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The Shedding and Growth Dynamics of Yak Down Wool and Links to Habitat Ecological Conditions

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Abstract

This research has been carried out to identify correlations between the shedding and growth dynamics of yak down wool and the ecological conditions of yak habitat. According to the research, the location of the aimags and soums where yak herds are bred in large cold Khangai mountains, with an average altitude of 2000-3300m above sea level. The average winter temperatures dropping to between -30^{0}C and -40^{0}C and average summer temperature +12^{0}C to +20^{0}C. In order to survive such harsh environment, the down wool between the coarse top hair fibres grows intensively on yaks at the start of the cold season; throughout winter a yak's body is covered with down wool with a complete morphological structure consisting of coarse down and mid- type fibres, enabling yaks to withstand cold temperatures. With the onset of spring and warmer temperatures, the hair fibres are gradually shed until June, when new fibres appear. However, the growth of new fibres slows down in the months of July and August, intensifying with the approach of colder months. The research reveals that the adaptive capacity of yaks to the ecological conditions of their habitat affects the renewal process of the morphological structure of yak down.

Keywords: Stabilization of hair fibre, hair growth and shedding, hair growth cycle, fine fibres (down and mid- type fibres)

Introduction

Yak herds are found in the mountainous regions of Afghanistan, Bhutan, Mongolia, Russia, China, India, Kyrgyzstan, Tajikistan and Nepal on the Central Asian plateau. There are about 14 million yaks worldwide. Interest in yak research has grown and a number of studies have been undertaken on yak biology and products. For instance, yaks have a strong body conformation, well-shaped large heads, broad foreheads, slightly hollow long noses, convex black muzzles, mobile and convex eyes, and short-, smaller ears, and they are mostly polled. Yaks' necks are short, and narrow at throat,

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broader at the base-skin folds are small, the thoracic vertebral projection is longer and vertical, therefore the animal is higher at the wither and relatively lower at the spine and croup and have shorter hips and narrow buttocks (Tumurjav, 1989; Bat-Erdene, 2002; Shagdarsuren, 2005; Tumurjav, and Doyoddorj, 2002; Bat-Erdene and Doyoddorj, 2010).

Last year's international research tended to focus on global warming and ecological equilibriums therefore; yak researchers are investigating the animal's biological and productive features in conjunction with the ecological conditions of its habitat.

It is emphasized that yaks' biological features as a whole are formed as a result of ecologically peculiar impacts on the anatomical-morphological, physiological and biological specificities of its body, cells, tissues and organs, which are uniquely adapted to severe natural and climatic conditions, the Central Asian high mountains (Bat-Erdene, 2002; Shagdarsuren, 2005; Wiener *et al.,* 2003).

Some researchers reported that one of the natural and ecological factors impacting on yak growth and body size was the air temperature of its habitat (Li, 1992; Yubi and Yuquing, 1995; Zhihua *et al.* (2000); Shagdarsuren, O. 2005).

Developed the following mathematical modeling derived from a calculation of the relationship between yak meat productivity and habitat air temperatures.

$$Y = 2.452 + 7.166\ T_7 + 1.726\ R_2$$

T_7: average air temperature in June, R_2: relative air humidity in February (Yubi and Yuquing, 1995).

According to some studies, long, thick hair and tails, greater down fibres, less sweat and oil glands, and soft and thick skin give yaks a unique resistance to the cold. Because the thermal regulation ability via body-surface heat loss is weak, yaks have less body thermal regulation in hot conditions and hence are not resistant to the heat. (Bat-Erdene, 2002; Shagdarsuren, 2005; Wiener *et al.,* 2003).

Studies by Xi and Qianfei (1984) demonstrated that yaks' coats consist of three hair fibres: Course, mid - type and down fibres which differ significantly with external appearances and technical characteristics. Of those, down fibre is a yak's winter clothing Jiying and Zhengfeng (1981) noted that the ability of yaks to live in extremely cold and wet conditions was due to the water impermeability of their coats.

Yaks' skeleton hair and down fibre are of a seasonal character; abdominal and tail-hair fibres are gradually shed and replaced by new ones, ensuring the thermal balance of the body in the cold seasons. It is described as a thin and light hair coat because short, thin, coarse, shiny hair is present during summer after shedding. (Bat-Erdene, 2002; Shagdarsuren, 2005; Tumutjav and Doyoddorj, 2002).

