90 cm apart were inserted into and across the north and south sides. Three small rectangular vents (13 by 13 cm) are present only in the upper adobe portion. One is in the fourth row of the south wall and near the southwest corner; and the other two are in the west wall, one at about the center of the third row, and one in the eighth row near the northwest corner. In addition, the interior of the north and west *tapia* walls has two niches which were directly carved out when the walls were dried. The niche on the north wall (47 by 25 by 10 cm deep) is 1.19 m from the floor and 1.17 m from the west wall. It is triangular in cross section. The one on the west wall (22 by 23 by 15 cm deep) is 1.21 m from the floor and 80 cm from the northwest corner. It is roughly rectangular in cross section. Lastly, most of the interior walls and vault portions were blackened from smoke, indicating that this structure had been used at least for cooking, and that the small vents might have functioned as smoke vents.

The second *putuku* has basically the same shape as the first (Figure 26). Other characteristics, however, such as its smaller size, exclusive use of adobe and mortar, absence of vents and niches, and lack of smoke blackening on the interior, indicate that this structure had a different function.

The rectangular plan measures 2.85 by 2.26 m, and the inclined walls of the lower portion include 10 layers of adobe to a height of 1.50 m up to and including the door lintel. The upper corbeled portion also has four well-defined sides and corners (Figure 27). It was built of 17 layers of adobe, with one additional last layer on top now missing; judging by the space, there had also probably been three adobe in this uppermost layer. The rectangular door, measuring 92 by 60 cm with a sill 20 cm above the floor, faces west. It has a wooden beam supporting the lintel, as well as impressions left by a door frame. Mud plastering was present only on the interior up to 1.74 m above the floor.

Comparisons and Distribution of *Putuku* And Settlements

A search of the current literature dealing with the Peruvian side of the Lake Titicaca Basin indicates that this kind of structure, as well as the use of *ch'ampa*, has been poorly documented and to some extent ignored. Most of these references include very general descriptions and lack illustrations (e.g., Romero 1928:354; Kidder 1943:16, plate I, figure 4; Martínez 1962:76-77; Ghersi and Arquinio 1966:50, 60; Sánchez Huanca 1970:24, 85; Cuentas Gamarra 1971:122-123; and Gutiérrez *et al.* 1978:147, 149-151). Although these references do not permit close comparisons to be made with the *putuku* described here, nevertheless, they help confirm that at least for the last 60 years *putuku* distribution has been from Taraco (communities of Qollana, Patascachi, Ramis, and Requena) to near Huancané. Furthermore, Romero (1928:354) indicates another concentration of *putuku* to the northeast of Lake Titicaca at the Peru-Bolivia border (on the Peruvian side).¹⁶ The

name given to this area is Umabamba, and it is near a hill called Ninantaya. In addition, we have also observed in the Cusco region, between Sicuani and Raqch'i, isolated corbel vaulted structures not forming household clusters, located near agricultural fields, and used as temporary shelters, or for storage. Likewise, similar structures were noted midway between Santiago de Huata and Escoma in Bolivia.

Another area where the *putuku* structure has been reported is the southern end of the Lake Titicaca Basin to the region of Lake Poopó. These corbeled buildings, which are usually related to the Aymara, Uru, and Chipaya peoples, are also associated with gabled rectangular structures, as well as with circular ones having thatched domes. Additional characteristics of technique, form, and basic building materials stand out in contrast to the constructions found in the northern end of the basin.

In comparing the shape of structures present at both the northern and southern ends of the basin, it is significant to note the absence of circular buildings in the former and preponderance of them in the latter, whether *putuku* or thatched structures. The following discussion of these circular structures found in Bolivia will reveal the similarities and differences they possess in comparison with the *putuku* in the northern end of the basin.

Urban houses of the Chipaya in the Department of Oruro, Bolivia,¹⁷ have a circular plan about 5 m in diameter, and the walls are made of sod blocks that corbel slightly toward the interior. The roof is a dome formed by firmly tied straw bundles (Posnansky 1937:

16. Emilio Romero refers to these structures as "*cuchi-putucos*" (*putuku* for pigs) which are built of *ch'ampa* and adobe, resembling truncated cones having a diameter no larger than 2 m, and similar to the ones built by the Ostiaks of Siberia. It is not clear whether he is referring to houses or to the smaller *putuku* which are also built for keeping pigs. Such pig houses (known as *k'uc'iputu*) were reported by La Barre (1948:96) in Bolivia, near Lucurmata. He describes this small structure as a "cobblestone-and-mud domed house about four feet high".

17. Mesa and Gisbert (1966:492-493) and Gisbert (1988: 124-125) refer to these one-room rural and urban structures as houses. However, no information is given as to whether each structure is an individual house, or whether two or more of them form a household. This information would be useful for comparison with the household clusters of Yanaoqo. The classification of houses into rural and urban is not clear either, and the building material referred to as chunks of mud directly cut from the ground, is most likely also *ch'ampa*.

figure 57; La Barre 1946: plate 114) made more solid by a mud paste, and is thatched with grass secured by a net rope over the dome. The door is 1.20 m high, the height of the walls 2.20 m, and the maximum height of the entire structure about 4 m (Gasparini and Margolies 1980:141-142, figures 125-126; Mesa and Gisbert 1966: 492-493).

The rural houses of the Chipaya, also known as *putuku* (see note 16), are one-room structures similar to the ones described above, but the corbeling of the walls extends upward to form a vault (Posnansky 1937: figure 104; Mesa and Gisbert 1966:493; Gasparini and Margolies 1980: figures 133-134).

Both kinds of circular structures, the corbel vaulted and the thatch domed, may be found together (Gasparini and Margolies 1980: figure 129; Posnansky 1937: figure 51). Furthermore, La Barre (1948:94-95) indicates that among the Uru of the Desaguadero River area, Ancoaqui, and in the Aymara village of Cañaviri, circular and rectangular gabled structures occur in equal numbers. From Wankarani, Ponce Sanginés (1970: figure 9) shows a circular and a rectangular gabled structure, both with thatched roofs, side by side. From the same period of time, Gisbert (1980: figure 16) reproduces a watercolor illustration of Poopó, in which four *putuku* having circular plans together with gabled structures are in front of a colonial church. Furthermore, Tschopik (1946:529, plate 110 top, from the desert of Carangas, and center, from the village of Punata) illustrates corbel vaulted sod structures of rectangular plan, that form clusters, each enclosed by a rectangular wall, similar to the *putuku* described in Yanaoqo.

Regarding the orientation of doors, La Barre (1948:93) notes that 75% of the Aymara houses in rural areas have the doors facing east, and when these are located in villages the doors face toward the plaza. Likewise, La Barre (1946:578) indicates that most Uru houses have the entrance always facing east; Posnansky (1937:115-116) notes on the Island of Panza (Lake Poopó) an eastward door orientation for both prehispanic and modern

houses; and Gisbert (1980:27, figures 12-15) describes a similar orientation for the prehistoric burial towers (*chullpa*), the church, and modern structures in the town of Anco-Cala, Department of Oruro. Although most authors do not explicitly indicate the orientation or shape of the door in different areas, it may be noted that their photographs confirm at least a consistent orientation towards one direction. The door jambs appear to be rectangular, with the exception of what appear to be trapezoidal doors in circular thatch-roofed Chipaya houses (Gasparini and Margolies 1980: figure 126). The orientation and shape of doors may be seen in the rows of Chipaya one-room structures shown by Posnansky (1937: figures 51-52; 1958: plate CVII.C.) and by Gasparini and Margolies (1980: figures 125, 129, 133-134).

The basic building materials employed in the construction of structures having a circular plan and straw or *tatora* thatched roofs include sod blocks (Gasparini and Margolies 1980:141-142), or "clay-bound cut turf" (La Barre 1948:93) in combination with stone at the lower layers (Posnansky 1937: figure 36; Gisbert 1980: figure 15). Sod blocks are also employed in building corral walls (La Barre 1948:95-96). The corbel vaulted *putuku* is mainly built of sod blocks. However, Forbes (1870:254-255 cited in La Barre 1948:95) observed round and oval stone houses with corbeled domes on the slopes of Illampu in the mid-nineteenth century. Another example, probably the remains of a corbel vaulted room, was built of very thin adobe (Ponce Sanginés 1970: figure 10).

