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Cases of melanism in mountain hare (*Lepus timidus*) in Yakutia

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ABSTRACT. Cases of melanism in the mountain hare *Lepus timidus* in the territory of Yakutia were analyzed. The highest frequency of this rare phenomenon was observed in the basin of the Vilyuy River, with at least nine cases over the last 50 years. It was proposed that this phenomenon was the result of increased mutagenesis in this territory, due to consequence of the features of the natural geochemical background and anthropogenic pollution.

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KEY WORDS: melanism, mountain hare, *Lepus timidus*, mutagenesis, Yakutia.

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Случаи меланизма у зайца-беляка (*Lepus timidus*) в Якутии

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РЕЗЮМЕ. В статье рассмотрены случаи меланизма у зайца-беляка *Lepus timidus* на территории Якутии. Наибольшая частота встречаемости этого редкого явления отмечена у данного вида в бассейне р. Вилюй, по крайней мере, 9 случаев за последние 50 лет. Предполагается, что наибольшая встречаемость зайцев-меланистов в бассейне р. Вилюй связана с повышенным мутагенезом на данной территории, являющимся следствием особенностей естественного геохимического фона и антропогенного загрязнения.

КЛЮЧЕВЫЕ СЛОВА: меланизм, заяц-беляк, *Lepus timidus*, мутагенез, Якутия.

Introduction

Melanism is found in many animal species. It is caused by a buildup of melanin pigment, producing abnormal black or dark brown coloration of the outer layers, such as skin and hair. Melanistic individuals are usually quite rare in nature, most often the result of a recessive mutation. However, there are also several examples where melanistic coloring of animals is adaptive and supported by natural selection, becoming fixed in separate populations and acquiring features of adaptive polymorphism. These examples include the phenomenon of industrial melanism in birch moth *Biston betularia* Linnaeus, 1758 (Kettlewell, 1955; Majerus, 2009), an increased number of tropical cats that are melanistic (Ulmer, 1941; Majerus, 1998; Eizirik *et al*., 2003). Leopards *Panthera pardus* Linnaeus, 1758 and jaguars *P. onca* Linnaeus, 1758, which manifest melanism, are both referred to as black panthers.

An example of the substantial spread of a mutation that leads to melanism among felines is found in the leopard population in Malaysia, where about 50% of the animals are black. In general, among large cats, melanism is usually more common in those populations that live in dense forests. With the reduced light, dark animals are less noticeable in such environments compared to open areas, giving them a selective advantage in hunting and survival (Kawanishi *et al*., 2010). A high frequency of occurrence of melanists is also noted among some species of pikas and hares. Black pika, often found in southern China (Yunnan), is sympatric with Forrest's pika *Ochotona forresti* Thomas, 1923, and has been described as a separate species, *O. nigritia* Gong *et al*., 2000. The black Manchurian hare *Lepus melainus* Li & Luo, 1979 is sympatric with Manchurian hare *L. mandshuricus*

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Radde, 1861. The species validity of these black forms has been questioned, and detailed morphological analysis has shown that *O. nigritia* and *L. melainus* are melanistic individuals of the Forrest's pika and Manchurian hare, respectively (Ge *et al*., 2012).

In other cases, an increase in the number of melanists is not associated with the adaptive value of dark coloration; however, it may correlate with some physiological feature that helps them survive in certain conditions. This phenomenon has been observed in the common brushtail possum *Trichosurus vulpecula* Kerr, 1792 (Pearson, 1938), common hamster *Cricetus cricetus* Linnaeus, 1758 (Gershenzon, 1946) and water vole *Arvicola terrestris* Linnaeus, 1758 (Evsikov *et al*., 1997; Bazhan *et al*., 1999, 2000).

In some poikilothermic animals, for example, insects (two-spotted ladybeetle *Adalia bipunctata* Linnaeus, 1758; Timofeeff-Ressovsky, 1940), and reptiles, melanistic colouration provides a more efficient use of solar radiation, increasing the length of their active periods (Clusella Trullas *et al*., 2008; Tuniyev *et al*., 2009). In addition, an increase in the number of melanists can be explained by increased mutagenesis, due to the influence of environmental geochemical conditions, including anthropogenic anomalies (Sharygin & Popov, 2003; Kukushkin, 2009), genetic drift and splitting of recessive alleles due to isolation and marginalisation of populations (Capula *et al*., 2008; Blanke, 2010), or a combination of these factors (Doronin, 2012).

