Variability of the Generative Function of Bulls of Different Breeds and Their Tolerance in Connection with the Change in the Lunar Phases

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Abstract. It was revealed that the Moon, being in its full phase, affects the quality of the ejaculate of sire bulls; there is an increase in the activity of spermatozoa in the ejaculate of all tested bulls, as a whole and separately for each line. A significant increase in the activity of sperm cells in the ejaculate from 8.4 points in the new moon to the maximum activity of 8.65 points in the full moon was revealed. The highest rate of sperm production was revealed in bulls in the full moon phase up to 6.2 ml of ejaculate, which is 16.1% higher than the smallest volume of ejaculate equal to 5.2 ml obtained in the new moon phase (P <0.001). The average indicator for sire bulls in terms of the concentration of sperm in the ejaculate was the maximum in the full moon phase - 1.18 bln/ml. That significantly exceeded the indicators of sperm concentration in the new moon and last quarter stage by 0.18 and 0.1 bln/ml, respectively, with a fairly high degree of variability of this feature of 31.8 ... 39.4%. The unequal ability to adapt to changing conditions of a space nature in animals of different breeds and lines has been established. The Montvik Chieftain 95679 bulls were less tolerant. The Siling Traijune Rokita sire bulls proved to be more tolerant. Sperm production in bulls of this line was more stable. With age, sires of all lines become more sensitive to the changing lunar phases. The greatest dependence is seen in the bulls of the Simmental breed.

1. Introduction

The research on the influence of various factors on the natural processes occurring in animals is relevant, since the use of animals is always limited by these factors. The main feature that living organisms have is their individuality. In this regard, the structure and behavior of biological groups brings to the fore the task of developing scientific well-grounded methods of population research.

The rapid development and improvement of space, geophysical and biotechnological research in the 1980–1990s radically changed knowledge and understanding of the environment and factors affecting the biosphere [1, 2, 3].

Biological science believes that phenotypic traits form groups conjugated within themselves by multiple correlations, in spite of this, traits groups have a correlation with the environment and are under its control. Characterizing each trait separately from the point of view of population genetic analysis without linking traits with environmental factors leads to a contradiction of views and judgments. Constant adaptation and changes in populations at most loci occur with a change in the frequency of genes and genotypes. It creates variability in trait correlation studies.

Therefore, the regularities of the studied traits in sire bulls, as well as cows, are considered as a single
polygenic system in the aggregate of genotype and environment [4, 5, 6, 7]. This assumption is based on the idea that “the direction of natural selection, and therefore the direction of the evolutionary process, is determined by specific forms of interaction between the organism and the external environment” (Schmalhausen, 1946). Therefore, the problem of the relationship between humans, animals, biosphere, astrophysical factors from the point of view of the scientific and technological revolution and environmental phenomena has become even more urgent.

From a scientific point of view, this problem occupies a special place and arouses an increased interest of scientists to the science which studies the influence of the Sun on the biosphere - heliobiology, as well as to the influence of changes in the lunar phases on the life processes of living organisms studied by selenobiology.

The diencephalons, kidneys, spleen, small intestine, cardiac muscles of the animal, and endocrine glands have the most intensive reaction to the effect of the magnetic field. The functions of the genital organs of animals are also most influenced by the magnetic field. It means that sires are magnetically affected [8].

The proximity of the Moon to the Earth determines its powerful influence on all living things. The influence of the Moon’s on the Earth processes is evident in the gravitational effect on the aquatic ecosystem, which is expressed in the ebb and flow of water bodies. Scientists from various fields, such as physics, biology, medicine, astronomy, are trying to find a scientific basis for the influence of the Moon on biological organisms living on our planet.

A.L. Chizhevsky, carrying out his fundamental research work, developed the concept of heliobiology as a completely new science. Later it developed into a separate, independent direction in biology - selenobiology. Selenobiology, as an independent science, studies the effect of the Moon on the processes taking place in the biosphere and on terrestrial organisms.

The Earth’s magnetic field is a connecting link through which the cosmogeophysical influence is carried out. The Earth’s magnetic field is highly dependent on the Moon, that is, the Moon has a gravitational and light effect on the Earth’s magnetic field.

