The *A* locus in domestic rabbit breeds (*Oryctolagus cuniculus*)

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Abstract. The domestic rabbit (*Oryctolagus cuniculus*) has a huge variability in terms of color patterns and fur color. One of the sources of variability is the *A* locus. The present paper aims at describing the color patterns that result from the recombination of alleles located at *A* locus. The color patterns of rabbit fur are determined by allelic and non-allelic interactions. Locus *A* is one that includes, in order of dominance, the alleles *A*, *at* and *a*. Recombining these alleles in different genomic contexts results in a large number of possible color patterns.
Key Words: agouti, allele, color patterns, marten, otter, tan.

Introduction. The domestic rabbit (*Oryctolagus cuniculus*) has a huge variability in terms of color patterns and fur color. One of the sources of variability is the *A* locus (Letko et al 2020). Three alleles are present at the *A* locus: *A*, which encodes the genetic information for agouti rabbits; *at*, which determines the tan pattern; and *a*, which is the allele for self colored rabbits (Dorożyńska & Maj 2021; thenaturetrail.com). The present paper aims at describing the color patterns that result from the recombination of alleles located at the *A* locus. In this paper, for allele and loci description, the English, and not the German system of notation, was used.

The Wild Type-Agouti. In some populations, domestic animals often retain the original form of color pattern, i.e. the most common wild form before domestication (Little 1958; Dorożyńska & Maj 2021). The agouti color pattern observed in some rabbit breeds is the wild type of color pattern. The agouti pattern is the result of the interplay of color pigments in their original form: dark hairs, called ticking, interspersed among their lighter middle coat (Dorożyńska & Maj 2021). The base of the hair shaft is dark, causing multiple rings of color to appear when you blow into the fur. Agouti rabbits have light cream to white markings on their undersides: the belly, chin, but also inside of the legs, and bottom of the tail (thenaturetrail.com). They have also dark lacing around the ear tips, white circles around the eyes and nostrils, and lighter insides of the ears. The agouti gene is the most dominant color gene in the rabbit genome in both allelic and non-allelic relationships (Little 1958). Examples of agouti specific colors include chestnut (Figure 1), lynx, opal, chinchilla (Figure 2), orange, yellow (Figure 3), steel, and others. A rabbit that expresses the agouti pattern may carry one of the two lesser genes without showing it (thenaturetrail.com).

Returning to the agouti fur color rings, we must say that there are some agouti color varieties that present peculiarities. Non-extension agouti rabbits such as cream rabbits and orange rabbits do not have dark undercolor (thenaturetrail.com).

