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Preceramic Animal Utilization in the Central Peruvian Andes

Uchcumachay Cave faunal remains document the process of camelid domestication in the Puna of Junín.

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The Puna of Junín, located in the Central Peruvian Andes at an altitude of more than 4000 meters above sea level, is an ecologically optimum area for the native American Camelidae: guanaco (*Lama guanicöe*), vicuña (*Lama vicugna*), llama (*Lama glama*), and alpaca (*Lama pacos*). The Puna is bounded on the south and west by the Mantaro River, on the north by Lake Junín, and on the east by decreasing altitudes, which terminate the puna environment (Fig. 1) (*1*, *2*). Within the Puna of Junín there is an abundance and variety of natural pasturage for the Camelidae (*Festuca dolicophyla, Bromus lanatus, Colamagrostis vicunarum, Hordeum muticum*, and others) which, because of the presence of lakes, ponds, marshes, springs, and rivers, remains verdant throughout the year. In contrast with other areas of the puna life zone, where the annual desiccation of pasturage during the dry season months (May to October) leads to dislocation of camelid territories and low population densities, the perennial pasturage and water resources of the Puna of Junín can support large and seasonally stable camelid populations. Here ecological factors and territorial behavior patterns combined to create a stable concentration of Camelidae within a definite geographic area, forming a kind of natural corral which was exploited by early hunters and within which the process of domestication was probably carried out. Faunal remains excavated from archeological sites in the Puna of Junín (Fig. 1 and Tables 1 and 2) document the abundance and importance of these animals during the preceramic period, and we know that numerous herds of Camelidae existed in the area at the time of the Spanish invasion (*3*, *4*). Introduction of the sheep (*Ovis aries*) by the invaders began a process of replacement of the Camelidae, which culminated in their virtual elimination while the Puna of Junín was under the control of the Cerro de Pasco Corporation.

Uchcumachay Cave: The Preceramic Sequence

The Cave of Uchcumachay (Tilarnioc) is located in the Puna of Junín at an altitude of 4050 m above sea level (kilometer 218.5 of the Lima-La Oroya-Cerro de Pasco highway in the Provence of Yauli, Department of Junín). This cave is one of many preceramic sites discovered by Matos Mendieta (Fig. 1) (*1*). Test excavations at Uchcumachay were completed by Kaulicke in 1972 (*5*, *6*), when highway and canal construction activities threatened destruction of the cave deposits. At the time of excavation these deposits covered a surface area of 376 m^2. A single test trench, 1 by 10.5 m, was excavated from the cave wall to the edge of the talus deposit. Road construction activities subsequently destroyed the outer limits of the talus deposit.

A total of seven natural stratigraphic levels reaching a maximum depth of 1.20 m were revealed. Levels 1 through 3 showed evidence of mixture, and for this reason we will not consider these materials here. Levels 4 through 7 represent undisturbed preceramic deposits and are the subject of this article. To date carbon-14 samples from these excavations have not been processed.

Level 7 represents the first occupation of Uchcumachay Cave. This deposit, which covered an area of approximately 1 m^2 in the test trench, was very thin and compact and lay directly on sterile sediments. Lithic remains from this level include a distal retouch split nodule scraper (Fig. 2) and seven waste flakes, all from local stone. Bones of extinct Pleistocene Cervidae (*Agalmaceros blicki*) and Equidae [*Parahipparion* (*Hyperhippidium*) *peruanum*] were also found in association with these lithic materials. *Parahipparion* (*Hyperhippidium*) *peruanum* (*7*) has also been found in levels 7, 8, and 9 of the site of Huargo, located at 4050 m above sea level in the Department of Huánuco, without associated lithic material (*8*). A radiocarbon date of 11,510 ± 700 B.C. has been obtained from animal bones found in level 8 (*9*). Likewise there may be some correlation with Pleistocene faunal materials of the Pacaicasa (20,000 to 13,000 B.C.) and Ayacucho (13,000 to 10,000 B.C.) complexes from Pickimachay Cave (levels k through i1 and h1 through h) in the Department of Ayacucho (*10*, pp. 12–16). Radiocarbon dates for this material, all from animal bone samples, range from 17,650 ± 3,000 B.C. to 12,750 ± 1,400 B.C. for the Pacaicasa complex and 12,200 ± 180 B.C. for the Ayacucho complex levels (*10*, pp. 12–16). According to MacNeish *et al.* (*10*), these two complexes correspond to periods 1 (20,000 to 13,000 B.C.) and 2 (13,000 to 10,000 B.C.) of their proposed Central Andean chronology and are character-

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ized by exclusive hunting of Pleistocene faunal forms which disappeared by 10,000 B.C. In the case of Uchcumachay Cave, however, the stratigraphic evidence indicates a more recent date for the Pleistocene fauna found in level 7. According to MacNeish and Nelken-Terner (*11*), the lithic assemblage from level 6 at Uchcumachay Cave closely corresponds to that of the Early Jawya complex of Ayacucho, which begins about 7,100 B.C. (*10*, p. 21). If this cross dating is even approximately correct for level 6, acceptance of a date greater than 10,000 B.C. for level 7 would imply a hiatus in occupation of at least 3,000 years—a hiatus for which there is no stratigraphic evidence. For this reason we suggest a tentative date of 10,000 to 7,000 B.C., corresponding to period 3 of the proposed Central Andean chronology (*10*, pp. 16–20), for level 7 at Uchcumachay Cave.