In conclusion, due to the nature of the information given in dispersed bibliographical references, systematic comparisons between structures at both ends of the Lake Titicaca Basin remain relatively limited. It may be said, however, that the similarities lie chiefly in three aspects: (1) The use of sod blocks of *ch'ampa* without mortar; (2) the technique of corbeling to form a conical vault; (3) similar door dimensions and total height of the structure; and (4) the association of *putuku* with gabled one-room structures. It may be pointed out that the thatched domes on frames of straw and mud represent an adaptation to the lack of

trees in this region (Mesa and Gisbert 1966:493), just as does the corbeling.

On the other hand, outstanding differences include: (1) rows or isolated groups of *putuku*, quite different from the individual household clusters enclosed within rectangular walls in Yanaoqo; and (2) the absence of a *putuku* having a rectangular plan in the south, and the absence of a circular plan in the north. This distribution is a complementary one. An exception to these two characteristics, however, can be found in Bolivia as shown by Tschopik (1946: plate 110). Photographs from the Desert of Carangas provide an exception to the former, while photos of the village of Punata illustrate an exception to the latter, in which there are dispersed household clusters and *putuku* with rectangular plans like those in Yanaoqo.

Regarding the presence of rectangular as opposed to circular *putuku*, two alternatives may be proposed to explain this complementary distribution. It may indicate or reflect two independent building traditions adapted to similar environmental conditions, or may indicate that people in the northern end of the basin had given up circular structures in favor of rectangular ones, as was the case in 1582 for circular houses in Jauja, central highland Peru (Vega 1965 [1582], Volume 1:171). A related case was reported in 1584 by Pedro Mercado Peñaloza dealing with the province of Pacajes in Bolivia, where many *caciques* gave up their circular plan houses to adopt ones with rectangular plans as a result of the Inca conquest (cited in Gisbert 1988:149).

Dispersed vs. Nucleated Settlements: Description and Interpretation

This section provides a broader context for the dispersed nature of settlements as in the case of Yanaoqo, and nucleated ones such as Taraco. Here, the issue of settlements is directly or indirectly related to the patterns developed or instituted during the last four centuries, as well as to those preceding the Spanish domination. Consequently, this section deals with the modern distribution and characteristics of settlements, while the next

section provides the historic and late prehispanic background.¹⁸

With respect to the kind of settlement pattern found in the southern end of the Lake Titicaca Basin, information is meager. Loza Balsa (1971:73), however, very briefly notes the dispersed nature of all the communities in the Aymara territory. Tschopik (1946:528) also states: "True town life seems not to have been typical of the majority of the *Aymara*. Although no reliable figures are available, the bulk of the population appears to have lived in family groups scattered in the *ayllus* of each town . . . In some regions, the *Aymara* live in towns, but occupy houses near their fields during the agricultural season."

These observations, then, coincide to some extent with my characterization of Yanaoqo and surrounding rural communities (Figure 1). Other writers, too, have reported a similar pattern in many rural areas of the north and western portions of the basin. For example, Ortiz Vergara (1965:19) states:

"And there are places in which the indigenous housing is notable for its dispersion, as is found on the Pampa de Ilave, Province of Chucuito, Department of Puno, which is called 'Little London', because of the great number of widely-dispersed houses, which at first glance looks like a forest of houses of immense extent; . . . as is the case in other parts of the department of Puno, such as the Pampa de Taraco, in the Province of Huancané."¹⁹

Similarly, Galdo Pagaza (1967:63), describing the area of the District of Capachica, notes that "In the 8 social divisions nuclear family

18. The reader should also be referred to a work by Teresa Gisbert (1988). Using a diachronic approach, she attempts to document and understand the problem of housing and settlement patterns in Bolivia.

19. "Y, hay lugares, en los cuales, la vivienda indígena tiene como distintivo el de su dispersión, tal como sucede en la Pampa de Ilave, provincia de Chucuito, departamento de Puno, a la cual se le llama 'Londres Chico', por el gran número de viviendas dispersas, que en un primer golpe de vista, parece como un bosque de casas de inmensa extensión; . . . como en otros lugares del departamento de Puno, como la Pampa de Taraco, en la provincia de Huancané . . ."

houses are dispersed and no villages are formed" ("En las 8 parcialidades las viviendas de las familias nucleares se encuentran dispersas, en ninguna de ellas forman poblado"). Finally, Emilio Romero (1928:174) writes in his monograph on Puno:

"The hacienda Indians live well apart in huts, separated one from another by thousands of meters. Those of the *ayllu* live in sheltered spots and in loose, rather than dense, hamlets, not forming villages or towns, so that they do not have urban life. The huts are nearby, separated by large fields. There is another sort of indigenous town that appears to be the remains of colonial reductions, that consists of collections of houses without urban life (known to the Indians as 'estancias')."²⁰

The issue here, then, is whether a rural settlement is clustered, in which case each household unit is built side by side within a given area, or is dispersed. When a rural settlement in a plateau is dispersed, households are widely separated from each other, as in the case of Yanaoqo, where its "boundaries" blend with the surrounding communities, making visual determination of the community difficult (Figure 1). However, recent observations (1992-93), particularly in the Copacabana Peninsula of Bolivia, indicate that each of the present-day dispersed Aymara communities is readily determined as they are bounded or limited by topographic features such as steep hills. We were also informed that the decision as to where to build a house is often made following a consultation with the local *yatiri* who determines or imposes a dispersed pattern (Eduardo Pareja Sifianis, personal communication).

Based on evaluation of historical references (see next section on Historic and Late

Prehistoric Background), and our direct observations in the south highlands, including the Lake Titicaca Basin, a hypothesis may be proposed here, indicating that there are environmental factors (such as climate, topography, and resources) in addition to social and political factors, that may generate or influence the mass population to develop nucleated and/or dispersed settlements patterns as follows:

(1) A dispersed settlement pattern composed of very scattered households is adapted to regions in the plateau of the Lake Titicaca Basin, where a topography of gentle gradient and relative environmental homogeneity is present over a large area. An environment like this would be more or less "evenly and extensively distributed," such that there are no "special" places that would encourage or require concentration or nucleation of settlements. Furthermore, maximization in the exploitation of resources and/or use of land is better achieved by dispersing settlements and scattering individual household clusters.

(2) A nucleated settlement pattern in which households are clustered forming densely populated towns and villages is adapted to regions like those in the Vilcanota Valley in Cusco and the Qolqa Valley in Arequipa. Environments like these are characterized by an irregular and steep topography composed of high slopes, alluvial fans, eroded terrain, tributaries leading to the main valleys, and canyons. Here the settlements are located mainly on rocky, infertile land, or half-way up a mountain slope, so that all possible land on the valley floor is preserved for cultivation and/or irrigation, while pasture lands are also available around the summit. The intensive use of cultivated lands includes terraces which can extend far up the alluvial fans and higher slopes. Johnson and Platt (1930:27, 31, figures 23-28) provide an example of this kind of topography and settlement located in the upper end of the main valley of the Qolqa River (Figure 32), and state that: "But for the alluvial fill of the glacial period the whole region would be pasture land only. It is a striking feature of the better-favored valleys that they are so completely occupied with fields that a larger population cannot find support except

20. "Los indios de hacienda viven dispersos en chozas distantes, separadas por miles de metros unas de otras. Los de ayllu viven en parajes abrigados y en caseríos agrupados, no juntos, no formando aldeas o pueblos, pues no existe entre ellos la vida urbana. Las chozas están proximas, separadas por grandes chacras. Hay otra clase de pueblos indígenas que parecen restos de aquellas reducciones coloniales: agrupamientos de casitas sin vida urbana (llamados entre los indios 'estancias')."

by diminishing the per capita food supply or by part-time employment elsewhere."