In general, there is a trend towards a relative increase in the number of melanists in the southern regions of Asia. In the north, in Siberia, melanists are rarer. Also, previous reports of mammalian melanists in the territory of Yakutia are limited and unsystematic. This also applies to the mountain hare *Lepus timidus* Linnaeus, 1758, one of the most important and widespread game species. This species has a pronounced adaptive seasonal dimorphism in fur coloration, having a snow white pelage in winter. It might be suggested that melanistic forms should not be supported by selection and survive in nature in the north. Nevertheless, Robert Maak, the well-known explorer of Siberia and the Far East, who explored the basin of the Vilyuy River, wrote that he "...brought from Vilyuy two skins of the black variety ... of mountain hare, ... representing there, however, a great rarity..." (Maak, 1886; p. 145). Earlier, in a preliminary publication, we reported on some cases of melanism in mountain hares of Yakutia (Vinokurov *et al*., 2017). In this current study, we analyzed all available sources and conducted a separate assessment of this issue.

Material and methods

To obtain information on melanists among mountain hares in the territory of Yakutia, we collected survey data from zoologists and hunters. In addition, the authors (BGG, VVN) analyzed their own perennial data from shooting, catching, and observations of the hares. Stuffed hares were also assessed, which were stored in various museums of Yakutia: the E.M. Yaroslavsky's Yakutsk State United Museum of History and Culture of the Peoples of the North, Yakutsk City; local museums in Tiksi, Chokurdakh, Chersky, Pokrovsk, Tit-Ary and Neryungri villages and towns; the Museum of the Yana Geological Party, Batagay settlement, Verkhoyansk District; the B.N. Andreev's Elgyay Regional Museum-Ecological Centre (short abbreviation — ERMEC), Elgyay village, Suntarsky District; and the Zoological Museum of the M.K. Ammosov's North-Eastern Federal University (ZM NEFU), Yakutsk City.

At ZM NEFU, with the efforts of taxidermist A.D. Makarov, various stuffed mammals with color anomalies were collected and mounted, including two melanistic *L. timidus*.

Results

The study of materials in various museums of Yakutia, as well as personal data and information from the regional press, allowed us to collect information on melanist hares registered in Yakutia over at least the past 50 years.

In the late 1950s and early 1960s, the skin of one of two single-outlet black melanist hares from the Megino-Kangalassky District (Dr. Yu.V. Labutin, pers. comm.) was brought to the Institute of Biology, Yakutsk. Subsequently, a stuffed animal was made from this skin.

In 1978, a melanist hare was caught by hunter A.R. Ksenophontov in the valley of the Tyukian River, in the vicinity of the Botulu Village, Verkhnevilyuisky District. Until recently, it was kept as a mounted specimen in the school museum of this village.

Three melanist hares were also hunted in the vicinity of Tuoydakh village in the Suntarsky District on the following dates: October 2002 by A.K. Alexeyev, December 22, 2002 by V.D. Grigoriev (Fig. 1), and December 2013 by V.A.Prokopyev (Fig. 2). The dead hares were sent to the Department of Biological Resources of the Ministry of Nature Protection of Yakutia. Taxidermy mounts were made from the hares killed by V.D. Grigoriev and V.A. Prokopyev, which were exhibited in the ZM NEFU. Thus, at least three melanist hares had been hunted in the same area over 11 years. As such, this color form of hare might be found regularly in this area.

Information about melanist hares was also received in 2003. In the local newspaper "Suntaar Sonunnar" (=Suntar News), No. 109, 25.09. 2003, Ivan Chagdinsky reported on a black hare being hunted in the vicinity of Neruktay. It was also noted in this article that two other melanist hares were hunted in 2002 in the Khadan and Ilimnir localities of the Suntarsky District. A mount of one of these hares was available in the ERMEC.

In the early 2000s, there were two reports of melanist hares being caught in the Nyurbinsky District (Vinokurov *et al*., 2017). In December 2012, a melanist hare was hunted in the Kobyai District. It was an adult overwintered individual with a body weight of about 2 kg.

Fig. 1. Stuffed melanist mountain hare *Lepus timidus* from the Suntarsky District, hunted in December 2002. Specimen from ZM NEFU.

Fig. 2. Stuffed melanist mountain hare *Lepus timidus* from the Suntarsky District, hunted in December 2013. Specimen from ZM NEFU.