Level 6 deposits contained 78 artifacts. This small sample size is a result of the reduced area of level 6 in the test trench. Included among the artifacts are projectile points (14.1 percent), other bifacial tools (6.1 percent), artifacts with lateral retouch (43.6 percent), artifacts with distal retouch (24.4 percent), and other miscellaneous artifact types (11.8 percent). Debitage (that is, the waste material produced in the manufacture of stone tools) represents more than seven times the volume of artifacts. Stone utilized in the manufacture of these tools is of local origin. Six types of projectile points were found, and artifacts with lateral retouch (43.6 percent) are the most common. On typological grounds we can compare the artifacts from level 6 with some from the Lauricocha I period at caves L-1 and U-1 in the Department of Huánuco (8,000 to 6,000 B.C.) (*12, 13*) and, as has been mentioned above, with the early levels of the Jawya complex (7,100 to 5,800 B.C.) of Ayachucho (*10*, p. 21). This corresponds to period 4 of the proposed Central Andean chronology, which dates from 7,000 to 5,500 B.C. (*10*, pp. 20–24).

Level 5 contained 442 artifacts including projectile points (28.5 percent), other bifacial artifacts (11.1 percent), artifacts with lateral retouch (24.2 percent), artifacts with distal retouch (28.1 percent), and other miscellaneous artifact types (8.1 percent). The volume of debitage was about three times that of artifacts. The frequency (from 14.1 to 28.5 percent) and variety (from 6 to 16 types) of projectile points increases from level 6 to level 5, while the manufacture of lateral retouch artifacts decreases (from 43.6 to 24.2 percent). The most common projectile point types include stemmed points with lateral wings, cordiform, double-ended (leaf-shaped), and concave-base points. The stone is of local origin. On typological grounds we note some correlations with the Early Chihua complex (4,550 to 4,200 B.C.) and the Piki complex (5,800 to 4,550 B.C.) of Ayacucho (*10*, p. 26), and the Lauricocha II period at caves L-1 and U-1 in Huánuco (6,000 to 3,000 B.C.) (*12, 13*). In terms of the Central Andean chronology (*10*, pp. 24–28) this level would appear to correspond in part to period 5, 5,500 to 4,200 B.C.

Level 4 contained 491 artifacts, including projectile points (37.7 percent), other bifacial artifacts (12.6 percent), artifacts with lateral retouch (21.4 percent), artifacts with distal retouch (especially end scrapers) (25.0 percent), and other miscellaneous artifact types (3.3 percent). Debitage amounted to slightly more than double the volume of artifacts. The frequency of projectile points continues to increase in level 4 (from 28.5 percent in level 5 to 37.7 percent) and 14 different projectile point types are identified. The most frequently represented are rhomboids and triangular points with straight sides and rounded bases. The stone utilized is of local origin with the exception of a few pieces of obsidian from the Quispisisa source in Huancavelica (*14*). Bone projectile points and awls were also recovered in this level. On typological grounds we can note some correlations with the Middle and Late Chihua complexes (4,200 to 3,100 B.C.) of Ayacucho (*10*, p. 30), the Lauricocha III period at caves L-1 and U-1 in Huánuco (3,000 to 1,000 B.C.) (*12; 13*, p. 145), and materials from Quishqui Puncu in Ancash (*15*). This suggests a date sometime between 4,200 to 2,500 B.C., corresponding in part to period 6 of the chronology proposed for the Central Andean region (*10*, pp. 28–32).

Table 1. Preceramic faunal remains from Uchcumachay Cave, Puna of Junín. Values are numbers of bones and percentages of faunal remains.

Identification	Level 4, 4,200–2,500 B.C.		Level 5, 5,500–4,200 B.C.		Level 6, 7,000–5,500 B.C.		Level 7, 10,000–7,000B.C.	
	No.	%	No.	%	No.	%	No.	%
			Camelidae					
Adult	443	50.3	684	57.3	66	37.7		
Juvenile	150	17.0	148	12.4	15	8.6		
Fetal or newly born	154	17.5	151	12.6	15	8.6		
Total	747	84.8	983	82.3	96	54.9		
			Cervidae					
Adult	105	12.0	157	13.1	65	37.1		
Juvenile	18	2.0	31	2.6	2	1.1		
Fetal or newly born			13	1.1	4	2.3		
Hippocamelus antisensis			5	0.4	1	0.6		
Odocoileus virginianus			1	0.1	1	0.6		
Agalmaceros blicki							2	25.0
cf. *Agalmaceros blicki*							1	12.5
Total	123	14.0	207	17.3	73	41.7	3	37.5
			Other species					
Parahipparion (Hyperhippidium) peruanum							1	12.5
cf. *Parahipparion (Hyperhippidium) peruanum*							2	25.0
Canis familiaris			2	0.2				
Dusicyon culpaeus	1	0.1			1	0.6		
Felis concolor	2	0.2						
Lagidium peruanum	5	0.6	2	0.2				
Rodent							2	25.0
Bird					5	2.8		
Total of identifiable bones	881	100	1,194	100	175	100	8	100
			Unidentifiable bones					
Camelidae-Cervidae size								
Adult	3,748		4,857		789			
Juvenile and fetal or newly born	623		516		211			
Less than Camelidae-Cervidae size								
Adult	1		13					
Juvenile and fetal or newly born								
Total of analyzed bones	5,253		6,580		1,175		8	