Scientific novelty is the study of the influence of changes in the lunar phases in connection with a change in the magnetic field and its effect on the organism of sire bulls in the process of ontogenesis. Many studies have recorded variations in the intensity of the geomagnetic field: the first seven days before the new moon, a general decrease in geomagnetic activity was recorded; in the next seven days after the new moon, there is a general increase in the intensity of the geomagnetic field; the frequency of geomagnetic disturbance significantly decreases with a new moon. At present, there are very few studies conducted and described in the research literature on the influence of the lunar phases and their interaction with the animal world, including domestic and farm animals. The existing research requires new approaches and testing, correct explanation and interpretation of the main existing connections. This provides a basis for a new attitude to the available observations of the influence of the Moon and the Sun on the processes of earthly life in general and on individual living organisms in particular [9, 10].

Life processes on the Earth are speed and rhythm. To study the essence of these phenomena means to understand and accept all or many of the laws of the existence of nature, human and animals. This understanding will make it possible to increase the efficiency of regulation of vital processes and, as a consequence, to more fully apply the mechanisms of adaptation of the animal organism [11, 12].

However, today there is already a fairly large amount of material that reliably testifies to the relationship between the motion of the Moon and the course of various biological processes in living organisms.

Biology has been studying lunar biorhythms and their effect on living organisms for a long time. Animals, plants and algae are exposed to the influence of lunar biorhythms. The human body is subject to lunar biorhythms, there is a relationship between the biorhythms of life and the rhythms of the Moon, such as fluctuations in mood, emotionality, performance. Scientists have proposed a hypothesis about the body fluids, their biological ebb and flow, which is caused by the change in the phases of the Moon.

Similar experiments to study the strength, methods and possibilities of the influence of paratypical factors on the productive qualities of animals were carried out in Russia abroad [13,14, 15, 16, 17].
2. Research materials and method
The research on the biological characteristics of the reproductive qualities of sire bulls was carried out in the breeding JSC “Hakasskoye”, according to the research aims and objectives.

The research aim was to study the variability of the generative activity of sire bulls of different lines, depending on the lunar phases and the age of economic use, predetermined by the individual tolerance of animals of different genotypes and their adaptive response to the influence of cosmogeophysical factors.

The research objective was to determine the influence of paratypical factors, the alternation of the phases of the Moon, on the generative function of sire bulls depending on their genotype.

To conduct research on the biological characteristics of the reproductive qualities of sire bulls, data were obtained on the quantitative indicators of ejaculate volume, concentration and motility of sperm in the ejaculate in selected sire bulls. The selection of animals for the study was carried out on the basis of breeding cards and breeding certificates, origin, time of birth (month and year). Uniform affiliation with the father’s line (half-siblings) made it possible to maximally align their biological rhythms and genetic inclinations, which largely determine the functional activity of animals and, in particular, their sexual activity and the ability to generative function.

Information about sperm production was taken from the “Laboratory register of the quality of bull sperm” for the entire period of use (form No. 2-io) only on those days that strictly coincided with the peak of the lunar phases.

Comparative characteristics were carried out for two breeds of sire bulls: Holstein breed - Montvik Chieftain 95679 line - nine bulls, Reflection Sovering 198998 - two bulls, and Siling Trajune Rokita 252803 – three bulls. For the Simmental breed, two bulls in each line, the line Bravo 6802 and Raphael 3111 line, were considered. The semen of eighteen animals was examined. The age of economic use of the studied bulls was the same - three years of age.

From the biological indicators of sperm production of bulls, the quality of sperm was determined by the motility of sperm; the assessment of activity was carried out on a ten-point scale using a microscope with an eye method. The photoelectric calorimeter was used to determine the concentration of spermatozoa; the mass of the resulting ejaculate was determined by weighing and measured in grams, the volume of the ejaculate was recorded in graduated sperm collectors.

As a result of biometric data processing with computer software and specialized programs, the average values of the indicators of ejaculate volume, concentration and motility of spermatozoa, errors of the mean value, and coefficients of variation of these signs by years of use and in the context of lines were obtained.

