

# Andean camelid herding in the South Andes: ethnoarchaeological models for archaeozoological research

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## ABSTRACT

Culling strategies are a key issue in the analysis of pastoral economic systems. Mortality patterns have been used for reconstructing the strategies of exploitation of herds in different pastoral records, the main point being the distinction between primary and secondary productions as reflected in the age-classes of particular (or regional) bone records. Andean camelid pastoralism is no exception, and pioneering efforts have been made in constructing mortality profiles, but by using Old World models and assumptions for interpreting the information. Mixed exploitation patterns of camelid use (*i.e.* for meat and fiber production) is common in the Andes, and this paper presents mortality profiles resulting from this kind of economic activity, through the analysis of bone assemblages from contemporary pastoral sites in the Puna de Atacama. This case study will enable us to discuss these issues on new bases.

## KEY WORDS

Mortality patterns,  
age-classes,  
South American camelids,  
Puna de Atacama.

## RÉSUMÉ

*L'élevage des camélidés dans les Andes du sud : modèles ethnoarchéologiques appliqués à l'archéozoologie.*

Les stratégies d'abattage sont un élément clé dans l'analyse des systèmes économiques pastoraux. Les courbes de mortalité ont été utilisées pour la reconstruction des stratégies d'exploitation des troupeaux dans différents cadres pastoraux, la question essentielle étant la distinction entre productions primaire et secondaire, telles qu'elles sont reflétées dans les classes d'âges des enregistrements particuliers (ou régionaux) des ossements. Le pastoralisme des camélidés andin n'est pas une exception, et des efforts novateurs ont été accomplis dans la construction des profils d'abattage, qui utilisent toutefois des modèles et des hypothèses d'interprétation des données issus de traditions pastorales de l'Ancien Monde. Les modes d'exploitation mixte des camélidés (*i.e.* pour la production de la viande et des poils) sont communs dans les Andes, et cet article présente des profils de

**MOTS CLÉS**

Courbes de mortalité,  
classe d'âges,  
camélidés sud-américains,  
Puna de Atacama

mortalité résultant de ce type d'activité économique, construits d'après l'analyse d'assemblage osseux de sites pastoraux actuels dans la Puna de Atacama. Cette étude de cas devrait permettre de discuter ces questions sur de nouvelles bases.

**RESUMEN**

*Pastoreo de camélidos en los Andes Centro Sur : modelos etnoarqueológicos para la investigación arqueozoológica.*

Las estrategias de matanza selectivas son un punto clave en el análisis de los sistemas económicos pastoriles. Los patrones de mortalidad han sido empleados para la reconstrucción de las estrategias de explotación de los rebaños en diferentes registros pastoriles, cuyo objetivo principal ha sido la distinción entre producción primaria vs. secundaria y su reflejo en las clases de edad de registros óseos particulares (o regionales). El pastoreo de camélidos andino no es excepción y esfuerzos pioneros se realizaron en la construcción de perfiles de mortalidad, aunque se utilizaron modelos y presupuestos originados en el Viejo Mundo para interpretar la información. Patrones de explotación mixta en el uso de los camélidos (p. ej. producción de carne y fibra) es común en los Andes. Este trabajo muestra perfiles de mortalidad originados en esta clase de actividad económica a través del análisis de sitios pastoriles contemporáneos de la Puna de Atacama. Este caso de estudio permitirá ubicar estos estudios sobre nuevas bases.

**PALABRAS CLAVES**

Patrones de mortalidad,  
clases de edad,  
camélidos sudamericanos,  
Puna de Atacama.

**INTRODUCTION**

The archaeozoological study of pastoralism has employed mortality profiles as an important tool for inferring past management practices. The model of kill-off patterns derived from the influential attempt by R. Payne (1973), were developed for caprine husbandry in a context of domestication, farming or nomadic pastoralism. These models have been used in discussing evidence for animal production, consumption and productive specialization.

The distinction between production modes is based on the assumption that pastoral production tends to obtain particular sets of animal products or services (meat, milk, wool, transport) by differentially managing herd culling patterns. This situation has been emphasized in different instances for the Old World (*i.e.* Davis 1987, Legge 1996). The assumption of productive specialization has also dominated the study of Andean camelid pastoralism.

