Morphometric indicators of the axial skeleton and their relationship with breeding characters in minks of different genotypes

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Abstract. American mink (Mustela vison / Neovison vison) is the main object of fur farming. Breeding work has a significant impact on animal morphology. Body size is a breeding trait, as it affects the cost of the final product through the area of the resulting skins. The study of the laws governing the formation of this feature is of practical importance in the rule of law. In the study of indicators: the mass of the carcass without skin and subcutaneous fat (CMWS), the total body length of the animal (BL), the length of the skull (SL) and the length of the spinal column: cervical (CL), thoracic (TL), lumbar (LL) and sacral (SL) and their interdependencies in minks of genotypes silver-blue (p/p), sapphire (a/a p/p), pearl (kk pp), palomino (kk), pastel (bb), albino pastel (cc bb), headlund (hh), scanblack (NN, Nn)), it was found that body weight mainly has significant differences. The total body length of the male genotypes is pearl (kk pp), headlund (hh) and scanblack (NN, Nn)), it was found that body weight mainly has significant differences. The total body length of the male genotypes is pearl (kk pp), headlund (hh) and scanblack (NN, Nn) significantly less than the animals of the remaining groups, and the longest males of the genotypes are silver-blue (p/p), pastel (bb) and albino pastel (cc bb). In females, the differences are not significant. The dependence of MCWS on BL is at a high level, while some parts of the axial skeleton have a significantly smaller effect on body weight, despite the fact that the thoracic region has a noticeable and high effect on the total length, which is apparently due to the large relative value of this department.

1. Introduction
American mink (Mustela vison / Neovison vison) is characterized by the durability of the fur and a high degree of its alignment throughout the body [1], in this regard, it is the main object of fur farming. It should be noted that animal species bred by humans in captivity undergo a number of processes and changes, known as domestication. Taming is not a point phenomenon - it is impossible to describe a turning point when a wild species becomes domesticated. This is a continuous process of transforming the wild form into a cultural one, which is the result of the selection and influence of agricultural conditions on a series of animal generations [2]. Artificial selection can also lead to unintended consequences when breeding traits are genetically linked to other traits. Thus, selection for the presence of complaisance in the cell red foxes Vulpes vulpes inadvertently led to a number of morphological changes in the population, apparently due to a number of developmental changes driven by the affected genes [3]. In domestic animals, selection is generally weakened for traits that increase survival or
productivity in wild populations, which can lead to changes in morphology, behavior and reproduction [4].

Currently, the process of domestication of minks continues, and selection work has a significant impact on the morphology of animals. First of all, variability concerns such signs as the ratio of different parts of the body, cranio-laboratory parameters, and the appearance of color varieties uncharacteristic of the wild form [5, 6]. For example, the size [7] and brain volume [8] of domestic mink appear to be decreasing. It should be noted that morphometric indicators depend not only on the conditions of detention, but also on the mink genotype [9, 10]. Body size is a breeding trait, since it affects the cost of the final product through the area of the resulting skins [11, 12]. Consequently, the study of the laws governing the formation of this trait is of practical importance in rule-making.

The purpose of this study was to compare the morphometric characters of minks of different genotypes, to study the sizes of the axial skeleton of minks and their mutual influence on such selectable indicators as the total body length and its weight. In our previous works, we have already considered these dependences in minks of certain genotypes. This work is a continuation of this study.

2. Materials and research methods

The research technique is the same for all studied mink genotypes and is described in detail in our previous works [13]. The object of the study was carcasses of minks of various genotypes (silver-blue (p/p), sapphire (a/a, p/p), pearl (kk pp), palomino (kk), pastel (bb), albino pastel (cc bb), headlund (hh), scanblack (NN, Nn)) obtained during the planned slaughter of a livestock farm located in the Stavropol territory. The farm practices slaughter of animals in the autumn-winter period at the age of 7.5 months. For carrying out the studies, 20 carcasses of males and females of each of the indicated genotypes were selected after skinning.

The following indicators were posthumously determined: carcass mass without skin and subcutaneous fat (CMWS), total body length of an animal (BL), skull length (SL) and the length of the spinal column: cervical (CL), thoracic (TL), lumbar (LL) and sacral (SL). The mass was determined on an electronic balance with an accuracy of 1 gr, linear dimensions were measured using a measuring tape with an accuracy of 1 mm. The total length of the body was taken to be the length of the carcass after skinning, measured from the root of the tail to the tip of the nasal cartilage [14].

The obtained digital data was processed using the statistical analysis package Microsoft Excel 2007. The arithmetic mean (M), standard error of the mean (m), coefficient of variation (Cv), the limit of values within the sample from minimum to maximum (lim), and reliability according to the Student criterion were determined. (p), the correlation coefficient of various indicators among themselves.

To describe the value of the correlation coefficient, we used the conditional scale proposed by R.E. Chaddock: the degree of correlation less than 0.3 is weak; 0.3-0.5 - moderate; 0.5-0.7 - noticeable; 0.7-0.9 - high; more than 0.9 - very high.

