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Informe: Lukurmata

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## INFORME: LUKURMATA

H. Lennstrom, C. Hastorf, and M. Wright  
Archaeobotany Laboratory Report #28  
University of Minnesota  
June, 1992

Introduction

Flotation samples were recovered from several parts of the site of Lukurmata during the 1986 and 1987 field seasons. Contexts sampled include habitation areas, the temple complex, and burials.

The strategy selected for our first phase of paleoethnobotanical analysis has been threefold: 1) to analyze at least some samples from all areas, 2) to focus on domestic areas, and 3) to work only with samples where information concerning cultural contexts, field notes, etc., were available. At the close of the 1989 field season we finished flotation of all available Lukurmata samples (approximately 223) which were then returned to the US. Because Lukurmata was one of the first areas we worked on in the lab, a large proportion of the samples were analyzed--a total of 140 or 63%.

As noted above, we tried to focus on the most informative materials, and did not complete many samples from the fill of the temple. Of the 140 samples completed 37 do not yet have secure cultural contexts, 8 are from ash deposits, 14 are from burials, 3 are from fill, 10 are from hearths, 7 are from midden, 12 are from occupation zones or surfaces, 3 are from offerings, 5 are from pits (non-trash pits), 16 are from trash pits, and 5 are from the inside of ceramic vessels. Time periods have not been separated, but it appears that the bulk of the samples examined date to the height of the Tiwanaku Empire. We did not focus on the later materials from K. Wise's area.

Individual sample size (site matrix prior to flotation) was small and varied somewhat. The mean number of liters per sample is 1.5, with a median of 1.6 and a range from 0.3 to 4.4 l. This disparity in sample size may cause distortion in some quantification schemes, as apparent differences may simply be a function of small and irregular sample sizes. Further, comparisons between this material and samples from the Tiwanaku habitation areas are difficult, as the latter averaged between 5 and 7 liters. For these reasons quantifications must be examined carefully, and DENSITIES are known to be more reliable than UBIQUITIES (Lennstrom 1991).

Methods*Field methods*

Botanical samples were processed using a motorized flotation system, modified from the SMAP machine design first published by Watson in 1976. Because the charred materials have a lower specific gravity than water, they float on the water's surface and can be poured off. Our machine is built from a 55 gallon oil drum as a water container, that is used to separate charred plant remains from the site matrix. Water is pumped into the system from below, and is moved upward in the drum by a submerged shower head. Inside the drum is a removable inner bucket, with a mesh bottom that the soil samples are poured into once it is partially submerged in the machine. The bottom mesh catches rocks, artifacts, and bones that do not float. This material that is caught is termed the "heavy fraction". It is dried, and the cultural material larger than 2 mm is removed and analyzed. In 1989 we used brass cloth in the bottom of the inner bucket, with an aperture of 0.5mm.

The charred plant remains on the surface of the water are poured off through a spout into fine-meshed chiffon. This material, termed the "light fraction", was allowed to dry, and then packaged for shipment to the University of Minnesota's archaeobotany laboratory.

Approximately 20 samples were processed per day. Each day we added 50 charred poppy seeds to a randomly selected sample to act as a check on the flot machine (see Wagner 1982, 1988). Poppy seeds are used in the Americas because they are not native (and hence will never occur in prehistoric deposits), and they are small in size (ca. 0.4 x 0.6mm). These features allow poppy seeds to act as a measure of the amount of small seeds that are lost or recovered. The average recovery rate for 1989-90 was 93.4% (46.7), indicating that most material from the samples was being recovered.

### *Laboratory methods*

Analysis of the charred plant remains from the light fraction started with removing carbon, bones, and fish scales from the floted matrix (mainly modern plant roots and soil). Lab analysis was done using low power (6-25X) stereoscopic microscopes with fiber optic light sources. Trained lab personnel extracted the charred plant remains from the samples, and made some preliminary identifications of plant taxa. H. Lennstrom checked all charred material removed from the samples and also scanned the remaining matrix for any identifiable plant parts that might have been missed. In addition she was responsible for the final identifications made of the charred plant parts. The identifications were made with the aid of Dr. Hastorf's South American reference collection of seeds, pressed plants, tubers, and wood in the lab. Material from each flot was examined two times, systematically, under the microscope. For ease of sorting, the samples were split using 2mm, 1.18mm, 0.5mm, and 0.3mm geologic sieves, keeping materials of the same size together in a separate tray. All charred material greater than 2 mm was pulled and identified, while wood was not removed from the <2 mm portion of the light fraction, as it is known to be too small for identification purposes (Asch and Asch 1975). Other plant material down to 300 microns was collected and identified. In some cases, when charred plant remains were particularly dense, it was not possible nor necessary to examine the entire sample. We used experimental results from Lennstrom's (1992) work with Peruvian flot samples which found that a 10-25% sub-sample could be used to represent the sample as a whole, if the sample contained several thousand plant fragments and had a total volume of over 0.5 liter of charred botanical remains. Samples were split using a riffle box, so that the sub-samples were divided without bias (Pearsall 1989).

Each sample was recorded on a data sheet, containing information on its provenience, type of sample, cultural context, volume of flot sample, amount of sample analyzed, counts of all the plant taxa that could be identified, and counts of those items that could not be identified. For recording, counts were chosen over weights as some of the seed taxa are very small, and their weights are negligible. Seed fragments and whole seeds were recorded by count. Material from the heavy fractions was identified in the same manner, and tallied on the same data sheet as the light fraction.