In this paper I argue as mixed production systems are characteristic of traditional herding in the Andes, new assumptions must be used in archaeofaunal analysis. In this line of thinking, I present an ethnoarchaeological case-study which provides bone-data for characterizing age-classes profiles indicative of mixed pastoral production. This model, in turn, will be useful for re-interpreting archaeozoological information, and for discussing the dynamics of herd utilization.

**OLD WORLD PRODUCTION MODES**

The assumption of the Old World model includes that herd size, demographic structure and sex ratios are more or less stable over time, and that herds are viable reproductive units. (Greenfield 1988). The models use age/sex classes to distinguish between different utilization in wool/meat/milk in sheep/goat production.

Briefly, the age classes for the different modes of herd utilization are as follows:

– 1. Meat production: males are slaughtered before maturity, while females are culled during adulthood. The expected percentages in each age-class for primary production, but with milk and wool component are: 30% infant-juveniles; 20% sub-adult; 50% adult.

– 2. Milk production: males are culled as soon as the milk yield is assured or when lactation levels decrease; so they are slaughtered at very early ages (before a year). Females have higher rates of survival to adulthood.

– 3. Wool production: emphasis is upon adults regardless of sex. The expectations derived from Payne's model are 30% infant-juveniles, 10% sub-adults, 60% adults. Cribb's simulation is somewhat different because he predicts only 4.9% of sub-adult, and 65.4% of adult, because he assumes that milk and meat is an important component in wool production (Cribb 1991).

The difference between kill-off patterns is clearly seen only in the proportion of sub-adults, and in a lesser extent, in increasing adult percentages (Fig. 1). The production modes interpretation has ambiguities recognized by diverse authors, highlighting that the same pattern can be produced by different exploitation strategies.

L. Martin's (1999) study on pastoral production in the Jordan steppe showed the difficulty of identifying different production practices, especially milk and meat from kill-off patterns, emphasizing that other lines of evidence must be included to obtain a clear interpretation. Besides, productive specialization may not be synchronic or spatially isomorphic. For example, Helmer, Gourichon and Vila (2006) showed for the northern Near East that milk was utilized since the beginning of the middle PPNB, while a major change occurred in the exploitation of the meat of young animals. Also, Vigne & Helmer (2007), contrary to earlier statements, showed that secondary products were used as early as the beginning of the Neolithic in the Near East and Europe, implying that milk production may have played a role in caprine domestication in the former

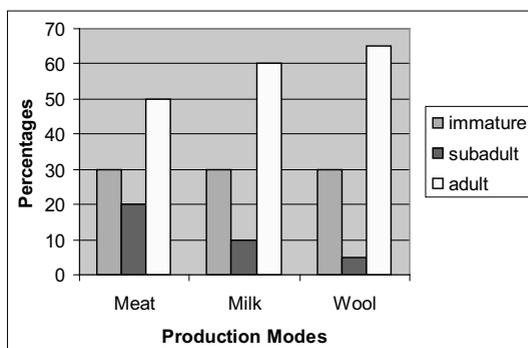


Fig. 1. – Ideal Models of Old World Production Modes (data from Greenfield 1988).

region. This situation adds another dimension of variation; that is, regional and/or local variability in herding practices.

## THE ANDEAN MODELS

The same reasoning was employed in dealing with Andean camelid pastoralism, assuming the three production strategies. Although milk production was deemphasized for a new alternative use as pack animal, because camelids do not produce milk, the idea of specialized production herds was an important, if not the main, assumption.

Thus, maintaining mature animals alive was considered an advantageous strategy if the llamas (*Lama glama*) were used as pack animals, and alpacas (*Lama pacos*) as sources of fibre (Wing 1972). E. Wing developed this idea:

“Animals that are raised for work or products, for example, the llama burden bearing or alpacas for wool, would most advantageously be maintained for their full productive lives. Natural and cultural events may mitigate this, and animals may be slaughtered or die while in their prime or as juveniles” (Wing 1986:248, see also Hesse 1982).