Furthermore, it may also be concluded that the *putuku* forming household clusters occur in the context of the former settlement pattern discussed above, and most especially appear to be associated with areas of poor soil drainage and/or near water edges, especially fluctuating ones. These *ch'ampa* structures constitute the best inexpensive weather and water resistant alternative using readily available local materials, and the corbeling provides a solution to the lack of suitable timber for beams in the region. *Ch'ampa* require a flat terrain and undisturbed ground where agricultural activities might otherwise conflict with their appropriate acquisition. Conversely, the *putuku* forming household clusters are absent in the lower valleys where conditions make them less suitable; better drained sloping terrain and large agricultural areas occur there, and trees are available for roofing gabled structures. One might predict, however, that where there is flat terrain, poor drainage, and little conflict with agriculture, sod structures might occur.

Historic and Late Prehistoric Background: Implications for the Archaeology of the Region

Corbel Vaulted Structures and Ch'ampa

The earliest documentation of a *putuku* structure was made by Ephraim George Squier on his journey to the north end of Lake Titicaca, probably around Taraco. At the same time, he pointed out similarities in design with prehistoric burial towers known as *chullpa*, and observed the characteristic remains left after their subsequent abandonment and collapse. Writing more than 100 years ago, Squier (1877:391-392) stated:

"The inhabitants here are all shepherds; and as what there is of solid ground is covered with a thin but tough turf, this is used exclusively in constructing their dwellings and the corrals, or pens for their flocks. Quaint and curious structures they are, looking like tall quadrilateral haystacks. In some of them, attempts had been made at something like architectural adornment; and these, as well as the chulpas,

have a kind of cornice at the point where the roof begins to converge from the vertical walls - a feature suggested perhaps by the chulpas, or a tradition of style descending from the ancient builders of the tombs . . . A few had been deserted and had fallen down, forming mounds of more or less regularity and elevation, in which digging would certainly expose what we generally find in mounds of earth all over the world - bones, fragments of pottery, some battered implements not worth removal, and traces of fire."

However, it should be noted that although he describes the *putuku* as a quadrilateral structure, the illustration he includes is one having a circular plan, and enclosed within a circular wall.

Many chroniclers such as Cieza de León (1962 [1553]: Chapter 63), Bernabé Cobo, and Vásquez de Espinosa (1948 [1617]: Section 69, page 26; Section 1609, pp. 558-559), have described these burial towers, but none of them (including Beronio's Aymara vocabulary and González Holguín's Quechua dictionary) use the word *chullpa* in reference to these structures (see also reference to *pu-cullo* in note 1). For our purposes, however, Cobo (1890-93 [1653]:236, vol. 4) describes the inner core of these burial towers as a corbeled vault, and referring to those present in Bolivia, he states:

"Inside there are spaces a little more than six feet deep, like a vault, which are closed with some wide, thin stones."²¹

On the other hand, Squier's surveys and descriptions of *chullpa* in this region are certainly the most extensive undertaken before the turn of the present century. Six years before his well-known work appeared in 1877, he wrote an article in which he seriated the *chullpa* and other related structures based on the form and technique employed (Squier 1871), constituting the first attempt at an evolutionary seriation of burial structures in Peruvian archaeology (S. Chávez 1979:319-321). Of importance here is his observation and documentation of an interior corbeled

21. "Por dentro están huecas poco más de un estado, á manera de bóveda, la cual cierran unas piedras anchas y delgadas."

vault in many rectangular and circular *chullpa* from the Puno region (Figure 30). Subsequent studies have confirmed that all *chullpa* retain an interior corbeled vault (M. Tschopik 1946:12-16; Gasparini and Margolies 1980:154).

In addition to *chullpa*, there is also an Inca "palace" with corbel vaulted roofs first documented by Squier (1877:343-346, and figure facing p. 343) from the Island of Titicaca (the Island of the Sun). This "palace" known as Pilco Kayma is a two-story building, where a ground floor formed by several rectangular rooms, each with very large double and triple jamb niches and corbel vaulted slab roofs, supports a second floor with additional rectangular rooms. Gasparini and Margolies (1980:262) observe that Tiahuanaco and Inca architectural decorative elements are integrated at Pilco Kayma.

Most of the references and comparisons made between the prehispanic corbel vaulted structures in the Maya-mesoamerican and Andean regions, as well as comparisons with the *putuku* of the southern end of the Lake Titicaca Basin may be found in: Smith (1940:202-221), Trimborn (1973:185-190), and Gasparini and Margolies (1980:142-159). No detailed literature existed for the northern basin, so that comparisons can now be extended to include the *putuku* described here for the north portion of the basin, which combines a rectangular wall with a circular corbeled vault.²²

22. Gasparini and Margolies (1980:142) conclude that while "the Maya corbeled vault almost always covers spaces arising from rectangular plans; the Andean corbeled vault, on the other hand, covers an interior space based on a circular plan." Although this statement is certainly true in light of the evidence provided among the prehistoric *chullpa* and the modern *putuku* of the southern end of the basin, our northern ethnographic examples of corbeled vaults adds the rectangular form and extends the possibility of its presence in prehispanic times. The "palace" of Pilco Kayma shows corbeling on rectangular walls in Inca times. Likewise, their assertion that "... the corbeled vaults of the Andean cultures (figure 129) [referring to Chipaya houses in Bolivia] are rough, without the least attempt to smooth the finish" (Gasparini and Margolies 1980:144), certainly does not describe the *putuku* of the north. Here, this description does not apply unless they

As we have seen, corbel vaulted structures were present in the burial towers of the region dating back to perhaps the Late Intermediate Period. In this respect, Hermann Trimborn (1973:189) proposes that the Ayмара of the altiplano may have discovered the corbel vault and introduced it to the coast. Similar structures are also present in the departments of Junín, Pasco, and Huánuco and might represent an influence from Tiahuanaco-Huari times (Gasparini and Margolies 1980:144-145). Although references to free-standing (*i.e.* apart from *chullpa* interiors) corbel vaulted structures are not mentioned by chroniclers, such structures were probably present from at least the Late Intermediate Period in the Lake Titicaca Basin, and may have developed as a result of an architectural adaptation to an environment where appropriate trees are absent, while alternative and readily available building material, like *ch'ampa* and stone, are present.

A related, but much simpler form of corbel vaulted structure is commonly used today in the highlands in the construction of temporary baking ovens known as *huathia*, which may also represent an ancient technique. These ovens are usually built near the agricultural fields using the compacted clumps of earth there (*k'urpa*), and can be about 70 cm in diameter and height. The relatively simple procedure of arching a door, corbeling about

are in a state of disrepair, great care is given during construction to shave and smooth the exterior which can also be finely plastered, as well as the rectangular portion of the interior.

Corbel vaulted structures may also be compared to the more recent house structures found in southeastern Italy known as *trullo* (singular) or *trulli* (plural), and the use of sod as building material to the sod houses of the north-central United States (see notes 5, 6, and 13, above). The corbel vaulted *trulli* (Allen 1969; Rudofsky 1964:figure 49) are built of slabs or slates of field limestone and without cement or mortar, may be plastered on the interior, and are reported to be well-adapted to summer and winter conditions. The lower wall portion has a rectangular plan, rectangular door, and windows are rare. The household clusters include several one-room structures adjoining one another which are added onto the original unit as needed, one at a time. The extremely thick walls (5-7 feet) are due to the abundance of stone in the region and the need to clean the fields for agriculture (Wilstach 1930:*passim*).

six layers of *k'urpa*, heating to red hot the interior, then collapsing the upper portion to place such products as oca and potato, and subsequently compacting and covering the oven with loose soil, provides the root crops with a different and appealing flavor.

Furthermore, corbel vaulted structures are also made today as temporary shelters using unworked slabs. We observed such structures in the Huaqoto basalt quarry near Cusco. This site is above the tree line at 4150 m., and is currently quarried by a small population of stone workers who reside in a nearby village. At this quarry, some masons carve stone blocks inside temporary corbeled shelters made of natural stone slabs and open on one side. Some of these have been deserted and, based on the surface pottery and a nearby large stone enclosure, the site may date to Inca times.