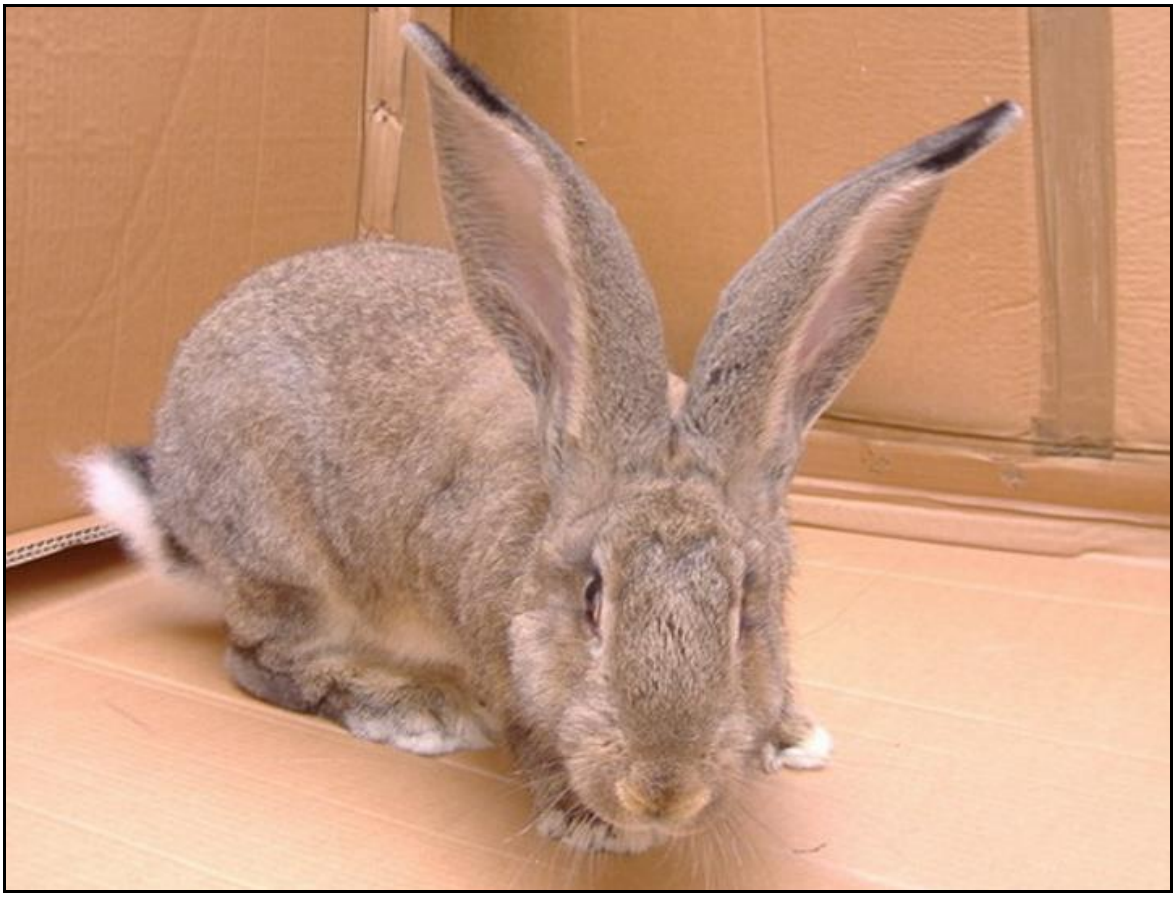

Figure 1. Chestnut color pattern, German Giant breed.

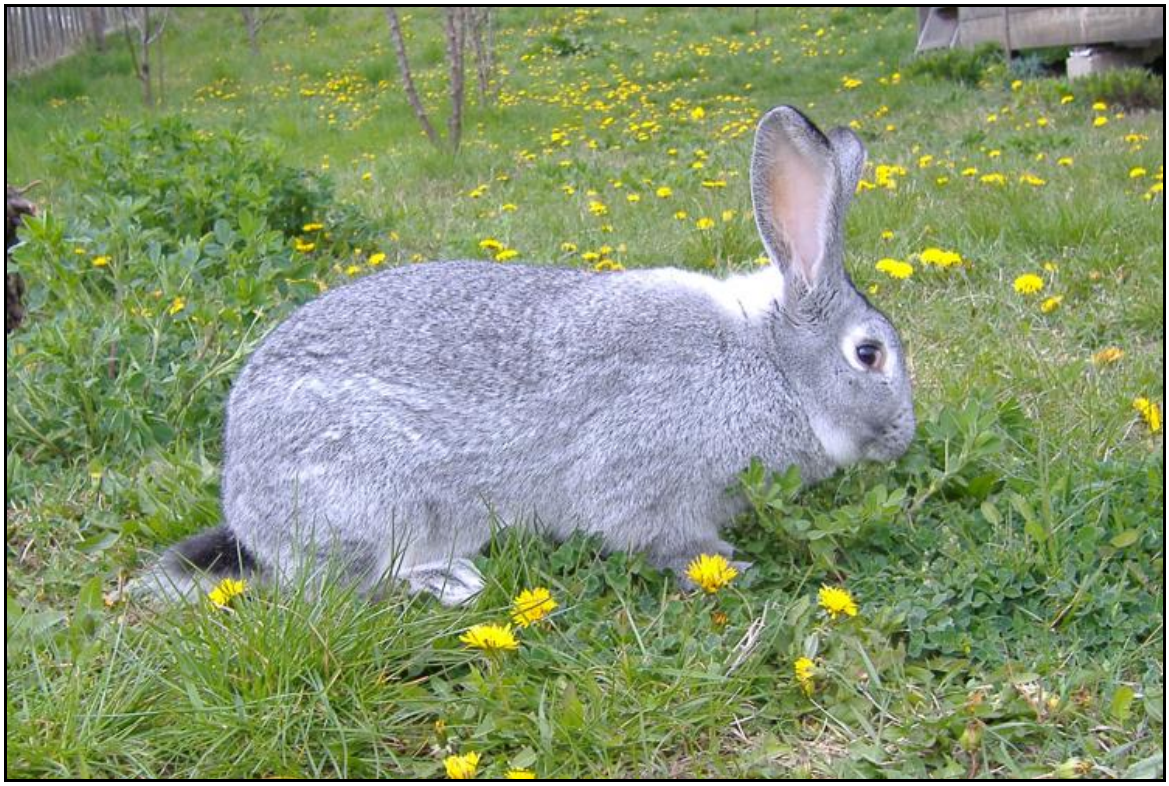

Figure 2. Chinchilla color pattern, Chinchilla breed.

