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## Sable — natural population and breeding

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# ON THE MATING OF DOMESTICATED AND WILD SABLES (*Martes zibellina* Linnaeus, 1758) TO GENERATE GENOTYPES WITH VARIOUS FUR COLORING

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Abstract

Sable (*Martes zibellina* L.) skins have always been in high demand on the fur market. At present, there is a trend towards an increase in interest in the skins of wild sables vs. cage-bred sables. According to experts from fur farms and auction houses, this id due to the inferior fur quality the cage-bred sables have during domestication, e.g., the hairline has become thicker and coarser, the fur is less silky, with a low variability in color and tone. According to the preferences of buyers at international fur auctions and the recommendations of auction house experts, sable skins with a fur color points 5 (brown with a golden tin), 6 (the color is somewhat lighter than for 5 points), and 7 (beige, sandy-golden with a dark brown ridge), of medium tone and chestnut shade are currently the most in demand. The assortment of sable breeding products can be expanded by matting with wild animals. This report presents the first results of obtaining hybrid animals with a fur color of 5-7 points from crossing purebred sables with individuals from the wild (females and males of the Yakut, Irkutsk and Yenisei ridges). The work was carried out at OOO Savvatyevo Animal Breeding Plant. The sables caught in Siberia was brought to the farm for mating with cage-breeding sable in 2021. According to the results of whelping in May 2022, two groups of sables were formed, the control (purebred puppies from mating caged-bred male and female sables, 35 males, 30 females) and experimental (crossbred puppies from mating purebred and wild sables, 39 males, 30 females). The resultant reproduction showed that when wild males mate with purebred females, the reproductive performance of females is not inferior to those in crossing with cage-bred males. In crossbred and purebred offspring, the average yield of puppies per successful female was 3.9 sables. Purebred male progeny is inferior to crossbreds in live weight (1279.6±17.8 g, 1560.0±68.5 g, $p \leq 0.001$) and body length (45.6±0.5 cm, 47.8±0.6 cm, $p \leq 0.01$). Purebred female progeny is somewhat superior to hybrid females in terms of live weight (1138.7±25.4 g, 1111.3±18.7 g, $p \geq 0.01$), but body length and chest girth behind the shoulder blades did not reveal differences. Purebred males and females complete their growth earlier than hybrids. Purebred young animals have two variations in the coloring covering hair, almost black and dark brown. In crossbred males and females, the covering hairs are dark brown, brown, light brown, almost black. Purebred and crossbred sables show no significant differences in the color of the base of downy hairs. Crossbred males and females have a greater variability in the color of the tops of downy hair compared to the purebred control. The quality of the hairline of crossbred males is 0.08 points higher than that of crossbred females. In color, crossbred males are lighter than females by 0.34 points, and the males are closer to the desired color variation. By tone, the resulting young sables approach the desired one, and by shade, they correspond (2.03 points for females and 2.07 points for males). Among the resulting males, there are fewer individuals with gray hair (10.5 %) vs. resulting females (13 %), a gray spot is present (average score for females 4.67, for males 4.52). Evaluation of parental pairs with regard to the main economically important traits showes that the best desired type of coloration of crossbred young animals results from mating light males with dark females of heterogeneous pairs. The

mother sable coloration does not influence the coloration of daughters and sons while males better transmit their traits by color to offspring, for sons, $r = 0.61$ ($p \leq 0.001$), for daughters, $r = 0.72$ ($p \leq 0.001$).

Keywords: sable, skins, coloring, tone, shade, furs, sable farming, breeding, selection

Sable (*Martes zibellina* Linnaeus, 1758) is a valuable fur-bearing animal [1, 2] of the order *Carnivora*, the family *Mustelidae*, the genus *Martes*, the subgenus *Martes* [1, 3-5]. The subgenus *Martes* on the territory of Eurasia also includes forest martens (*M. martes* L., 1754), stone martens (*M. foina foina* Erxleben, 1777), and yellow-throated marten (*M. flavigula* Bjddaert, 1785) [1, 5, 6]. Outside Eurasia, there are two more members of the subgenus *Martes* [7]. When crossing the area of sable and marten, their hybrids, kidus, are encountered [1, 8, 9]. Sable appearance (an elongated body, a small head, and short legs) is typical of the *Mustelidae* family. The body length of males varies within 40-55 cm, the tail length is 20 cm, and the weight of an individual is on average up to 1.5 kg. Females are slightly smaller than males. Ears up to 5.5 cm long, blunt. The limbs are relatively short and wide. Winter hair is quite thick, lush, silky, and shiny. The color in different parts of the area varies from yellowish-brown to dark brown, almost black. The head is usually lighter than the back. In the neck there may be a light, rounded spot, sharply limited or with vague edges [1]. In natural populations, the color of the sable's hair is extremely variable, from very light to pitch-black with many transitional variations [10]. Black sable (with color ranging from dark brown to resinous black) is rare in nature. Much more often, you come across light-colored individuals with fur coloring from sandy yellow to dark brown tones. The proportion of individuals with light coloration in some natural populations reaches almost 100% [11].

Significant variability in the color of the sable is associated with the individual, age, and sex characteristics of the animals, as well as the geographic areas of their habitat. Even the color of the same animal does not remain constant throughout the year. In summer, it is darker than in winter, mainly due to a decrease in the proportion of downy hair in the hairline [10]. With great individual variability in fur color within the same population, in the same areas, sometimes even in the same broods, there are very dark, very light (close to straw color) and medium-colored individuals [1].

Based on the color and shades of the lower part of the downy hair on sable skins, 29 variants were identified, which can be assigned to 6 groups based on the main color. In the color and shades of the upper part of the downy hair, 38 variants were identified, which were combined into 11 groups. In addition, the lighter the upper part of the downy hair, the larger part of the hair length it occupies [10]. Based on the nature of intraspecific variability in color, silkiness and degree of softness of the hair in the Russian sable, geographic races are distinguished (historically they are called ridges). In 1938, 8 ridges were described: Tobolsk, Altai, Yenisei, Minusinsk, Barguzin, Amur, Yakut, and Kamchatka. This geographic variability is characterized by a gradual darkening of the fur color of sables from west to east. In the north of the range, as well as in the highlands with extreme winter weather conditions, populations with lighter fur have formed [1]. According to N.N. Bakeeva et al. [1], of the 18 previously designated subspecies, four currently exist. The Altai subspecies (large in size, relatively dark fur color, 3.08 point color index; the population is 26% dark, 66% medium and 8% light) is distributed throughout Altai and in the northeastern part of Tuva. Sakhalin subspecies is very small and light-colored form, color index of 2.60 points; the population is 16% dark, 78% medium, 6% light and separated from mainland individuals by the Strait of Tartary. Kamchatka subspecies (individuals of particularly large sizes, fur color index is 3.2 points, belongs to the dark subspecies); the area of the subspecies is