3. Research results and discussion

An analysis of the measurements (table 1) made it possible to determine that males of different breeds by mass are mostly significantly different from each other, while silver-blue (p/p) - 1621.4 ± 32.59 g, have the largest average mass and sapphire has the smallest one (a/a p/p) - 1289.6 ± 33.51 g. The largest consolidation by mass is observed in the group of male hedlund (hh) (Cv = 7.3), and scrubble (NN, Nn) (Cv = 20.3), while the indicator of body weight without skin and subcutaneous fat is in a wide range from 878.0 to 1828.0 grams. Apparently, this peculiarity of male scanblack (NN, Nn) can be due to the presence in the group of both homozygous and heterozygous N gene individuals. It should be noted that this fact did not have a significant effect on the total body length.
| Group          | Breeds                  | Indicator | CMWS, gr | The length of the departments of the axial skeleton, cm |
|---------------|-------------------------|-----------|----------|--------------------------------------------------------|
|               |                         |           | BL       | SL          | LL        | SL        | SL        |
| 1             | Silver-blue (p/p)       | M±m       | 1621.4±32.59 | 46.1±0.32 | 8.4±0.08 | 9.3±0.14 | 17.2±0.20 | 7.5±0.10 | 3.8±0.06 |
|               |                         | Cv        | 10.0     | 3.5        | 4.6        | 7.4       | 5.9       | 6.9       | 8.1       |
| 2             | Sapphire (a/a p/p)      | M±m       | 1289.6±33.51 | 45.7±0.58 | 8.6±0.10 | 9.3±0.28 | 17.8±0.36 | 7.7±0.19 | 3.2±0.14 |
|               |                         | Cv        | 11.6     | 5.7        | 5.6        | 13.5      | 9.0       | 11.2      | 19.0      |
| 3             | Pearl (kk pp)           | M±m       | 1408.0±47.21 | 44.9±0.44 | 7.9±0.09 | 9.2±0.14 | 17.0±0.26 | 7.4±0.12 | 3.3±0.07 |
|               |                         | Cv        | 15.0     | 4.3        | 4.8        | 6.9       | 7.0       | 7.3       | 9.1       |
| 4             | Palomino (kk)           | M±m       | 1537.1±32.32 | 45.9±0.31 | 8.1±0.12 | 10.5±0.18 | 16.4±0.17 | 7.6±0.18 | 3.4±0.06 |
|               |                         | Cv        | 9.4      | 3.1        | 6.4        | 7.8       | 4.7       | 10.7      | 8.1       |
| 5             | Pastel (bb)             | M±m       | 1492.9±36.36 | 46.5±0.47 | 8.5±0.08 | 9.4±0.17 | 17.3±0.28 | 7.5±0.16 | 3.9±0.07 |
|               |                         | Cv        | 10.9     | 4.6        | 4.3        | 8.1       | 7.2       | 9.3       | 8.4       |
| 6             | Albino pastel (cc bb)   | M±m       | 1230.8±182.10 | 42.0±0.53 | 8.9±0.93 | 8.0±1.10 | 16.0±0.20 | 5.8±0.88 | 3.4±0.45 |
|               |                         | Cv        | 11.0     | 3.1        | 8.1       | 7.3       | 4.3       | 5.1       | 8.8       |
| 7             | Headlund (hh)           | M±m       | 1307.1±21.41 | 42.7±0.37 | 7.8±0.11 | 8.3±0.21 | 16.0±0.20 | 7.1±0.13 | 3.5±0.06 |
|               |                         | Cv        | 7.3      | 3.9        | 6.4        | 11.6      | 5.6       | 8.0       | 8.2       |
| 8             | Scanblack (NN, Nn)      | M±m       | 1334.9±60.92 | 44.8±0.41 | 8.3±0.10 | 9.8±0.13 | 15.9±0.25 | 7.2±0.12 | 3.7±0.05 |
|               |                         | Cv        | 20.3     | 4.1        | 5.6       | 5.8       | 7.1       | 7.5       | 6.2       |

Significance of differences between groups by Student criterion

| p 2-8   | 0.0117 | 0.0006 | 0.0001 | 0.0285 | 0.0080 |
| p 4-8   | 0.0131 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| p 6-8   | 0.0121 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| p 1-8   | 0.0029 | 0.0046 | 0.0020 | 0.0028 | 0.0028 |
| p 7-8   | 0.0015 | 0.0000 | 0.0000 | 0.0000 | 0.0109 |
| p 5-8   | 0.0022 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 2-5   | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| p 4-5   | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0000 |
| p 3-5   | 0.0033 | 0.0008 | 0.0008 | 0.0000 | 0.0000 |
| p 6-5   | 0.0216 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 1-5   | 0.0006 | 0.0000 | 0.0002 | 0.0004 | 0.0008 |
| p 2-7   | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| p 4-7   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 3-7   | 0.0042 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 6-7   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 1-7   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 2-1   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 4-1   | 0.0014 | 0.0025 | 0.0000 | 0.0028 | 0.0003 |
| p 3-1   | 0.0000 | 0.0065 | 0.0001 | 0.0001 | 0.0001 |
| p 6-1   | 0.0022 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 2-6   | 0.0108 | 0.0191 | 0.0191 | 0.0191 | 0.0191 |
| p 4-6   | 0.0296 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 2-2   | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

*Only significant differences are indicated with p<0.05.