In addition, it should also be noted that the corbel vaulted technique was not only employed in covering three-dimensional structures, but also occurred in façades forming doors, corbeled arches, and stepped niches (e.g., at the Island of Koati [Gasparini and Margolies 1980:264, figure 255]; and as doors of rectangular *chullpa* at Curahuara de Carangas, Oruro Department in Bolivia [Mesa and Gisbert 1966: plate 3]). In this respect, several examples of niches (some with two stories) having corbel vaulted roofs and doors, one about 2 m in height and depth, are found at Huata (Figure 31). This hilltop site is some 29.6 km west of the city of Cusco, and about three hours by foot climbing steep hills to the summit which overlooks the valley around the town of Huarucondo. There are several fortification walls, some remaining to a height of 7 m, rectangular and circular structures (including a *chullpa*), most built of fieldstone and mud, unlike Inca stone masonry. A short description of the site was published by Rowe (1944:53, plate VII, figure 6, and plate VIII, figures 1-3), and a more extensive reference can be found in Kendall (1976:72-77, plates 15-16, and plan 8).

In conclusion, the form of a corbel vaulted structure has been documented on an

Inca building from the Island of Titicaca and on different burial towers and niches which may just predate and/or be contemporary with Inca occupation. Regarding the use of *ch'ampa* (aside from the *ch'ampa*-built *chullpa* of unknown date reported by La Barre in Bolivia [1948:95]), no other such structures or remains of households have been reported or preserved archaeologically. Even in the Cusco region no Inca sod structures have been preserved (Niles 1987:215), but the use of *ch'ampa* must certainly be ancient.

Unlike the relatively good preservation of adobe (e.g., K. Chávez 1982:258, figure 10 from a 1000 B.C. context at the site of Marcavalle in Cusco; Moorehead 1979 on Inca structures in the Cusco region), and *pirca* or round stones set in mud (e.g., K. Chávez 1989:18, figure 1 from the architectural complex at Chiripa in Bolivia dating from 900 to 100 B.C.), *ch'ampa* by its very nature may disintegrate and quickly blend with the surrounding soil, making its archaeological detection more difficult. On the other hand, there is a relative ignorance in the ethnographic and related literature about the importance of *ch'ampa* as a basic building material in favor of stone and mud (and related uses of mud as adobe or *tapia*, and in *pirca*). In fact, a volume entirely devoted to Andean technology (Ravines 1978) makes no references to *ch'ampa*.

At any rate, *ch'ampa* should not be underestimated as a readily available building material. The extensive and effective use of the material documented here may have also solved similar structural problems in prehispanic times. These problems include the production of domestic architecture for large populations, especially in regions where severe climatic conditions existed and suitable trees for construction were absent. Therefore, it is possible that the bulk of many prehispanic populations in the region may have lived in structures and settlements not unlike those described here for Yanaoqo. In this respect, even the early structures at the site of Chiripa in Bolivia (ca. 600 B.C.) have now been reinterpreted as part of a temple-storage complex of the Yaya-Mama Religious Tradition, rather

than as a nucleated village (K. Chávez 1989). Likewise, the large and complex Pucara site in Peru (ca. 100 B.C.) still lacks convincing evidence for a truly domestic occupation (S. Chávez 1992). Hence, domestic structures and settlements may still await detection as dispersed rather than nucleated settlements, with houses made of the more perishable *ch'ampa* rather than of adobe and/or stone, and containing relatively modest household/cultural remains.

The following characteristics may be used as possible archaeological indicators in the detection of *ch'ampa* built structures, and possibly even of corbel vaulted structures. The list derives from the ethnographic cases and observations presented here:

1. Following Squier's observations (1877:391-392), a collapsed *putuku* (or any *ch'ampa* built house) would form small mounds, each of about consistent size and shape, and perhaps even forming clusters. Based on our observations, the first blocks to collapse are those on the upper corbeled portion (Figure 15), and the inclination of all walls and the dome toward the interior would probably also encourage further collapse of blocks toward the interior of the room.
2. Pottery and other non-perishable remains may be found in front of and/or inside the structure(s). Sometimes a stone slab is permanently placed in front of the exterior door sill.
3. If the structure had a multi-purpose use, then it is possible that a consistent arrangement of interior features may also be present such as observed in Yanaoqo: as one enters the room, a stove in the corner left of the door, a rocker mill or grinding slab in the left corner opposite the door, and a platform used as a bed on the right side wall. In addition, some kind of *pago* or offering (like a small pot, for example) should remain buried in the center of the room.
4. Long and narrow mounds visible on the surface may indicate remains of previous *ch'ampa* built walls or causeways in tempo-

rarily inundated areas. Other mounds may indicate raised platforms for structures.

Settlement Patterns

The bulk of prehispanic populations probably followed a dispersed pattern here, with a major nucleation around ceremonial centers beginning in the Early Intermediate Period such as at the site of Pucara. For example, Kidder (1943:18), based on archaeological reconnaissance carried out in Taraco and in Saman 2.5 km to the west, indicates that "both places may well have been part of a single scattered settlement with ceremonial centers at various points." Kidder (1956:153) also noted that: "with farmland less restricted than on the coast and with herds to care for, the Titicaca highlanders, at least, were probably widely dispersed at this period [Pucara, Tiahuanaco]. I also believe that this continued until fairly late, when large villages and towns begin to appear [just pre-Inca/Inca]." Likewise, John H. Rowe (1946:228-229), describing the Inca towns, states that:

"Most Indian towns grew up without benefit of architect, and the houses were consequently scattered in a haphazard manner along the paths already in use . . . Cobo remarks that such towns had no regular streets or squares, and the houses were quite widely separated. They were built on slopes and rocky places when possible so as not to occupy land that can be cultivated . . . The *Inca* initiated a policy of urbanization to relocate the Indian towns where they would have easier access to their fields and be further removed from their old forts... The ideal town seems to have been laid out in square blocks, each containing one, two, or four *kancha*-type enclosures, but this was modified in practice to fit the topography . . . *Inca* towns were not much bigger than the unplanned towns of earlier periods, and the *Inca* seem not to have practiced urban concentration in the European sense."

A review of the early historical literature indicates that beginning early in the Colonial Period this pattern was changed. However, two territorial divisions were established. First was the *corregimiento* for rural Spanish administration (dispersed settlements were moved and nucleated). Subsequently, the *capitanía* was established and set up to obtain labor for the mines. According to Julien

(1983:10), *capitanías* followed the Inca provincial divisions. For example, during the *visita* (inspection tour) made in 1567 to the Province of Chucuito, there were dispersed settlements and these were joined with others to facilitate the Indian indoctrination into the Catholic faith (Diez de San Miguel 1964 [1569]:25, 35, 52). The actual reconcentration of dispersed populations was undertaken on a pan-Andean scale in 1571, with the administrative reforms instituted by the fifth viceroy, Francisco de Toledo (e.g., Kubler 1946:337, 345-346; Dobyns and Doughty 1976:92-93). Specifically, an *Ordenanza* (regulation) instituted by Toledo (Ballestéros 1752:150) given in Ciudad de la Plata on February 7, 1574, reads:

"... orders that as for the Yanacona Indians, who have and have had many persons in their fields in this Province of Charcas, who were (as ordered by the Viceroy) to be visited by certain persons, so that the said Indians would be reduced, and made to live, in a manner that would permit their being instructed in the things of our Holy Catholic Faith ... and to have many years in which they will not have to pay tribute if they can be moved right away, and placed under the Royal Crown as ordered by His Majesty and as laid out in his laws and Royal Provisions, bringing them together and reducing them into towns so that they pay tribute to His Majesty ..."²³

In addition, Gisbert (1988:118) provides a version from unpublished manuscripts housed in the Archivo de Sucre, of additional related information, as follows:

"... in that all the Indians have been reduced into towns set up on the places chosen for them by the *visitadores generales* ... I order

23. "... dar orden en lo que tocava á los Indios Yanaconas, que tienen y han tenido en sus Chacras muchas perfonas en esta Provincia de los Charcas, las cuales el dicho nueftro Viforey á hecho que fe vifiten por perfonas particulares, para que los dichos Indios eftuvieffen reducidos, é poblados, de manera que pudieffen fer enfeñados, y doctrinados en las cofas de nuefta Santa Fé Catolica ... y aver tantos años que no pagan tributo se les pudieran quitar defde luego, y ponerlos en la Corona Real como Yanaconas vacos, como fu Mageftad lo manda, y tiene ordenado por fus leyes, Provifiones Reales, juntandolos, y reduciendolos á Pueblos para que alli pagaffen tributos á fu Mageftad . . ."