Information was transferred from the data sheets into data files on floppy disks that were then loaded onto the mainframe computer. The mainframe used is an IBM 4381 available at the University of Minnesota's St. Paul computer center. Data analysis was carried out using the SAS statistical package (SAS Institute 1985a; 1985b; 1985c; 1985d). This system was chosen for several reasons. First, it had the capability of managing a very large dataset, and provided the types of summary, parametric, and non-parametric statistics which were of interest.

Also, it had an attached graphics package that allowed the plotting of publication quality graphics, without having to transfer data to another system.

### *Sorting strategies for archaeobotanical material in the lab*

Because time and money are always in high demand in the lab there are several different strategies that can be used when sorting and identifying archaeobotanical material to maximize data collection while minimizing time expended. Other considerations are the goals of the study at hand, the quality of the collection and recovery techniques used to retrieve botanical material, and the overall quality of archaeological information available for the interpretation of the materials.

Below are sorting schemes devised especially for flotation samples, where the study of domesticates is the main focus.

#### *Strategy 1: Complete sort*

In the best of all possible worlds it is nice to be able to sort out and identify all prehistoric material from a sample. It is especially desirable because a single flot sample is already only a small sample of any given archaeological context, and one wants as complete a picture as possible. In our case, one would sort out, and identify all charred material, except <2mm wood, which is usually unidentifiable. All bones and other animal and artifactual materials are pulled out and given to appropriate specialists.

This type of strategy gives RATIO level data, with exact counts (and/or weights) entered onto the computer. Descriptive statistics such as RELATIVE PERCENTAGES, DENSITIES, UBIQUITIES, and DIVERSITIES can be generated from this type of data.

This strategy is the most labor intensive, and can be redundant when you work past the point of diminishing returns, ie, you get the exact same values by sorting entire sample that you would by making estimates based on some fraction of the whole (50%, 25%, etc).

#### *Strategy 2: Sample splitting*

In this strategy time is saved by splitting (by weight) some or all of the sample. It is usually done to one of the smaller fractions separated by the geologic sieves, eg, 100% of the material that is >2mm is sorted, while 50% of all material <2mm is sorted and all counts of the identified specimens are doubled. The decision to split a sample should be based on the following guidelines. The average amount of time spent on a sample is about 2 1/2 hours, including sorting and identifying light and heavy fractions, as well as material recovered from the sieves in the field. The two main factors that are considered are both the volume of the charred material, and the density of the seeds. The desired amount of material to be sorted from each size fraction of the sample is enough to fill one of the sorting trays (in a thin layer, as when ready for sorting). If a brief scan of even this amount appears to contain hundreds of seeds, it should be split again. A rule of thumb that has proven effective for the 1986 Pancán (Perú) material was never to let the sorted portion fall below 1.0g or 12.5% (Lennstrom 1992). In these samples it was found that this was approximately the point of diminishing returns for very dense samples such as those from burnt stores of crops, where seeds and tuber densities per 6-liter of soil averaged in the thousands. That is, if at least these 12.5% or 1.0g of each size fraction was sorted the estimates of total densities and taxa diversity were found to be insignificantly different than if the whole sample had be sorted. We noted on the form which fractions were split, what percentage was

sorted, and the weight of the material prior to sorting. Of course, special circumstances may occur, and less may be sorted without losing accuracy.

Trials with a 0.3mm geologic sieve show that very few seeds will pass through this mesh size. Another time saving measure in dusty samples is not to sort the material that is less than 0.3mm. If bones and fish scales are too numerous, they can be left in the remains while noting their occurrence and/or abundance can be put on the data sheet. If very small lumps are overabundant one can leave those <1.18mm (with no distinctive characteristics, such as a surface) in the remains.

As with the complete sort, one gets RATIO level data, and can generate RELATIVE PERCENTAGES, DENSITIES, UBIQUITIES, and DIVERSITIES. Because actual counts are estimated this type of data can be used in comparison with that of Strategy 1 with no conversion.

This method is a good time saver, especially for samples that are quite homogeneous. Drawbacks are that diversity may be lost, and rare species are either missed or over represented.

[Other sorting strategies have been designed, including a switch to examining only the material that is >0.5mm, (see Lennstrom and Hastorf 1989), but these were not used with the Lukurmata samples.]

#### Quantification of Lukurmata samples

In this section we report the different plant taxa recovered from the samples and three different quantification schemes used to help interpret the botanical remain (DENSITY, UBIQUITY, and RELATIVE PERCENTAGES). Density is expressed as the number of seeds (or seed fragments) per liter of site matrix. This standardizes the counts of material, so that samples of differing original volume can be compared (Pearsall 1989; Popper 1988). Also, each taxon can be considered independently, and density values seem least biased when comparing samples of different original soil volume (see Lennstrom 1991).

Ubiquity is expressed as a percentage, and is calculated as the percentage of samples which contain each taxon (Hubbard 1975; Popper 1988). For example, if maize is identified in 10 of 30 samples it has a ubiquity value of 33%. The advantage of ubiquity scores is that each taxon is considered separately, and the amount of each does not affect the others. Also, the amount of each taxon in a sample does not affect the ubiquity value, so that 1 or 1000 of the same seed in a single sample carries the same weight.