The main parameters of keeping and feeding sire bulls remain stable over a long period. The diets used for feeding animals throughout the entire period of keeping, as well as during the research period, are balanced in terms of nutrients, energy and vary with the age and intensity of use of the sire bulls. The general level of feeding ensures the breeding condition and the highest nutritional status of the sire bulls thus contributing to the production of good quality semen. The use load for all bulls is even and strictly follows the developed and approved semen collection schedules. Data on the phases of the Moon for the research period were obtained from the “Astronomical calendar”, the reference book established in 2004 by “AstroKA and published annually in the series “Astro Library”.

The research results prove the probability of using the revealed patterns for the effective organization of work with sire bulls for obtaining high-quality sperm.

3. Research results
Analysis of sperm motility in the ejaculate, depending on the lunar phases and on the change in age in bulls of different lines, shows the evidence of the greatest motility of spermatozoa in the new moon, as well as in the average full moon, both for the entire period of use, and in the context of linear belonging. This pattern does not change with age. Sperm activity was also high in the full moon phase at all age periods.

As for the comparative characteristics of sperm activity in bulls of different linearity, it was found
that the bulls of the Montvik Chieftain 98679 line had the maximum sperm motility, which was the
highest on the full moon. On average, over the entire period of economic use of sire bulls of this line,
the difference in sperm change activity varied from 0.4 to 0.6 points, (P <0.001) - table 1. In the last
quarter, sperm activity was minimal. At the same time, it should be noted that in all years of economic
use on a full moon, the volume of ejaculate is maximum. The excess of the ejaculate volume was 1.6 ml
in comparison with the new moon phase at the third confidence threshold. The concentration of sperm
during all the years of use during the full moon phase was maximum. The difference in the number of
sperm in one ejaculate on average for the period of economic use in the full moon phase, in comparison
with the new moon, in bulls of the Montvik Chieftain line was 0.26 bln/ml (P <0.001).

Table 1. The dynamics of sperm productivity of bulls of the Montvik Chieftain line depending on the
lunar phases.

| Years of use | Lunar phases       | Montvik Chieftain line 95679 (n=9) |
|--------------|--------------------|-----------------------------------|
|              | Number of ejaculates | Activity X±m (point) | Volume of ejaculate X±m (ml) | Concentration of sperm X ±m (bln/ml) |
| 1            | new moon           | 34 | 8.2±0.05 | 5.2±0.3 | 0.90±0.05 |
|              | first quarter      | 48 | 8.4±0.03 | 5.6±0.3 | 1.10±0.07 |
|              | full moon          | 43 | 9.1±0.02 | 6.7±0.3 | 1.30±0.08 |
|              | last quarter       | 37 | 8.6±0.04 | 5.3±0.4 | 1.10±0.06 |
| 2            | new moon           | 45 | 8.7±0.02 | 5.4±0.2 | 1.01±0.04 |
|              | first quarter      | 38 | 7.9±0.02 | 5.9±0.3 | 1.07±0.05 |
|              | full moon          | 49 | 8.5±0.02 | 6.8±0.3 | 1.10±0.05 |
|              | last quarter       | 44 | 8.3±0.06 | 5.7±0.3 | 1.05±0.05 |
| 3            | new moon           | 51 | 8.3±0.03 | 4.8±0.2 | 0.90±0.03 |
|              | first quarter      | 42 | 8.3±0.08 | 5.9±0.2 | 1.10±0.08 |
|              | full moon          | 47 | 8.4±0.02 | 6.6±0.4 | 1.20±0.07 |
|              | last quarter       | 53 | 7.8±0.09 | 5.3±0.2 | 1.10±0.05 |
| Entire period of use | new moon           | 130 | 8.4±0.02 | 5.1±0.1 | 0.94±0.02 |
|              | first quarter      | 128 | 8.3±0.10 | 5.8±0.2 | 1.09±0.04 |
|              | full moon          | 139 | 8.8±0.01 | 6.7±0.2 | 1.20±0.04 |
|              | last quarter       | 134 | 8.2±0.04 | 5.4±0.2 | 1.08±0.03 |

In bulls of the Siling Trajune Rokita 252803 line (table 2), there were no significant differences in
sperm motility in the ejaculate; however, over the entire period of use in the full moon phase and in the
first quarter phase, sperm activity was 8.4 points higher. The volume of ejaculate in bulls of this line at
the full moon phase for the entire period of economic use was maximum 5.7 ml, and the difference in
the volume of ejaculate at the full moon and in the last quarter of the moon phase was 0.6 ml, which is
10.5%.