not limited to the Kamchatka Peninsula, it lives in the adjacent continental territories (the basins of the Apuki and Penzhina rivers). The Tobolsk subspecies is represented by large individuals, the lightest in color (color index 1.78 points; the population is 26% dark, 66% medium, and 8% light); the area covers the entire Cis-Ural region, namely, the right bank of the Pechora River basin, the upper reaches of the Kolva and Vishera rivers, as well as the Urals and Trans-Urals. In other populations occupying the interior regions of the sable's range, it is very difficult to find boundaries, although some morphological differences between them are often expressed quite reliably. Consequently, it is difficult to confirm the reality of separating other groups of sables (Yenisei, Tunguska, Angara, Kuznetsk, Sayan, Chikoy, Barguzin, Shantar and Kuril) into subspecies; they can be considered as local morphs [1].

In the past, sable was widespread from the forest zone of Eastern Europe to northern Asia. This species was found in Belarusian, Polish, and Lithuanian forests. However, as a result of the influence of anthropogenic factors (taiga logging, deforestation, fires, plowing of land, grazing, hunting), the sable disappeared from the territory of Europe, and behind the Ural ridge its once continuous area fell into a number of areas isolated from each other [1, 12-14]. By the beginning of the 20th century, sable became an endangered species. It was necessary to take emergency government measures to protect the sable, control and prohibit hunting, create nature reserves and sanctuaries, artificially resettle the animals into empty lands, and develop cage-based sable farming [14-17]. The measures taken have yielded positive results. The able population was 701 thousand individuals ш 1960, 723 thousand individuals in 1978, and 1180 thousand individuals by 1988. In the 1980s, active sable hunting resumed. Over the past years, the number of sable in the Russian Federation has been stable and accounted to 1400-1500 thousand individuals. According to the Ministry of Natural Resources and Ecology of the Russian Federation, in 2020 there were 1546.0 thousand individuals. The main commercial resources of the species are concentrated in the Far Eastern (796.0 thousand individuals) and Siberian (675.7 thousand individuals) federal districts, Krasnoyarsk Territory (332.6 thousand individuals), the Republic of Sakha (Yakutia) (256.2 thousand individuals), Khabarovsk Territory (200.0 thousand individuals), Irkutsk Region (200.0 thousand individuals) [18]. The habitat area of the sable in Russia is about 7 million $km^2$ [19]. The current range of the sable, in addition to the Russian Federation, includes China [20-23], North Korea [24], Japan [25], Mongolia [26, 27], and Kazakhstan [28, 29].

For a long time, attempts to breed sable in cages remained unsuccessful due to the peculiarities of its reproductive strategy, which differs significantly from that of most predators [30-32]. The rut usually occurs from mid-June to early August. During estrus, which occurs in the summer, there are several periods of sexual heat with an interval of 8-10 days, of which only the last ends with provoked ovulation. Pregnancy lasts 7.5-8 months, and after the latent period (late February-early March), the blastocyst is implanted into the uterine wall. The total duration of the period of development and formation of the embryo after implantation (true pregnancy) is only 30-35 days [1, 30, 31].

Russia became the first and only country where industrial technology for the production of sable skins was developed, and to this day Russia remains the leader in this production. Domestic sable breeding has a long history. Commercial sables were used to form cage populations and for breeding [11, 32].

Regular sable breeding in Russia began in 1931 [11, 30-32]. The ancestor of cellular sable breeding was the Pushkin State Animal Farm (currently the Federal State Unitary Enterprise Russian Sable) which later bred black sable (the

animals differed from wild animals in having a more saturated black hair color) [31-33].

For the first time, P.A. Manteuffel managed to obtain offspring from a sable under cage conditions in 1929 at the Moscow Zoo [31]. In the same year, K.G. Tuomainen obtained sable puppies in Solovetsky Pushkhoz [31, 32]. To create a cage population of sable, the gene pool of nine natural populations of animals different in size and fur color from different regions of Siberia, the Urals (including those belonging to the so-called low-value ridges), and from Tuva was used [34-36]. A total offspring accounted for apprx. 100 individuals in 1929 and 129 individuals in 1930. In 1931, the creation of a unique herd began, from which the entire population of cage-bred sables in Russia originates [32, 34].

In the USSR, at the first stage, individuals from different ridges were crossed, and the Barguzin dark females initially turned out to be the worst in terms of reproduction rates. In 1935, to improve the herd, animals were brought to the Pushkin State Animal Farm from the Barguzinsky Reserve (13 females, 2 males) and the Povenets Farm (Karelian Autonomous Soviet Socialist Republic) (25 females and 20 males). In 1936, 280 sables from the reorganized Aleksandrovsky State Animal Farm were additionally brought together with 25 females and 37 males of the Barguzin Ridge caught in the wild nature [32]. In the Pushkinsky fur farm in 1936, dark males accounted for less than 30% of the population, in 1940-1941 there were 48% dark males [32]. Breeding the "ideal sable" with a large body size, dark coloring and silky fur was complicated by the fact that the initial population consisted mainly of light-colored animals (brown and sandy-yellow with a large throat patch). In addition, the behavior of the animals turned out to be wild; the females generally did not reproduce at all. Animals of the Amur ridge predominated. There were fewer Yenisei, Ural and Altai animals. To consolidate the dark color, a decrease in fertility was allowed [33]. To speed up selection for darkening fur, dark Barguzin males were crossed with females from the Yenisei Ridge, and the darkest females were selected from the offspring to be again crossed with Barguzin males. Crossing Barguzin males with Amur Ridge females gave good results. In addition to targeted crossings of sables from different ridges, lines and families with dark colors, thick fur and the largest fertility were created [32]. In 1940, 70 females and 70 males of raised young animals were transferred from the Pushkinsky fur farm to the Krasnoyarsky fur farm (Krasnoyarsk Territory). In the first post-war years, young animals from the Pushkinsky animal farm supplied the sable breeding farms of the Saltykovsky (Moscow Province), Biryulinsky (Tatar Autonomous Soviet Socialist Republic) and Beloyarsky (Krasnoyarsk Territory) state farms [32]. In the early 1970s, the Saltykovsky state farm approved and further constantly used the influx of blood from Barguzin sables caught in the wild. For 30 years, the farm selected sables with the coloration and fur structure characteristic of the Barguzin Ridge wild sables with simultaneous selection for larger size, better fur quality, and higher reproductive potential [31].