We studied two melanist hares from the area around Tuoydakh village. The first, hunted in December 2002, was an adult male of more than one year of age, which had apparently overwintered, and had a body length of 58 cm, a hindfoot length of 15 cm and an ear length of 6.5 cm. The second hare, caught in December 2013, was a young male with a body length of 47 cm, hindfoot length of 14.5 cm, ear length of 7.5 cm and body weight of about 2 kg. Both individuals showed healthy development. The fur on these hares was even, thick, fluffy, and shiny. Their noses and lips were black, and their ears were normal. The hair color on the upper lips was black-gray, while the vibrissae were black. The ears were densely covered with monotonous black hair, and underfur was black. Hair color on the head was black, with black-gray colored hair around the eyes. The iris of the eye was a normal brown color. The neck and chest areas were black. The fur on the body (on the shoulder blades, shoulders, back, rump, sides, groin, and abdomen) was monotonously black, with the underfur being thick and black-gray. Tails were black, with black and gray underfur. The front and posterior legs were black on the superior portion, and blond and ash-gray on the inferior part. The transition from black to ash-gray was sharp. The claws were dark. The average height of hair on the back was: guide, 4.5 cm; guard, 3.5 cm; and down, 2.5–3.0 cm (Vinokurov *et al*., 2017).

Discussion

Over the past 50 years, at least 12 cases of melanist hares have been recorded in the territory of Yakutia, all within the central and western part of Yakutia, the territory inhabited by the subspecies *L. timidus gichiganus* J. Allen, 1903 (Ognev, 1940; Averianov, 1994; Hoffmann & Smith, 2005). Of these, nine specimens were hunted in the middle reaches of the Vilyuy River basin (Fig. 3). Besides, consideration should be given to the discovery in this region of two hares of the "black variety" by R. Maak in the mid-19th century (Maak, 1886). As such, the reasonably regular occurrence of melanist hares in the Vilyuy group of districts (Verkhnevilyuisky, Suntarsky, and Nyurbinsky Districts) suggested their occurrence was more than just sporadic. Indeed, it has been suggested that the fairly regular occurrence of melanist hares in the Vilyuy River basin indicated that the melanistic coloring might have some selective advantages (Vinokurov *et al*., 2017). For example, during autumn hunting, before snowfall, dark hares are harder to see than those that are white, potentially giving the melanists a survival advantage. However, there was a lack of reports of melanistic hares in southern and northern Yakutia, which also regularly has autumn hunting.

The Vilyuy River and its adjacent territories belong to environmentally unfavorable areas of Yakutia. They are natural but abnormal geochemical zones due to an increased background of rare and heavy elements, including those that are especially toxic and mutagenic: arsenic, mercury, lead, antimony, thallium, and radioactive strontium. Pollution of the Vilyuy River basin by toxic elements increased significantly in the second half of the 20th century as a result of intensive development of diamond mining and energy industries, as well as underground nuclear explosions in the 1970s and 1980s, which resulted in polycomponent pollution zones (Burtsev & Kolodeznikov, 1996; Marshintsev & Yagnishev, 2008). The high occurrence of melanist hares in the basin of the Vilyuy River basin may be associated with an increased mutagenic background of both natural and anthropogenic origin. However, long before the industrial development of this region of Yakutia, in the mid-19th century, there were recorded cases of melanistic mountain hares and Siberian chipmunk *Eutamias sibiricus* (Laxmann, 1769) in the Vilyuy River basin, Suntarsky District (Maak, 1886). Also, similar cases in chipmunks were described in the Suntarsky District and in the 1930s (ERMEC data). Even so, in the past 50 years, the occurrence of melanist hares has increased in this area, which was consistent with an increase in anthropogenic pollution.