that the said towns shall not move to other places, nor will the said judges allow them to move, before they understand that the said reduction shall be carried out, and that the said towns shall be built to the given plan, and that the Indians shall make their houses. Those not made to the agreed plan shall be destroyed, along with any remaining old houses, and those who have to build anew shall be given a hundred lashes in public if they are common Indians, and if they are caciques and leaders they shall be fined 30 pesos ... and the houses shall be destroyed at their own expense in such a manner that nothing remains of the buildings in which the ancient Indians used to live ... and they shall be destroyed with the exception of the homes that will be given to each judge who is to carry out what is ordered by the said *visitadores* in the places where they are to make their plantings in which, by being far from the towns, they will have to pass the night."²⁴

The so-called "reducciones de Indios," then, reduced the number of settlements and increased their individual size to facilitate Spanish missionary and administrative efforts. However, at the end Toledo's reforms were not totally successful; for example in Bolivia Gisbert (1988:119) notes that some settlements maintained their ancient characteristics (e.g., Chipaya), others returned to the ancient pattern (e.g., Ancocala in Oruro), some were abandoned (e.g., Caiza in Potosí), or their populations were relocated (e.g., Quescamarca in Pacajes-Omasuyo moved to the new town

24. "por quanto por los visitadores generales todos los Indios están reducidos a pueblos elegidos a los sitios en lugares de ellos ... mando que dichos pueblos no se muden a otra parte, ni los dichos jueces los dejen mudar, antes entiendan en que la dicha reducción se concluya y acabe, y los dichos pueblos lleven la traza que les está dada, y los Indios hagan sus casas. Los que no tuviesen hechas conforme a la dicha traza ... mandamos derrocar [y] las casas [antiguas] si algunas quedaron fechas, y al que se hallare que las hace de nuevo le serán dados cien azotes, publicamente si fuere indio común y si fuere cacique e principal será condendo con pena de 30 pesos ... e se le derruequen a su costa por manera que por ninguna via deje, o haya de dejar rastro de las casas viejas donde antiguamente vivieron los antiguos indios ... y serán derrocados a su costa excepto las casas que se dará por memoria a cada juez que han de dejar conforme a lo ordenado por dichos visitadores en las partes donde han de hacer sus sementeras que por estar lejos de sus pueblos se han de quedar alguna noche."

of Pucarani). Likewise, for the northern portion of the basin, Ortiz Vergara (1965:18-19) remarks that in the great majority of cases Toledo's reforms failed to achieve its goals, and the settlements continued to be dispersed as can be seen today in the Pampa de Ilave and Taraco.

Nevertheless, it should also be pointed out that in areas where Toledo's reforms were successfully implemented, the effects on the traditional settlements were drastic and massive. For example, within the province of Pacajes in the southern basin, Mercado Peñaloza (cited in Gisbert 1988:122) reports the reduction of more than 73 ancient settlements into 12 *pueblos*.

The nature of the two sites used in our study and the characteristic settlements they represent (the dispersed rural community of Yanaoqo and the urban/nucleated town of Taraco) may certainly also be related to the same forces that shaped the present nature of those described for the southern portion of the basin. Yanaoqo and its surrounding rural communities may have maintained or returned to their original dispersed character after the *corregimiento*. Taraco, on the other hand, retains many characteristics of the Spanish-imposed plan, as proposed by Juan de Matienzo in 1567 (who also accompanied Toledo in his journey through the southern portions of the Viceroyalty): A plaza surrounded by *calles*, *cuadras con solares*, *casa del padre* (streets, blocks of houses, and a rectory) next to the church, and *casa de concejo* (town hall) (Matienzo 1910 [1567]). Here, the social and natural environments in which these communities developed await the input from archaeology and history to document, explain, and incorporate them within a wider Andean context. Specifically, the determination of whether "a site" represents a dispersed or nucleated pattern is an important issue to be considered during archaeological reconnaissance and surface survey.

The issue of rural and urban settlements, as well as the use of appropriate building materials and technology, continues to be part of an ongoing process. Despite several expen-

sive developmental programs over the last 50 years, instituted and/or supported by the Central Government to "integrate the *campesinado* into the national society" (Fonseca and Mayer 1988:185), this region continues to be one of the forgotten parts of the country. Substantial populations have migrated to the larger cities attracted by ideals of "*progreso y adelanto*" ("progress and getting ahead"). On the other hand, places like Taraco, having a population of higher social and economic status, maintain their position in relation to communities like Yanaoqo. In the former, brick and cement structures are already beginning to be built (including a Catholic complex for spiritual retreat, and a cement bridge over the Ramis River halted for lack of funds). In Yanaoqo, in contrast, materials like "tin" or corrugated iron roofs have become so expensive that there is a continued building of structures like the *putuku* in appropriate technology and materials.

On the other hand, a university-trained professional builder knows more about building a brick and cement chalet, is always knowledgeable about modern designs, and is willing to apply foreign and "efficient" materials (such as asbestos-based roof tiles and water pipes in Puno; Teobaldo Yábar, personal communication), while he most likely ignores even the existence of *putuku*. Likewise, the *campesino* who migrates to the city is readily available to be trained as a construction worker to help, more often than not, to build a house which he cannot afford to own. In this respect, a statement made by Jorge Flores Ochoa (1988:258) regarding programs of technical cooperation to "improve Puno's livestock," seems also appropriate here:

"In this manner and with national backing, one will have closed once again a new cycle of neocolonialism, technological dependency and economic domination, sustained by the imposition of foreign technologies, thanks to our myopia or inertia when faced by the Andean techniques, the efficacy of which we do not test experimentally, much less improve, because we do not even know of their existence."²⁵

25. "De esta manera y con apoyo nacional, se habrá vuelto a cerrar una vez más un nuevo ciclo de neocolo-

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nialism, dependencia tecnológica y dominación económica, sustentados en la imposición de tecnologías foráneas, gracias a nuestra miopía o inercia frente a las técnicas andinas, cuya eficacia ni siquiera nos ponemos a evaluar en vías de experimentación, mucho menos a mejorar, porque ignoramos hasta su misma existencia."

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Table 1. Comparisons of *Putuku* Attributes in the Northern Lake Titicaca Basin

CHARACTERISTICS	YANAOQO	TARACO
Rectangular plan without foundations	X	X
Approx. degrees of wall inclination	8°	5°
Circular vault	X	
Rectangular vault or equivalent	X ^a	X
Trapezoidal door jamb	X	
Rectangular door jamb		X
Entryway	X	X
Door sill above ground	X	X
Use of wooden beams in door lintel	X	X
Smoke vents at the apex	X	
Vents in the upper and lower portions	X	1 case
Niches in the interior	X	1 case
Wooden supports at the four corners	X	
Wooden pole(s) for hanging things	X ^b	X
Mud plastering of the exterior	X ^c	X
Mud plastering of interior lower walls	X	X
Wooden pegs on interior lower walls	X	
Small addition for storage space	1 case	
Use of <i>ch'ampa</i> in the construction	X	
Use of adobe and/or <i>tapia</i> in construction		X
<i>Putuku</i> within wall enclosures	X	X
Used for cooking, eating, and sleeping	X	
Used for storing harvested products	X ^d	X
Used for housing domestic animals	X	X
Time spent in construction	2 days	5 days
Labor spent in construction	4 people	4 people

a. This shape has been observed at Yanaoqo only in the *taklla putuku*.

b. The long poles supporting the rectangular vault of the *taklla putuku* are also used to hang things.

c. Exterior mud plastering occurs infrequently at Yanaoqo.

d. A *putuku* or *taklla putuku* built exclusively to store products occurs only among families who can afford separate *putuku* for cooking and sleeping.