Sable color is determined by the zonal coloring of the underfur, the color of the guard hairs, the size and color of the throat patch, and the appearance of gray hair. Many of these traits are inherited independently of each other. Until 2015, no genetically confirmed mutations in hair color were found in sables. It was believed that the general diversity of color in nature and during cage breeding of sables is due to modifier genes that suppress pigment formation in the hair to varying degrees [36].

Sables are characterized by a lighter coloration of the head compared to the body due to natural suppressor genes that inhibit pigment production in the hair. Black-headed individuals with the same color of the head and body resulted from long-term selection for darkening the color of the fur at the Pushkinsky fur

farm [36, 37]. Black-headedness arises when modifier genes (black-headedness polygenes) remove the suppression of pigment formation encoded by natural suppressor genes. Black-headedness is inherited as a quantitative trait and positively correlates with the overall color of the hair coat the darkening of which accelerates when common sables are crossed with black-headed sables [37, 38]. According to the requirements of OST 1010-86, the 5-point scor of fur color corresponded to the darkest individuals of the black or dark brown type. Animals that did not meet these requirements were culled during selection. Since in almost all breeds and types of fur-bearing animals, heterozygous individuals, as a rule, have a worse color rating than homozygous ones, possible carriers of mutant color genes were removed from the herd. In 1991, when wild caught sables of standard color were added to the fur farm population (six males in total, five of them from Kamchatka), animals began to appear with some lightening of color (with beige, pastel and gray shades) [39-41].

Over 25 generations of commercial domestication of sables on specialized fur farms, the de novo appearance of animals with extensive white spotting or piebalds on the paws, tip of the tail, muzzle and body occurred. The size and color of the spots vary greatly. The color of the spots can be not only white, but also yellow of varying intensity. Based on the inheritance of this phenotype, it was suggested that sables have two mutations that determine white spotting [30]. One mutation occurs in a dominant gene and is expressed both in hetero- and homozygous states. Another mutation appears to affect a semidominant gene with a recessive lethal effect. In a heterozygous state, it causes white spotting, and in a homozygous state, it causes white hair coloration. Spotted sables often have blue eyes, and the nasal planum is partially or completely depigmented. Homozygous individuals die at the prenatal or postnatal stage. There was only a single case of welping when a young sable lived to 45 days of age [30].

The first pastel-colored sable was born from a pair of black sables in 2005 (Pushkinskoye animal farm). These parents previously had nine black puppies from three crosses. A genealogical analysis of these parents showed that all their ancestors for three generations had black fur. A.D. Manakhov et al. [41] did not identify either homozygous or heterozygous *TYRP1b* sables in natural populations and suggest that the pastel variant of the sable arose de novo in the Pushkinskoye animal farm. Parents of pastel coloring, both in homogeneous selection of pairs and when mating with black sables, in most cases produce offspring separated by hair color. According to G.A. Kuznetsova [39, 40], pastel color is due to a dominant mutation. *PP* is homozygous genotype for pastel color, *Pp* is heterozygous. Thus, the pastel coloration of the hair in caged sables is the first proven mutation in this species. In the *Pp* genotype, the dominant mutant gene can alter the color tone, two mutant *PP* genes increase the effect. In addition, the effect of associated genes, in particular modifier genes, is possible (41).

The modern Russian caged sables can be divided into phenotypic groups depending on the degree of color lightening due to an increase in the expression of modifier genes. These are standard purebred, characteristic of the black sable breed, with the absence of activity of modifier genes; standard crossbreds of the first generation from crossing purebred black and pastel animals (including those with lightened ears, muzzle or head); standard lightened ones (like lavender, smoky and other shades that lighten the color); dark pastels; mid-tone pastels; light pastels; ferret type; palominoids (with high expression of modifier genes, the birth of white sables is possible) [40, 41].

Currently, by catching, breeding and selection of sable in Russia, the breeds Black Sable (1969, patent holder is the Federal State Unitary Enterprise Russian Sable), Saltykovskaya 1 (2007, patent holder is the Saltykovsky Breeding

State Farm JSC), Saltykovskaya silver (2020, patent holder is the Saltykovsky Breeding State Farm JSC, Vavilov Institute of General Genetics) and the breed type Pushkin Amber (2018, patent holder is the Federal State Unitary Enterprise Russian Sable) [31, 42, 43]. However, international auctions in recent years show that interest in commercial sable skins is currently growing; their share of those offered for sale averages 86%, while caged sable skins are sold on average at 27% [43, 44, 45]. According to experts from fur farms and auction houses, the reason is a decrease in the fur quality during sable domestication, the hair has become thicker and coarser, less silky, with low variability in color and tone, therefore, an expansion of the product range is required. The most in demand at present are sable skins with 5-7 point colors, medium tone, chestnut shade, with silky fur [43, 44]. Expanding the range of sable breeding products is possible by mating cage-bred sables with individuals from wild populations.

In this work, for the first time in the history of modern Russia, we analyzed the results of mating cage-bred and commercial sable. The indicators of the reproductive capacity of commercial males (Yakut, Irkutsk and Yenisei ridges) and females of the Saltykovskaya 1 breed, bred at the Savvatyevo Animal Farm LLC (Tver Province), are assessed. A comparative analysis of the growth dynamics of purebred and crossbred sable puppies is carried out. New requirements for grading (individual assessment) of crossbred young animals have been developed. A comprehensive assessment of the body size, fur quality and hair color of crossbred young animals was carried out. The selection of parental pairs to produce crossbred sables with competitive skin products that meet modern market requirements are analyzed.

The purpose of the study was 1) to compare rutting and whelping peculiarities of the cage-bred and wild sables, 2) to assess the growth rate of purebred and crossbred young sables during the growing period and 3) to evaluate the effectiveness of parent selection when mating a wild sable with a cage-bred sable to create the technology of sable selection based on color and hair quality.

*Materials and methods.* The work was carried out at LLC Zveroplemzavod Savvatyevo (Tver Province, 2021-2022). In 2020-2021, wild sables *Martes zibellina* L. (2 females and 10 males), caught in Siberia (Yakut, Irkutsk and Yenisei ridges) was brought to the farm for mating with cage-bred sable, which was carried out in July 2021. The most highly productive domesticated females aged from 2 to 9 years with an average progeny of 3.5-5.5 welps were selected for mating with wild males. Females Nos. 5190002 and 5200004 were wild (brought from the Kemerovo region and the Republic of Sakha-Yakutia, respectively). Male No. 5180001 from the natural population (did not cover any females), wild females No. 5200004, 5190002, and purebred females No. 3150516, 2180360, 2150620, 3150026, 3150078, 1180150, 1190132 which did not produce offspring were excluded. As a result, the sample included 9 wild males and 18 purebred females.