The same assumption of sex/age-classes differences relating to alternative uses is adopted based on contemporary management practices in Peru and, sometimes, using historical sources. Today camelid herding in Peru is specialized in the production of fibre for the international market,

since the alpacas are the main producers of high quality fibre, while llamas are raised as beasts of burden. Only a minor proportion of camelid meat is consumed and can be either alpaca or llama (Flores Ochoa 1968: 115-118; Flores Ochoa & MacQuarry 1995). This is further complicated because of the difficulty for distinguish camelid sexes through bone analysis in fragmentary series. Moore (1989) based on ethnographic data from Peru (Sotomayor 1984) established two patterns of herds (alpacas) exploitation: the managed, and the traditional herd. As managed herd respond to intensive exploitation by governmental agencies, we are interested here in the second strategy. In the traditional herd "males serve as pack animals and wool producers, and many live to a relatively great age" (Moore 1989:276). In this kind of practice she estimated that young of the year (0-1 year) contributes 27/28%, sub adults (1-3 years), 10%, and adults (greater than 3 years), 60%. So, this profile is pointed to represent a secondary production strategy.

The actual management of camelids with species-specific uses (alpaca-fibre, llama-transport) especially in Perú and Bolivia appears to be a post-hispanic consequence of the depletion of camelid herds and the introduction of European livestock (Bonavía 1996). On the contrary, historical and archaeozoological data seems to indicate that, except for the Andean states, the Incas at the core of the Empire (Murra 1978, Dedenbach Salazar 1990, D'Altroy 2002), and Tiwanaku in the Titicaca region (Webster 1993), herd managing was not economically specialized in production modes analogous to the Old World.

Moreover, in Northwestern Argentina and other sectors of the Southern Andes, prehispanic pastoralism was based exclusively on llamas, as today, because alpacas are ill adapted to the arid and dry conditions of the southern Puna (Sotomayor 1990).

Today production systems of the domestic units in the Southern Puna are related to environmental and economic factors. In this vein, two production systems can be distinguished (Lamas 1994, Lamas 2006, pers. comm.):

– 1. Fibre/meat system: low grassland production; small herds, and great distances to

consumption centers. This production mode is associated to the most arid Puna, roughly at the west of the 100 mm isohyets.

– 2. Meat/fibre system: good grassland production; greater herd size, and lesser distances to consumption centers. This mode is associated to moister Puna zones (Fig. 2).

Theoretically, the two systems would generate different mortality profiles, although the two are mixed production modes. Our objective is to document the first production system discussed above.

## ETHNOGRAPHIC ANALYSIS

Susques is located in an alluvial terrace at 3600 m near the confluence of the Pastos Chicos and Susques rivers on the southwest portion of the Puna, Jujuy Province (Northwest Argentina), in the transition between de Dry and Salt Punas. The area consists of ravines and a high plateau above 3900 m framed by two mountain chains, the Sierra de Cobres to the east, and Sierra de Taire to the west (Fig. 2). The climate is cold and dry with summer rains (December-March), which average 190 mm per year. The average temperature is 7.5°C, and there is frost all year round. The annual variation in precipitation is as high as 60%, droughts are frequent, and sometimes long-lasting; at least one every four year is of "severe drought", with precipitation 40-45% below the average. Due to the altitude above sea level there is a huge daily temperature range (as high as 25°C) and high evapotranspiration.

There are three main plant communities in which the livestock feed (Cabrera 1976, Arzamendia *et al.* 2006, Borgia *et al.* 2006):

- 1. Shrub steppe (*Tolar*) dominated by *Parastrephia lepidophylla* and *Fabiana densa* with low proportion of herbs (5%) is the most extensive pasture area of the zone between 3500 to 4100 m.
- 2. Herbaceous steppe (*Pajonal*) dominated by *Festuca* spp, and other grasses, like *Poa* sp. above 4100 m to 4500 m.
- 3. Marshes (*Vegas*) composed by short grasses, sometimes with swamp areas with dense grassland of *Deyeuxia* sp., and *Mulembergia* sp. They