The total body length of the male genotypes pearl (kk pp), headlund (hh) and scanblack (NN, Nn) is significantly less than that of the animals of the other groups, while they significantly differ from each other. The headlund males (hh) have the smallest average long length - 42.7 ± 0.37 cm, and the silver-blue (p/p) genotypes longest males - 46.1 ± 0.32 cm, pastel (bb) - 46.5 ± 0.47 cm and albino pastel (cc bb) - 46.5 ± 0.33 cm.
### Table 2. Relative indicators of the axial skeleton of male minks of different genotypes.

| Group                  | Breeds               | Indicator | The relative length of the departments of the axial skeleton, % |
|------------------------|----------------------|-----------|---------------------------------------------------------------|
|                        |                      | BL       | SL     | CL     | TL     | LL     |
| **1**                  | Silver-blue (p/p)    | M±m      | 18.2±0.13 | 20.1±0.27 | 37.3±0.30 | 16.2±0.20 | 8.2±0.13 |
|                        |                      | Cv       | 3.6    | 6.8    | 4.1    | 6.1    | 7.8    |
|                        |                      | min-max  | 17.0-19.5 | 17.4-22.9 | 34.8-40.1 | 13.2-18.3 | 7.1-9.5 |
|                        | Sapphire (a/a p/p)   | M±m      | 17.1±0.21 | 20.3±0.54 | 38.9±0.59 | 16.8±0.38 | 7.0±0.27 |
|                        |                      | Cv       | 5.6    | 11.8   | 6.8    | 10.0   | 17.4   |
|                        |                      | min-max  | 15.2-19.0 | 15.7-24.1 | 33.1-45.0 | 14.0-20.4 | 4.8-9.6 |
|                        | Pearl (kk pp)        | M±m      | 17.7±0.16 | 20.6±0.20 | 37.7±0.32 | 16.5±0.31 | 7.4±0.13 |
|                        |                      | Cv       | 4.0    | 4.4    | 3.8    | 8.3    | 7.8    |
|                        |                      | min-max  | 16.7-19.1 | 19.5-22.4 | 34.8-40.4 | 14.3-19.1 | 5.9-8.3 |
|                        | Palomino (kk)        | M±m      | 17.5±0.22 | 22.8±0.34 | 35.8±0.36 | 16.6±0.37 | 7.3±0.13 |
|                        |                      | Cv       | 5.5    | 6.6    | 4.5    | 9.9    | 8.1    |
|                        |                      | min-max  | 15.3-19.8 | 20.4-26.0 | 32.8-38.7 | 12.7-19.6 | 6.3-8.8 |
|                        | Pastel (bb)          | M±m      | 18.2±0.22 | 20.2±0.30 | 37.1±0.38 | 16.1±0.27 | 8.4±0.14 |
|                        |                      | Cv       | 5.4    | 6.6    | 4.5    | 7.5    | 7.3    |
|                        |                      | min-max  | 16.4-20.2 | 18.6-22.9 | 33.3-40.2 | 15.3-18.6 | 7.6-10.0 |
|                        | Albino pastel (cc bb)| M±m      | 17.6±0.24 | 20.4±0.34 | 38.2±0.30 | 15.9±0.15 | 7.8±0.14 |
|                        |                      | Cv       | 6.2    | 7.5    | 3.5    | 4.2    | 7.9    |
|                        |                      | min-max  | 13.8-18.8 | 18.5-24.4 | 36.2-40.2 | 14.7-17.1 | 6.6-8.9 |
|                        | Headlund (hh)        | M±m      | 18.3±0.22 | 19.4±0.41 | 37.6±0.47 | 16.7±0.25 | 8.1±0.14 |
|                        |                      | Cv       | 5.5    | 9.4    | 5.5    | 6.8    | 7.8    |
|                        |                      | min-max  | 16.6-20.5 | 15.5-22.7 | 34.8-43.3 | 14.6-19.1 | 7.0-9.2 |
|                        | Scanblack (NN, Nn)   | M±m      | 18.5±0.19 | 21.9±0.21 | 35.4±0.40 | 16.0±0.24 | 8.2±0.10 |
|                        |                      | Cv       | 4.6    | 4.2    | 5.0    | 6.9    | 5.6    |
|                        |                      | min-max  | 16.4-19.5 | 20.0-23.9 | 31.4-38.0 | 13.5-18.4 | 7.2-9.1 |