In April 2022, the females gave birth. Based on the results of whelping in May 2022, two groups of sables were formed, group I was purebred puppies (35 males, 30 females) from mating purebred males and females (control), group II was crossbred puppies (39 males, 30 females) from mating purebred and wild sables. The groups were formed according to the date of the welp birth, the mother's age and her average fertility in previous years.

From May to October 2022, the growth rates of purebred and crossbred young animals were compared. Control and test yong sables after weaning f (at 45 days of age) was measured and weighed every 15 days until 60 days of age and then every 30 days until 150 days of age. Body length, chest circumference behind the shoulder blades were measured with tape, an accuracy of 0.5 cm. Young

animals were weighed on a Vibra AJ-620 lE electronic scale (SHINKO DENSHI Co., Ltd., Japan), with an accuracy of 10 g. The absolute and relative increase in live weight and body length were calculated monthly.

Individual characterization of young sables aged 6 months and their parents was carried out in October 2022. The young sables were assessed for body size, build, fur quality, coloring and additional traits (throat patch, gray hair), and the parents was assessed for coloring. We used OST 1010-86 "Industry standard. Farm animals. Fur-bearing animals of cage breeding. Zootechnical requirements for grading (assessment)" (Moscow, 1986) with additions developed by us. For purebred and crossbred young animals (taking into account the requirements for grading crossbred young animals of the desired type), size, quality of pubescence, and quality of hair color were assessed. When grading young animals, special attention was paid to the desired type of color characteristic of wild sable (5-7 point color, medium tone, chestnut shade).

In November 2022, the results of mating and whelping were assessed according to the number of males who covered and did not cover females, the number of covered females, the number of empty females, the number of successfully whelped females, fertility, the number of animals for removing, the yield of young animals.

In December 2022, based on zootechnical documentation, we analyzed the results of the selection of parents for matings wild sable with cage-bred sable and assessed the correlation between the coloration of parents and young animals (Pearson's correlation coefficient).

Variation statistics was used for data processing (the Microsoft Excel computer program and statistical analysis packages Statistica 6.0, StatSoft, Inc., USA). Means ($M$) and standard errors of the mean (±SEM) were calculated. The significance of differences was assessed using Student's $t$-test. Differences were considered statistically significant at $p \leq 0.05$.

*Results.* The frequency of mutations is known to increase under conditions beyond the optimal habitat, under stress and physiological discomfort [46]. Populations living in the peripheral pessimum of the area are at the limit of the adaptive capabilities which should lead to a more rapid accumulation of mutations. Yakutia has the most severe conditions of the sable's range where the likelihood of encountering individuals with non-standard hair color may be the highest. Currently, among sable skins from different regions of Yakutia, proportion of light-colored skins is high [46]. There are especially many individuals with light fur in the northwestern and western populations [46]. In almost all ecological and geographical zones, there was a shift in the color ratio towards lightening. According to N.N. Osipova et al. [46], the selection involving sables from the northern taiga regions of Yakutia, especially from areas with a high frequency of non-standard coloring, could have great prospects for Russian fur farms [46]. We used sables from the Yakut, Irkutsk and Yenisei ridges in crossbreeding (schemes are submitted in Table 1).

Table 2 presents the results of whelping in the experimental batch of sables in 2022. Of the 9 males in the rut in 2021, only 8 covered females (see Table 2). Male No. 5190011 had the best rutting results, covering 8 females, 6 of which whelped. Males Nos. 5190003, 5200013 and 5200009 each mated with 2 females, but only every second of them whelped. Male No. 5180001 did not cover a single female. In total, of the 25 covered females, 72% gave birth, the rest (28%) were empty. As a result, 77 puppies were obtained from 18 females, 6 of which died before registration.

**1. Scheme of mating wild male sable *Martes zibellina* L. with females of different origins** (OOO Zveroplemzavod Savvatyevo, Tver Province, 2021)

| Male No. | Female No. | Female age in 2021 | Average female fertility for previous years | Origin of females |
|---|---|---|---|---|
| 5190011 | 3130566 | 8 years | 4,0 | OOO Vostok, Krasnodar Province |
| | 3120714 | 9 years | 4,0 | OOO Vostok, Krasnodar Province |
| | 2180488 | 3 years | 4,0 | FSUE Russian Sable, Moscow Province |
| | 2180360 | 3 years | 4,5 | FSUE Russian Sable, Moscow Province |
| | 3150516 | 6 years | 4,0 | OOO Znamenskoye Animal Farm, Tver Province |
| | 2150820 | 6 years | 4,4 | FSUE Russian Sable, Moscow Province |
| | 1150338 | 6 years | 4,6 | OOO Plemzverocomplex Magistralny, Altai Territory |
| | 1150054 | 6 years | 4,6 | OOO Plemzverocomplex Magistralny, Altai Territory |
| 5190001 | 3170006 | 4 years | 2,0 | OOO Znamenskoye Animal Farm, Tver Province |
| | 3160206 | 5 years | 4,5 | OOO Znamenskoye Animal Farm, Tver Province |
| | 1150142 | 6 years | 4,2 | OOO Plemzverocomplex Magistralny, Altai Territory |
| 5200011 | 4180174 | 3 years | 4,0 | OOO Zveroplemzavod Savvatyevo |
| | 3150034 | 6 years | 5,2 | OOO Znamenskoye Animal Farm, Tver Province |
| | 2150620 | 6 years | 3,8 | FSUE Russian Sable, Moscow Province |
| | 1150214 | 6 years | 4,0 | OOO Plemzverocomplex Magistralny, Altai Territory |
| 5190007 | 3170380 | 4 years | 3,3 | OOO Znamenskoye Animal Farm, Tver Province |
| | 2150608 | 6 years | 2,6 | FSUE Russian Sable, Moscow Province |
| | 1190098 | 2 years | 2,0 | OOO Plemzverocomplex Magistralny, Altai Territory |
| | 5190002 | 2 years | 4,0 | Captured in Nyurengri, Republic of Sakha-Yakutia |
| 5190003 | 3160032 | 5 years | 3,5 | OOO Znamenskoye Animal Farm, Tver Province |
| | 3150026 | 6 years | 2,2 | OOO Znamenskoye Animal Farm, Tver Province |
| 5200013 | 3170454 | 4 years | 4,0 | OOO Znamenskoye Animal Farm, Tver Province |
| | 3150078 | 6 years | 4,4 | OOO Znamenskoye Animal Farm, Tver Province |
| 5200009 | 1180150 | 3 years | 5,5 | OOO Plemzverocomplex Magistralny, Altai Territory |
| | 3150562 | 6 years | 4,0 | OOO Znamenskoye Animal Farm, Tver Province |
| 5190005 | 1190132 | 2 years | 0,0 | OOO Plemzverocomplex Magistralny, Altai Territory |
| 5190009 | 5200004 | Age unknown | No pregnancy | Caught in Mariinsk, Kemerovo Province |
| 5180001 | Did not mate with females | | | |

N o t e. Females of the Saltykovskaya 1 breed were used.