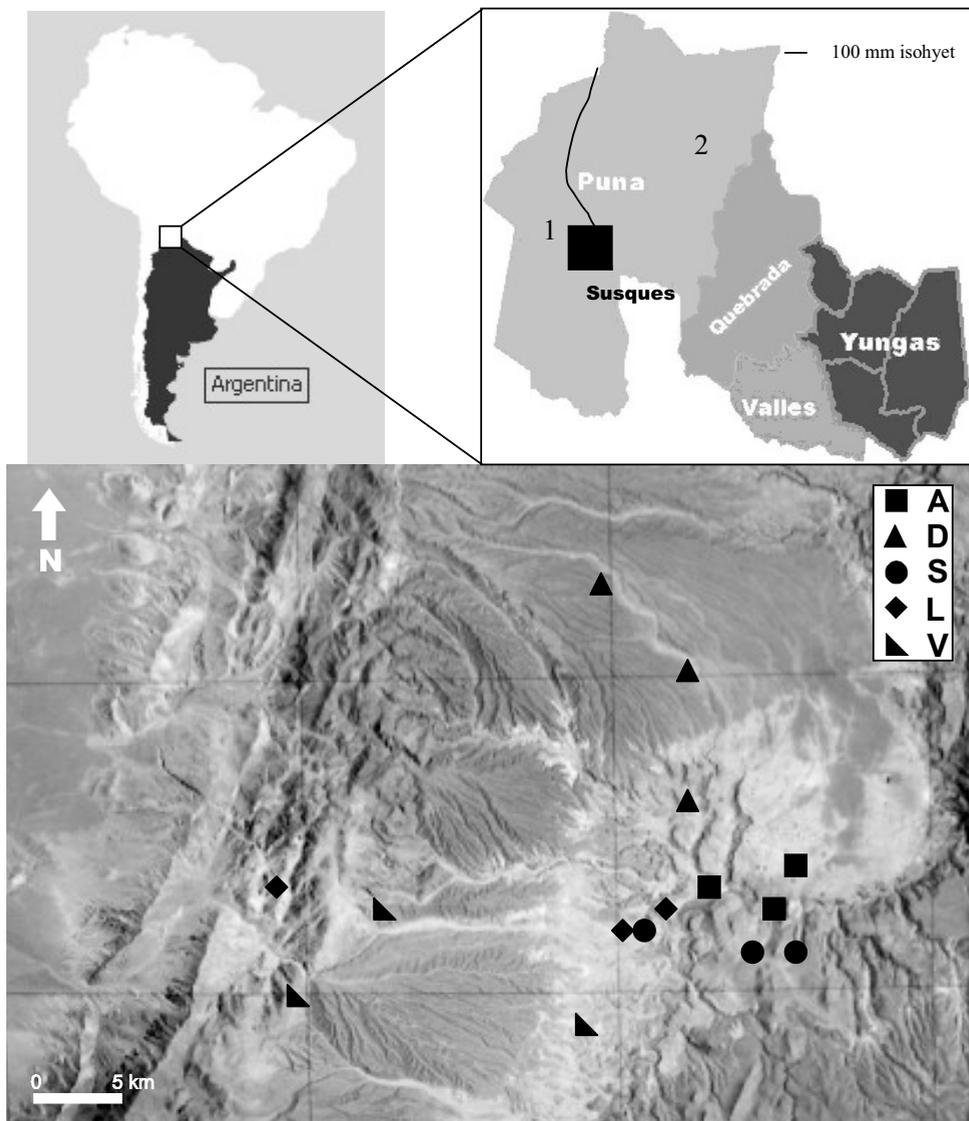


FIG. 2. – Location of the study area, and distribution of settlements by domestic unit. Above right: 1. Area of fibre/meat production system; 2. Location of pastoral settlements.

are small areas of 4-6 ha, located both in the headwater or mouth of small gorges. In our study area *vegas* are at 3600/3700 m.

In ecotonal areas (*i.e.* between 4000/4200 m) mixed steppes of shrubs and gramineae can be found. All these pasturelands are not homogeneously used during the annual cycle. The

*pajonal* and *tolar* are winter pastures (*i.e.* dry season), whereas *vegas* and *tolares* below 3900 m are used in summer (*i.e.* wet season) (Fig. 3).

The spatial separation and temporal availability of pasturelands is managed by mobilizing herds and people. As a consequence of this mobility the settlement pattern is disperse over the landscape.