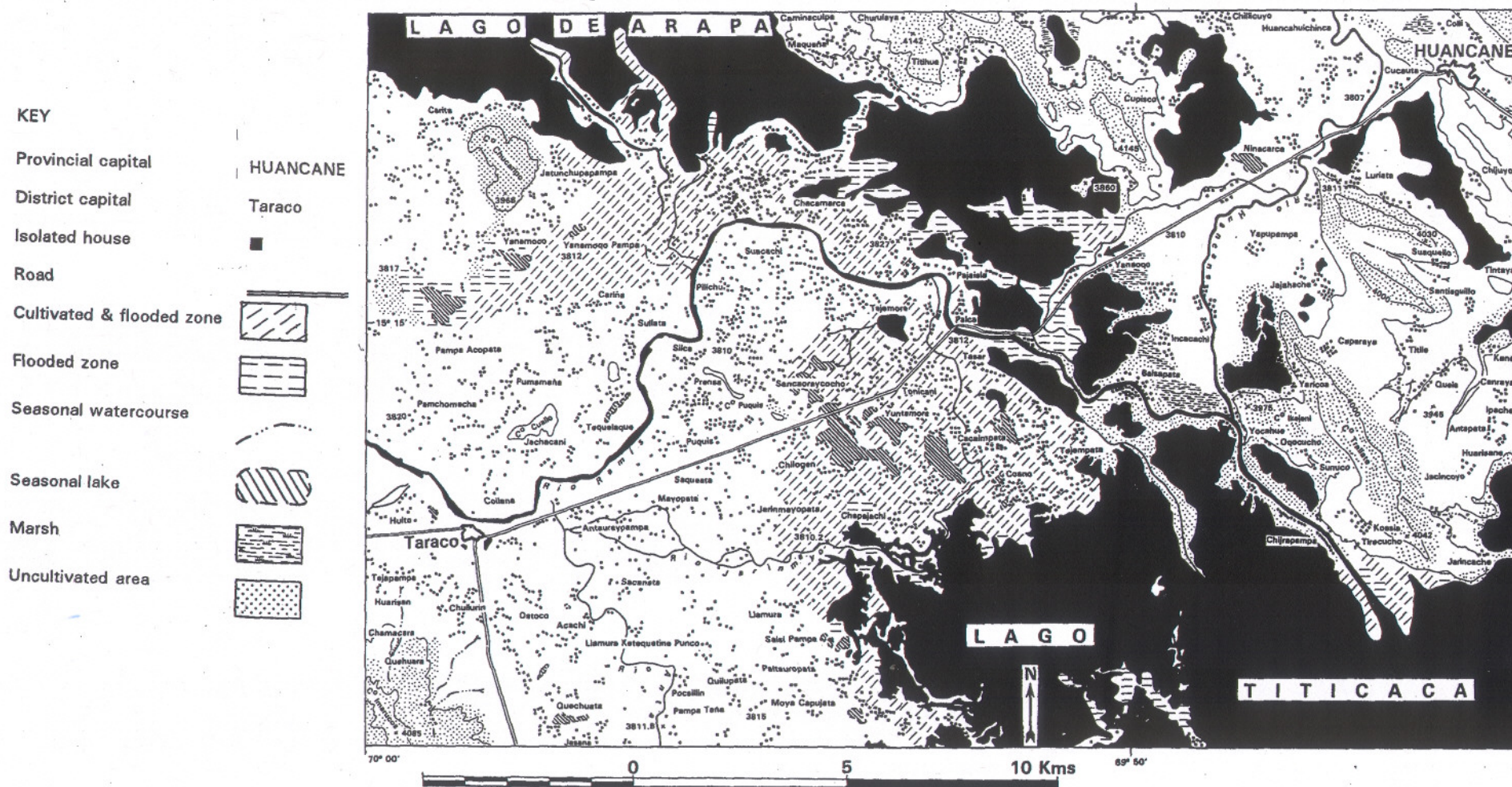


Figure 1. Map of the northern end of the Lake Titicaca Basin, based on Carta Nacional 1:100,000, hoja 31x (Huancané), Instituto Geográfico Militar, 1964. The arrow indicates the location of the *putuku* in construction at Yanaoqo. Rivers, lakes and lagoons are indicated in black; the cultivated terrains are in white; and the contour lines indicate elevations at 3850 and 4000 meters above sea level.



Figure 2. View of a household cluster near Yanaoqo composed of three *putuku* built of *ch'ampa* and enclosed within *tapia* walls. These dispersed household clusters typify the settlement pattern of rural areas.



Figure 3. A *putuku* near Yanaoqo in which guinea pigs are kept. Note the slightly elevated terrain with *ch'ampa* surrounded by a temporary flood from one of the lagoons, and the regrowth of grass at the first layer of *ch'ampa*.



Figures 4 (left) and 5 (right). Steps in the preparation of *ch'ampa* blocks: **4.** The *chaki-taklla* is inserted obliquely into the ground. **5.** The rectangular block which is trapezoidal in cross section is removed.



Figure 6. Third step in the preparation of *ch'ampa* blocks: The underside is evened out with the *chaki-taklla*.



Figure 7. View of an area in Yanaoqo after the *ch'ampa* blocks have been removed. Note the regrowth of grass in the lowermost layers.



Figure 8. Blocks of *ch'ampa* brought from Yanaoqo Pampa and stacked near the site where a *putuku* will be built.



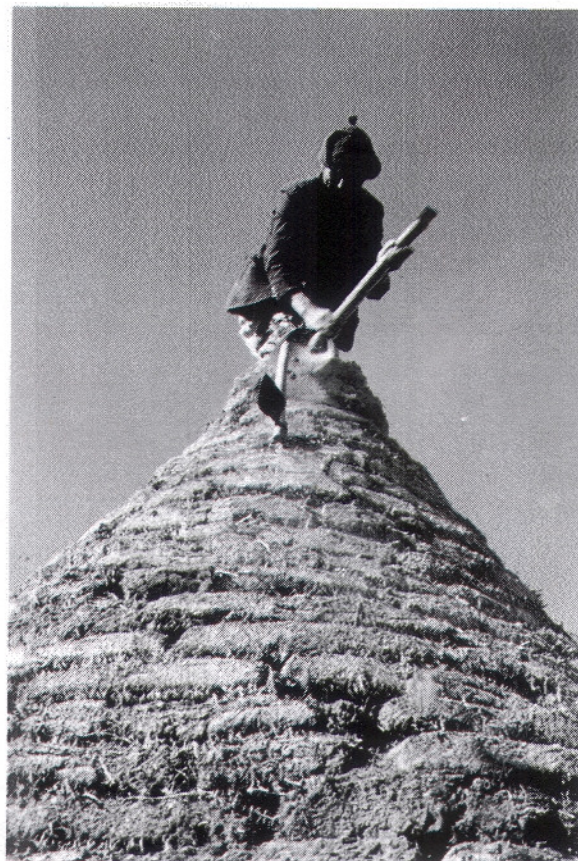
Figure 9. View of the wall surrounding the school at Yanaoqo. This 2 m high wall was built of adobe and mortar on a foundation of *ch'ampa* layers set at ground level for protection against ground moisture, and was capped with *ch'ampa* layers above to protect against rain.



Figure 10. View of a household cluster in Yanaoqo composed of a *putuku*, a small corral on the left, and a gabled structure. The gabled structure is built of adobe with stone foundations which extend about 40 cm above ground. The roof is built of corrugated iron sheets, the door is carpentry made, and the glass windows have metal frames. The structure being built is a *putuku*.



Figure 11. A *ch'ampa* block in the process of being reshaped with the *chaki-taklla* to be used in the corbel vaulted portion of the *putuku*.



Figures 12 (left) and 13 (right). Two views showing the construction of the new *putuku*: **12.** The last *ch'ampa* block is being placed at the apex. **13.** The exterior of the corbel vault is being scraped and evened out with the shovel.



Figure 14. Close-up view of the front of the new *putuku* in Figures 12-13. Note the vents at the right and above the door, and one of the temporary wooden supports inside the door.



Figure 15. An abandoned household cluster in Yanaoqo. Note the doors closed with *ch'ampa* blocks, and the collapse of the entryway and apex portions.



Figure 16. A household cluster in Yanaoqo composed of three *putuku*. Note the *putuku* in the center which has a convex-walled vault in contrast to the conical vault to the right.