The third quantification method we present is relative percentage (Popper 1988). These values are expressed as the percentage each taxon makes up relative to the number of items in an individual sample, and is displayed as a pie diagram. The advantage of this scheme is that all taxa can be considered simultaneously, and the relative proportions of taxa from different samples can be compared, regardless of the original volume of the sample, or the density of charred plant remains.

#### List of plant taxa:

Plant remains from the Wila Jawira botanical samples were commonly identified to the family level, and sometimes to genus. When referring to plants by scientific names authorities (initials) are usually cited when the taxon is first mentioned in the text. For example *Zea mays* L. indicates that Linnaeus named the species (for complete list see appendix) Genera (eg: *Chenopodium*) are always capitalized, and underlined, or italicized. The second part of the species name is also put in italics, or underlined, but is always lower case

(*Chenopodium quinoa*). The addition of "spp." following the genus name indicates that it might be represented by one or more species, but we cannot determine which one(s). When two species from the same genus are referred to in succession the genus is usually abbreviated to a single letter for the second species.

- Large (>1.18mm) *Chenopodium* spp. (seeds) Probably domesticates: either quinoa (*Chenopodium quinoa*) or cañiwa (*C. pallidicaule*). Food source.
- Small (<1.18mm) *Chenopodium* spp. (seeds) Possibly domesticates: either quinoa (*Chenopodium quinoa*) or cañiwa (*C. pallidicaule*). Food source.
- Lumps (Unidentifiable charred plant fragments, these might be tubers or other fragments of domesticates.) Possible food source.
- Small Poaceae (seeds) Grass family. Possibly used as fodder, fuel, or in construction. May also be derived from dung.
- Large Poaceae (seeds) Grass Family, likely *Stipa* spp. or *Festuca* spp. Possibly used as fodder, fuel, or in construction.
- Wild Leguminosae (seeds) Fabaceae-Bean family. Common weed, possible fodder, possibly derived from dung.
- Scirpus* sp. (seeds) Tortora. Used as food, fuel, fodder, construction material. Grows in and around water.
- Verbena* spp. (seeds). Common weed.
- Medium Poaceae (seeds). Grass family. Possibly used as fodder, fuel, or in construction.
- Malvaceae (seeds) Mallow family. Common weed. Also found in dung.
- Relbunium* spp. (seeds) A plant used in S. America for red dye.
- Rubus* spp. (seeds) Some types could have been used as a casual food source, or as medicines.
- Cyperaceae (seeds) Sedge family, often associated with wetlands. Many industrial purposes: mats, boats, roofing, etc.
- Cruciferae (seeds)- Mustard family (Brassicaceae), common weed in disturbed areas.
- Unknown 224 (seeds). Possibly mint family
- Potamogeton* spp. Pondweed, wetland plant.
- Cereus* spp. a type of cactus.
- Unknown 264 (seeds)
- Amaranthus* spp. (seeds) Usually a weedy annual; found in disturbed habitats, possible casual food source.
- Unknown 270 (seeds)
- Unknown 242 (seeds)
- Compositae (seeds). Sunflower family
- Kañiña (seeds). This is an Aymara name, scientific name unknown.
- Unknown 265 (seeds)
- Unknown 261 (seeds)
- Juncus* (seeds). Common water plant. Useful in construction of matting, etc.
- Caryophyllaceae (seeds) Pink family
- Unknown 266 (seeds)
- Solanaceae (seeds) Nightshade family
- Nicotiana* spp. (seeds) These are likely of a type of tobacco which grows wild/feral in the area today, though we cannot distinguish them from more tropical domesticated species at this time.
- Sisyrinchium* (seeds)

*Zea mays* (maize) kernels and cupules (cob fragments)  
*Capsicum* (seeds) Chile pepper. Probably grow in a lower area.  
 Domesticated Leguminosae (seeds) Beans or Tarwi  
 Polygonaceae (seeds) Knotweed family.  
 Oxalis (seeds).  
 Unknown 202 (seeds) Possibly Borage family (Boraginaceae)  
*Oenothera* (seeds) Evening primrose.  
 Unknown 271 (seeds).  
 Unknown 235 (seeds).  
 Unknown 201 (seeds).  
 Wheat/Barley (seeds). Introduced by Spanish, found in one sample.  
 Unidentifiable seeds  
 Tubers, (food) probably domesticated species, such as the potato  
 Wood and twig fragments-Fuel, construction, tools.  
 Leaves-Type unknown.  
 Dung-Fertilizer and/or fuel.

#### Densities, Ubiquity scores, and Relative proportions:

On the following page the average DENSITIES and UBIQUITY values are given for Lukurmata. On the top half of each table Lukurmata (LKM) is shown along with other Tiwanaku Valley sites (eg: Tiwanaku=TIW). In the second portion the Lukurmata samples are split according to general context categories. The ubiquity scores are read as follows: (for example) for LKM the allmaize (kernels and cupules together) the score is 0.13 this translates to 13% of all samples from Lukurmata contain maize remains.

On the pages following the tables of ubiquity and density values are pie-diagrams which express the RELATIVE PERCENTAGES of taxa within each of the contexts represented at Lukurmata. In the context diagrams the "n" is the number of plot samples that went into the diagram. Caution must be used when comparing digrams with highly disparate "n" values, as increasing numbers of samples elevate the total seed counts which nearly always increase the diversity of the chart contents.