Two types of settlements can be discerned: (1) residential bases (*casas*); and (2) temporary sites (*estancias*). The residential bases are located near water sources or *vegas*; they are complex structures with many rooms like kitchens, bedrooms, etc, and are occupied 7-8 months mainly in the wet season, although one or several members of the family group, not directly engaged in the care of the herds, always live there. Their size is around 740 m<sup>2</sup> of living quarters, and 765 m<sup>2</sup> of corrals. The temporary sites are smaller, usually composed of one room averaging 9.5 m<sup>2</sup>, and a corral of about 80 m<sup>2</sup>. They are occupied 1.5-3.5 months a year in the dry season or winter, located in *tolares* or *pajonales* above 3900/4000 m, but not necessarily near water

sources (Caracotche 2001, Yacobaccio & Madero 2001). Every family own 2 to 7 temporary sites, but only two are used in each annual cycle. Both llamas and caprines are carried out to those places, although in certain situations (*i.e.* lack of manpower) llamas can be left alone in a *vega* for several days without watching them.

The size of the herds (llama/sheep/goat) in the Susques area is between 30 to more than 300 animals, with an average of 75, and the percentage of llamas is of 45%, the highest in all the Puna of Jujuy<sup>1</sup>. In Susques agriculture is almost non-existent, and camelid and caprine herding is the main economic activity of the domestic units. Although the degree of integration to the town, and hence with the regional economy, have been

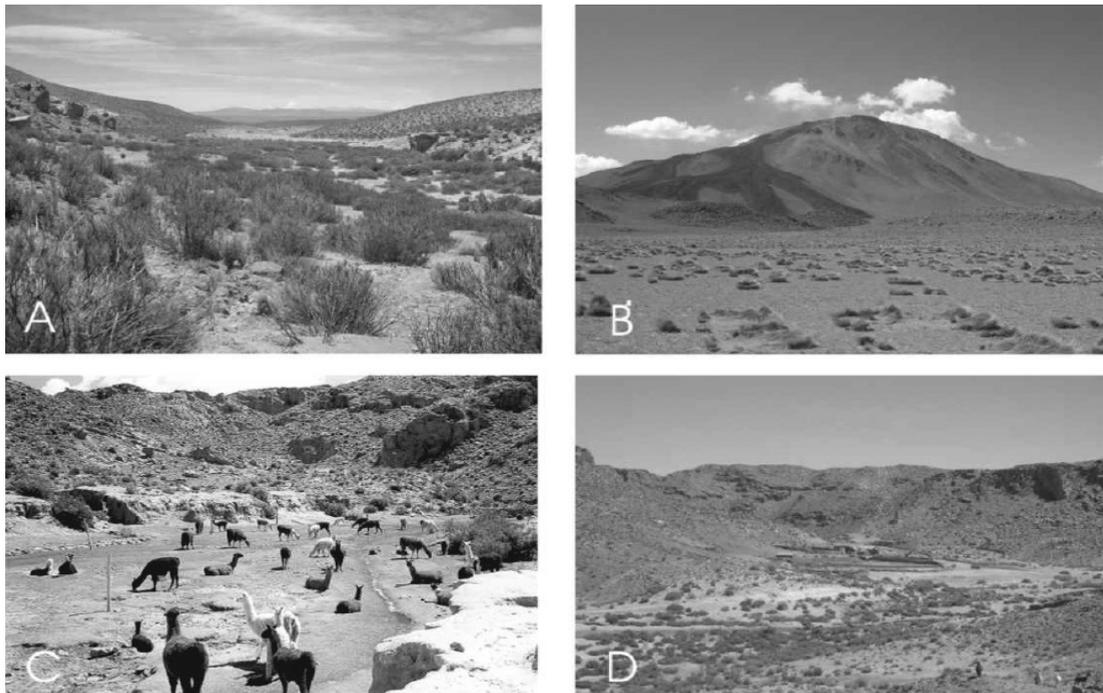


FIG. 3. – Winter pasturelands: A: Shrub steppe; B: Herbaceous steppe. Summer pasturelands; C: Marsh (Vega); D: Shrub steppe.