Figure 17. Corbel vaulted structures in the household cluster belonging to Mariano Quispe Bautista, our informant and *putuku* builder, and his wife Paula Caira Larico in Yanaoqo. A *putuku* being used for cooking, eating and sleeping. Note the small extension at the right side, and the two stone vessels from the Island of Amantani.



Figure 18. Corbel vaulted structures in the household cluster belonging to Mariano Quispe Bautista, our informant and *putuku* builder, and his wife Paula Caira Larico in Yanaoqo. A *putuku* built by Mariano's father which was being disassembled in order to rebuild it. Note the adobe gabled structure thatched with *titora* at the right.



Figure 19. The northern portion of Mariano's household cluster. A corral attached to the northwest corner walls, in which two of the walls are built of two layers of irregular stone at the bottom followed by *ch'ampa* layers on top.



Figure 20. The northern portion of Mariano's household cluster. Mariano standing next to the corral holding a fishing implement he made. Note the adobe wall behind the corral with an additional layer of *ch'ampa* at the top, and the wall surrounding the school of Yanaoqo in the background.



Figure 21. View from Taraco north towards the Ramis River and beyond to the community of Qollana, a rural settlement comprised of many dispersed household clusters.



Figure 22. Partial view of Taraco, an example of a nucleated settlement. In the center is the tower of the church of San Táraco. Note the two abandoned *putuku* in the house lot enclosed by *tapia* walls.



Figure 23. Two corbel vaulted structures within a *tapia* wall enclosure used for keeping harvested products. The large *putuku* is part of the enclosure wall, and the wall in the foreground borders a portion of one of the streets in Taraco.



Figure 24. Exterior view of the corbeled vault seen in the large *putuku* of Figure 23. Standing next to the doorway of this *tapia* and adobe built *putuku* is Francisco Palomino Olivera who was our informant and builder of this structure.



Figure 25. Interior view of the corbeled vault seen in the large *putuku* of Figure 23, showing the technique used in building and closing the adobe corbeled vault. The wood pole set into the north and south walls is used for hanging things.

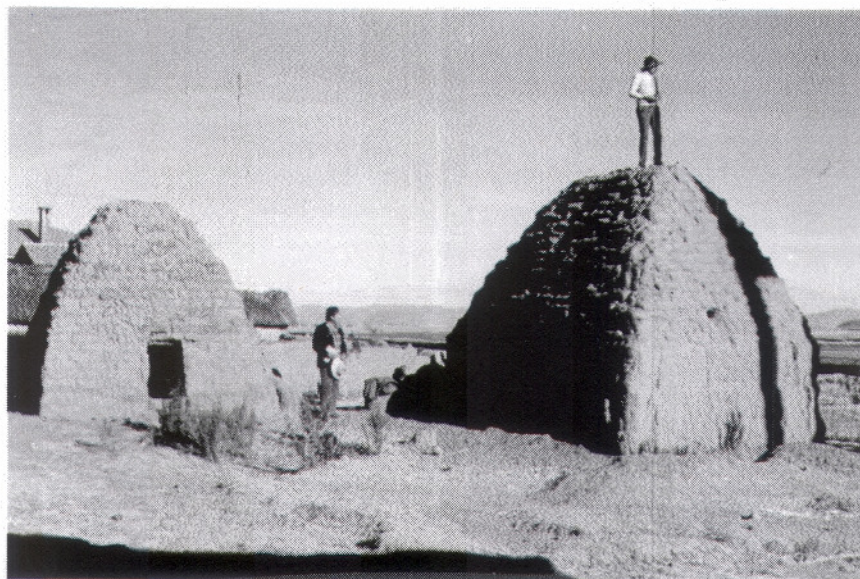


Figure 26. Abandoned *putuku* in Taraco. The large *putuku* was built of *tapia* and adobe, and the medium-sized one was built entirely of adobe and mortar.



Figure 27. Abandoned *putuku* in Taraco. Interior view of the corbeled vault of the medium sized *putuku*. Compare the well defined sides or corners of the corbeled vault here and the purposeful avoidance of them in Figures 24-25.



Figure 28. View of the large *putuku* of Figure 26 built of *tapia* and adobe.

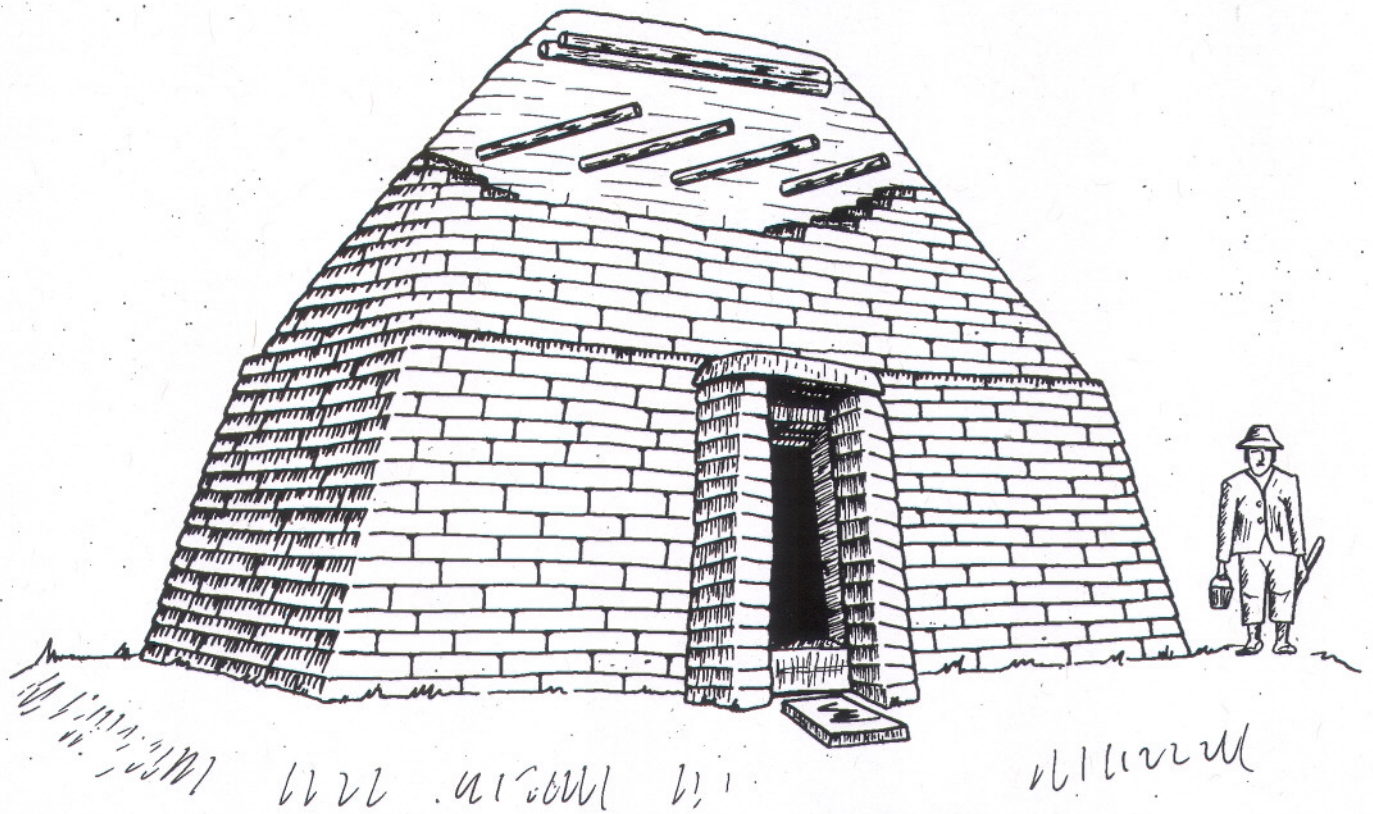


Figure 29. Drawing of a *ch'ampa*-built *taklla putuku*.