Although extensive research on Mongolian yak biological and economic factors have been conducted, there have only been limited studies carried out on the specific characteristics of yak hair in relation to the prevailing ecological conditions; therefore, more detailed studies on this area will be significant in terms of the advancement of yak down processing technology and optimization.

Methodology

Geographical locations of the aimags and soums covered in the study Geographically, 79.3 percent of the total number of yak populations are located in the Khangai and Khuvsgul mountains of Mongolia. (Mongolian Statistical yearbook, 1998-2012).

A sampling survey was conducted among 70 khot ails (a group of herder families living in the same vicinity and sharing access to common seasonal pasturelands) with 350 yaks of different ages and gender. Samples were collected from main parts of the body: The neck, throat, kidney, side and legs. All samples were recorded and coded by aimag, soum, khot ail, animal age, sex, and date of sampling. Based on the spread of yak herds across the Altai and Khangai mountain regions, samples were taken from localities at the longitude of $99^0$07/-$102^0$07/ and latitude of $46^0$07/-$49^0$50/ with an average elevation above sea level of 2200м: 13 soums in Arkhangai, Uvurkhangai, Bayankhongor and Khuvsgul aimags (Ikh Tamir, Tariat, Undur-Ulaan, Khangai, Tsenger, Erdene-tsogt, Gurvanbulag, Galuut, Jargalant, Uyanga, Bat-Ulziit and Ulaan-uul and Khatgal).

Results

Geographical localization

Herders and business entities raising a number of yaks are evidence of their characteristics, their adaptability to nature, and the capability of their technological features for processing productivity. Because of this, locations at altitudes above sea level were surveyed. Maps of some aimags where the study was conducted are partially demonstrated, as illustrated below, with the purpose of showing where yaks are bred.

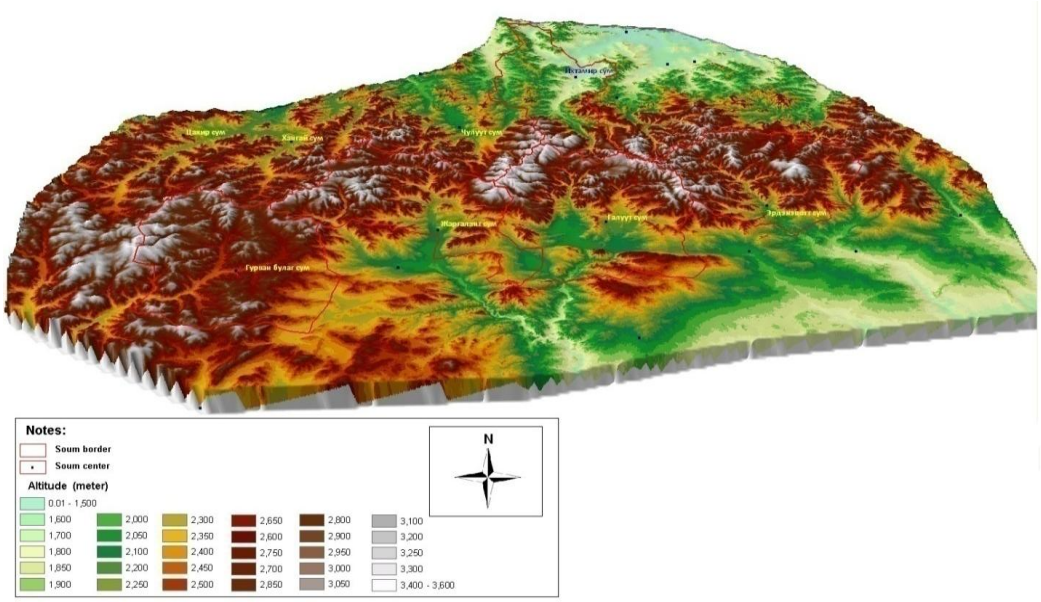

Figure 1: Geographical localizations of yak breeding areas (Bayankhongor and Arkhangai aimags)

The map above shows that the geographic location of the aimags and soums in which yak husbandry is carried out is at a significantly higher altitude. Soums in Arkhangai aimag, in which yaks are bred are at 2464—3239 m above sea level, whereas those of Bayankhongor aimag are at 2685 - 3290m, Uvurkhangai aimag at 2431-2787 m, and Khuvsgul aimag at 2077–3077 m. In other words, the valleys of larger rivers at 2000-2300 m and 2500-3000 m mountains prevail.