Uchcumachay Cave: The Faunal Remains

The faunal remains excavated at Uchcumachay Cave provide evidence of change in animal utilization patterns during the preceramic period, beginning with the hunting of an extinct Pleistocene fauna and terminating with intensive utilization of the Camelidae. A total of 13,016 animal bones and bone fragments recovered from levels 4 through 7 of Uchcumachay Cave were analyzed utilizing comparative osteological collections at the Laboratorio de Paleoetnozoología of the Universidad Nacional Mayor de San Marcos in Lima (*16, 17*). For 2,258 of these osseous remains it was possible to identify the genera or species. Bones of Camelidae—*Lama guanicöe*, *L. vicugna*, *L. glama*, and *L. pacos*—have been recorded as a single group (Camelidae) because of the lack of documented characteristics for visual separation of the bones of these species. These remains were subdivided into three age groups: (i) adult (more than 18 months), (ii) juvenile (approximately 2 to 18 months), and (iii) fetal or newly born (up to approximately 2 months), by utilizing skeletons of *L. glama* and *L. pacos* of known age and sex from the Centro Nacional de Camelidos Sud-Americanos, Instituto Veterinario de Investigaciones Tropicales y de Altura, La Raya, Puno, in the collections of the Laboratorio de Paleoetnozoología. Likewise the bones of Cervidae were subdivided into (i) adult (fused), (ii) juvenile (unfused bones and deciduous teeth), and (iii) fetal or newly born. The remaining unidentifiable fragments were subdivided into two groups: (i) animals of Camelidae-Cervidae size and (ii) animals of less than Camelidae-Cervidae size. The results of this analysis are presented in Table 1.

Level 7 of Uchcumachay Cave contained remains of Pleistocene Cervidae and Equidae (Table 1). *Agalmaceros blicki* is a high-altitude Pleistocene cervid which has previously been described from geologic deposits in Ecuador (*18*). An antler fragment and a frontal portion (Fig. 3, a and b) represent, to the best of our knowledge, the first reported occurrence of this species both in Perú and in association with human activity (*19*). After the *A. blicki* antler fragment in the excavated material at Uchcumachay Cave was identified, another antler portion of this species was found amid the debris left by recent pothunters at the site. Also, a nearly complete skull of an adult *A. blicki* was located by R. Matos Mendieta in the nearby village of San Pedro de Cajas (Fig. 4), which allowed positive species identification of the frontal portion from level 7. This skull, found during excavations for a well, is in a private collection and has not been available for detailed study.

In addition to *A. blicki*, an astragalus (Fig. 5a), first phalanx (Fig. 5b), and cervical vertebra of native American equid were also found in level 7 deposits. The first phalanx has been identified as *Parahipparion (Hyperhippidium) peruanum* by Hoffstetter (*19*). This species has apparently not previously been reported from an archeological site in Perú, despite the fact that the small zebra-like form of *Parahipparion* was far more common than true *Equus* (for example *Amerhippus* or *Equus andium*) (*20*). Equid bones from the site of Huargo in the Department of Huánuco were identified as *Amerhippus* sp. (*21*) but in fact pertain to the species *P. peruanum* (*7*). Bones identified as *E. andium* were found at Pickimachay Cave in the Department of Ayacucho (*10*, pp. 12–16). Dates for the equids from Huargo [11,510 ± 700 B.C. (*9*)] and Pickimachay Cave [20,000 to 10,000 B.C. (*10*, pp. 12–16)] are greater than the date indicated for level 7 at Uchcumachay (10,000 to 7,000 B.C.) but, as Hoffstetter indicated while examining the bones from level 7, the possibility that both *A. blicki* and *P. peruanum* survived in the high Andean puna until such a recent date is not surprising (*19*). The most important aspect of level 7 at Uchcumachay Cave, however, is the undoubted association of extinct species with evidence of human activity (Fig. 2). Future excavations at Uchcumachay should amplify our understanding of both the date and nature of this early hunting economy.

Level 6 faunal remains (Table 1) (7,000 to 5,500 B.C.) appear to represent a transitional stage in the long-term trend toward increasingly intensive utilization of the Camelidae. Of the bones 54.9 percent are of Camelidae and 41.7 percent of Cervidae, indicating an almost equal importance of both in the diet. Faunal remains of this period recovered at the site of Panaulauca (level 7) (Fig. 1 and Table 2) in the Puna of Junín included 26.0 per-