The volume of sperm production in bulls of this line does not increase with age. There were no
significant differences in sperm concentration. Although on average over the entire period of use in the
new and full moon phases, this figure was the best 1.3 bln/ml. It is remarkable that in terms of age, the
concentration of spermatozoa per unit volume in bulls of this line increases. Moreover, in the full moon
phase, it turned out to be maximum and from the first to the third year of use amounted to 0.5 bln/ml.
Table 2. The dynamics of sperm productivity of bulls of the Siling Trajune Rokita line depending on the lunar phases.

| Year of use | Lunar phases | Siling Trajune Rokita line (n=2) |  |
|-------------|--------------|---------------------------------|--|
|             |              | Number of ejaculates | Activity X±m (point) | Volume of ejaculate X±m (ml) | Concentration of sperm X ± m (bln/ml) |
| 1           | new moon     | 3                  | 8.1±0.4               | 4.7±0.3                     | 1.06±0.03                           |
|             | first quarter| 10                 | 8.2±0.3               | 4.9±0.5                     | 1.07±0.14                           |
|             | full moon    | 10                 | 8.4±0.1               | 5.9±0.6                     | 1.10±0.10                           |
|             | last quarter | 10                 | 8.3±0.3               | 5.6±0.5                     | 1.10±0.10                           |
| 2           | new moon     | 18                 | 8.2±0.2               | 5.5±0.4                     | 1.20±0.09                           |
|             | first quarter| 20                 | 8.6±0.1               | 5.5±0.3                     | 1.30±0.10                           |
|             | full moon    | 12                 | 8.5±0.7               | 5.9±0.6                     | 1.13±0.09                           |
|             | last quarter | 0                  | 0                    | -                           | -                                   |
| 3           | new moon     | 14                 | 8.1±0.1               | 5.6±0.6                     | 1.50±0.15                           |
|             | first quarter| 6                  | 8.3±0.2               | 5.7±0.7                     | 1.30±0.15                           |
|             | full moon    | 10                 | 8.4±0.2               | 5.1±0.3                     | 1.60±0.09                           |
|             | last quarter | 6                  | 8.2±0.2               | 4.3±0.3                     | 1.40±0.10                           |
| Entire period of use | new moon     | 35                 | 8.2±0.1               | 5.5±0.3                     | 1.30±0.07                           |
|             | first quarter| 36                 | 8.4±0.09              | 5.4±0.2                     | 1.20±0.07                           |
|             | full moon    | 32                 | 8.4±0.2               | 5.7±0.3                     | 1.30±0.07                           |
|             | last quarter | 16                 | 8.3±0.2               | 5.1±0.4                     | 1.20±0.10                           |

In bulls of the Reflection Sovering 198998 line, sperm activity was similar to the bulls of the previous lines (table 3).

In the full moon phase, the greatest mobility of sperm is observed in all years of use. The activity indicator, for the entire period of economic use of sire bulls of this line, in the full moon phase was 8.4 points (on average), with a significant difference in this indicator in comparison with other lunar phases. In terms of the volume of ejaculate, there is no clear picture. The difference in ejaculate volume between the phases of the moon is insignificant and unreliable.

According to the concentration of spermatozoa in the ejaculate, these bulls had an advantage in the full moon stage, and the difference in comparison with the indicator of sperm concentration in the new moon phase was 14%.

The gene pool of different breeds is predetermined by the presence of different genotypes, which have their peculiarity to manifest themselves in the phenotype and, under appropriate environmental conditions, show the emerging traits characteristic only of this particular breed having the distinctive features unique for this breed.