Reliability of differences between groups by student criteriona

| p 2-8 | 0.0001 | 0.0106 | 0.0000 | 0.0009 |
| p 4-8 | 0.0033 | 0.0300 | 0.0000 | 0.0000 |
| p 3-8 | 0.0068 | 0.0001 | 0.0006 | 0.0001 |
| p 6-8 | 0.0011 | 0.0024 | 0.0000 | 0.0027 |
| p 1-8 | 0.0000 | 0.0036 | 0.0000 | 0.0000 |
| p 7-8 | 0.0000 | 0.0005 | 0.0010 | 0.0000 |
| p 5-8 | 0.0000 | 0.0010 | 0.0000 | 0.0010 |
| p 2-3 | 0.0027 | 0.0181 | 0.0000 | 0.0000 |
| p 4-5 | 0.0310 | 0.0001 | 0.0226 | 0.0001 |
| p 3-5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| p 6-5 | 0.0209 | 0.0000 | 0.0070 | 0.0000 |
| p 1-5 | 0.0175 | 0.0175 | 0.0401 | 0.0000 |
| p 1-7 | 0.0004 | 0.0295 | 0.0000 | 0.0000 |
| p 4-7 | 0.0221 | 0.0000 | 0.0081 | 0.0011 |
| p 3-7 | 0.0127 | 0.0000 | 0.0026 | 0.0000 |
| p 6-7 | 0.0000 | 0.0000 | 0.0401 | 0.0000 |
| p 1-7 | 0.0004 | 0.0479 | 0.0000 | 0.0010 |
| p 4-1 | 0.0215 | 0.0000 | 0.0027 | 0.0002 |
| p 3-1 | 0.0169 | 0.0000 | 0.0004 | 0.0004 |
| p 6-1 | 0.0414 | 0.0000 | 0.0414 | 0.0000 |
| p 2-6 | 0.0000 | 0.0000 | 0.0329 | 0.0000 |
| p 3-6 | 0.0081 | 0.0000 | 0.0000 | 0.0000 |
| p 2-3 | 0.0001 | 0.0007 | 0.0000 | 0.0000 |
| p 2-4 | 0.0005 | 0.0000 | 0.0000 | 0.0000 |

aOnly significant differences are indicated with p<0.05.

It should be noted that sapphire minks (a/a p/p), having the lowest average weight, have a good body length of 45.7 ± 0.58 cm, although it is significantly less than the best breeds in terms of this indicator.
The variability of the indicator, both the total body length and the axial skeleton, is low and indicates a high consolidation of these indicators in male minks, regardless of genotype. An analysis of the length of the chest clot on average reaches from 35.4 ± 0.40% in scanblack (NN, Nn) to 38.9 ± 0.59% in male sapphire (a/a p/p), respectively. The second largest is the cervical region, but it is much shorter than the chest. Slightly different in length from the cervical, the lumbar region has measurements from 7.1 ± 0.13 cm for headlund (hh) to 7.7 ± 0.19 cm for sapphire (a/a p/p), between most breeds there are no reliable differences, this fact is even more indicative when comparing the relative sizes of the departments of the skeleton (table 2), a significant difference is observed only between the maximum and minimum indicators.

On the whole, the analysis of the relative lengths of the different parts of the axial skeleton suggests that the length of the chest clot on average reaches from 35.4 ± 0.40% in scanblack (NN, Nn) to 38.9 ± 0.59% in male sapphire (a/a p/p), while the maximum of this department can be 45.0% for sapphire (a/a p/p), and at least 31.4% for scanblack (NN, Nn). The cervical region is in second place in relative magnitude, which makes up about 20% in all breeds, and is significantly higher than in others for palomino minks (kk). A skull length of about 17% also has a significant effect on the overall body length. The relative length of the lumbar region, as well as the absolute length in male minks, does not have a significant difference except for albino pastel (cc bb) and headlund (hh). The sacral size has the smallest absolute and relative size while having significant differences between the breeds.

For a better understanding of the mutual influence of the studied parameters, the correlation coefficients of morphometric indicators in male minks were calculated. In males, pastel (bb) and headlund (hh) dependence of body weight without skin is at a weak and moderate level on the total body length and axial skeleton departments. At the same time, in other genotypes, the dependence of mass on the total body length is high, despite this, certain parts of the axial skeleton have a lesser effect (table 3).