**2. Whelping during matings of wild male sables *Martes zibellina* L. with females of different origins** (OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Male No. | Mated/gave birth | Female No. | Date of birth | Fertility | Died before registration | Offspring |
|---|---|---|---|---|---|---|
| 5190011 | 8/6 | 2180488 | 14 April | 5 | 0 | 5 |
| | | 3120714 | 18 April | 3 | 0 | 3 |
| | | 3130566 | 05 April | 4 | 1 | 3 |
| | | 1150054 | 12 April | 4 | 0 | 4 |
| | | 1150338 | 02 April | 6 | 0 | 6 |
| | | 2150820 | 28 March | 7 | 4 | 3 |
| | | 3150516 | No pregnancy | | | |
| | | 2180360 | No pregnancy | | | |
| | | | *M* | 4.8 | | 3.0 |
| 5190001 | 3/3 | 1150142 | 09 April | 6 | 0 | 6 |
| | | 3160206 | 10 April | 4 | 0 | 4 |
| | | 3170006 | 14 April | 4 | 0 | 4 |
| | | | *M* | 4.7 | | 4.7 |
| 5200011 | 4/3 | 1150214 | 01 April | 5 | 1 | 4 |
| | | 2150620 | No pregnancy | | | |
| | | 3150034 | 15 April | 4 | 0 | 4 |
| | | 4180174 | 19 April | 4 | 0 | 4 |
| | | | *M* | 4.3 | | 3.0 |

*Continued Table 2*

| | | | | | | |
|---|---|---|---|---|---|---|
| 5190007 | 4/4 | 2150608 | 11 April | 4 | 0 | 4 |
| | | 3170380 | 17 April | 4 | 0 | 4 |
| | | 1190098 | 14 April | 2 | 0 | 2 |
| | | 5190002 | 14 April | 4 | 2 | 0 |
| | | | *M* | 3.3 | | 3.3 |
| 5190003 | 2/1 | 3150026 | No pregnancy | | | |
| | | 3160032 | 19 April | 4 | 0 | 4 |
| | | | *M* | 4.0 | | 2.0 |
| 5200013 | 2/1 | 3150078 | No pregnancy | | | |
| | | 3170454 | 11 April | 4 | 0 | 4 |
| | | | *M* | 4.0 | | 2.0 |
| 5200009 | 2/1 | 3150562 | 20 April | 3 | 0 | 3 |
| | | 1180150 | No pregnancy | | | |
| | | | *M* | 3.0 | | 1.5 |
| 5190005 | 1/0 | 1190132 | No pregnancy | | | |
| 5180001 | Did not mate with females | | | | | |

N o t e. For animal numbers, see Table 1. Females of the Saltykovskaya 1 breed were used (female No. 5190002 was caught in the wild). M is the average offspring of a male from all covered females and the average yield of offspring. Fertility is the number of puppies (living and dead) of a successfully whelped female. Decline before registration is the number of puppies that did not survive to be weaned from their mother (45 days of age). Output is the number of puppies that survived until November 1 of the current year (counting date for registration).

**3. Reproductiveness of purebred mothers (*Martes zibellina* L.) of the control and test progeny from mating with males of different origins** (OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Number | Group I (control) | Group II (test) |
|---|---|---|
| Successfully whelped females | 18 | 18 |
| Puppies | 73 | 77 |
| Average fertility | 4.1 | 4.3 |
| Puppies died before registration | 2 | 6 |
| Live puppies | 71 | 71 |
| Live puppies per successfully whelped females | 3.9 | 3.9 |

N o t e. Females of the Saltykovskaya 1 breed were used. In the control group, 35 males and 30 females (purebred animals) were born, in the experimental group 39 males and 30 females (crossbred animals).

We noted the best average fertility indicators in females covered by male No. 5190011 (4.8 puppies) and male No. 519001 (4.7 puppies), good results were in females covered by male No. 5200011 (4.3 puppies). In terms of progrny per the main female (4.7 puppies), male No. 519001 was the leader. In male No. 5190011, due to two empty females and a 17.2% loss of young animals, the observed output decreased to 3 puppies, which may be due to the heavy load (the male covered 8 females with polygamy of the species 1:4).

Our results of mating of wild males with purebred females correspond to the reproduction rates of cage-bred sables [47, 48].

An assessment of the reproductive ability of purebred mothers from whom sables of the control and test groups were born in 2022 (Table 3) showed that with minor differences in average fertility and the number of puppies in favor of mothers of crossbred puppies from wild fathers, the number of dead crossbred puppies was higher. As a result, the yield of puppies by November and the average yield of puppies per successful female in both groups were the same (see Table 3).

**4. Dynamics of live weight and measurements of sables *Martes zibellina* L. in the offspring from mating wild sables with sables of the Saltykovskaya 1 breed** (*M*±SEM, OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Group | Parameter | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|
| Group I (control): | | | | | | | |
| females | weight, g | 637.5±25.5 | 855.9±21.4 | 994.2±15.6 | 1145.8±100.9 | 1120.7±16.1* | 1138.7±25.4 |
| (*n* = 30) | length, cm | 30.5±0.5 | 37.3±0.7 | 40.7±0.3 | 41.9±0.3 | 42.6±0.2 | 42.4±0.3 |
| | girth, cm | 18.4±0.4 | 20.2±0.2 | 20.4±0.2 | 20.7±0.2 | 20.8±0.2 | – |
| males | weight, g | 679.8±34.8 | 967.6±34.5 | 1158.5±17.7 | 1221.4±14.0 | 1267.7±12.9 | 1279.6±17.8 |
| (*n* = 35) | length, cm | 30.9±0.6 | 37.7±0.8 | 43.2±0.37 | 44.7±0.3 | 45.7±0.3 | 45.6±0.5 |
| | girth, cm | 19.1±0.4 | 22.18±0.16 | 22.3±0.1 | 22.7±0.2 | 22.8±0.1 | – |