Air temperature

Based on the information provided by meteorological stations in the aimags and

soums studied, the average air temperatures in the past 5 years in the above areas where yaks are bred are shown in Diagram 1, and average annual precipitation is shown in Figure 2. (Mongolian Statistical yearbook, 2007-2013).

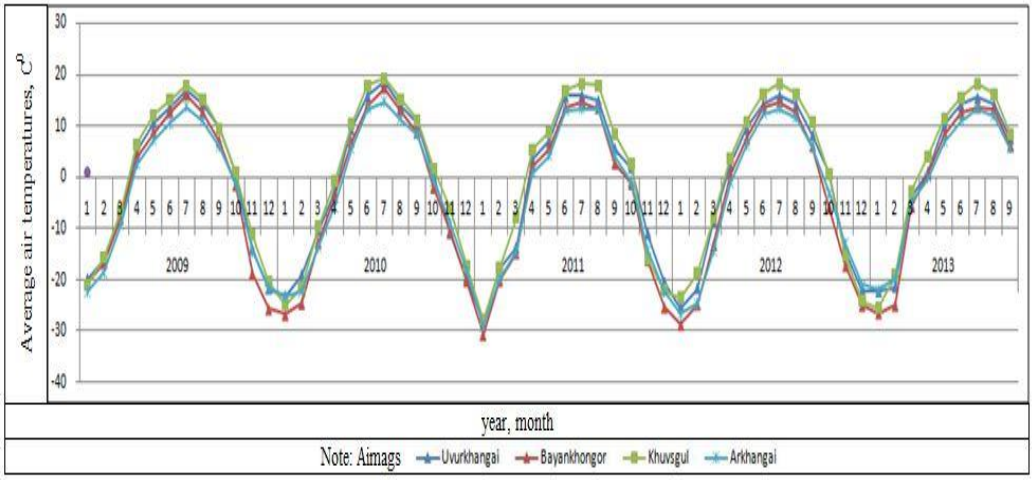

Figure 2: Average air temperatures in the aimags where yaks are bred (temperature ^{0}C)

Figure 2 shows the average air temperatures of the past five years in the yak - breeding soums of those aimags exceed -20^{0}C in January and reach -30^{0}C to -40^{0}C in some years. The average air temperature in July is 12^{0}C to 20^{0}C. The warm and cold regimes from March to September are identical to tropical regions, while those from September to March are identical to cold regions. In other words, the habitat of yaks has strong seasonal distributions; cold and warm.

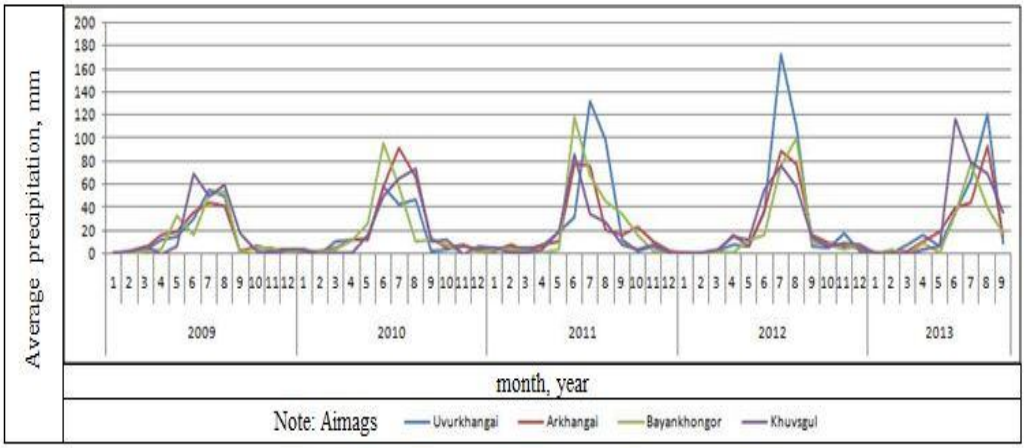

Figure 3: Average annual precipitation of yak-breeding aimags (mm)

Figure3 reveals annual precipitation in the yak-breeding soums of those aimags for the past five years has different seasonal distributions. Of the total level of annual precipitation, 15-20 percent occurred in cold seasons or from November to March, while the remaining 85-90 percent was from April to October. These soums and aimags belong

to wet and cold weather zones of the Khangai high mountainous region.

