

A Glimpse into the Effects of Climate Adaptation on Shaping the Goat Genome

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Summary and Implications

The goat is one of the most adaptable livestock species, present worldwide in many different environments. The ADAPTMAP consortium collected DNA from goats worldwide to investigate the genetic basis of adaptation to these environments. The major findings were that animals in the Tropical areas had genetic differences likely associated with genes that influence the size (smaller animals), while in the other environments, different forms of the same gene were seen in different environments suggesting natural or artificial selection.

Introduction

The goat is one of the most adaptable livestock species which lives worldwide in many different environments. Goats provide milk, meat, fiber, leather, and transportation for many people in rural areas of the world so that they are often addressed as the “poor person’s cow”. The peculiar adaptation ability has led to the differentiation of more than 600 breeds worldwide that differ from each other in many aspects, partially due to events of environmental adaptation. The ADAPTMAP consortium compiled a dataset of high-throughput genotyped animals collected from more than 30 countries. One of the aims of the consortium is to investigate the genetic basis of the adaptation of the goat species to different environments.

Materials and Methods

In this research, a total of 73 breeds had available GPS coordinates and were uniquely assigned to one of the 4 main climate groups based on the Köppen classification system in which different parts of the world are classified: Tropical, Dry, Temperate, Cold; see Table 1.

Table 1. Number of breeds and animals

	N. breeds	N total animals
Tropical	7	141
Dry	29	796
Temperate	33	632
Continental	4	120

These groups were compared at a genomic level, to investigate region of major gene differences between them.

Results and Discussion

A total of 20 genomic markers were identified for each group. A unique pattern of markers was detected for the Tropical group, particularly on chromosome 5 nearby the HOXC gene cluster that is involved in the control of body size. Most of the breeds assigned to the Tropical classification were indeed characterized by a smaller and shorter size and it is known that small body size can contribute to the heat tolerance, as small animals have a higher surface area to body mass. Overlapping patterns were detected for the Dry and Temperate/Continental groups, with an opposite genotypic distribution worldwide (Figure 1) and these differences are located nearby genes that have been associated with production traits.

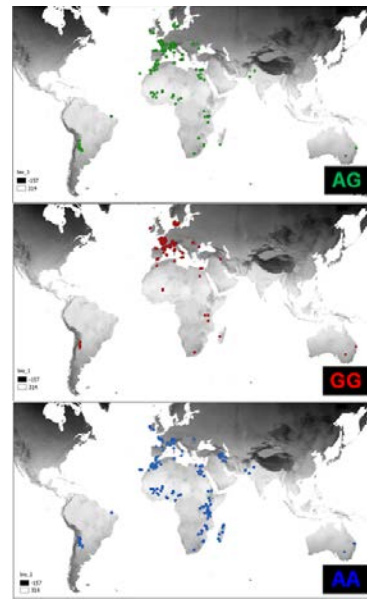


Figure 1. Example of genotype distribution of a marker located on chromosome 14 detected for Dry, Temperate, and Continental groups. Note how the genotype GG (red) is absent in the most arid part of the world e.g. several areas in Africa.

Conclusions

Climate adaptation plays a role in directing the selection of part of the genome in goat. Genes in goats from Arid and Temperate/Continental locations have significant differences in their forms and these may also influence several production traits. The unique pattern detected for Tropical goats may be related to the adaptation to hot and high humidity environments.

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