1. The size of domestic herds in the Andes agrees with this figure. In Peru herds including llamas and alpacas average between 30 and 237 animals (Browman 1990), at Ulla Ulla (Bolivia) 41, at the Puna of Iquique (Chile) 70, and in other sectors of the Puna of Jujuy herds average is between 30 and 52. In the nearby town of Huancar, 22 km south of Susques, herd size range is of 31-613, with an average of 178, but the lama percentage is only 26.4% (Göbel 2001).

increasing over the last ten years, when this study was made (1989-1994), herd management was a familiar activity. Camelid production was oriented to fibre/meat, whilst the sheep/goat to wool, meat, and in good years, milk. Each family or domestic unit is made up of three generations: grandparents, parents, and their children. Women and children usually work in daily herding, whereas men are recruited when physically demanding labors like shearing, castration, building of corrals or Pachamama ceremony are carried out (for details, see Göbel 1994).

The caprines demand more manpower than llamas, so this variable is crucial for establishing the managing strategy in each family group. Sometimes the entire herd feeds together all the year, but if there are enough people to handle separate herds, they can be in different places annually or seasonally. Sheep and goats have to be confined every night, and they have two parturitions in a year, one in the winter (June-July) in which newborns must be kept in warm places or *chiqueros*.

Llamas have a yearly calving season in summer, and newborn mortality is around 38% and 50%, mainly by pneumonia or enterotoxemia (see below). They are sheared once a year from 2 years old to 8 years old, and the yield is about 1-1.2 kg of fibre per individual. The rate of slaughter is one adult every two months, and this is maintained all the year round, but just before the winter (May-June) very old animals are sacrificed to make dried meat (Göbel 2001). Also, on special occasions, such as the Pachamama ceremony, more than one llama can be slaughtered for making the ritual meal. There is no selection for special phenotype, but several morphological types are mixed together in one herd. Taking a herd of 100 llamas as a baseline, the regular composition is 57% of adult females, 13% of castrated males, 2% of bachelors, and 10% of yearlings.

## BONE ANALYSIS

For the sake of this study we worked with five families or domestic units (Yacobaccio 1994, Yacobaccio *et al.* 1998). Caracotche (2001: 106-

107) made an analysis of bones sampled after the first main sampling, and correspond to the deposition of 1 to 3 years; she directed her analysis only to temporary sites. In this paper more complete sets of bones and sites are included.

These five families use 15 sites in the annual cycle in a territory of 612 km<sup>2</sup> (Fig. 2). The size and specific composition of their herds is shown in Table 1; except for one case, llamas amount more than 40%, and the mean herd size is 112 animals. Eleven sites were sampled: two residential bases or *casas* (families D and V), and nine temporary sites or *estancias*. All the bones from these settlements were thoroughly collected including small fragments. No digging was made, because bones did not bury due to the hard substratum; only discarded bones were picked up. A total of 3 428 fragments were retrieved, out of which 41% (1 409) was identified. As can be seen in Table 2, llama bones outnumbered caprine bones in all cases. Camelids amount 65% both in identified bones as well as in minimal number of individuals. There are not statistical differences in llama bone abundance among families, although the sites with higher profusion are all temporary sites (Achitar A and B, Unquillar, Puesto Caliente, and Casto).

Bones are in good condition. Weathering is generally low, so bones can be identified without difficult. A potential bias, however, could be attributed to the action of dogs. Dogs have been signaled as playing an important role in the attrition of bones in hunter-gatherer campsites, because dogs are not fed, and for the majority of them the only way to get food is to scavenge discarded bones (Walters 1984). Ethnoarchaeological studies demonstrated that small taxa were the main target of dogs' action, and for this reason they could be underrepresented (Hudson 1993). In our case study, we observed that caprines bones were more damaged than camelid bones due to their small size. But, concerning the llama bones, it is expected that bones of newborn will be more damaged. When interviewed, herders said that dogs are well fed. In fact, they fed dogs with internal organs of llamas and/or caprines. Sometimes, they fed them with bones, like vertebrae, and other ones that are discarded

TABLE 1. – Herd composition by domestic unit.