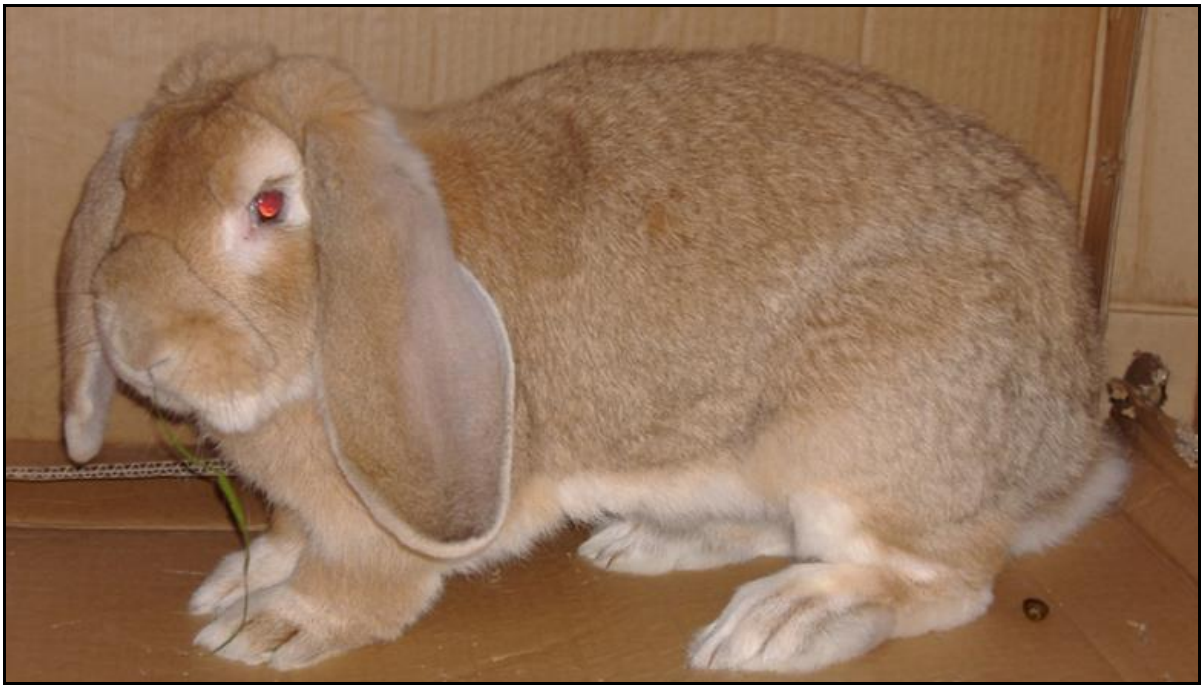

Figure 3. Yellow agouti pattern, one of the Lop breeds.

Genetic Basis for Otter and Marten Rabbits. The next allele according to the dominance level is the *at* gene, which encodes the tan pattern (Pusta et al 2013). Tan patterned rabbits are regular self colored on the top - like black (Figure 4), chocolate (Figure 5), blue, lilac (Figure 5), Siamese sable, or tortoise - and have lighter markings underneath, like agouti rabbits (thenaturetrail.com). Tan patterned rabbits do not present ring color or ticking on the body topside. Examples include specific colors like: otter (Figure 5), sable marten, silver marten, tort otter, and all the tan breeds. Agouti cannot be hidden by a tan pattern. However, the tan pattern can hide the self gene (thenaturetrail.com).