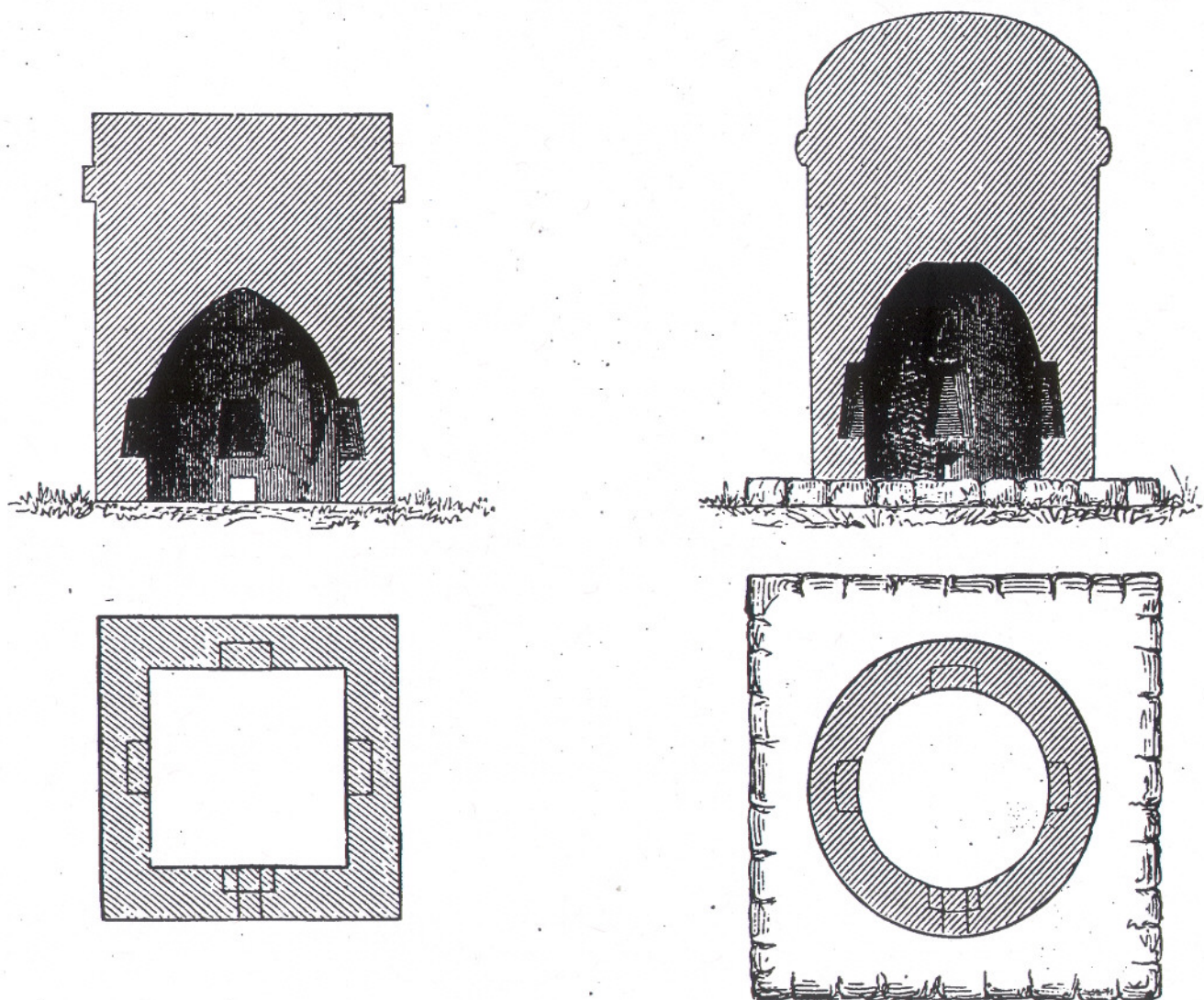


Figure 30. Plan and section of a circular and a square *chullpa* in Puno, the first such illustration of *chullpa* with interior corbel vaults. After Squier 1877:353.



Figure 31. A corbel vaulted niche about 2 m in height and depth at the site of Huata north of Cusco. Photograph taken by Ann Kendall during a trip to Huata with the author.

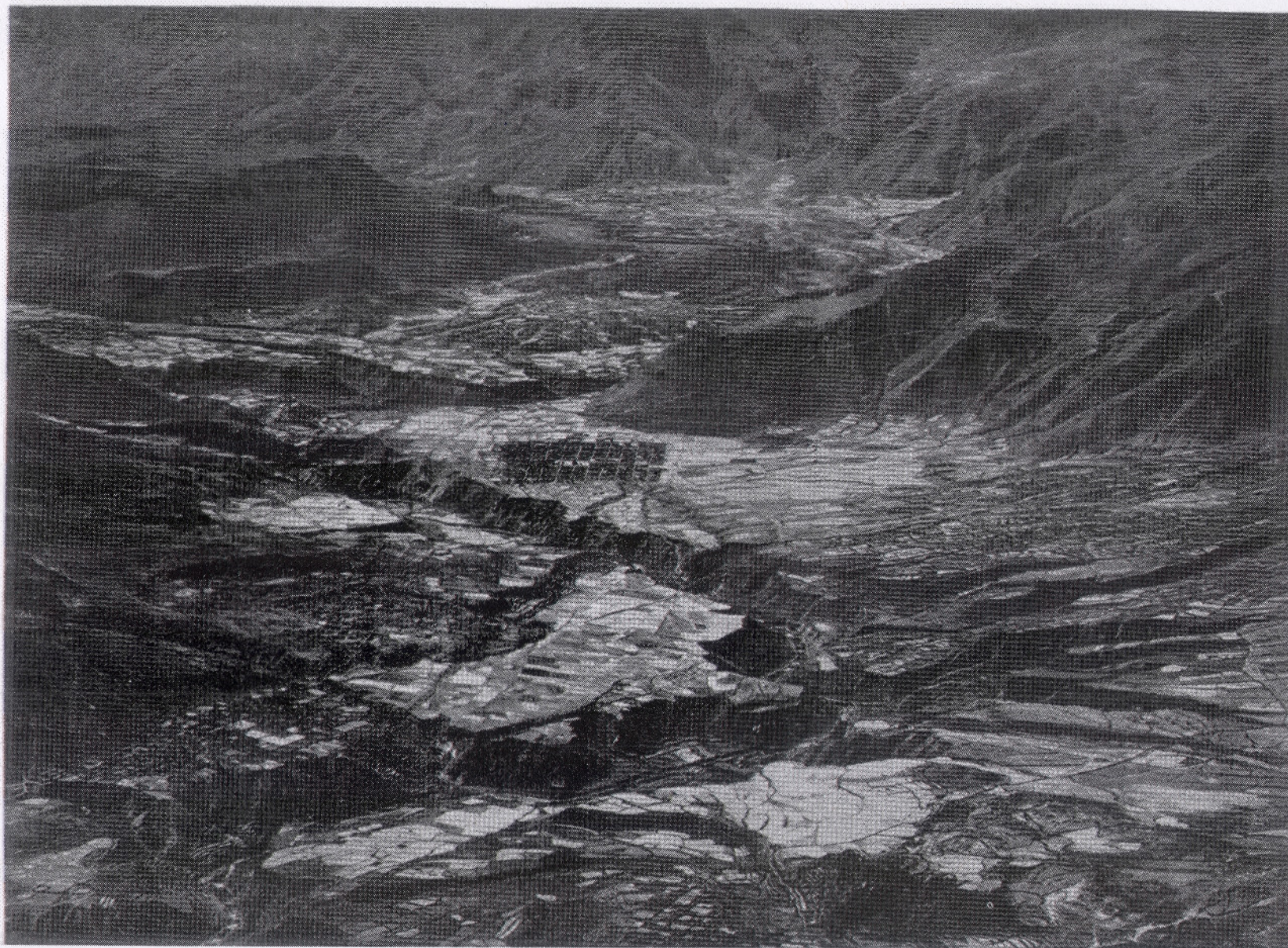


Figure 32. View of at least five clustered settlements in the lower valleys of the Qolqa River (in contrast to dispersed settlements in the Lake Titicaca Basin). From an air photograph in Johnson and Platt (1930: figure 28).