#### Interpretation of Lukurmata samples

The botanical remains from Lukurmata are not nearly as "patternless" as first thought (see Wright and Lennstrom 1990). Now that a larger number of samples from this and other sites are finished we can begin to put Lukurmata into perspective.

Charred plant remains from the sites in the Titicaca Basin are plentiful and can provide insights into the environment and the use of plants in the region. Lukurmata samples had an average of 460 plant specimens, with a median value of 146 and a range of 0 to 5096 specimens/sample.

Lukurmata contains a wide variety of wild and domesticated plant taxa. All of the major domesticate groups were recovered from the site, including maize, *Chenopodium* (likely *C. pallidicaule*, cañiwa), tubers, legumes, and chile peppers. Weeds are numerous, especially grasses and mallows which are common on the Altiplano today. Many of the weeds are common in disturbed habitats and may indicate the disturbance caused by widespread cultivation of land during the reign of the Tiwanaku empire.

The types of plants recovered from Lukurmata can still be seen as *generally* very similar to the other sites in the area, as noted in our earlier reports. Yet in detailed analysis, which has only recently begun, there are subtle differences which can help define unique characteristics about this site. In

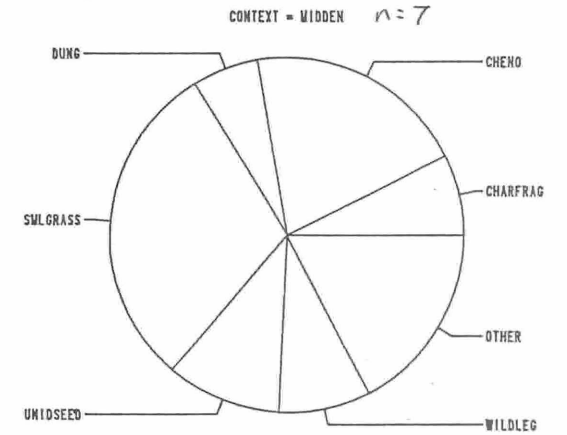
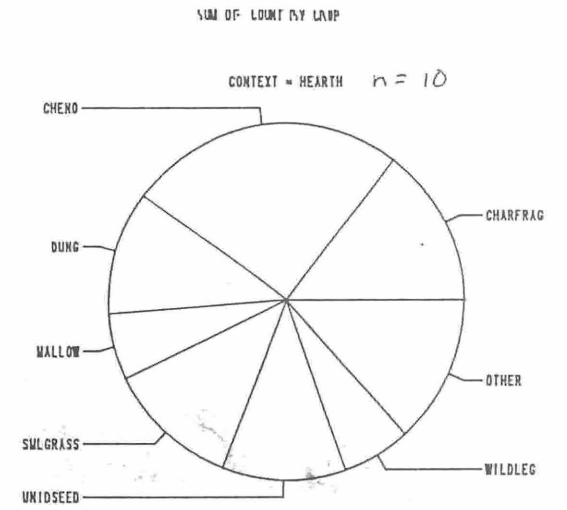
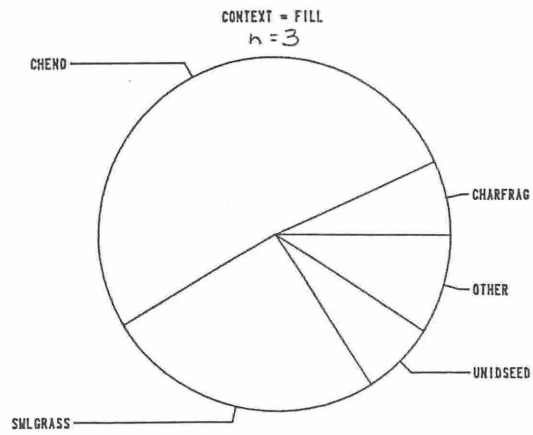
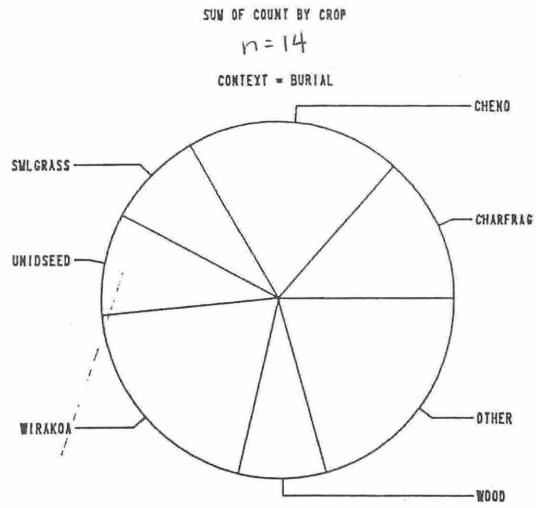
## AVERAGE UBIQUITY