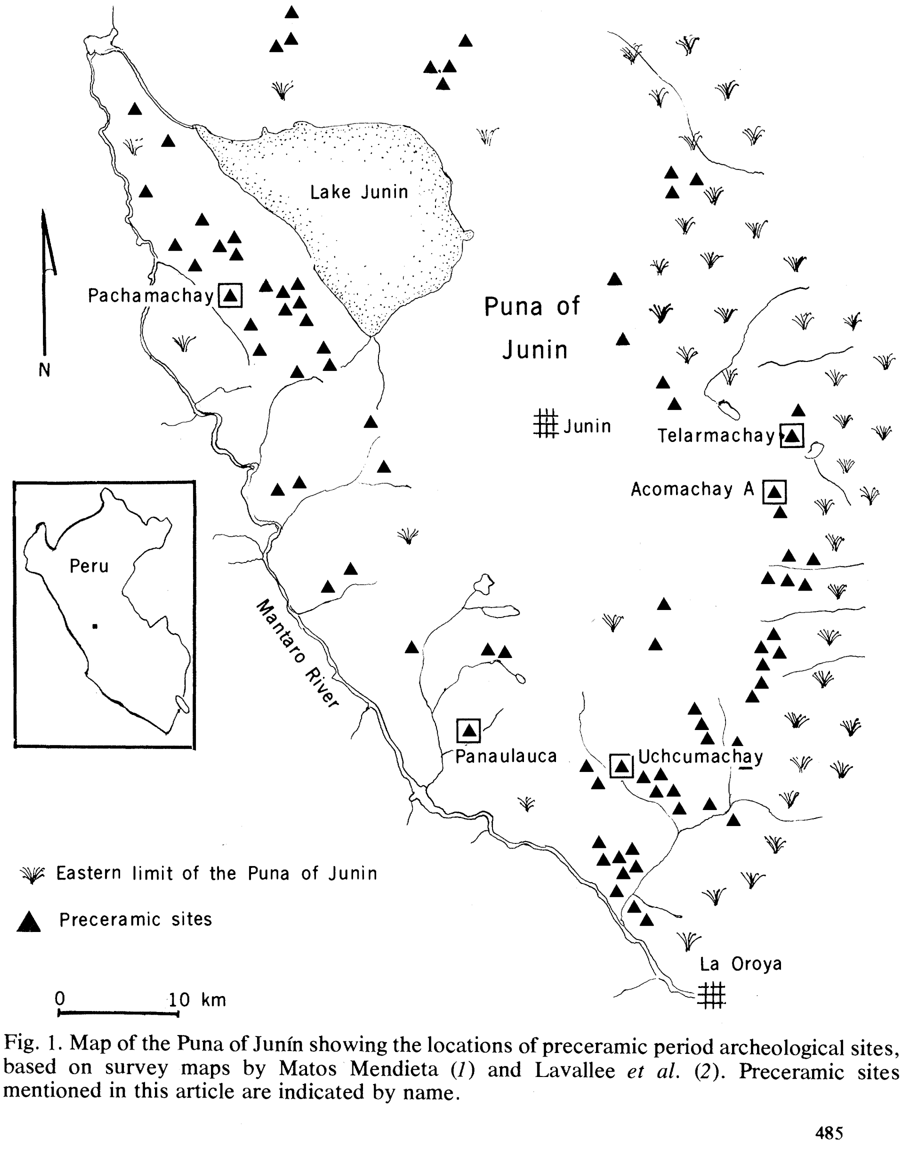


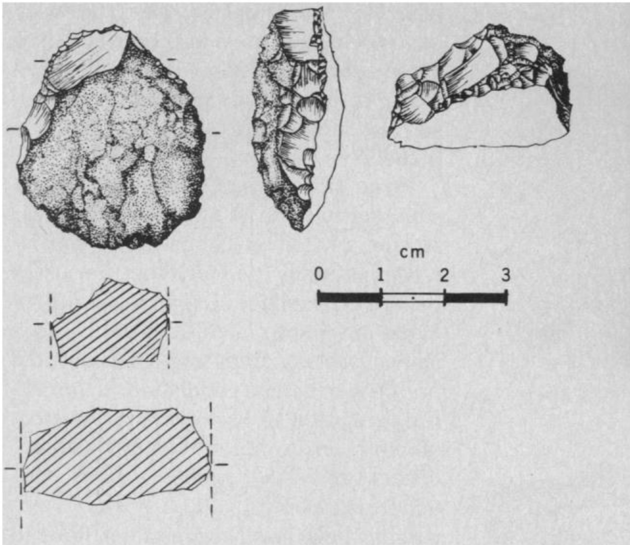
Fig. 1. Map of the Puna of Junín showing the locations of preceramic period archeological sites, based on survey maps by Matos Mendieta (*1*) and Lavallee *et al.* (*2*). Preceramic sites mentioned in this article are indicated by name.

cent Camelidae and 74.0 percent Cervidae. Proportions similar to those from Uchcumachay (59.1 percent Camelidae and 40.9 percent Cervidae) were also found at Lauricocha Cave L-1 (levels 20 and 21) (Table 2), which is situated in the puna life zone of the nearby Department of Huánuco.

Level 5 (5,500 to 4,200 B.C.) represents an economy based on primary camelid utilization (82.3 percent) (Table 1), with relatively minor consumption of Cervidae (17.3 percent) and rare small mammal exploitation (0.4 percent). Of particular importance among the bones from level 5 at Uchcumachay are an axis and canine tooth of domestic dog, *Canis familiaris*. These bones, together with an-

Table 2. Preceramic faunal remains from archeological sites in the Puna of Junín and the nearby Puna of Lauricocha. A total of 25,146 animal bones from these sites were analyzed by J. Wheeler Pires-Ferreira, E. Pires-Ferreira, P. Kaulicke, C. R. Cardoza, E. Angulo, and D. Pozzi-Escot of the Laboratorio de Paleoetnozoología, Lima. Of these bones, 5,644 could be identified to genus or species level. The sites of Uchcumachay, Panaulauca, and Pachamachay were excavated by P. Kaulicke and R. Matos Mendieta, Acomachay A and Telarmachay by Lavallee and Julien (*2*, *24*), and Lauricocha L-1 by A. Cardich.

Uchcumachay Cave (Tilarnioc)	Panaulauca Cave (Panalagua)	Pachamachay Cave	Acomachay A	Telarmachay	Lauricocha Cave (L-1)
Period 7 (2,500–1,750 B.C.)					
		Levels 3 to 7 96.1% Camelidae 2.7% Cervidae 0.1% *Canis familiaris* 0.1% *Lagidium peruanum* 0.4% Felidae 0.4% bird (unidentifiable) 0.2% *Batrachophrynus* sp.	Levels 2 to 4 (sounding 1) Level 2 (sounding 2) 94.1% Camelidae 5.9% Cervidae	Level 5 (sounding 1) 84.8% Camelidae 13.5% Cervidae 1.7% *Lagidium peruanum*	
Period 6 (4,200–2,500 B.C.)					
Level 4 84.8% Camelidae 14.0% Cervidae 0.6% *Lagidium peruanum* 0.3% bird (unidentifiable) 0.2% *Felis concolor* 0.1% *Dusicyon culpaeus*	Level 1 to 3 85.8% Camelidae 13.9% Cervidae 0.3% *Felis concolor*	Levels 8 to 12 97.8% Camelidae 2.0% Cervidae 0.2% *Canis familiaris*			Levels 12 to 14 (Lauricocha III) 84.7% Camelidae 13.1% Cervidae 2.2% *Canis familiaris*
Period 5 (5,500–4,200 B.C.)					
Level 5 82.3% Camelidae 17.3% Cervidae 0.2% *Lagidium peruanum* 0.2% *Canis familiaris*	Levels 4 to 6 87.6% Camelidae 12.3% Cervidae 0.1% *Canis familiaris*				
Period 4 (7,000–5,500 B.C.)					
Level 6 54.9% Camelidae 41.7% Cervidae 2.8% bird (unidentifiable) 0.6% *Dusicyon culpaeus*	Level 7 26.0% Camelidae 74.0% Cervidae				Levels 20 to 21 (Lauricocha I) 59.1% Camelidae 40.9% Cervidae
Period 3 (10,000–7,000 B.C.)					
Level 7 25.0% *Agalmaceros blicki* 12.5% cf. *Agalmaceros blicki* 12.5% *Parahipparion (Hyperhippidium) peruanum* 25.0% cf. *Parahipparion (Hyperhippidium) peruanum* 25.0% rodent (unidentifiable)					