Domestic unit	Herd composition			Size
	lama	sheep	goat	
A	20 (40%)	–	30 (60%)	50
D	108 (42.6%)	30 (11.8%)	115 (45.4%)	253
L	50 (58.8%)	35 (41.1%)	–	85
S	50 (58.8%)	35 (41.1%)	–	85
V	16 (18.1%)	39 (44.3%)	33 (37.5%)	88

TABLE 2. – Archaeofaunal data by family, settlement, and species. RB: Residential Base

Family	Site	Llamas		Sheep/Goats		% Llamas	
		NISP	MNI	NISP	MNI	NISP	MNI
A	El Altito	295	7	248	7	54.3	50
	P. Caliente	40	3	2	1	95.2	75
D	Lapao (RB)	185	9	170	3	48	75
	P. Pista	131	7	107	2	56.7	77.7
	Estancia	156	2	160	3	49.3	40
L	Achitar A	35	3	11	1	76	75
	Achitar B	134	6	53	3	71.6	66.6
S	P. Casto	148	3	36	2	80.4	60
	Unquillar	120	6	26	3	82.1	66.6
V	Vertiente (RB)	138	4	155	1	47	80
	A. Taire	27	1	15	1	64.2	50

in whole condition (head bones, ribs, and scapulae). Caracotche (1995) noted that out 304 bones, 52 (17%) axial bones showed carnivore (dog) marks, but only 17 (5,6%) apendicular ones showed this kind of marks.

Even this, newborn long bones could still be underrepresented. Newborn mortality in the puna de Atacama is thought to be caused mainly by pneumonia and enterotoxemia (Parreño & Marcoppido 2006), although no quantitative information is available for evaluating its occurrence as a factor of newborn mortality (Zetti 2007, pers. comm.). Anyway, interviewed herders from the Susques area said that they do not consume newborn died by illness: instead they buried them at a distance. This could be the reason that explains the small quantity of newborn camelid bones in discard areas of the settlements. Usually, in these places, only the skeletal parts of **consumed** anatomical units are discarded.

A sub-sample of 118 bones was useful for age-class analysis, and also 28 mandibles were taken into account (Figs 4, 5 and 6). This sub-sample is evenly distributed in all the sites sampled. I used the sequence of long bone fusion for alpaca developed by J. Kent (1982), which is the only complete set hitherto registered. Some bones have long ranges of fusion, such as distal metapodials (from 6 to 36 months) or proximal radiocubitus (from 3 to 24 months), so a sub-set of bones with short ranges of fusion was employed. In order to avoid this overlapping three fusion stages were determined (De Nigris 2004):

– Early fusion (between 6 and 12 months): pelvis, scapulae, and distal humerus.

– Middle fusion (between 12 and 24 months): proximal first phalanx, calcaneum, and distal tibiae.

– Late fusion (between 24 and 36 months): proximal femur, distal femur, and proximal tibiae.

After 36 months all the bones are fused so this last category includes also old animals. Rates of

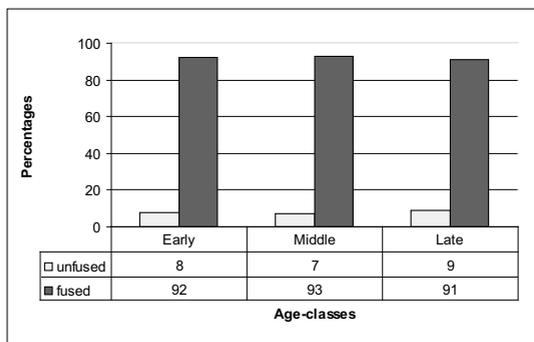


FIG. 4. – Age-classes profiles of Residential Bases.

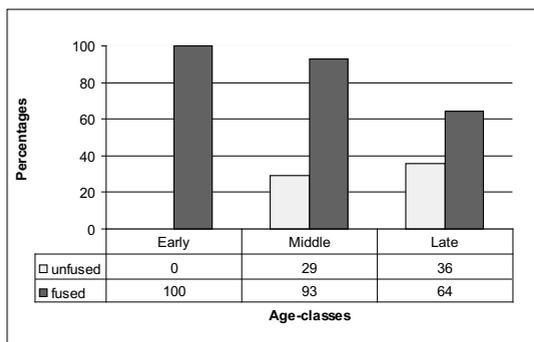


FIG. 5. – Age-classes profiles of Temporary Sites.