Bulls of the Raphael line, belonging to the Simmental breed, in the second and third years of productive activity, and also, in this regard, during the entire period of use, had the highest rate of sperm activity in the full moon phase (table 4). However, the difference is significant only in comparison with the first and last quarters.
Table 3. The dynamics of sperm productivity of bulls of the Reflection Sovering line depending on the lunar phases.

| Year of use | Lunar phases | Reflection Sovering 198998 (n=2) | 198998 (n=2) |
|-------------|--------------|----------------------------------|--------------|
|             |              | Number of ejaculates | Activity X±m (point) | Volume of ejaculate X±m (ml) | Concentration of sperm X ± m (bln/ml) |
| 1           | new moon     | 16 | 8.01±0.1 | 4.1±0.4 | 1.00±0.1 |
|             | first quarter | 18 | 7.7±0.4 | 4.6±0.3 | 0.83±0.06 |
|             | full moon    | 18 | 8.3±0.1 | 4.6±0.3 | 0.98±0.08 |
|             | last quarter | 15 | 8.07±0.5 | 4.2±0.3 | 0.95±0.07 |
| 2           | new moon     | 9  | 8.3±0.2 | 6.8±0.9 | 0.88±0.10 |
|             | first quarter | 11 | 8.4±0.2 | 6.0±0.5 | 1.3±0.20 |
|             | full moon    | 12 | 8.4±0.1 | 5.8±0.5 | 1.1±0.10 |
|             | last quarter | 19 | 7.8±0.2 | 6.1±0.4 | 1.2±0.10 |
| 3           | new moon     | 0  | 0       | -       | -         |
|             | first quarter | 0  | 0       | -       | -         |
|             | full moon    | 3  | 8.7±0.3 | 6.0±1.0 | 1.6±0.20 |
|             | last quarter | 0  | 0       | -       | -         |
| Entire period of use | new moon | 25 | 8.1±0.1 | 5.1±0.5 | 0.96±0.09 |
|             | first quarter | 29 | 7.9±0.2 | 5.1±0.3 | 1.01±0.08 |
|             | full moon    | 33 | 8.4±0.09 | 5.2±0.3 | 1.1±0.07 |
|             | last quarter | 34 | 7.9±0.2 | 5.3±0.3 | 1.08±0.08 |

In regards to the data characterizing the volume of sperm production, there was no clear picture. For the entire period of economic use, the bulls of this line had almost the same indicator of the volume of ejaculate, both in the full moon stage and in the other phases of the moon. A similar picture was observed for the concentration of spermatozoa in the new moon and full moon stages (table 4).

Table 4. The dynamics of sperm productivity of bulls of the Raphael line depending on the lunar phases.

| Year of use | Lunar phases | Raphael line 3111 (n=2) | 3111 (n=2) |
|-------------|--------------|-------------------------|-----------|
|             |              | Number of ejaculates | Activity X±m (point) | Volume of ejaculate X±m (ml) | Concentration of sperm X ± m (bln/ml) |
| 1           | new moon     | 5  | 8.6±0.2 | 5.6±1.2 | 0.7±0.10 |
|             | first quarter | 7  | 7.9±0.7 | 5.0±0.6 | 0.7±0.08 |
|             | full moon    | 3  | 8.3±0.3 | 5.3±1.2 | 0.7±0.10 |
|             | last quarter | 11 | 8.0±0.5 | 4.9±0.6 | 0.8±0.10 |
| 2           | new moon     | 12 | 8.6±0.15 | 6.0±0.4 | 1.2±0.10 |
|             | first quarter | 8  | 8.6±0.18 | 6.3±0.9 | 1.0±0.10 |
|             | full moon    | 6  | 8.7±0.21 | 6.2±0.9 | 1.2±0.20 |
|             | last quarter | 10 | 8.4±0.03 | 6.5±0.6 | 1.1±0.20 |
| 3           | new moon     | 9  | 8.7±0.17 | 5.4±0.7 | 1.1±0.08 |
Bulls of the Bravo 6802 line in the full moon phase had a fairly high rate of sperm activity in all years of generative activity (table 5). Although for the entire period of use, the average indicator in the full moon stage was the highest - 5.7 ml, however, in the new moon phase and the last quarter, significant fluctuations in the magnitude of sperm activity were traced. And also, unlike bulls of other lines, the volume of ejaculate in the age aspect remains rather unstable. The fluctuation in this indicator is from 4.6 to 7.2 ml in the second year of use and from 4.2 to 6.0 ml in the third year of their activity in different lunar phases. This indicates their low tolerance to changing conditions and should be considered as an undesirable phenomenon that disturbs the stability of the production process.