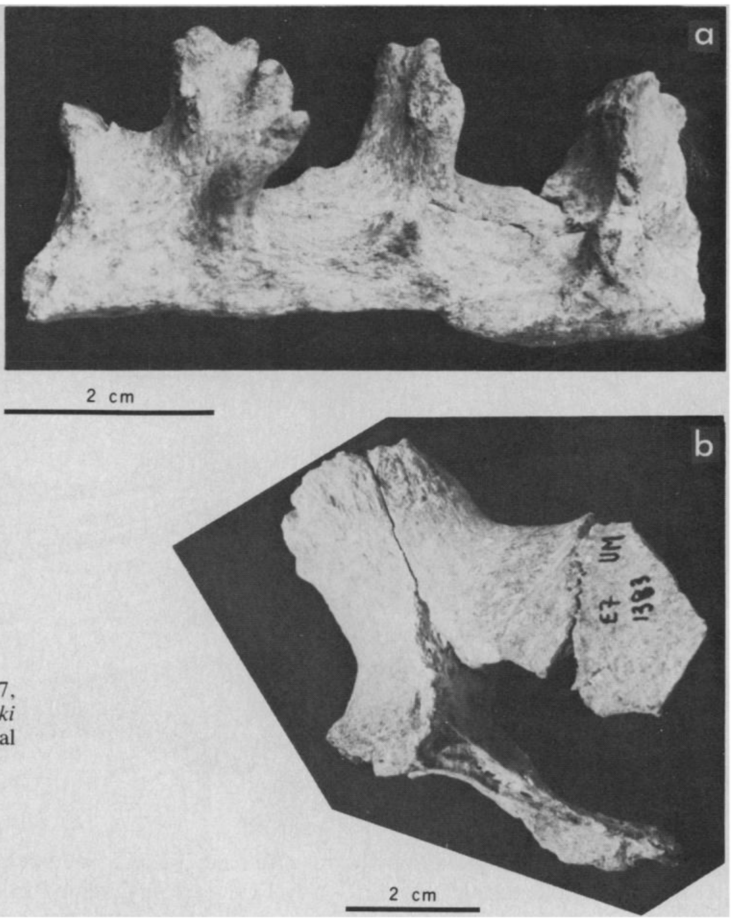


Fig. 2 (left). Distal retouch split nodule scraper from level 7, Uchcumachay Cave. Fig. 3 (right). Bones of *Agalmaceros blicki* from level 7, Uchcumachay Cave: (a) antler fragment and (b) frontal portion.

other canine of similar date from level 4 at Panaulauca Cave (Table 2), apparently represent the earliest evidence of domestic dog so far recovered in Perú (*22*). Faunal remains of this period found at Panaulauca Cave (levels 4 to 6) included 87.6 percent Camelidae, 12.3 percent Cervidae, and 0.1 percent *C. familiaris* (Table 2). Cardich (*13*, p. 145) reports a predominance of camelid, together with some cervid and rare small animal remains, for the Lauricocha II period (6,000 to 4,000 B.C.) in Huánuco, but no bones of this period were included in the sample from Lauricocha Cave L-1 analyzed at the Laboratorio de Paleoetnozoología.

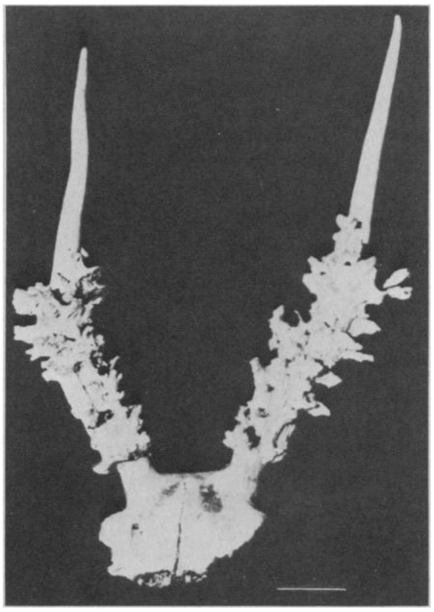
Level 4 (4,200 to 2,500 B.C.) shows no significant evidence of change in the pattern of animal utilization found in level 5 at Uchcumachay Cave. Primary dependence on the Camelidae as a source of meat is recorded at 84.8 percent, while cervid remains account for only 14.0 percent of the total. A similar pattern is also seen at Panaulauca Cave (levels 1 to 3) (Table 2) where faunal remains of this period included 85.8 percent Camelidae, 13.9 percent Cervidae, and 0.3 percent *Felis concolor* (mountain lion). Likewise, animal bones from Pachamachay Cave (levels 8 to 12) (Fig. 1 and Table 2), which is also located in the Puna of Junín, included 97.8 percent Camelidae, 2.0 percent Cervidae, and 0.2 percent *C. familiaris*. Bones from Lauricocha Cave L-1 (levels 12 to 14) (3,000 to 1,000 B.C.) produced similar totals of 84.7 percent Camelidae, 13.1 percent Cervidae, and 2.2 percent *C. familiaris* (Table 2).