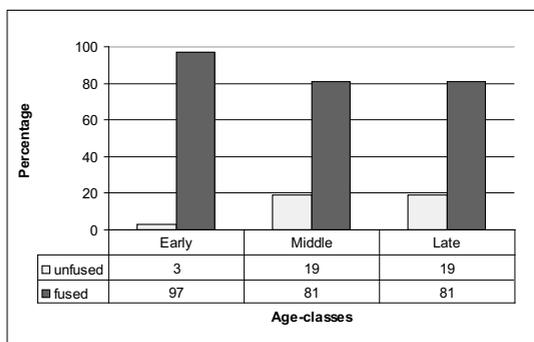


FIG. 6. – Age-classes profiles of the average between settlement types.

TABLE 3. – Exact samples by category fusion. Un: unfused; Fu: fused

Type of site	Early Fusion		Middle Fusion		Late Fusion	
	Un	Fu	Un	Fu	Un	Fu
Residential Base	1	11	3	25	2	12
Temporary Site	0	24	10	24	5	11
Total	1	35	13	49	7	23

teeth eruption and wear patterns established by Wheeler (1982) for llama were used in estimating mandibles ages, and were considered separately from long bones.

Age-classes profiles for both types of settlement are shown in Figs. 4 and 5, and the exact sample in Table 3. It can be observed that adult camelids dominate in the three categories. However, in temporary sites fairly important percentages of non-fused bones in the categories of 12-24 and 24-36 months indicate a certain amount of llamas under 36 months were slaughtered.

Although for the middle fusion category the difference of non-fused bones between sites is not statistically meaningful ( $\chi^2$ : 0.73,  $p$ = 0.39), it is for the late fusion category ( $\chi^2$ : 7.24,  $p$ = 0.007). The higher presence of bones of sub-adults in temporary sites may be related to the transport of small bones into these sites. We have to remember that slaughtering and butchering are made in the residential base, and only bone specimens are carried out to the temporary sites, so this difference is an effect of bone transport and the availability of containers for cooking in temporary sites (Yacobaccio *et al.* 1998: 50-52)<sup>2</sup>. But if we plot together the data from both types of sites, adults dominate the sequence (Fig. 6).

This data is confirmed through mandible analysis, from both residential bases and temporary sites. Out of 28 mandibles, 43% are old camelids (older than 8 years), and 29% adult (between 3.5 and 8 years), 14% sub-adults, and 14% newborns. Again, 72% of the sample relate

2. The size of containers is important in order to analyze cooking practices. The 69% of the containers in temporary sites are under one liter, and 24% between 1 and 3 liters. So, small bones or heavily fractured ones can be included in meals.

to adult individuals. Both kinds of data correspond, and show that the production of fibre/meat, characteristic of Andean herders, has a correlate of adult and old animals as dominant age-classes.

## DISCUSSION AND CONCLUSION

We have shown that a mixed production mode has an age-classes pattern in which adult dominate. Besides, ethnographic data suggests that Andean herders engaged in this kind of production system mainly slaughter adult animals (Delgado & Peñaranda 1988; Göbel 2001). If this pattern can be generalized, then archaeozoological data of prehispanic herders must be re-interpreted.

It have been noted that the age-profiles of the Formative Period (1000 BC-AD 1000) are dominated by juveniles individuals, and a shift to adults occurred after AD 1000 in archaeozoological contexts at Northwestern Argentina (Olivera 1997). The same pattern has been detected in the Pongora-Huarpa drainage in Ayacucho (Peru) (Pozzi-Escot & Cardoza 1986). Webster (1993) also notes that rural sites in the Lake Titicaca basin (Bolivia) have more individuals in the older age groups contrasting with the urban sites of the same region.

These age profiles from sites of the Late Prehispanic Period (AD 1000-1450), and some from Incas' sites (AD 1450-1536) from Northwestern Argentina, and also those from Ayacucho, have been interpreted as originating in specific managing practices for secondary production (Madero 1994; Rodríguez Loredo 1997) or specialized production (Pozzi-Escot & Cardoza 1986). The percentage of adults is around 62-68% in the former case, and between 68-85% in the second one. These figures agree with the expected adult contribution to mixed production mode. Considering the evidence here reviewed it would be more economical to interpret these age-class profiles as originating in this case of Andean pastoral production management.

As a final remark I would like to highlight that it is important not to extrapolate Old World models based on exotic species (caprines) to camelid herding, as most of the herds are not specialized in one type of production as it has been showed, and emphasize the need to develop specific regional models.

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