*Continued Table 4*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Group II (test): | | | | | | | |
| females, | weight, g | 614.4±29.3 | 820.1±28.1 | 956.7±18.5 | 1022.8±14.8 | 1065.3±15.8 | 1111.3±18.7 |
| ($n$ = 30) | length, cm | 30.3±0.4 | 36.4±0.8 | 40.2±0.4 | 41.7±0.3 | 42.7±0.2 | 42.9±0.2 |
| | girth, cm | 18.6±0.4 | 19.8±0.3 | 20.1±0.2 | 20.5±0.2 | 21.0±0.2 | – |
| males, | weight, g | 746.3±26.8 | 1048.0±33.5 | 1246.0±17.2** | 1309.5±12.8*** | 1480.5±28.0*** | 1560.0±68.5*** |
| ($n$ = 39) | length, cm | 32.1±0.2 | 38.9±1.0 | 44.0±0.4 | 45.4±0.3 | 46.5±0.3 | 47.8±0.6** |
| | girth, cm | 20.3±0.4* | 21.9±0.2 | 22.2±0.1 | 22.1±5.4 | 22.8±0.2 | – |

Примечание. Dashes in the table mean that no measurements were taken.
*, **, *** Differences between groups are statistically significant at $p \le 0.05$, $p \le 0.01$, and $p \le 0.001$, respectively.

**5. Absolute and relative increase in body weight and size in sables *Martes zibellina* L. offspring from mating wild sables with sables of the Saltykovskaya 1 breed** ($M$±SEM, OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Group | Body weight gain | | Body length increase | |
|---|---|---|---|---|
| | absolute, g | relative, % | absolute, cm | relative, % |
| | | Aged 60 days | | |
| I (control): | | | | |
| females ($n$ = 30) | 4.6±0.1 | 16.2 | 0.11±0.03 | 9.12 |
| males ($n$ = 35) | 6.4±0.2 | 19.7 | 0.18±0.03 | 14.59 |
| II (test): | | | | |
| females ($n$ = 30) | 4.6±0.1 | 16.7 | 0.13±0.05 | 10.44 |
| males ($n$ = 39) | 6.6±0.2 | 18.9 | 0.17±0.04 | 13.11 |
| | | Aged 90 days | | |
| I (control): | | | | |
| females ($n$ = 30) | 5.1±0.2 | 15.2 | 0.04±0.02 | 2.95 |
| males ($n$ = 35) | 2.1±0.1 | 5.4 | 0.05±0.01 | 3.47 |
| II (test): | | | | |
| females ($n$ = 30) | 2.2±0.1 | 6.9 | 0.05±0.02 | 3.73 |
| males ($n$ = 39) | 2.1±0.1 | 5.1 | 0.05±0.02 | 3.18 |
| | | Aged 120 days | | |
| I (control): | | | | |
| females ($n$ = 30) | –0.8±0.1 | –2.2 | 0.02±0.01 | 1.67 |
| males ($n$ = 35) | 1.5±0.1 | 3.8 | 0.03±0.01 | 2.24 |
| II (test): | | | | |
| females ($n$ = 30) | 1.4±0.1 | 4.2 | 0.03±0.01 | 2.40 |
| males ($n$ = 39) | 5.7±0.2 | 13.1 | 0.04±0.01 | 2.42 |
| | | Aged 150 days | | |
| I (control): | | | | |
| females ($n$ = 30) | 0.6±0.1 | 1.6 | –0.01±0.01 | –0.47 |
| males ($n$ = 35) | 0.4±0.1 | 0.9 | 0.00±0.00 | –0.22 |
| II (test): | | | | |
| females ($n$ = 30) | 1.5±0.1 | 4.3 | 0.01±0.01 | 0.47 |
| males ($n$ = 39) | 2.7±0.1 | 5.4 | 0.04±0.01 | 2.80 |

Crossbred males had the maximum average bodyweight at the beginning of the experiment (June) and until its end (November). In purebred males in June, the average bodyweight was 66.5 g less (the differences are not significant). In November, this difference in males of the test and control groups was 280.4 g ($p \le 0.001$). This is confirmed by the absolute and relative bodyweight gain (Table 5).

Crossbred females from group II at the beginning of the experiment were inferior in bodyweight to the control ones by 23.1 g (the differences are not significant). In purebred females, a sharp increase in bodyweight occurred from August to September, but in October this figure decreased and in November stabilized. The absolute and relative increase in bodyweight in females of the control group in September were –0.8 g and –2.2%, respectively (see Table 5). In crossbred females, the bodyweight changed more smoothly, without sudden jumps. In November, the control females exceeded the test ones in bodyweight by 27.4 g (the differences are not significant).

At the beginning of the experiment, males from group II exceeded males from the control group by 1.2 cm in body length (see Table 4, the differences are not significant). There were no significant fluctuations in body length in males of both groups from June to October. However, in October the crossbred males continued to grow, while in the control males the body length stabilized and by

November practically did not change. This is evidenced by the absolute and relative increase in body length (see Table 5). Initially, for males of the control group there were 0.18 g and 14.59%, respectively, for males of the test group 0.17 g and 13.11%. At the end of the experiment, the figures were 0 g and –0.22% for control males, and 0.04 g and 2.8% for test males. At the end of the experiment, the difference in body length between caged and crossbred males was 2.2 cm in favor of the latter ($p \leq 0.01$).

There was no significant difference in body length between control and test females throughout the study.

The data presented in Table 4 show that at the beginning of the experiment, crossbred males exceeded males in the control group in chest girth behind the shoulder blades by 1.2 cm ($p \leq 0.05$). However, from June to July, purebred males had a more accelerated increase in this trait value. Since July, in males of the control group, the chest girth behind the shoulder blades has stabilized; in crossbred males, it has decreased in September, which is apparently due to a decrease in bodyweight during this period. In control and crossbred females, the chest girth behind the shoulder blades increased until July, and then it stabilized.

It is known that the color of the awn and underfur is controlled by multiple genes. Very complex, polygenic inheritance of color in sable has not yet been sufficiently studied [1, 37]. In nature, the color of the fur varies from straw-yellow, sand, orange to pitch-black with many transitional options [10]. Currently, in accordance with OST 1010-86, the desired color type for dark brown sables is dark brown to almost black, uniform throughout the body. The down should be dark gray with a blue tint, evenly colored along the entire length of the hair. The mark for coloring is reduced if the tops of the down hair are dark brown, chestnut, the coverts are brown or light brown, the color of the sides and body is lighter, the color of the down is gray of varying intensity with light chestnut tops. When sorting sable skins at the Soyuzpushnina auction, the skin color is assessed by colorftion from 1 (darkest) to 10 (lightest), by tone (1 meams dark, 2 meams medium, 3 meams light) and shade (1 meams blue, 2 meams chestnut, 3 meams red). Gray hair is also assessed, dividing the skins into six categories, dull (without gray hair), 1 meams light gray, 2 meams gray, 3, 4, 5 meams bright gray [45].