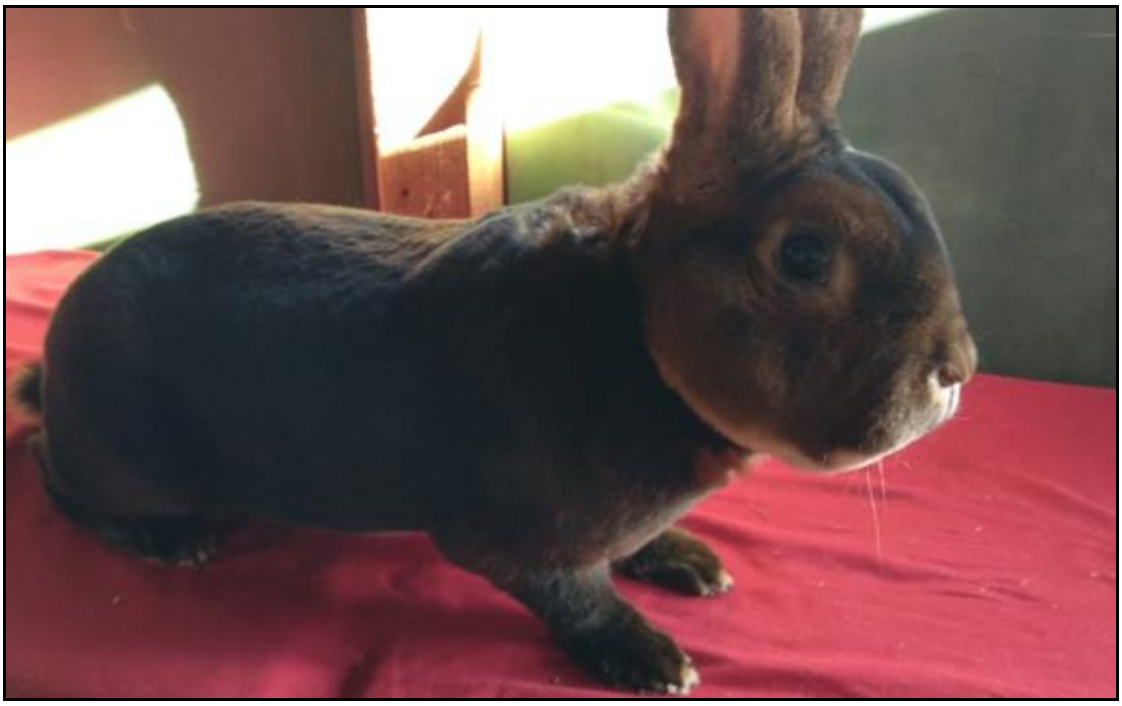

Figure 4. Black Tan color pattern, one of the Rex breeds (Photo: Danciu Dorel).