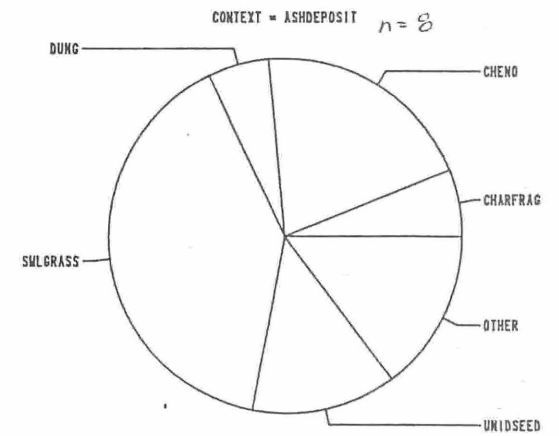
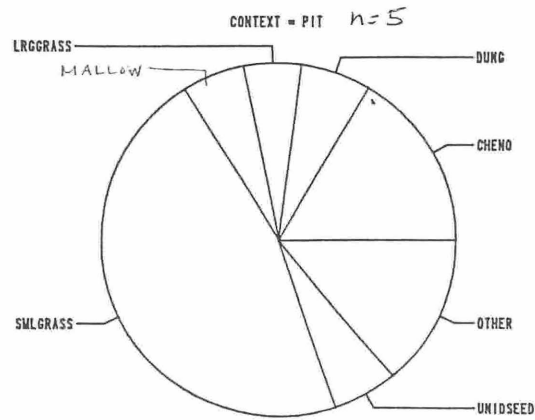
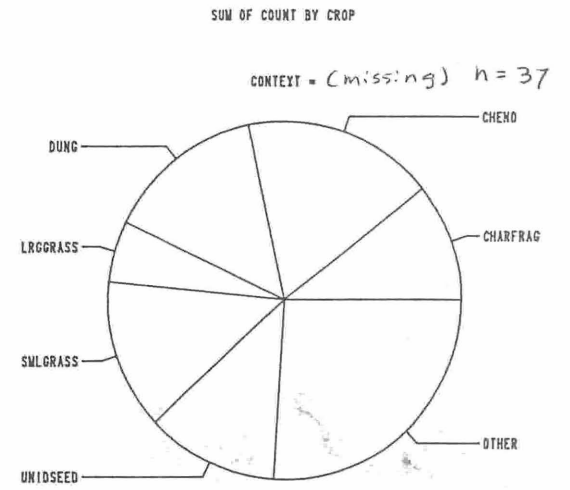
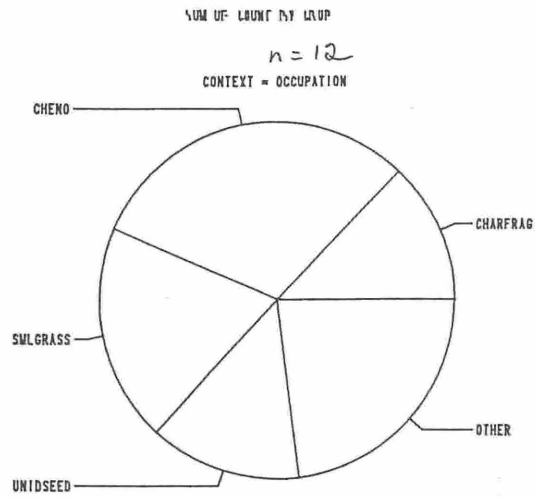
SITE	CUADRA	CONTEXT	_FREQ_	ALLMAIZE	KERNELS	COBS	LCHENO	SCHENO	TUBER	LEGUME	WOOD	GRASS	LUMPS	DUNG	MALLOW
ALL			11	0.00	0.00	0.00	0.27	1.00	0.00	0.00	0.36	1.00	0.82	0.00	0.91
GUA			14	0.14	0.14	0.00	0.29	0.79	0.00	0.00	0.71	0.86	0.71	0.29	0.43
IWA			10	0.00	0.00	0.00	0.30	0.90	0.00	0.00	0.30	0.70	0.60	0.30	0.60
LKM			140	0.13	0.10	0.05	0.49	0.83	0.02	0.01	0.67	0.82	0.88	0.49	0.64
OBS			12	0.00	0.00	0.00	0.17	0.92	0.25	0.00	0.58	0.83	0.75	0.25	0.67
PUK			6	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.50	0.17	0.00	0.17
TIW			380	0.31	0.20	0.17	0.54	0.96	0.08	0.01	0.87	0.96	0.85	0.37	0.82
TMV			27	0.04	0.04	0.00	0.56	0.96	0.04	0.00	0.70	0.96	0.74	0.19	0.78
LKM			37	0.19	0.16	0.05	0.46	0.89	0.03	0.00	0.78	0.86	0.89	0.57	0.68
LKM		ASHDEPOSIT	8	0.38	0.38	0.00	0.75	1.00	0.13	0.00	0.88	1.00	1.00	1.00	0.88
LKM		BURIAL	14	0.00	0.00	0.00	0.14	0.50	0.00	0.00	0.43	0.36	0.71	0.14	0.07
LKM		FILL	3	0.00	0.00	0.00	0.33	0.33	0.00	0.00	0.33	0.33	0.33	0.00	0.33
LKM		HEARTH	10	0.10	0.00	0.10	0.60	0.90	0.00	0.00	0.50	1.00	0.90	0.60	0.80
LKM		MIDDEN	7	0.00	0.00	0.00	0.71	0.71	0.00	0.00	0.71	0.71	0.71	0.57	0.71
LKM		OCCUPATION	12	0.25	0.25	0.08	0.50	0.83	0.00	0.00	0.75	0.83	0.92	0.33	0.58
LKM		OFRENDA	3	0.33	0.00	0.33	1.00	1.00	0.33	0.00	1.00	1.00	1.00	0.33	1.00
LKM		PIT	5	0.20	0.20	0.20	1.00	1.00	0.00	0.20	1.00	1.00	1.00	0.80	0.80
LKM		POTFILL	5	0.00	0.00	0.00	0.20	0.80	0.00	0.00	0.40	0.80	1.00	0.40	0.40
LKM		TRASHPIT	16	0.13	0.06	0.06	0.25	0.81	0.00	0.00	0.50	0.81	0.88	0.31	0.69