We have changed the color requirements for crossbred sables, regarding the desired type. The color of the awn, tone (color of the down), shade (color of the tops of the down hair), gray hair, and throat patch were assessed separately. In grading young animals of groups I (control) and II (test) we studied the color of the hairline elements (Table 6).

The young animals of the control group had two variations in the color of the covering hairs, the almost black (47% in females, 81% in males) and dark brown (53% in females, 19% in males). In group II, in males and females, this trait varied within four color categories. In crossbred test females and males, dark brown color predominated (38 and 60%, respectively). The lightened color of the awns was more pronounced in crossbred females (31% brown, 23% light brown) than in males (28% brown, 8% light brown). The greatest diversity in the downy hair color occurred in males of the control and test groups (5 color categories identified). In females of the control group, 4 variations in the color based of the down were observed. The least rang of variation occurs in female of test group. The most common color variations were gray (40-73%) and dark gray (13-31%). Gray-brown coloration of the down base was observed in 16%, 8% and 7% of cases, respectively, in control males, crossbred males and control females. Gray with a blue tint down base was rare (4% of control and crossbred males). Thus, we did not find any significant differences in the color of the downy hair base in

control and crossbred sables, but males turned out to be the most variable in the coloration of the downy hair base compared to females.

**6. Distribution (%) of hair color variants in the offspring from mating wild sables (*Martes zibellina* L.) with sables of the Saltykovskaya 1 breed** (OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Hair element | Color | Group I (control) | | Group II (test) | |
|---|---|---|---|---|---|
| | | females ($n$ = 30) | males ($n$ = 35) | females ($n$ = 30) | males ($n$ = 39) |
| Covering hair | Almost black | 47 | 81 | 8 | 4 |
| | Dark brown | 53 | 19 | 38 | 60 |
| | Brown | 0 | 0 | 31 | 28 |
| | Light brown | 0 | 0 | 23 | 8 |
| Down bases | Gray | 73 | 45 | 69 | 40 |
| | Dark gray | 13 | 27 | 31 | 28 |
| | Light gray | 7 | 8 | 0 | 20 |
| | Taupe | 7 | 16 | 0 | 8 |
| | Gray with a blue tint | 0 | 4 | 0 | 4 |
| Down tops | Plain | 40 | 42 | 8 | 8 |
| | Chestnut | 53 | 31 | 53 | 32 |
| | Brown | 7 | 27 | 16 | 28 |
| | Beige | 0 | 0 | 15 | 4 |
| | Orange tint | 0 | 0 | 8 | 0 |
| | whitish | 0 | 0 | 0 | 12 |
| | Light gray | 0 | 0 | 0 | 16 |

Crossbred males expressed the greatest diversity in the color of the tops of downy hair (see Table 6). In animals of group II, six variations of this trait were found. In crossbred females from group II, five color variants were identified. In control males and females, the trait varied within three color categories. Brown coloration of the tops of downy hair was the most common in control and crossbred females (53% in both groups). Plain tops were most common in control males and females (42% and 40%, respectively). These data indicate that crossbred young sables (both males and females) are more variable in the color of the downy hair tops. The uniformity of the downy hair top color in control males and females indicates that the uniformity of down color is one of the main target trait when breeding dark sables. At all sable breeding farms the darkest individuals with underfur without zonal coloring were selected for many decades [31, 33, 38, 44].

In assessing the fur quality, hair color and additional traits (gray hair, throat patch) of crossbred young animals (Table 7), special attention was paid to the color parameters characteristic of wild sable (5-7 point color, tone 2 medium, down 2 with chestnut tops) which are now desired traits for breeding.

**7. Results of assessment of crossbred sables *Martes zibellina* L. in the offspring from mating wild sables with cage-bred sables** (OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Quality | | Color | | Tone | | Shade | | Gray | | Throat spot | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| points | % | designation | % | points | % | points | % | points | % | points | % |
| Crossbred females (group II, $n$ = 30) | | | | | | | | | | | |
| 5 | 30.0 | 1 | 23.4 | 1 | 43.3 | 1 | 6.7 | 0 | 86.7 | 5 | 80.0 |
| 4 | 66.7 | 2 | 20.0 | 2 | 46.7 | 2 | 83.3 | 1 | 6.7 | 4 | 13.3 |
| 3 | 3.3 | 3 | 30.0 | 3 | 10.0 | 2/3 | 6.7 | 2 | 3.3 | 2 | 6.7 |
| | | 4 | 23.3 | | | 3 | 3.3 | 3 | 3.3 | | |
| | | 6 | 3.3 | | | | | | | | |
| $M$ = 4.26 | 100 | $M$ = 2.66 | 100 | $M$ = 1.67 | 100 | $M$ = 2.03 | 100 | $M$ = 0.23 | 100 | $M$ = 4.67 | 100 |
| Crossbred males (group II, $n$ = 38) | | | | | | | | | | | |
| 5 | 42.1 | 1 | 7.9 | 1 | 26.3 | 2 | 94.7 | 0 | 89.5 | 5 | 81.6 |
| 4 | 50.0 | 2 | 21.0 | 2 | 50.0 | 2/3 | 5.3 | 1 | 10.5 | 4 | 2.6 |
| 3 | 7.9 | 3 | 44.7 | 3 | 23.7 | | | | | 3 | 2.6 |
| | | 4 | 18.4 | | | | | | | 2 | 13.2 |
| | | 5 | 5.4 | | | | | | | | |
| | | 6 | 2.6 | | | | | | | | |
| $M$ = 4.34 | 100 | $M$ = 3.00 | 100 | $M$ = 1.97 | 100 | $M$ = 2.05 | 100 | $M$ = 0.10 | 100 | $M$ = 4.52 | 100 |

Grading of the crossbred young animals (see Table 7) showed that the quality of hair in males is 0.08 points higher than in females. In color, crossbred males are 0.34 points lighter than females and closer to the desired color. The resulting young animals were close to the desired sables in tone and were also consistent in shade (2.03 points for females and 2.07 points for males). Among the resulting crossbred males, there are fewer individuals with gray hair than among females (10.5% vs. 13.0%). In caged sables, for which the throat spot is undesirable, it is practically absent, but was passed on to the resulting youngs (average score for females 4.67, for males 4.52) (see Table 7).