Remains of the terminal preceramic period 7 (2,500 to 1,750 B.C.) (*10*, pp. 32–37) from Uchcumachay Cave are not included in this analysis because levels 1 to 3 were disturbed. However, the faunal adaptation of this period is known from other sites in the Puna of Junín: Pachamachay Cave (levels 3 to 7) (Table 2), Acomachay A (levels 2 to 4, sounding 1; and level 2, sounding 2), and Telarmachay (level 5, sounding 1) (*23, 24*) (Fig. 1 and Table 2). The greater than 80 percent frequencies of camelid utilization found during the preceding periods for levels 4 and 5 at Uchcumachay Cave continue to increase during the terminal preceramic, rising to 96.1 percent at Pachamachay, 94.1 percent at Acomachay A, and 84.8 percent at Telarmachay, where there is evidence for domestication (*23, 25*).

This sequence from the Puna of Junín documents the process of development of a stable economic adaptation based on primary camelid utilization, which began with the first appearance of these animals in the area around 7,000 B.C. and terminated with their domestication between 2,500 and 1,750 B.C. Although there is as yet no evidence for the existence of fossil Camelidae in Pleistocene deposits of the Central Andes (Perú) (*20, 21*), they are known from Punín, Ecuador, to the north, and Tarija, Bolivia, to the south (*26–29*). This noncontiguous distribution of fossil forms, taken together with the apparent correlation between the disappearance of Pleistocene fauna and the appearance of Camelidae in archeological sites (Table 2) (*10*, pp. 12–20), suggests the possibility of a climatic change that favored the dispersion and increase of camelid populations in the Central Andes between 10,000 and 7,000 B.C. Paleoecological studies, which could explain this phenomenon, are lacking.

The Phenomenon of Primary Camelid Utilization

While it is clear that the processual decrease in cervid remains throughout the preceramic period at Uchcumachay Cave and other sites in the Puna of Junín (Table 2) reflects a decrease in hunting activities, we cannot yet explain the corresponding increase in camelid utiliza-



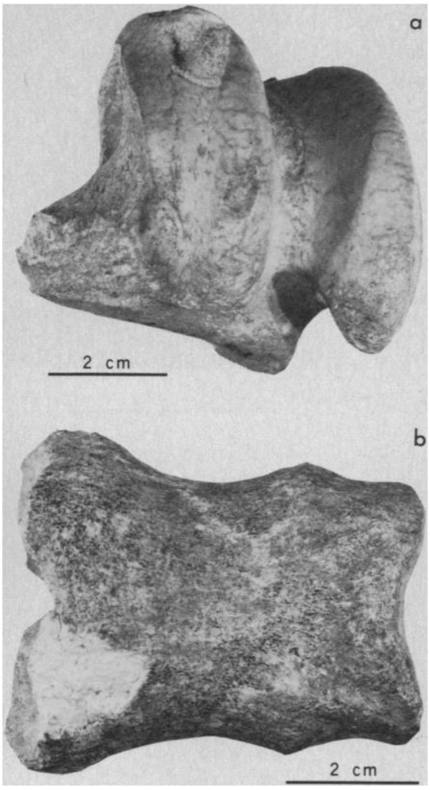


Fig. 4 (left). Cranium of *Agalmaceros blicki* from San Pedro de Cajas, Junín. Scale bar, 5 cm. Fig. 5 (right). (a) Astragalus of cf. *Parahipparion (Hyperhippidium) peruanum* and (b) first phalanx of *Parahipparion (Hyperhippidium) peruanum*, both from level 7 of Uchcumachay Cave.

tion. One reason for this is that the increase in Camelidae through time at Uchcumachay Cave is correlated with an increase in the percentage of bifacial artifacts and projectile points. If these tools, especially the projectile points, reflect hunting activity, it seems clear that the increasingly intensive camelid exploitation must be considered in much wider terms than domestication. For this reason we present four models that can be used to interpret the phenomenon of primary camelid utilization (that is, a greater than 80 percent dietary dependence on the Camelidae) during the preceramic period in the Central Peruvian Andes.

1) Specialized hunting, characterized by primary dependence on the wild Camelidae [any or all of *L. vicugna*, *L. guanicöe*, *L. huanachus cacsilensis* (guanaco), wild forms of *L. glama*, *L. pacos*, or others], together with infrequent exploitation of other species. The social organization and territorial behavior of the wild Camelidae provide optimal conditions for the development of a stable specialized hunting economy. The vicuña, the most extensively studied of the wild Camelidae (*30, 31*), and probably the guanaco (*32–34*), have a social organization based on family groups composed of a single adult male and four to seven adult females. The male maintains his family unit within a clearly defined territory, which he defends against all other family groups and solitary males and from which he expels both male and female juvenile members. These territories are maintained in essentially the same place at all times throughout the year, and year after year, and provided the pressure exerted by the human population remains below a certain level, represent a spatially and numerically stable supply of meat protein. Vicuña and guanaco territories are interspaced (*35*), and both animals would probably have been jointly available before their displacement or destruction as the result of human activities. What this means is that early humans in the Andes could have developed a specialized hunting economy based on primary camelid utilization simply by judicious hunting of the highly predictable and territorially stable wild camelid populations, and sedentarism could have occurred as a result. The hunting technique utilized would most likely have been the ambush of individual animals, as surround hunting would destroy the stability of local camelid territories.