## AVERAGE DENSITY

SITE	CUADRA	CONTEXT	_FREQ_	ALLMAIZE	KERNELS	COBS	LCHENO	SCHENO	TUBER	LEGUME	WOOD	GRASS	LUMPS	DUNG	MALLOW
ALL			11	0.00	0.00	0.00	0.13	3.04	0.00	0.00	0.07	1.54	0.40	0.00	0.58
GUA			14	0.90	0.90	0.00	0.73	9.36	0.00	0.00	7.58	5.65	3.41	3.46	0.57
IWA			10	0.00	0.00	0.00	0.29	4.04	0.00	0.00	0.52	4.07	2.25	0.40	1.09
LKM			140	0.23	0.16	0.08	2.78	58.60	0.03	0.00	14.14	70.05	28.79	23.17	10.33
OBS			12	0.00	0.00	0.00	0.18	49.01	0.13	0.00	1.64	19.59	5.16	0.62	1.04
PUK			6	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	1.16	0.16	0.00	0.16
TIW			380	0.36	0.20	0.16	1.05	17.83	0.07	0.00	6.66	22.64	8.07	14.61	3.36
TMV			27	0.02	0.02	0.00	0.69	164.02	0.02	0.00	0.78	9.63	3.58	0.52	1.91
LKM			37	0.25	0.22	0.03	2.01	45.83	0.05	0.00	9.01	53.83	32.61	47.00	13.63
LKM		ASHDEPOSIT	8	0.71	0.71	0.00	9.82	150.00	0.16	0.00	11.69	280.36	49.34	35.43	12.57
LKM		BURIAL	14	0.00	0.00	0.00	0.42	5.73	0.00	0.00	2.20	3.29	5.26	0.27	0.55
LKM		FILL	3	0.00	0.00	0.00	0.63	4.38	0.00	0.00	3.13	7.71	7.29	0.00	0.63
LKM		HEARTH	10	0.06	0.00	0.06	7.41	68.04	0.00	0.00	3.54	38.98	44.73	31.06	17.87
LKM		MIDDEN	7	0.00	0.00	0.00	1.11	42.03	0.00	0.00	8.51	62.56	16.07	16.21	2.99
LKM		OCCUPATION	12	0.53	0.50	0.04	3.95	85.58	0.00	0.00	5.64	64.13	54.62	7.50	7.46
LKM		OFRENDA	3	0.16	0.00	0.16	0.98	29.99	0.33	0.00	96.63	12.80	8.46	9.67	1.93
LKM		PIT	5	1.63	0.25	1.38	2.62	133.74	0.00	0.13	15.57	422.60	20.99	52.08	47.82
LKM		POTFILL	5	0.00	0.00	0.00	0.67	41.98	0.00	0.00	152.13	34.93	20.04	7.33	13.47
LKM		TRASHPIT	16	0.13	0.05	0.08	1.97	58.40	0.00	0.00	5.77	56.27	20.94	17.63	8.77