| Indicators | Breed             | Total body length | Skull length | Spine parts |
|------------|-------------------|-------------------|--------------|-------------|
|            |                   |                   | cervical     | thoracic    | lumbar      | sacral      |
| CMWS ♂     | Silver-blue (p/p) | 0.8               | 0.3          | 0.2         | 0.7         | 0.3         | 0.5         |
|            | Sapphire (a/a p/p)| 0.7               | 0.4          | 0.4         | 0.5         | 0.2         | 0.4         |
|            | Pearl (kk pp)     | 0.8               | 0.6          | 0.6         | 0.7         | 0.1         | 0.5         |
|            | Palomino (kk)     | 0.8               | 0.4          | 0.5         | 0.1         | 0.5         | 0.2         |
|            | Pastel (bb)       | 0.3               | -0.2         | 0.0         | 0.3         | 0.4         | 0.5         |
|            | Albino pastel (cc bb) | 0.7          | 0.6          | 0.0         | 0.4         | 0.4         | 0.5         |
|            | Headlund (hh)     | 0.4               | 0.4          | 0.2         | 0.1         | 0.5         | -0.1        |
|            | Scanblack (NN, Nn)| 0.8               | 0.3          | 0.4         | 0.7         | 0.4         | 0.3         |
|            | Silver-blue (p/p) | -                 | 0.6          | 0.4         | 0.7         | 0.5         | 0.3         |
|            | Sapphire (a/a p/p)| -                 | 0.5          | 0.5         | 0.7         | 0.5         | 0.5         |
|            | Pearl (kk pp)     | -                 | 0.6          | 0.8         | 0.9         | 0.0         | 0.6         |
|            | Palomino (kk)     | -                 | 0.5          | 0.6         | 0.4         | 0.4         | 0.2         |
|            | Pastel (bb)       | -                 | 0.3          | 0.6         | 0.8         | 0.6         | 0.5         |
|            | Albino pastel (cc bb) | -              | 0.8          | 0.2         | 0.6         | 0.6         | 0.4         |
|            | Headlund (hh)     | -                 | 0.5          | 0.7         | 0.4         | 0.5         | 0.4         |
|            | Scanblack (NN, Nn)| -                 | 0.6          | 0.7         | 0.7         | 0.4         | 0.5         |

Table 3. Correlation coefficients of morphometric indicators in male minks.
The total body length shows a different correlation with the departments of the axial skeleton. Regardless of the genotype, the thoracic region has a noticeable and very high effect on the total length, which, apparently, is associated with the large relative size of this part.

Table 4. Morphometric indicators of FEMALE mink of different genotypes.

| Group        | Breeds        | Indicator | CMWS, gr | The length of the axial skeleton parts, cm |
|--------------|---------------|-----------|----------|-------------------------------------------|
|              |               |           |          | BL  | SL  | CL  | TL  | LL  | SL  |
| 1            | Silver-blue (p/p) | M±m       | 970.8±20.52 | 38.9±0.27 | 7.3±0.08 | 8.4±0.12 | 14.0±0.13 | 6.5±0.10 | 2.6±0.04 |
|              |               | Cv        | 9.5       | 3.2  | 4.9  | 6.5  | 4.1  | 6.7  | 6.8  |
|              |               | min-max   | 834.0±118.70 | 37.0±4.15 | 6.5±7.9 | 7.7±9.5 | 12.6±15.2 | 5.8±7.4 | 2.4±3.0 |
|              |               | M±m       | 822.8±19.52 | 40.0±0.31 | 6.6±0.06 | 8.0±0.15 | 15.7±0.16 | 6.6±0.09 | 3.1±0.06 |
| 2            | Sapphire (a/a p/p) | Cv        | 10.6      | 3.5  | 4.2  | 8.3  | 4.4  | 5.8  | 8.0  |
|              |               | min-max   | 702.0±1084.0 | 38.0±43.7 | 6.4±7.5 | 6.6±9.2 | 14.4±16.9 | 6.0±7.0 | 2.5±3.5 |
|              |               | M±m       | 787.3±23.50 | 39.6±0.30 | 7.0±0.07 | 8.0±0.10 | 15.0±0.18 | 6.7±0.06 | 3.0±0.07 |
| 3            | Pearl (kk pp)  | Cv        | 13.3      | 5.9  | 4.5  | 5.5  | 4.3  | 10.00 |
|              |               | min-max   | 620.0±965.0 | 37.7±42.4 | 6.5±7.5 | 6.8±9.0 | 13.6±16.3 | 6.1±7.3 | 2.3±3.5 |
|              |               | M±m       | 832.2±26.14 | 39.8±0.31 | 6.8±0.07 | 7.9±0.12 | 15.4±0.19 | 6.7±0.10 | 2.9±0.07 |
| 4            | Palomino (kk)  | Cv        | 14.0      | 3.5  | 4.9  | 6.9  | 5.4  | 6.9  | 11.3 |
|              |               | min-max   | 575.0±1003.0 | 37.3±42.5 | 6.0±7.5 | 7.0±9.2 | 14.0±17.0 | 6.0±8.0 | 2.5±3.5 |
| 5            | Pastel (bb)    | M±m       | 879.8±19.30 | 40.4±0.38 | 7.9±0.22 | 7.7±0.14 | 14.9±0.17 | 6.6±0.11 | 3.2±0.04 |
|              |               | Cv        | 10.1      | 4.3  | 12.7 | 8.1  | 5.1  | 7.3  | 6.4  |
|              |               | min-max   | 691.0±1012.0 | 38.0±46.0 | 6.8±12.0 | 6.7±9.2 | 13.4±16.4 | 6.0±7.9 | 2.8±3.5 |
| 6            | Albino pastel (cc bb) | M±m       | 812.5±20.72 | 39.4±0.35 | 7.2±0.08 | 7.9±0.15 | 14.5±0.17 | 6.7±0.13 | 3.1±1.00 |
|              |               | Cv        | 11.4      | 3.9  | 4.7  | 8.7  | 5.3  | 8.5  | 14.0 |
|              |               | min-max   | 675.0±963.0 | 36.0±42.4 | 6.5±7.8 | 6.5±9.6 | 12.8±16.0 | 5.2±7.9 | 2.4±4.3 |
| 7            | Headlund (hh)  | M±m       | 891.3±13.33 | 39.2±0.31 | 7.2±0.06 | 8.3±0.22 | 14.3±0.25 | 6.7±0.11 | 2.7±0.06 |
|              |               | Cv        | 6.7       | 3.6  | 3.9  | 11.8 | 7.7  | 7.3  | 9.7  |
|              |               | min-max   | 779.0±989.0 | 36.5±42.3 | 6.7±7.6 | 7.2±10.1 | 12.3±16.8 | 5.8±7.7 | 2.3±3.3 |
| 8            | Scanblack (NN, Nn) | M±m       | 834.0±21.85 | 39.2±0.23 | 7.4±0.07 | 8.7±0.18 | 13.5±0.23 | 6.6±0.08 | 3.1±0.04 |
|              |               | Cv        | 11.7      | 2.6  | 4.0  | 9.3  | 7.5  | 5.7  | 6.3  |
|              |               | min-max   | 623.0±1050.0 | 37.0±41.0 | 6.7±8.0 | 7.5±10.7 | 10.8±14.5 | 6.0±7.1 | 2.7±3.4 |