2) Control of semidomesticated Camelidae, characterized by primary dependence on herds of semidomesticated or half-tamed animals in which breeding with wild animals regularly occurs, creating a single gene pool, together with negligible exploitation of other species. This situation could closely parallel that described for Chuckchi reindeer-herding by Leeds (*36*, p. 95): "Chuckchi reindeer are only half tamed. Though they differ slightly in appearance and morphology from the wild reindeer, they appear to have no specific traits dependent on their association with man. They interbreed freely with the wild deer, an event considered highly desirable by Chuckchi herders."

In the case of the Camelidae a similar situation could exist as a result of the extension of human control over the already naturally delimited territories of the wild Camelidae. Experience with vicuñas at Pampa Galeras in Perú (*35*) has shown that overhunting, and not the presence of human population, is the critical factor that causes the abandonment of family territories and removal to more distant and inaccessible regions. Attempts to control wild camelid populations could have begun either prior to or as the result of territorial abandonment caused by overhunting or the presence of domestic dogs. The objective of such control would be to maintain the balance between the human population and the meat supply within a given area, and the emphasis would be on limiting the territorial dispersal of the wild animals, not on breeding control. Crossbreeding between semidomesticated females and wild solitary males and exchange between the semidomesticated and wild populations would occur. Herd attrition would be caused principally by wild males stealing semidomesticated females.

It should be noted that, contrary to popular belief, interbreeding between all the wild and domestic forms of modern Camelidae produces fertile offspring (*37, 38*). The karyotype for all four species is $2n = 74$, a factor which facilitates the crosses (*38*) and raises some question as to whether we are dealing with one single or four distinct species (*37*). Examples of male vicuñas stealing female alpacas to form a family are known (*39*) and the fecundity of the pacovicuña (*L. pacos* × *L. vicugna*) is well documented (*38*). Cabrera and Yepes (*40*) comment on the existence and fertility of llamavicuñas (*L. glama* × *L. vicugna*) and llamaguanacos (*L. glama* × *L. guanicöe*), and studies of the vicuñaguanaco (*L. vicugna* × *L. guanicöe*) are under way in Argentina (*39*). Crossbreeding between llama and alpaca (*L. glama* × *L. pacos*) commonly occurs, producing the huarizo or misti (*40*, p. 80). The family structure and territorial defense mechanisms described for the present-day wild Camelidae exist in these hybrids as well as in the herds of llama and alpaca and are important factors in the low reproductivity rates of these animals (*39, 41*). This suggests that whatever the ancestral form of the domestic Camelidae was—guanaco, vicuña, wild llama, wild alpaca, or others—their territorial behavior patterns were probably very similar to those exhibited by the vicuña and guanaco today.

3) Herding of domestic Camelidae, characterized by primary dependence on such herds and negligible exploitation of other species. This implies not only human control over the territorial disposition of the animals but also the exertion of strict breeding control, which led to the development of both the llama and the alpaca and subsequently of specialized breeds such as the suri and huacaya alpacas. The culmination of this process was seen in the pure herds of the Inca empire, herds which have not been equaled since the Spanish invasion.

4) Hunting of wild Camelidae and herding of semidomesticated or fully domesticated Camelidae (or both), together with negligible exploitation of other species. Any combination of the three preceding models is possible and most likely the norm in a primary camelid exploitation economic adaptation. Presumably the hunting of vicuñas for their fine wool and guanacos for their prized meat (*40*, p. 76) was always practiced.

Camelid Domestication: A Model

Although the four models of primary camelid utilization presented above have been considered separately, the first three represent sequential stages which, when integrated with model 4, form a single model (Fig. 6) that explains some of the factors and processes that led to camelid domestication and the establishment of herding economies in ancient Perú. The territorial and social organizational characteristics of wild Camelidae are key elements both in the development of a specialized hunting economy from an earlier generalized hunting pattern, and in the origin of human control over these territories which led to the appearance of semidomesticated animals. Increasing territorial control resulted in increased breeding control and the development first of domesticated Camelidae, and thereafter of specialized breeds.

Latcham (*42*) has suggested that the center of camelid domestication was in the Lake Titicaca region of southern Perú and Bolivia, but there is no archeological evidence from the preceramic period with which to test this hypothesis. The fact that this region contains the greatest concentrations of domestic Camelidae today does not prove that it was a center of domestication, because the present-day distribution is in part the result of economic disturbances that began with the Spanish invasion and culminated in the disappearance of the llama and alpaca, as well as guanaco and vicuña, from many parts of Perú and Bolivia. One area where Camelidae were once abundant but have been supplanted by sheep is the Puna of Junín (Table 2). As noted above, the Puna of Junín forms a natural corral with ecologically optimum conditions for the support of large and seasonally stable camelid populations. This circumstance provides the necessary conditions for the development of camelid domestication according to our model. The hypothesis that the Puna of Junín could have been a center of camelid elid domestication is partially substantiated by the great quantities of camelid bones which have been recovered from various preceramic sites in the Puna (Table 2). Although it has been impossible to determine which forms (or species) of Camelidae were represented in these sites because of the many problems concerning the taxonomy, genetics, and comparative osteology of these animals, we believe there.are two points of reference that relate the increase in camelid utilization during the preceramic period in the Puna of Junín to our model (Table 3). First, period 4 (7,000 to 5,500 B.C.) (Table 2) probably represents a generalized hunting economy, and second, in period 7 (2,500 to 1,750 B.C.) we have evidence of domestic Camelidae (*23, 25*). In between, the process of camelid domestication took place, and we propose that period 5 (5,500 to 4,200 B.C.) may represent a trend from specialized hunting toward semidomesticated Camelidae and that period 6 (4,200 to 2,500 B.C.) includes the change from semidomesticated to domestic Camelidae. This may explain, in part, the increase in both projectile points and Camelidae bones through time; much work remains, however, to test this hypothesis.

