

Adaptative Characteristics of SACs to High Altitude and Semi-desert Environments: Ecological Importance

Animals living in high altitude environments must be able to survive extreme conditions such as radical temperature fluctuations (from -15° to 20° C), low food quality, dehydration, dryness, winds, and low ambient oxygen. It is not surprising, therefore, that SACs have developed, through evolution and domestication, special adaptative characteristics for dealing with life at nearly 5,000masl.

Nutrition

A review of the existing literature on the nutrition of the *llama* (*Lama glama*) and *alpaca* (*Lama pacos*), revealed that these South American camelids are better adapted to the harsh environment of the Andean Region than advanced ruminants. Lamoids differ from advanced ruminants in stomach morphology and digestion, and they eat selectively. Protein and energy requirements of SACs are lower than those of other domestic ruminants. Also, they thrive on sites where phosphorous and copper are so severely lacking that cattle suffer debilitating deficiency diseases and sheep are affected by a crippling disease associated with low copper content in the soil.

Available data indicate that stocking ratios should be 1.0:1.0 for *alpaca*: sheep and 1.5:1.0 for *llama*:sheep. Thus, one *alpaca* of 65kg, will be equal to a sheep of 40kg (i.e., will eat the same amount that a sheep eats), and two *llamas*, will be similar to three sheep. From the digestive point of view, they are able to adapt to extreme conditions better than most other large herbivores.

Bloat is defined as tympany of the first stomach compartment. Bloat in other ruminant species is usually classified as primary (frothy) or secondary (free-gas). The consultant, in his 25 years of experience, has not encountered, either personally or in the literature, any cases of frothy bloat in SACs. *Alpacas* and *llamas* have been observed to graze on alfalfa or clover pastures without bloating, and this would normally produce bloat in conventional ruminants. Cases of free-gas bloat do occur, albeit infrequently, probably due to toxic plants.

Circulatory System

Adaptation to low ambient oxygen tension consists of changes in the primary biochemical processes of energy expenditure and oxygen utilisation at the intracellular levels and in the mechanisms concerned in the transport of oxygen to the mitochondrial sites of these processes. Their haemoglobin shows a high affinity for oxygen, thus, increasing the oxygen carrying capacity of the blood and perhaps is one of the most important mechanisms. The large number of very small red cells (microcytosis) are advantageous at high altitudes but are not necessarily specific adaptations to the environment for they also occur in the low altitude desert camels of Africa. Microcytosis is certainly important in increasing the oxygenation rate in red cells. The elliptical shape of the red cells of camelids may also be useful but this has not been studied.

Parturition Behaviour

Births in the *alpaca* and *llama* occur during full daylight when the temperature is favourable for the young. Daylight parturition is probably an adaptation to avoid giving birth during the freezing night-time temperatures of high altitude regions. This is also in contrast with other domestic ungulates, among which the majority of births occur during the dark hours. One of the most important causes of the high neonatal mortality rate of lambs in Peru is pneumonia caused by below zero temperatures very late at night and very early in the morning.

Feet

The *puna* is an ecosystem highly susceptible to degradation as a result of the extreme climate which is characterised by sparse vegetation and very low temperatures most of the year. The special anatomical features on the extremities of the SACs allow them to walk firm-footed across any type of terrain. The SAC's foot has digits and the planar surface is covered with a soft cornified layer similar to that on the bulb epithelium of the heel in sheep or goats. Beneath the protective epithelium lies a fatty fibroelastic pad, similar to the digital cushion of the horse. The nail or claw is small and carries no weight. The broad, elastic pads prevent them from causing damage to plants and soil. This is in contrast to the sharp-edged hooves and claws of domestic animals, such as sheep, goat, cattle, and horses, which tear up the soil's surface and destroy the sparse turf, especially during periods of drought.

Teeth

The distinctive lower incisors of the lamoid enable it to eat small plants, which are close to or lie directly on the ground, without tearing out or loosening the forage plants. (When the Incas first saw sheep, they named them "fire-mouth" because of the way they tore out the vulnerable vegetation cover of the high Andes.) Increased utilisation of these areas by the SACs will bring about a decrease in the degradation of the ecosystem, thus avoiding large-scale destruction and erosion of the topsoil.

Skin Cover

The fine, thick hair is an important protection against heat gain from the intense solar radiation at high altitudes and in a treeless environment. It also serves as protection against below zero temperatures during almost all the nights of the year. The resistance of these animals to cold is remarkable. For example, they can withstand temperatures of -25°C and lower and, in snowstorms, they happily hunker down and often get covered up until only their heads can be seen.

Resistance to Drought

It is worth noting that under uncertain climatic conditions, such as drought, the domestic SACs have shown better adaptive abilities than other domestic species. During the drought that severely affected the Department of Puno, Peru, during 1956-1957, approximately 80 per cent of the cattle and horses died, whereas 40 per cent of the sheep and only 25 per cent of the camelids perished. If this is representative of other areas of high-Andean ecology, it suggests that the *alpaca* and *llama* constitute the most reliable nutritional and economic resources available to the peasants who inhabit this zone.

Disease Resistance

Although disease resistance is not an adaptive characteristic to high altitude and semi-desert environments, we will discuss this advantage. Lamoids are resistant to pulmonary adenomatosis (or ovine pulmonary carcinoma), a major economic problem in Peruvian sheep husbandry. This disease is caused by a virus that produces an ultimately fatal lung tumour, which has been experimentally transmitted to lambs. This chronic, progressive, and ultimately fatal, disease is untreatable. Sheep pulmonary adenomatosis frequently coexists with ovine progressive pneumonia. Culling affected animals is as yet the only way to fight both diseases.

Also, lamoids are resistant to footrot, by far the most common disease in sheep. It is highly contagious, particularly during the rainy season. *Alpacas* are animals that like to graze in *bofedales*. *Bofedales* are areas with constant moisture underground, retaining a fresh green colour during the dry season. It appears that the species most characteristic of *bofedales* is *Distichia muscoides*, a member of the *Juncaceae* family. Footrot has never been reported in the *alpaca* and it is very rare in *llamas* that like to graze in drier areas.

Epididymitis is a testicular inflammation found in a variety of domestic male animals, especially in sheep, causing ram infertility and abortion in some pregnant ewes. This disease is mainly caused by *Brucella ovis*. *Alpaca* or *llama* epididymitis has not been reported, except in cases of traumatic injury of the scrotal content.