Reliability of differences between groups by Student criterion

| p 2-8 | 0.0000 | 0.0117 | 0.0000 |
| p 4-8 | 0.0000 | 0.0023 | 0.0000 |
| p 3-8 | 0.0001 | 0.0021 | 0.0000 |
| p 6-8 | 0.0008 | 0.0036 | 0.0000 |
| p 1-8 | 0.0005 | 0.0485 | 0.0000 |
| p 7-8 | 0.0029 | 0.0366 | 0.0002 |
| p 5-8 | 0.0218 | 0.0016 | 0.0000 |
| p 2-5 | 0.0472 | 0.0000 | 0.0031 |
| p 4-5 | 0.0002 | 0.0187 |
| p 3-5 | 0.0003 | 0.0468 |
| p 6-5 | 0.0150 | 0.0468 |
| p 1-5 | 0.0008 | 0.0005 | 0.0013 |
| p 7-5 | 0.0160 | 0.0312 | 0.0000 |
| p 2-7 | 0.0172 | 0.0000 | 0.0004 |
| p 4-7 | 0.0023 | 0.0000 |
| p 3-7 | 0.0006 | 0.0445 | 0.0057 |
| p 6-7 | 0.0039 | 0.0173 |
| p 1-7 | 0.0005 | 0.0000 |
| p 2-1 | 0.0000 | 0.0285 | 0.0000 | 0.0445 | 0.0000 | 0.0000 |
| p 4-1 | 0.0005 | 0.0369 | 0.0002 | 0.0139 | 0.0000 | 0.0037 |
| p 3-1 | 0.0000 | 0.0121 | 0.0027 | 0.0000 | 0.0000 |
| p 6-1 | 0.0000 | 0.0135 | 0.0003 |
| p 2-6 | 0.0000 | 0.0000 | 0.0000 |
| p 4-6 | 0.0009 | 0.0015 |
| p 3-6 | 0.0137 |
| p 2-3 | 0.0026 | 0.0027 |
| p 4-3 | 0.0000 | 0.0000 |
| p 2-4 | 0.0000 | 0.0000 |

*Only significant differences are indicated with p<0.05.

Analysis of morphometric measurements of females of different genotypes presented in table 4 allowed us to determine that females of different breeds mainly reliably differ from each other by their
body weight, while silver-blue (p/p) – 970.8±20.52 g have the highest average mass, and pearl (kk pp) less than males – 787.3±23.50 g.