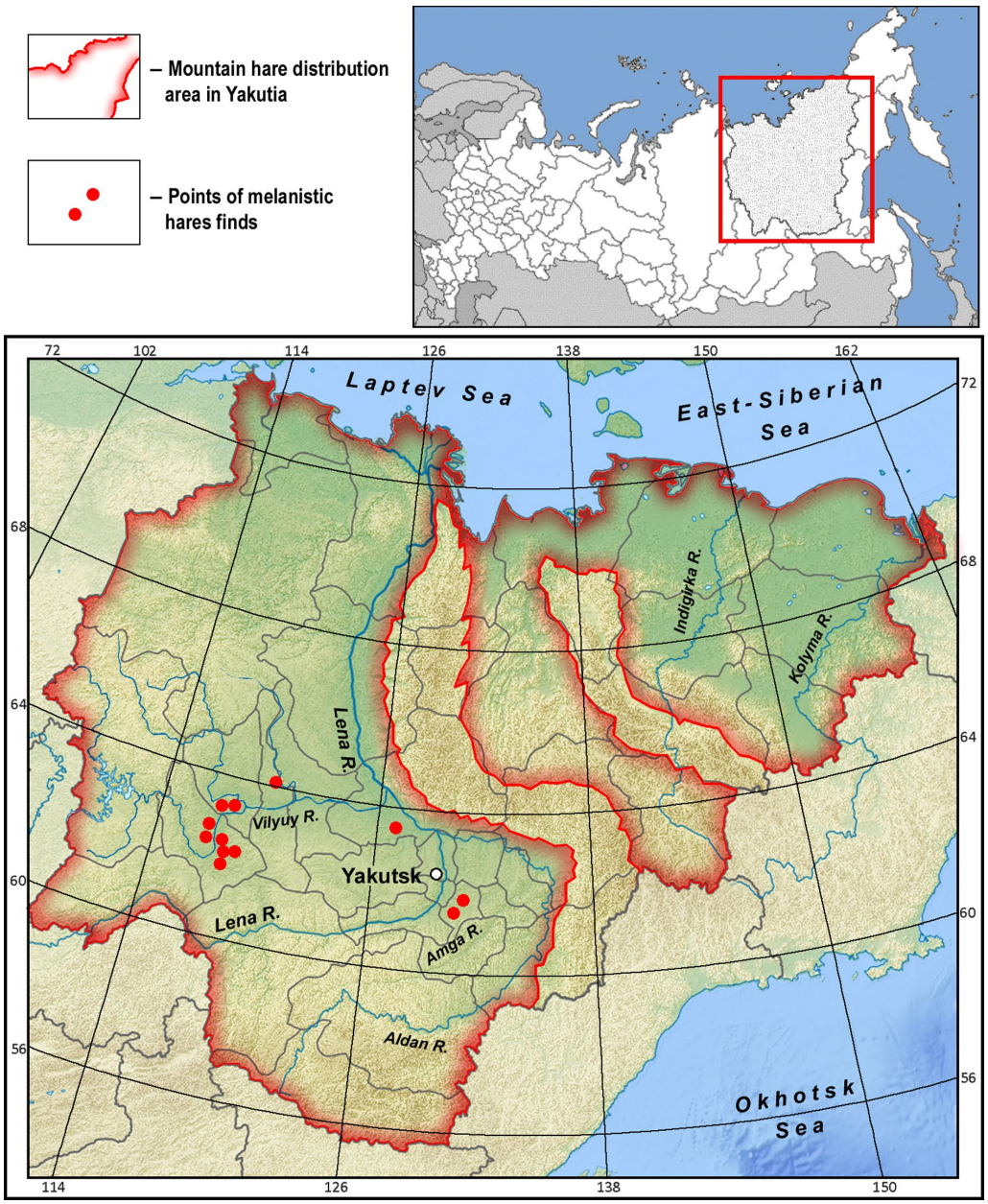

Fig. 3. Distribution of the mountain hare *Lepus timidus* in the territory of Yakutia (after Tavrovsky et al., 1971) and the locations of finds of melanist hares from the mid 20th century to the beginning of the 21st century.

Other examples confirmed this hypothesis. A rare case of melanism was found in the bank vole *Myodes glareolus* Schreber, 1780, in the zone of radioactive contamination after the accident at the Chernobyl nuclear power station (Krapivko, 1999). Apparently, an increased mutagenic background caused by high seismic activity could have caused the appearance of melanists in two systematically distant species, the northern pika *O. hyperborea* Pallas, 1811 (Malyshev, 2015) and the northern red-backed vole *Myodes rutilus* Pallas, 1779 in the Upper Angara River structural basin, Northern Transbaikalia (Malyshev, 2010).

Cases of melanism in the mountain hare have been rarely observed in other regions, in Moscow (Mutsetoni, 1987) and Tyumen (Gashev & Parfenov, 2006) regions. Several cases of melanists in the European hare *L. europaeus* (Pallas, 1778) have also been recorded in Ukraine (Galaka, 1967). Melanism in these species of hares might be caused by a rare recessive allele (or alleles).

In some mammalian species, it has been indicated that melanistic individuals might have certain ethological and physiological advantages that allow them to successfully compete against individuals with wild-type coloring, such as: increased caution (red fox *Vulpes vulpes*

Linnaeus, 1758; Heptner *et al*., 1967); possible resistance to viral infections and faster reactions (domestic cat *Felis catus* Linnaeus, 1758; Seidensticker & Lumpkin, 2006); and cold tolerance (common hamster; Gershenzon, 1946; and common brushtail possum; Pearson, 1938). Perhaps melanism in mountain hares also provides some advantage, which allows them to overwinter without a typical cryptic winter coloration of the fur in Yakutia conditions with an extended snow cover.

The phenomenon of melanism in hares in the territory of Yakutia requires further in-depth studies, involving both environmental data and genetic research.

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