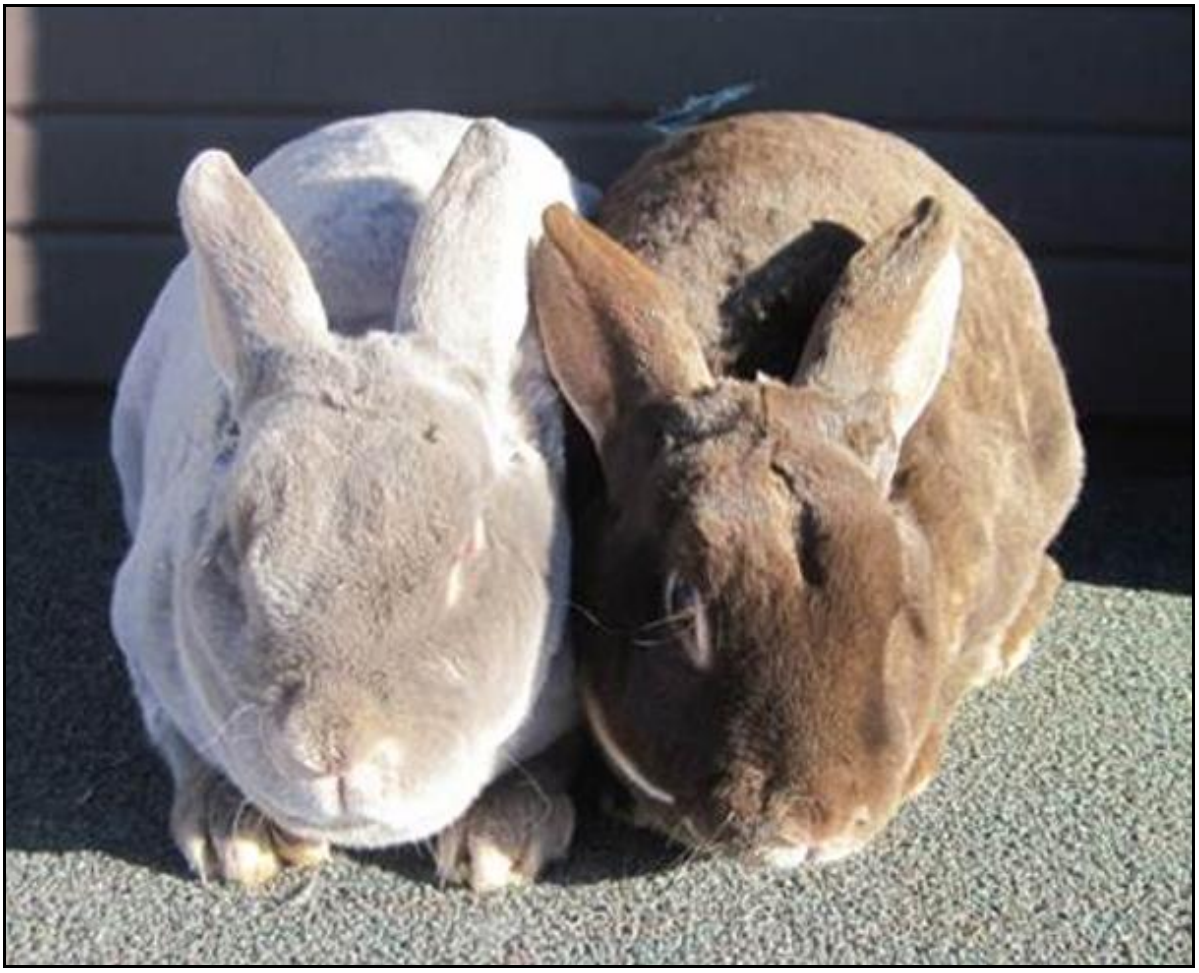

Figure 5. These two otter rabbits differ in only a single allele. The animal on the left is a Lilac Otter (having genotype: at- bb C- dd) and the one next to it (her father) is a Chocolate Otter (having genotype: at- bb C- Dd) (http://minkhollow.ca/gene-rummy/?page_id=87).

The Self Gene. The last allele in the series according to the dominance level is the *a* gene, which encodes the self trait (Parkhurst & Wilson 1933). A rabbit that shows a self color certainly presents the *aa* genotype. The allele *a* cannot hide agouti or tan pattern under it (Parkhurst & Wilson 1933). In the rabbit exhibition (rabbit show, rabbit contests), the term "self" means one single color all over the body, like black (Figure 6), chocolate, blue (Figure 7), and lilac (thenaturetrail.com). In genetic terms, the definition of "self" is slightly different. In addition to black, chocolate, blue, and lilac, self colors also include tortoise, Siamese sable, sable point, smoke pearl, and other unrecognized varieties (non-standard varieties). Although some genetically self rabbits have some shading, a genetically self rabbit will never have agouti or tan pattern markings (thenaturetrail.com).