It was previously shown that in pastel individuals the intensity and shades of pigmentation vary significantly. The color of the guard hairs is from very light brown to dark brown, sometimes similar to the usual dark sable, the underfur is from dark gray to light gray, almost blue, with the tops of the hairs from light brown to brown. Moreover, the color tone of the awn almost always correlates with the color of the underfur [39, 40]. Our experiment established a similar correlation.

**8. Distribution (%) of color among young crossbred sables *Martes zibellina* L. at different types of mating of commercial sables with cage-bred sables** (OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Mating depending on the color of the awns of the parents (mother × father) | *n* | Awn color in young animals | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 × 1 | 6 | 83.3 | 0 | 0 | 16.7 | 0 | 0 |
| 1 × 2 | 13 | 23.1 | 30.7 | 23.1 | 23.1 | 0 | 0 |
| 1 × 6 | 26 | 0 | 11.5 | 65.4 | 19.3 | 3.8 | 0 |
| 1 × 7 | 4 | 0 | 0 | 0 | 25.0 | 25.0 | 50.0 |
| 2 × 2 | 10 | 20.0 | 60.0 | 20.0 | 0 | 0 | 0 |
| 2 × 6 | 5 | 0 | 20.0 | 40.0 | 40.0 | 0 | 0 |
| 3 × 6 | 4 | 0 | 0 | 50.0 | 50.0 | 0 | 0 |

In variants with heterogeneous selection of parents according to hair color (mother × father: 1 × 6, 1 × 7, 2 × 6, 3 × 6; Table 8), that is, when light males are mated with dark females, individuals predominate in the offspring have intermediate or lightened coloring of the guard hairs, characteristic of males. With homogeneous selection (1 × 1, 2 × 2, see Table 8) when dark females are mated with dark males, the resulting young sables have a darker hair color. However, with this type of selection, in addition to dark animals, individuals with the color 4 are selected, which corresponds to a light brown. It is obvious that the intensity of the color of the covering hair is inherited as a quantitative polygenic trait. The same was noted by G.A. Kuznetsov, K.V. Kharlamov [36] and G.A. Kuznetsov [37]. Sables are characterized by a lighter coloration of the head compared to the body, which is due to the action of natural suppressor genes that inhibit the development of pigmentation in the hair. Black-headed individuals, in which the color of the head and body do not differ, resulted from many years of selection for darkening the color of the fur at the Pushkinsky fur farm [36, 37].

The results of studies on producing lightened sable progeny (2004-2010) indicate that palomin and pastel colors are not caused by oligogenic mutations, but by the action of modifier genes that alter the degrees of lightening of the standard color. It is possible that modifiers are recessive polygenes with incomplete expression. Homozygosity for these genes ensures the birth of white puppies who die in the first days of life, and survivors with a smaller set (or reduced expression) of genes have a light pastel color [39, 40]. According to A.P. Nyukhalova et al. [38], the degree of darkening of the hairline is also controlled polygenically and is inherited as a recessive epistasis [38]. Since sables homozygous for black color genes obviously do not exist, it is natural that even the blackest individuals are carriers of part of the genes in a heterozygous state and, when mating with each

other, produce both their own types and various deviations. Light shades are, as a rule, found in animals heterozygous for color genes [38]. This means that previously, in order to preserve the existing color, animals heterozygous for recessive color genes, and sometimes for dominant ones, were constantly culled from the herd. This selection technology excludes the preservation of individuals with a different hair color. Therefore, it is natural that in fur farms until recently there were no sables with officially registered mutant color types [39]. The purpose of our research is to preserve and improve existing sable breeds and expand the range of competitive skin products that meet modern market requirements.

**9. Correlation between the coloration of parents and crossbred young animals during mating of females of the Saltykovskaya 1 breed and wild male sables (*Martes zibellina* L.)** (OOO Zveroplemzavod Savvatyevo, Tver Province, 2022)

| Parent—offspring | *n* | | Correlation coefficient |
|---|---|---|---|
| | parents | offspring | |
| Mothers—daughters | 18 | 30 | $r = 0.051$ ($p \geq 0.05$) |
| Mothers—sons | 18 | 35 | $r = 0.098$ ($p \geq 0.05$) |
| Fathers—daughters | 8 | 30 | $r = 0.72$ ($p \leq 0.001$) |
| Fathers—sons | 8 | 35 | $r = 0.61$ ($p \leq 0.001$) |

The Table 9 shows that there is practically no correlation in color between mothers and daughters, and the same for sons (the color of the mother does not affect the color of the sons). Vice versa, the males influence the coloration of both sons ($r = 0.61$ at $p \leq 0.001$) and daughters ($r = 0.72$ at $p \leq 0.001$), and the correlation is even stronger for daughters. That is, males are better able to pass on hair color to their offspring.

In conclusion, the inheritance of lightened coloration in matings of wild and purebred sable must be further studied to find out what wild sable genotypes can ensure the desired hair color in the population of Savvatyevo Zveroplemzavod LLC. It is equally important to study in detail how the softness and silkiness of the hair is inherited.

Thus, in mating with wild sable males, the reproduction rates of purebred females are not lower than for cage-bred sables. On average, the yield per successfully whelped female for both groups was 3.9 puppies. In the resulting offspring, crossbred males were superior to purebred males in terms of growth (by 280.4 g at $p \leq 0.001$ and 2.2 cm at $p \leq 0.01$ for bodyweight and body length, respectively). Cage females slightly exceeded crossbreds in bodyweight (by 27.4 g, $p \leq 0.01$), but did not differ in body length and chest circumference behind the shoulder blades. Purebred offspring (males and females) of sables finished growing 2 months earlier than crossbred animals. Purebred young animals have two variations in the color of the covering hairs, almost black and dark brown. In crossbred males and females, the trait varies within four color categories (dark brown, brown, light brown, almost black). We did not find any significant differences in the color of the downy hair base between purebred and crossbred sables, but all males turned out to be more variable than females in the downy hair base coloration. Crossbred males and females are more variable in the color of the downy hair top. In control (purebred) males and females the observed uniformity of coloring downy hair tops indicates that uniformity of downy hair coloring is one of the main selection trait when breeding dark sables. Crossbred males have a higher quality of hair than females, the fur is lighter and closer to the desired color. A similar trend can be seen in tone. In terms of shade, crossbred females are more consistent with the target indicator than males. Among crossbred males there are fewer individuals with gray hair than among females. The throat spot has been transmitted to both females and males. The probability of obtaining the expected color in crossbred young animals is higher when light males are mated with dark females. The mother

color does not affect the color of daughters and sons, while fathers are better at transmitting their color to the offspring (for sons $r = 0.61$, for daughters $r = 0.72$; $p \leq 0.001$).

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