**Table 5.** Relative indicators of measurements of the axial skeleton of female minks of various genotypes.

| Group             | Breeds     | Indicator | The relative length of the axial skeleton parts, % |
|-------------------|------------|-----------|--------------------------------------------------|
|                   |            |           | BL     | SL     | CL     | TL     | LL     |
| 1                 | Silver-blue (p/p) | M±m       | 18.8±0.14 | 21.5±0.25 | 36.1±0.27 | 16.8±0.23 | 6.8±0.09 |
|                   |            | Cv        | 3.3     | 5.1     | 3.4     | 6.2     | 5.6     |
|                   |            | min-max   | 17.6-20.0 | 20.0-23.5 | 33.4-38.7 | 15.6-19.4 | 6.1-7.6  |
|                   |            | M±m       | 16.6±0.12 | 19.9±0.29 | 39.3±0.34 | 16.5±0.18 | 7.7±0.11 |
| 2                 | Sapphire (a/a p/p) | M±m       | 15.7±17.9 | 16.5-22.1 | 36.9-42.3 | 15.2-17.9 | 6.3-8.5  |
|                   |            | Cv        | 3.3     | 6.5     | 3.9     | 4.8     | 6.1     |
|                   |            | min-max   | 17.6±0.14 | 20.1±0.25 | 37.8±0.29 | 16.8±0.17 | 7.7±0.15 |
| 3                 | Pearl (kk pp) | M±m       | 16.5-18.8 | 17.0-21.7 | 35.4-39.8 | 15.4-18.5 | 5.9-8.5  |
|                   |            | Cv        | 3.5     | 5.5     | 3.4     | 4.6     | 8.6     |
|                   |            | min-max   | 17.2±0.16 | 19.9±0.22 | 38.5±0.35 | 16.8±0.25 | 7.3±0.18 |
| 4                 | Palomino (kk) | M±m       | 15.5-18.7 | 18.6-21.8 | 35.9-42.5 | 15.0-19.8 | 6.2-9.0  |
|                   |            | Cv        | 4.2     | 5.0     | 4.0     | 6.7     | 10.7    |
| 5                 | Pastel (bb) | M±m       | 19.6±0.41 | 19.1±0.28 | 37.0±0.27 | 16.5±0.25 | 7.9±0.12 |
| 6                 | Albino pastel (cc bb) | M±m       | 16.2-26.1 | 17.2-21.9 | 35.3-39.5 | 14.4-19.0 | 6.5-8.9  |
|                   |            | Cv        | 4.2     | 6.6     | 3.9     | 8.0     | 12.9    |
| 7                 | Headlund (hh) | M±m       | 18.4±0.17 | 20.1±0.30 | 36.7±0.32 | 17.1±0.31 | 7.8±0.22 |
|                   |            | Cv        | 5.0     | 10.0    | 6.7     | 6.4     | 9.6     |
| 8                 | Scanblack (NN, Nn) | M±m       | 19.0±0.13 | 22.1±0.51 | 34.3±0.48 | 16.7±0.18 | 7.8±0.10 |
|                   |            | Cv        | 3.1     | 10.3    | 6.3     | 4.8     | 5.9     |

| Reliability of differences between groups by Student criterion* |
|---------------------------------------------------------------|
| p 2-8             | 0.000000  | 0.00010  | 0.00000  | 0.0436  |
| p 4-8             | 0.000000  | 0.00005  | 0.00000  | 0.0000  |
| p 6-8             | 0.000000  | 0.00021  | 0.00000  | 0.0000  |
| p 8-10            | 0.026500  | 0.00006  | 0.00000  | 0.0000  |
| p 1-8             | 0.000000  | 0.00024  | 0.00000  | 0.0000  |
| p 7-8             | 0.009300  | 0.01390  | 0.00000  | 0.0000  |
| p 5-8             | 0.000000  | 0.00000  | 0.00000  | 0.0000  |
| p 2-5             | 0.000000  | 0.00001  | 0.00000  | 0.0349  |
| p 4-5             | 0.000000  | 0.00002  | 0.00000  | 0.0000  |
| p 3-5             | 0.000100  | 0.00091  | 0.00000  | 0.0000  |
| p 6-5             | 0.025200  | 0.00007  | 0.03950  | 0.0000  |
| p 1-5             | 0.000000  | 0.03950  | 0.00000  | 0.0000  |
| p 7-5             | 0.027400  | 0.00190  | 0.03820  | 0.0004  |
| p 2-7             | 0.000000  | 0.00080  | 0.03770  | 0.0000  |
| p 4-7             | 0.000100  | 0.01470  | 0.00320  | 0.0095  |
| p 3-7             | 0.002400  | 0.00010  | 0.00000  | 0.0000  |
| p 6-7             | 0.021100  | 0.00007  | 0.03950  | 0.0000  |
| p 1-7             | 0.041300  | 0.00000  | 0.00000  | 0.0000  |
| p 2-1             | 0.000000  | 0.00006  | 0.00000  | 0.0000  |
| p 4-1             | 0.000000  | 0.00001  | 0.00000  | 0.0000  |
| p 6-1             | 0.000000  | 0.00008  | 0.00000  | 0.0000  |
| p 2-6             | 0.000000  | 0.00010  | 0.00000  | 0.0000  |
| p 4-6             | 0.000000  | 0.00001  | 0.00000  | 0.0000  |
| p 3-6             | 0.002200  | 0.01380  | 0.00000  | 0.0000  |
| p 2-3             | 0.000000  | 0.00010  | 0.00000  | 0.0000  |
| p 4-3             | 0.000000  | 0.00001  | 0.00000  | 0.0000  |
| p 2-4             | 0.021900  | 0.00000  | 0.00000  | 0.0000  |

*Only significant differences are indicated with p<0.05.
The greatest mass consolidation is observed in the group of female headlund (hh) (Cv=6.7), and palomino (kk) (Cv=14.0) have a high variability of this trait, while the body mass index without skin and subcutaneous fat is in a wide range from 575.0 to 1003.0 grams with an average value of 832.2±26.14 g.

The average indicator of the total body length of females of the silver-blue genotype (p/p) is the smallest and is 38.9±0.27 cm despite the largest body weight. The sapphire (a/a p/p) females have the longest length – 40.0±0.31 cm and pastel (bb) – 40.4±0.38 cm. It should be noted that the total length between the groups generally differs insignificantly.