Table 5. The dynamics of sperm productivity of bulls of the Bravo line depending on the lunar phases.

| Year of use | Lunar phases  | Bravo line 6802 (n=2) |  |
|-------------|---------------|------------------------|--|
|             |               | Number of ejaculates   | Activity X±m (point) | Volume of ejaculate X±m (ml) | Concentration of sperm X±m (bln/ml) |
| 1           | new moon      | 12                     | 8.3±0.3             | 5.4±0.5                      | 0.95±0.10                        |
|             | first quarter | 11                     | 8.3±0.1             | 4.6±0.4                      | 0.9±0.09                         |
|             | full moon     | 7                      | 8.6±0.2             | 5.3±0.5                      | 0.97±0.20                        |
|             | last quarter  | 0                      | 0                    | -                            | -                               |
| 2           | new moon      | 7                      | 8.4±0.2             | 5.1±0.1                      | 1.1±0.20                         |
|             | first quarter | 6                      | 8.2±0.16            | 7.2±0.9                      | 0.9±0.10                         |
|             | full moon     | 3                      | 8.0±0.0             | 7.0±0.0                      | 1.1±0.30                         |
|             | last quarter  | 8                      | 7.5±0.8             | 4.6±0.6                      | 1.1±0.20                         |
| 3           | new moon      | 5                      | 8.2±0.2             | 4.2±0.8                      | 0.86±0.80                        |
|             | first quarter | 12                     | 8.4±0.26            | 5.3±0.6                      | 1.4±0.20                         |
|             | full moon     | 14                     | 8.4±0.2             | 5.6±0.3                      | 0.86±0.08                        |
|             | last quarter  | 6                      | 8.2±0.2             | 6.0±0.8                      | 1.0±0.20                         |
| Entire period of use | new moon | 24                     | 8.3±0.2             | 5.1±0.3                      | 0.9±0.08                         |
|             | first quarter | 29                     | 8.3±0.1             | 5.4±0.4                      | 1.1±0.08                         |
|             | full moon     | 24                     | 8.4±0.15            | 5.7±0.2                      | 0.93±0.08                        |
|             | last quarter  | 14                     | 7.8±0.5             | 5.2±0.5                      | 1.1±0.10                         |

Analysis of the research on bulls of all lines according to average data shows that the activity of sperm in the full moon stage was the highest for all years of economic use. The difference ranged from...
0.25 to 0.55 points, relative to adjacent phases, when the revealed difference was highly reliable (P <0.001). During this phase, sperm activity was more constant (table 6).

Table 6. Average indicators of the generative activity of bulls depending on the lunar phases and their variability with age.