The above studies show that yak habitat is distributed in ecological conditions with seasonal distributions, with obvious differences shifting from wet and warm weather to wet and cold weather, and vice versa.

Therefore, the formation of norms with broader fluctuations of physiological reactions maintaining unique biological characters withstanding seasons with such sudden shifts, reproducing, producing next generations and giving their productivity is seen to be as the main outcome of various harmonies of its evolution. As one of them, study on dynamics of principles of growth intensification, maturation and shedding of hair fibres, involved in thermal regulation in conjunction with air temperature changes for different periods is of greater significance.

Yak hair coat

A yak's hair coat differs according to body region; skeleton hair has greater down fibres, thick abdominal hair, a thick and long tail hiding its thigh, back and groin regions,; a short forehead is covered with hair, but the inside of the thigh, abdomen, udder and scrotum has fine, soft hair. Observations and experiments on the dynamics of seasonal replacements of hair fibres of the yak skeleton were conducted for our study, with the results shown in Figure 4.

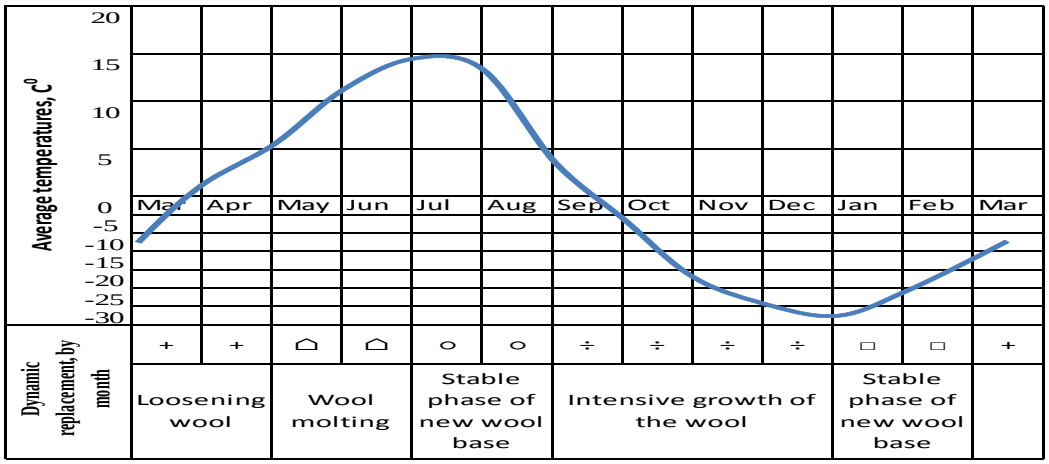

Figure 4: Dynamics of the replacement of yak hair fibres

Figure 4 reveals that fine fibres grow intensively between coarse fibres on the skin from the start of the cold period and that their growth intensifies during the cold winter, when yaks' bodies are covered with a morphologically complete structure of thick long hair. Hair then gradually comes off and is shed in warmer months new, shiny coarse hair grows and fine fibres appear, and the source of these fine fibres becomes stabilized, when yak habitats enter into the warmer summer months. Fine fibres then grow intensively, with their growth completed by the onset of the cooler months. According to such principle, repeating of dynamics of yak hair renewal and changes are found. In such a fashion, seasonal renewal and changes to yak hair fibres in conjunction with environmental temperatures can be seen as one of the unique principles of adaptability to ecological conditions, cyclically repeated in a pattern of hair shedding, growing and stabilizing.

Conclusions

Because yak- breeding aimags and soums in Mongolia are located in high mountains,

larger valleys, and river basins at 2000-3300 m above sea level, yaks are acclimatized to living in different weather conditions, shifting from wet cold to wet warm and vice versa.

Seasonal renewal and changes in yak hair fibres in conjunction with environmental temperatures can be seen as one of unique principles of adaptability to ecological conditions, cyclically repeated in an annual pattern of hair shedding, growing and stabilizing.

Studies on the growth principles and dynamics of yak hair fibres are significant for technological optimization for the preparation and processing of yak hair and the advancement of yak husbandry technology.

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