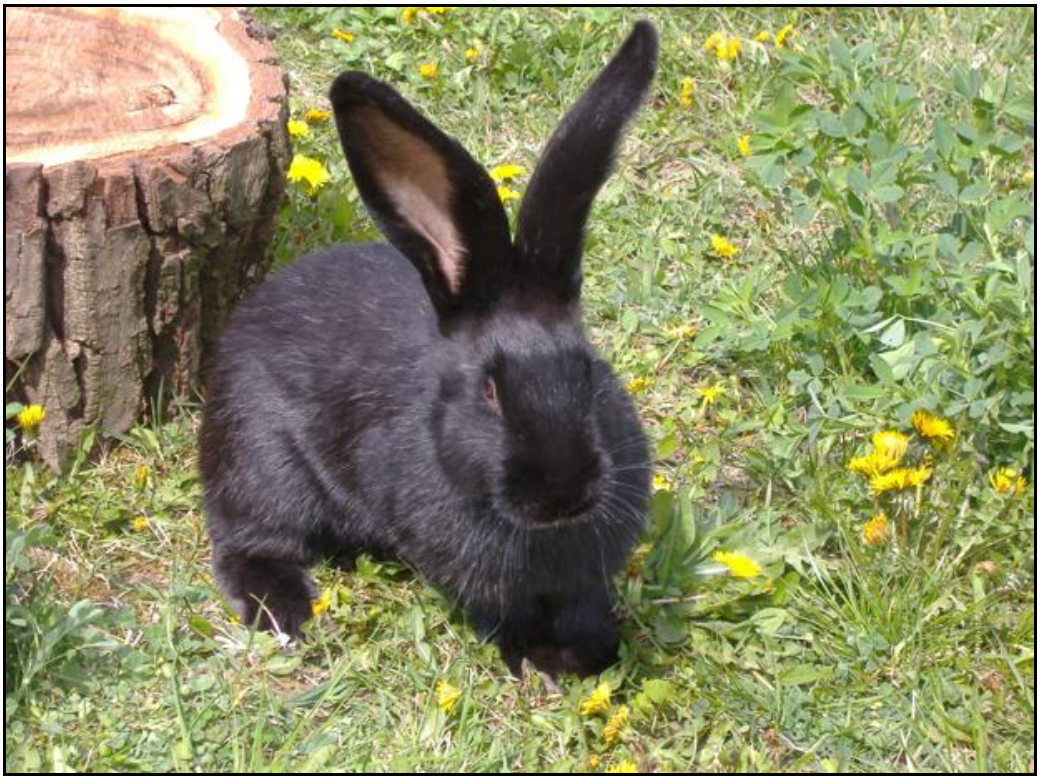

Figure 6. Self colored rabbits, Black Giant breed.

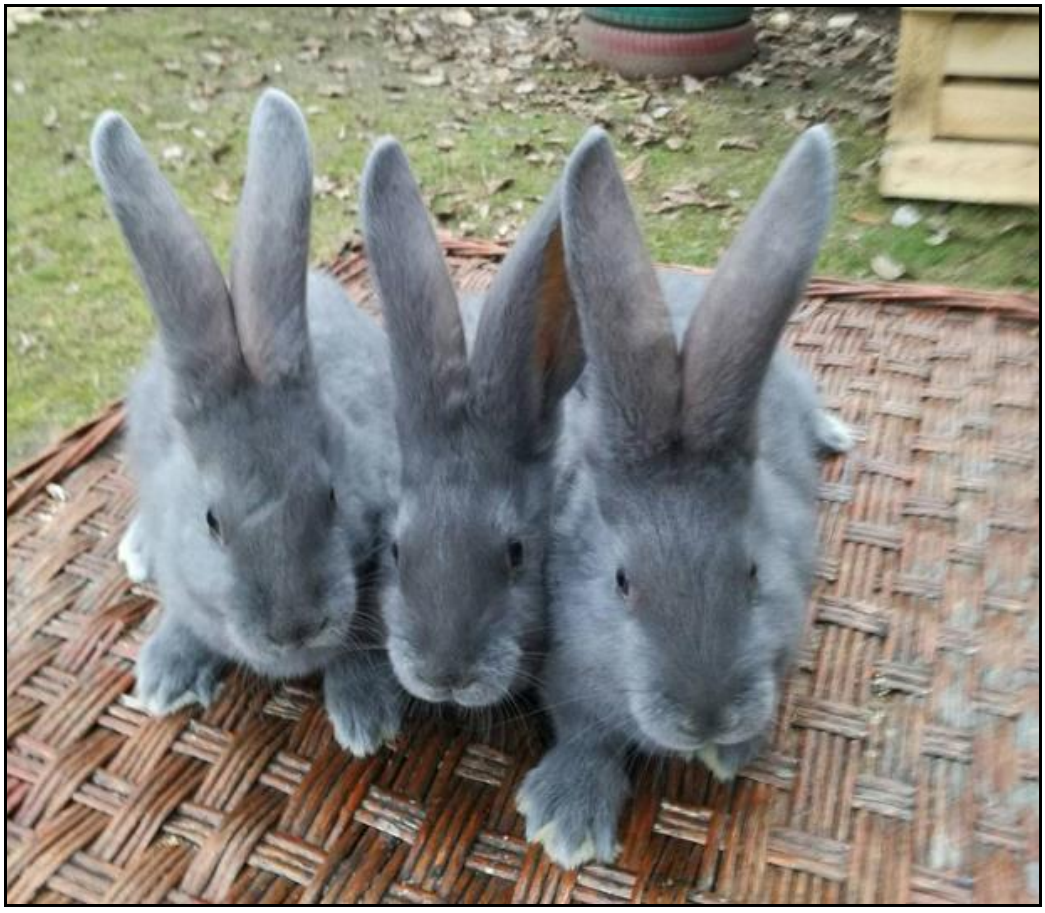

Figure 7. Self colored rabbits, Blue Giant breed (owner and photo: Iosif Câmpan).

Conclusions. The color patterns of rabbit fur are determined by allelic and non-allelic interactions. Locus *A* is one that includes, in order of dominance, the alleles *A*, *at* and *a*. Recombining these alleles in different genomic contexts results in a large number of possible color patterns.

Conflict of Interest. The authors declare that there is no conflict of interest.

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*** https://thenaturetrail.com/rabbit-genetics/agouti-tan-self-a-series-otter/

*** http://minkhollow.ca/gene-rummy/?page_id=87

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