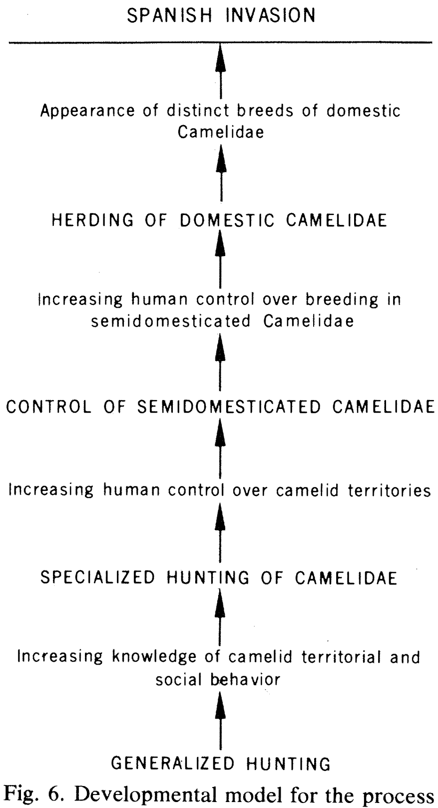


Fig. 6. Developmental model for the process of camelid domestication in the puna life zone of the Central Andes.

Osteological Implications

The problems of distinguishing between the bones of *L. glama*, *L. pacos*, *L. guanicöe*, and *L. vicugna* even as we now know them are complex. We know of no complete comparative study of the osteology of these animals that has been published, and the few documented cranial characteristics that can be used for visual separation (*43*) are rarely preserved among the fragmentary archeological remains. If one were to accept the conclusion of Herre (*43*) that *L. guanicöe* is the ancestral form of *L. glama* and *L. pacos*, as well as the largest of the Camelidae, it would be expected that the first detectable change in the bones to occur with domestication would be the appearance of an alpaca form intermediate in size between the large *L. guanicöe* and the small *L. vicugna*. Appearance of this intermediate domestic form would be recorded in terms of size variation in the bones of Camelidae preserved in archeological sites. This size variation is a factor which Wing (*44, 45*), accepting Herre's conclusion, has interpreted as one indicator of domestication.

However, the size variation found among the bones of fossil Camelidae indicates both forms of the same size as modern vicuñas, guanacos, alpacas, and llamas as well as considerably larger Camelidae up to the size of a modern dromedary (*26–29*). This suggests that other ancestral forms of the present domestic Camelidae may have existed, and raises some question concerning the viability of osteometric analysis as a tool for determining the origins of camelid domestication. This problem is further complicated by the presence of a small Peruvian guanaco, *Lama huanachus cacsilensis* Lönneberg 1913 (*21*, pp. 34–35; *46*), which has molars smaller than those of alpaca (*46*) but larger than those of vicuña. The range and distribution of this animal have apparently not been studied (nor have those of the other, larger Peruvian guanaco), but the possibility of its presence in archeological faunal samples must be considered. Guanaco and vicuña ranges are interspaced (*35*), and presumably both would have been utilized if specialized hunting was being practiced. If the small guanaco were present, size variation would be found in the resultant faunal remains which, following the conclusions drawn from Herre (*43*), could be interpreted as indicative of domestic animals. Semidomesticated Camelidae would not exhibit any difference in size variation from the wild animals with which they crossbreed, and a similar lack of size variation should also characterize herds of domestic Camelidae. Again, following the conclusions drawn from Herre (*43*), faunal remains from either of the two preceding cases might be interpreted as indicative of wild Camelidae. Much more work on the osteometry of modern, archeological, and paleontological Camelidae is needed before we can determine what forms of Camelidae existed and reliably identify those forms from bone shape and size. Meanwhile, nonmetrical techniques may provide more exact results.

Pollard and Drew (*47*) analyzed samples of the bones of modern Camelidae from collections of the American Museum of Natural History, New York, examining petrological thin sections of bone under polarized light. Although "the bones available were mostly from zoo animals and the results were somewhat obscured by the pathologic condition of some of the specimens" (*47*, p. 300), their results indicated the existence of some observable differences in the bone structure of the animals sampled. They suggested that "adult domestic animals, whether through lack of exercise, poor nutrition, genetic deterioration, or a combination of these factors, lack sufficient bone material to develop the sturdy bones characteristic of adult wild animals" (*47*, p. 300), and that this results in observable structural differences in their bones. However, examination of a large control sample of llama, alpaca, guanaco, and vicuña bones of known variety, age, sex, and dietary and health history and from their natural habitat is needed before we can begin to understand what these observable differences really signify and before we can reliably apply this technique in the analysis of archeological material.

The examples we have cited are but a few of the problem areas in dealing with osteological material from archeological sites and the question of camelid domestication. New techniques will undoubtedly help to solve them, but we must always remember not to separate the bones from the animals in our analysis and interpretation of archeological faunal remains.

Summary

The analysis of animal bones recovered from preceramic period deposits at Uchcumachay Cave and other sites in the Puna of Junín has documented the development of an economy involving primary camelid utilization beginning around 5,500 B.C. and culminating with the appearance of domestic forms between 2,500 and 1,750 B.C. A model that can be used to explain this process in both the Puna of Junín and the Central Andes has been presented.

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