The variability of the indicator, both the total body length and the axial skeleton, is at a low level and indicates a high consolidation of these indicators, as in males, regardless of genotype. An analysis of the correlation coefficients of morphometric indicators in female minks (Table 6).

| Breed            | Total body length | Skull length | Spine parts |
|------------------|-------------------|--------------|-------------|
|                  |                   |              | cervical    | thoracic   | lumbar   | sacral   |
| CMWS             | Silver-blue (p/p) | 0.8          | 0.6         | 0.5        | 0.5      | 0.3      | 0.5      |
|                  | Sapphire (a/a p/p)| 0.7          | 0.9         | 0.4        | 0.4      | 0.1      | 0.5      |
|                  | Pearl (kk pp)     | 0.8          | 0.4         | 0.1        | 0.8      | 0.3      | 0.4      |
|                  | Palomino (kk)     | 0.6          | 0.0         | 0.5        | 0.5      | 0.5      | -0.1     |
|                  | Pastel (bb)       | 0.7          | 0.2         | 0.5        | 0.8      | 0.2      | 0.1      |
|                  | Albino pastel (cc bb) | 0.8       | 0.5         | 0.5        | 0.6      | 0.4      | 0.1      |
|                  | Headlund (hh)     | 0.7          | 0.0         | 0.2        | 0.3      | 0.7      | 0.1      |
|                  | Scanblack (NN, Nn)| 0.8          | 0.4         | 0.0        | 0.4      | 0.6      | 0.3      |
|                  | Silver-blue (p/p) | -            | 0.8         | 0.6        | 0.6      | 0.4      | 0.5      |
|                  | Sapphire (a/a p/p)| -            | 0.6         | 0.7        | 0.5      | 0.6      | 0.7      |
|                  | Pearl (kk pp)     | -            | 0.6         | 0.4        | 0.8      | 0.3      | 0.6      |
|                  | Palomino (kk)     | -            | 0.5         | 0.7        | 0.7      | 0.3      | 0.3      |
|                  | Pastel (bb)       | -            | 0.7         | 0.5        | 0.8      | 0.3      | 0.1      |
|                  | Albino pastel (cc bb) | -          | 0.5         | 0.7        | 0.7      | 0.3      | 0.4      |
|                  | Headlund (hh)     | -            | 0.1         | 0.6        | 0.5      | 0.5      | 0.1      |
|                  | Scanblack (NN, Nn)| -            | 0.6         | -0.2       | 0.7      | 0.6      | 0.3      |

The axial skeleton parts have different effects on the total body length, but regardless of the genotype, the thoracic part has a noticeable and high effect on this indicator, which, apparently, in males is associated with a large relative size of this part.

4. Conclusion

Summarizing the results, we can draw the following conclusions:

The body weight of both males and females of the studied genotypes mainly has significant differences, while silver-blue (p/p) have the highest average mass – 1621.4±32.59 g ($\bar{x}$) and
970.8±20.52 g (♀), and the smaller sapphire (a/a p/p) in males – 1289.6±33.51 g, and in females pearl (kk pp) – 787.3±23.50 g.

The greatest mass consolidation is observed in the minks of the hedlund genotype (hh) (Cv=7.3♂ and 6.7♀), and the male mallets (NN, Nn) (Cv=20.3) and palomino females have a high variability of this trait. kk) (Cv=14.0).

The total body length of the male genotypes is pearl (kk pp), headlund (hh), and scanblack (NN, Nn) significantly less than in animals of the other groups, and the longest males of the silver-blue (p/p) genotypes are 46.1±0.32 cm, pastel (bb) – 46.5±0.47 cm and albino pastel (cc bb) – 46.5±0.33 cm.

In females, this distribution is not observed, so despite the greatest mass, the total body length of the silver-blue genotype (p / p) is the smallest and is 38.9 ± 0.27 cm. However, in general, the total body length in females of different genotypes is mainly different unreliable.

The length of the various sections of the axial skeleton obeys the general-specific features of the minks, however, it also has interbreed differences, since the most developed thoracic part averages from 35.4±0.40% (15.9±0.25 cm) in males and 34.3±0.48% (13.5±0.23 cm) in females of scanblack (NN, Nn) and up to 38.9±0.59% (17.8±0.36 cm) in males and 39.3±0.34% (15.7±0.16 cm) in females sapphire (a/a p/p), while the maximum in individual individuals it can be 45.0% (♀) in sapphire (a/a p/p), and a minimum of 28.4% (♂) for scanblack (NN, Nn). The relative length of the lumbar, as well as the absolute, regardless of gender, does not have significant differences with the exception of males albinos (cc bb) and headlund (hh).

With the exception of males pastel (bb) and headlund (hh), the dependence of body weight without skin of the animals of all studied genotypes on the total body length is at a high level, while individual parts of the axial skeleton have a significantly smaller effect on body weight, despite the fact that the thoracic part has a noticeable and high effect on the total length, which is apparently due to the large relative size of this part.

The data obtained in the process of work and the revealed patterns can be used both in breeding work with individual breeds of minks, and in interbreeding.

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