| Year of use | Lunar phases       | A group of bulls, n =18 |   |
|-------------|-------------------|-------------------------|---|
|             | Number of ejaculates | Activity X±m (point) | Volume of ejaculate X±m (ml) | Concentration of sperm X ± m (bln/ml) | Variability (CV,%) activity | Variability (CV,%) volume of ejaculate | Concentration of sperm |
| 1           | new moon          | 70                      | 8.2±0.06                  | 4.9±0.2                       | 0.92±0.04                    | 6.4                      | 34.1                      | 34.8                   |
|             | first quarter     | 94                      | 8.2±0.08                  | 5.2±0.2                       | 0.99±0.04                    | 9.5                      | 31.3                      | 36.7                   |
|             | full moon         | 81                      | 8.8±0.04                  | 5.9±0.2                       | 1.20±0.05                    | 3.7                      | 30.8                      | 36.3                   |
|             | last quarter      | 73                      | 8.4±0.10                  | 5.1±0.2                       | 1.02±0.05                    | 10.4                     | 26.4                      | 37.9                   |
| 2           | new moon          | 91                      | 8.5±0.04                  | 5.6±0.2                       | 1.07±0.04                    | 4.8                      | 29.2                      | 32.2                   |
|             | first quarter     | 83                      | 8.2±0.03                  | 5.9±0.2                       | 1.14±0.04                    | 3.8                      | 32.1                      | 34.5                   |
|             | full moon         | 82                      | 8.7±0.04                  | 6.5±0.2                       | 1.11±0.04                    | 6.4                      | 31.8                      | 34.3                   |
|             | last quarter      | 81                      | 8.1±0.09                  | 5.8±0.2                       | 1.09±0.05                    | 9.9                      | 32.7                      | 39.2                   |
| 3           | new moon          | 79                      | 8.3±0.04                  | 4.9±0.2                       | 1.03±0.03                    | 3.7                      | 33.3                      | 25.6                   |
|             | first quarter     | 63                      | 8.3±0.08                  | 5.8±0.2                       | 1.18±0.06                    | 7.2                      | 38.1                      | 37.8                   |
|             | full moon         | 77                      | 8.4±0.04                  | 6.2±0.2                       | 1.20±0.05                    | 4.1                      | 30.4                      | 36.1                   |
|             | last quarter      | 74                      | 7.9±0.08                  | 5.4±0.2                       | 1.12±0.05                    | 8.8                      | 30.9                      | 34.2                   |
| Entire period of use | new moon | 240                    | 8.4±0.03                  | 5.2±0.1                       | 1.00±0.02                    | 4.9                      | 32.9                      | 31.8                   |
|             | first quarter     | 240                    | 8.2±0.04                  | 5.6±0.1                       | 1.10±0.03                    | 7.1                      | 31.6                      | 38.8                   |
|             | full moon         | 240                    | 8.65±0.03                 | 6.2±0.1                       | 1.18±0.03                    | 4.9                      | 31.8                      | 36.6                   |
|             | last quarter      | 228                    | 8.1±0.05                  | 5.4±0.1                       | 1.08±0.03                    | 9.9                      | 34.8                      | 39.4                   |

The indicator of sperm activity on average for bulls of all lines was 8.4 points on the new moon and 8.65 points on the full moon.

The indicator of sperm motility in the full moon phase was also higher compared to the phase of the first quarter of the moon by 0.45 points (P <0.001).
There is an increase in the volume of ejaculate from 5.2 ml on the new moon to 6.2 ml on the full moon (P <0.001). The sire bulls in the full moon stage had an average sperm volume of 9.7% more than in the first quarter of the moon. The difference in the full moon and in the first quarter of the moon was 0.6 ml throughout the entire period of use, which is reliable at P <0.001. Similar indicators were noted for the volume of ejaculate received in the full moon phase, in comparison with the volume of ejaculate received in the last quarter of the moon, the volume of ejaculate increased by 0.8 ml or 12.9%, P <0.001.

In regards to the volume of ejaculate, comparative assessment of bulls of different lines showed that the bulls of the Montvik Chieftain 95679 line had the highest volume (6.7 ml) on average for the entire period of economic use. Bulls of the Siling Trajune Rokita 252803 line produced the least volume of sperm (5.2 ml). The maximum increase in ejaculate volume with age was also noted in sire bulls of the Montvik Chieftain 95679 line and it was 1.6 ml, with P <0.001. Consequently, geomagnetic changes caused by a change in the phases of the moon demonstrate a different, uneven, effect on the quantitative indicators of reproductive function in bulls of different genotypes.

The variability of ejaculate volume remains significantly high in all lunar phases, not dropping below 26.4%. This indicates a strong influence of paratypical factors on this sign.

But across the entire group of bulls, there is a tendency for the greatest variation in the ejaculate volume indicator in the new moon and the last quarter, 32.9% and 34.8% respectively. During the full moon and the first quarter, the greatest stability in terms of ejaculate volume was observed.

It is known that spermatogenesis is, first of all, the life cycle of a specific cell population, which is closely interconnected with environmental processes. This fact is proved by the process of sperm formation, which determines such sign as the concentration of sperm in the ejaculate. If the indicator of ejaculate volume is largely associated with the function of the accessory gonads, then the value of the concentration of sperm in the ejaculate is a pronounced function of the testes, showing the intensity of their action.