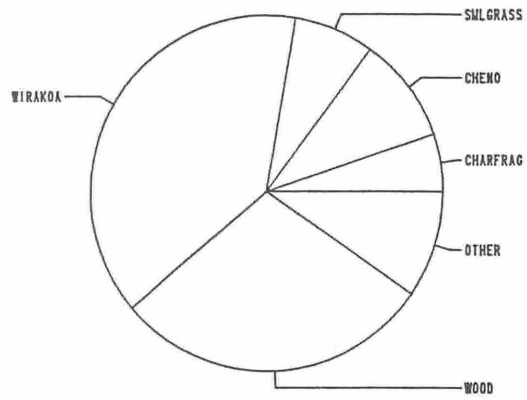




SUM OF COUNT BY CROP

n = 3

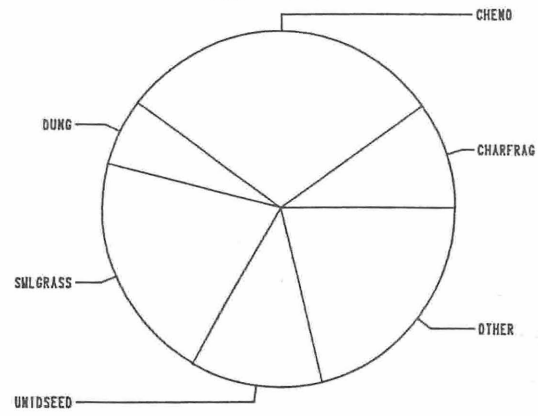
CONTEXT = OFRENDA



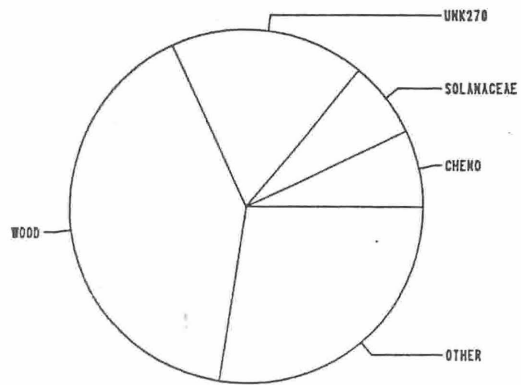
SUM OF COUNT BY CROP

n = 16

CONTEXT = TRASHPIT



CONTEXT = POTFILL n = 5



comparison to other sites in the area Lukurmata can be seen to have fairly large quantities of food remains, second only to the various parts of the site of Tiwanaku proper. It appears that a fair amount of maize and *Chenopodium* (especially the large-seeded type) were used or consumed at the site. Ubiquity scores indicate that the crops were also more widespread than at other smaller valley sites (such as those excavated by Juan Albarracin-Jordan and Jim Matthews), but again, Tiwanaku itself has remains more widely distributed. This suggests that the people at Lukurmata had adequate access to domesticated foodstuffs. Unlike other Andean areas we have studied in the UM lab (such as the Jauja area sites), Lukurmata has more fragments of maize *kernels* than *cobs*. It may be that less maize was grown in the area and that it was transported after shelling elsewhere. This is not surprising as maize can only be grown with great care on Isla del Sol or the raised fields, and is usually quite small. One possible process to help determine whether or not the maize is locally produced would be a study of projected kernels size and row number, based on the available fragments (see Johannessen and Hastorf 1989).

Remains of charred wood are quite common and they are denser at Lukurmata than they are at all the other sites we have investigated in the area. Grass seeds are and dung also denser than at other sites. Perhaps the areas investigated at Lukurmata contain more contexts where burning took place. This has not yet been determined and will require more detailed contextual and spatial analysis. In any event, it appears that fuel was available, although the wide variety of possible sources exploited may suggest that it was a prized and scarce commodity.

At Lukurmata the greatest concentrations of food remains are found in the ash pits, occupation zones, and midden. This pattern is not the same as that of the Tiwanaku samples, where the densest remains are normally associated with large trash pits. In contrast, the trash pits at Lukurmata do not contain particularly dense materials. It is possible that domestic refuse was disposed of in a more haphazard fashion at Lukurmata. This could be a function of a number of different actions. At Lukurmata there may have been more open space than at the core of the urban center surrounding the Akapana mound. People at Lukurmata may have been free to dispose of plant trash in less prescribed areas. This might possibly be related to simple site hygiene. On the other hand it may go deeper into the lifestyle at the site. Certainly the houses discovered at Lukurmata by Bermann are less formal and rigid in their construction canons than those at Putuni and other areas of Tiwanaku proper. Yet some ash deposit in the site may be from something such as hearth cleaning (hearths have low densities of plants), suggesting that the inhabitants of Lukurmata were not without rules or notions concerning trash disposal.

Individual context groups also show varied patterns. Lukurmata is unique in the strong presence of Wira Koa (an herb used today in Pachamama offerings) in both the burial and other "ofrenda" contexts. We do not see such a striking correlation in other sites. This suggests that this plant (the scientific name is unfortunately unknown) was important in rituals as far back as the Tiwanaku III time period. This is impressive evidence for a possible long-term historical association between the people and the earth goddess. The fact that this is somewhat unique to Lukurmata--and does not match the llama (and tuber) offering found on the summit of the Akapana by Linda Manzanilla--suggests that rituals took many forms and were not mandated to be identical at all Tiwanaku installations.

In short it appears that Lukurmata contained many of the same types of deposits, and hence represent some of the same type of activities going on elsewhere in the valley, especially at the Tiwanaku center. As predicted, Lukurmata appears to contain more plant materials than smaller hinterland sites,

but less than at Tiwanaku. This helps confirm its intermediate status between the sites of higher and lower rank (size and status-wise). The access of the residents to all food types, the occurrence of special botanical offerings also highlight the unique and important nature of the center of Lukurmata.

APPENDIX: RAW DATA  
CODES USED FOR WILA JAWIRA COMPUTER INPUT:

IDNO = This is used for identification in the botanical lab  
 SITE  
 CUADRA  
 NIVEL = level  
 SPECIMEN = the bag number assigned in the field  
 UNIDAD1 = The North unit designation  
 UNIDAD2 = The East unit designation  
 RASGO = feature  
 FLOTNUM = The flot number assigned in the field  
 FLOTVOL = Volume of sample in liters (as collected in the field)  
 LFPICK = Weight of carbon sorted out of the sample  
 COLLYPE = whether sample is BULK (101) or PINCH (102).  
           Screen material (1/4") is 201  
 CULTCONT = Three digit code for cultural context of sample. Check  
           raw data sheet for definitions. This information is taken  
           directly from tags on samples and/or field notes.  
 CARD/CRD/CRDNO/CARDNO = These are for data loading (ignore).  
 BOXSIZE = Size of storage box used for sample  
 YEAR = Year sample collected

Taxa names refer to different identifiable plant parts:

LRGCHENO = *Chenopodium* spp. L. seeds larger than 1.18 mm  
 SMLCHENO = *Chenopodium* spp. seeds smaller than 1.18mm  
 LUMP = Unidentifiable fragment of charred plant tissue  
 SPOACEAE = Small Grass family seeds (Poaceae)  
 LPOACEAE = Large Grass family seeds (Poaceae)  
 WILDLEG = Wild seeds from the Bean family (Leguminosae or  
           Fabaceae)  
 SCIRPUS = *Scirpus* spp. L. Seeds of tortora reeds  
 VERBENA = *Verbena* spp. L.  
 PLANTAGO = *Plantago* spp. L.  
 MALVACEA = Mallow family (Malvaceae)  
 RELBUN = *Relbunium* spp. Hook.  
 MPOACEAE = Medium Grass family seeds (Poaceae)  
 RUBUS = *Rubus* spp. L.  
 CYPERAC = Sedge family (Cyperaceae)  
 CRUCIFER = Mustard family (Cruciferae or Brassicaceae)  
 UNK224 = Unknown seed #224  
 POTAMOG = Pondweed, *Potamogeton* spp. (Tourn) L.  
 CEREUS = *Cereus* spp. Mill.  
 UNK264 = Unknown seed #264  
 MODPOPPY = Modern poppy seeds added as check on flot machine  
 AMARANTH = *Amaranthus* spp. L.  
 UNK270 = Unknown seed #270  
 UNK242 = Unknown seed #242  
 COMPOSIT = Sunflower family (Compositae or Asteraceae)  
 UNK265 = Unknown seed 265  
 LABIATAE = Mint family  
 KAINYA = Aymara name, scientific name unknown  
 UNK261 = Unknown 261  
 JUNCUS = *Juncus* spp. L.

UNK248 = Same as *Rubus* spp.  
CARYOPHL = Caryophyllaceae (Pink family)  
UNK266 = Unknown 266  
SOLANAC = Solanaceae seeds (Nightshade family)  
NICOTIAN = *Nicotiana* spp. L.  
SISYRINC = *Sisyrinchium* spp. L.  
ZEAKERN = *Zea mays* L. kernels  
ZEAEMBR = *Zea mays* embryos apart from kernels  
COBCUP = *Zea mays* cob and cob fragments  
CAPSICUM = *Capsicum* spp. L. Chili peppers  
DOMLEGUM = Domesticated legumes exact genus unknown  
POLYGON = Polygonaceae (Knotweed family)  
OXALIS = *Oxalis* spp. L.  
UNK202 = Unknown seed 202 (probably Borage family, Boraginaceae)  
OENOTHER = *Oenothera* spp. L.  
LSOLANAC = Large seeds of Nightshade family, possibly *Solanum* spp.  
UNK271 = Unknown 271  
UNK235 = Unknown 235  
PORTULAC = *Portulaca* spp. L.  
UNK201 = Unknown 201  
TRITHORD = *Triticum* spp. L. (Wheat) or *Hordeum* spp. L. (Barley) both introduced by the Spanish from the Old World  
CACTUS = Cactaceae, exact genus unknown  
UNK279 = Unknown seed 279  
UNIDSEED = Seeds too poorly preserved to identify to family level  
TUBER = Domesticated tubers, exact taxon not identifiable  
WOODCT = Count of wood fragments  
WOODWT = Weight of wood fragments in grams  
TWGBRNCH = Twig and branches (showing nodes)  
STALK = Stalks  
DUNG = Animal dung, type undefinable  
LLAMADNG = Camelid dung  
CUYDUNG = Cuy dung  
WIRAKOA = Aymara name, leaves used in *Pachamama* rituals  
LEAVES = Leaves, exact taxon unknown  
TRITRACH = *Triticum* spp. or *Hordeum* spp. rachis  
SORTTYPE = Number refers to sorting strategy used in the laboratory, see preceding pages  
FAUNAL = 0= No bones or fish scales; 1= Bones and/or fish scales present

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430	LKM	034	09978	N2894	E2915		4129	1.8	2.4	101	. 1	12	102	126	60	141	20	.
440	LKM	024	09348	N2894	E2915		4448	0.3	0.4	101	498	1	.	6	2	2	1	.
431	LKM		06804	N2894	E2917	3	4176	2.1	1.9	101	410	1	3	17	25	23	6	34
425	LKM	20	06803	N2894	E2917	3	4016	1.8	2.6	101	410	1	3	20	2	2	2	21
436	LKM	031	09567	N2894	E2919		4076	0.3	1.4	101	. 1	1	31	13	1	3	1	.
436	LKM	022	08841	N2894	E2923		4208	0.3	1.6	101	498	1	1	55	15	35	11	28
431	LKM	022	08861	N2894	E2925		4120	2.3	0.4	101	. 1	.	6	4	2	.	.	.
436	LKM	023	09158	N2894	E2925		4113	0.3	0.7	101	. 1	.	6	8	1	.	.	1

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\$357	LKM	021	08499	N2896	E2913	4121	2.1	1.2	101	497	1	1	24	14	18	3	1	.
\$358	LKM	021	08501	N2896	E2913	4021	1.0	2.6	101	497	1	2	69	6	8	2	4	.
\$321	LKM	029	10177	N2896	E2915	4057	1.6	1.1	101	297	1	2	76	11	117	17	8	.
\$319	LKM	034	09954	N2896	E2917	4078	1.8	2.3	101	342	1	14	1100	244	324	37	36	28
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\$369	LKM	031	09824	N2896	E2917	4173	1.8	4.5	101	.	1	5	281	51	18	455	5	.
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R	N	V	E	R	P	C	N	T	E	N	P	D	U	R	N	I	A	N
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A	K	T	A	K	K	U	K	H	C	R	S	U	O	O
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