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Short note

Himalaya: an evolutionarily paradoxical phenotype in rabbits (*Oryctolagus cuniculus*)

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Abstract. This short note discusses about a peculiar and interesting case of color coat observed today in several domesticated rabbit breeds (Himalaya, Californian, Transylvanian Giant) but considered present also in the wild: Himalaya.

Key Words: coat color, Himalaya trait, rabbit, natural selection, *Oryctolagus cuniculus*.

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During the last decade, coat coloration in domesticated mammals has been investigated in a large number of studies. Many of these domesticated strains are excellent model organisms for research (Petrescu-Mag *et al* 2010). In contrast to their wild ancestors, domesticated species are often characterized by a huge allelic variability of coat-color-associated genes (Fontanesi *et al* 2006; Cieslak *et al* 2011). In the wild, color traits evolve sometimes divergent due to sexual selection and/or natural selection (Darwin 1868; Cotton *et al* 2006; Bourne & Watson 2009; Lozinsky 2011). We will discuss here about a peculiar and interesting case of color coat observed today in domesticated rabbit breeds but considered present also in the wild.

The history of the Himalaya trait is quite controversial among zoologists and rabbit breeders. There are many opinions about the origin of this phenotype but no solid scientific evidence exists so far. Today, many domesticated rabbit breeds are pointed black (or acromelanistic: Himalaya, Californian, Transylvanian Giant; see Toba 2011; Petrescu-Mag *et al* 2009, 2011, 2012; European Standard of Rabbit Breeds 2003), and all these breeds descend from Himalayans. Rabbits having this color coat are also called Russian rabbits, Chinese rabbits, Egyptian rabbits, Black Nose rabbits and so on.

Many non-scientific resources claim that the acromelanistic rabbit came from Himalayan Mountains, their coat being an adaptation to Himalayan environment that is abundant in snow (homochromia). Such assumptions are not valid in many concrete contexts. For instance, the recessive Himalayan allele c^h at C locus, in homozygous form (c^hc^h), or heterozygous form (c^hc, where c allele is albino), converts tyrosinase into a thermolabile form, with greater production of melanin in colder body parts (Searle 1990). This biochemical process leads to a specific albino rabbit: although eyes are pink or red and coat is white, the nose, ears, feet and tail are black, brown, grey or blue. The above assumption fails to explain why the nose, ears, feet and tail are darker in winter and whitish in summer (how can this be exploited by animals?). Such a "behavior" in coat color change would not be useful to rabbit species in most of the environmental circumstances and it is most probable detrimental according to natural selection theory (Darwin 1859).

Another problem of the above hypothesis is related to color of the eyes. Pink or red eyes lack of melanin and melanin is protective for the eye when the light is too intense. Here, the fact that *O. cuniculus* lives underground a large part of its life can be an explanation. Visual signals are not very important underground, while the seldom daylight contact with sunlight and irradiation is not a selective pressure. However, the darker nose, ears, feet and tail in winter and their whitish color in summer remain paradoxical. The most probable explanation is that Himalaya gene is a mutation that does not (or does not significantly) affect the rabbit's health or fitness in heterozygous form (c^hC). Thus, the gene spreads randomly in populations as neutral and detrimental only in some cases of rare homozygous individuals (c^hc^h). Such c^hc^h animals have better chances to survive in natural conditions when the habitat is plenty of snow all year long. In such conditions, the Himalaya gene might be even advantageous. This can also explain the reason why Himalayan rabbits were thought to populate cold regions or mountain regions.

The large number of domesticated Himalayan breeds (see Figs 1-3) available today is due to artificial selection. The gene/allele c^h is most likely older than genus *Oryctolagus* as it was also reported in other rodents (e.g. in genus Cavia, Rodentia: Caviidae). Such neutral mutations appear spontaneously, remain

hidden in populations, they "travel" over thousands of years due to fate and even pass from older species to newer ones. When the environment makes the gene advantageous, its copies rapidly multiply and spread and the new phenotype establishes itself in a new niche. These reserves of neutral genes are in fact a kind of buffer for cases of suddenly changing environments.

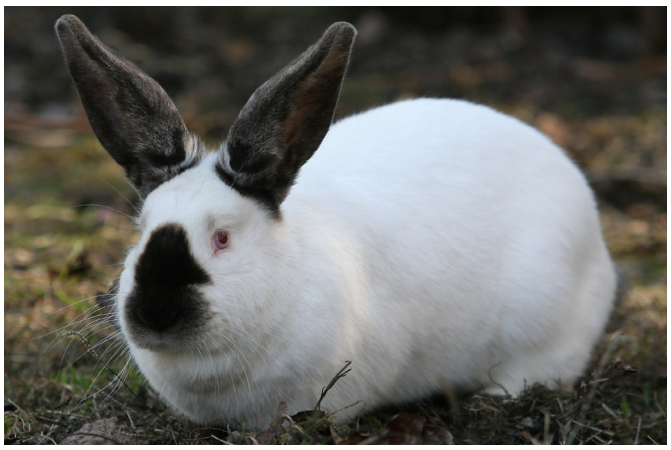

Fig. 1. Transylvanian Giant rabbit breed (first Romanian breed in history; photo: Mircea Rosca www.MirceaRosca.com).

Fig. 2. Californian rabbit breed (Source: European Standard of Rabbit Breeds 2003).

Fig. 3. Himalaya rabbit breed (Source: European Standard of Rabbit Breeds 2003).

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