Depending on the change in the lunar phases, in regards to the age, bulls of different lines show certain pattern of changes in the sperm concentration in the ejaculate. It is manifested both during the period of intensive economic use and in the context of the considered lines. The given research allows asserting that a significant quantitative increase in sperm in the resulting ejaculate is noted in the full moon phase. At the same time, it was revealed that with age there is an increase in the number of sperm in bulls of all lines, except for bulls of the Bravo 6802 line.

The research showed that, on average, the maximum amount of sperm in the ejaculate of sire bulls during the full moon phase was 1.18 bln/ml. That significantly exceeded the indicators of sperm concentration in the stage of the new moon and the last quarter by 0.18 and 0.1 bln/ml, respectively.

This clearly indicates a change in the functional activity of the testes, depending on the change in the lunar phases. Evidently, in the full moon phase, generative activity is activated in bulls of different lines and ages, and the function of the gonads increases. Strengthening the activity of the gonads function in sire bulls leads to an increase in the volume of ejaculate and, as a result, the concentration of sperm in the ejaculate increases.

4. Summing up
An increase in the activity of sperm cells in the ejaculate on average for the group of bulls and in the section of lines has been proved. The volume of ejaculate and the concentration of sperm in the ejaculate in the full moon phase reach and maintain maximum values. The noted tendency remains stable, persists in all age periods and does not depend on the breed and lineage. Considering these processes in different lunar phases, it is clear that the full moon period has the greatest effect on generative activity in comparison with the new moon and other phases. This was especially evident in the bulls of the Montvik Chieftain line. The influence of the phases of the moon on sperm production remains stably constant at different age periods of producers with any genotype.

Bulls of different linearity have unequal tolerance to the change in the lunar phases. The most reactive were the bulls of Montvik Chieftain line; whereas the bulls of Siling Trajune Rokita line turned out to be more tolerant. Their sperm production was more stable during all lunar phases. This situation allows
adjusting the volume and intensity of the load in the process of vital activity, as well as streamlining and stabilizing the frequency of use of bulls for sperm production.

Probably, the unequal ability to adapt to the environment under conditions of instability and changes in the cosmogeophysical nature is explained by the fact that as the period of productive use increases, sire bulls of all lines show a greater sensitivity to geomagnetic activity. Specifically, in the sire bulls of the Simmental lines, this is most clearly expressed. Obviously, in the process of ontogenesis, adaptive functions are disturbed; the degree of their reaction to constantly changing conditions associated with a change in the phases of the moon decreases.

On the basis of the above, another side of this assumption arises. Spermatogenesis is considered as the main limiting factor in the development of evolution. Evolving, all types of animals were constantly changing and adapting to external conditions, but, nevertheless, the degree of tolerance is not the same. For them to exist for a long time, spermatogenesis must always be a reliable and stable process.

5. Conclusion

1. In the group of bulls analyzed, a significant increase in the activity of sperm in the ejaculate from 8.4 points in the new moon to the maximum activity of 8.65 points in the full moon was revealed. On the full moon, sperm activity is higher, compared with the first quarter, by 0.45 points (P <0.001) and in comparison with the last quarter by 0.55 points (P <0.001).

2. The highest rate of sperm production was revealed in bulls in the full moon phase up to 6.2 ml of ejaculate, which is 16.1% higher than the smallest volume of ejaculate equal to 5.2 ml obtained in the new moon phase (P <0.001).

3. The average indicator for sire bulls in terms of the sperm concentration in the ejaculate was the maximum in the full moon phase - 1.18 bln/ml. That significantly exceeded the indicators of sperm concentration in the stage of the new moon and the last quarter by 0.18 and 0.1 bln/ml, respectively, with a fairly high degree of variability of this feature of 31.8 ... 39.4%.

4. The influence of the lunar phases on the generative abilities of bulls was established, both in the context of different lines and in the age aspect. Bulls of the Montvik Chieftain 95679 line had a lower tolerance. Sire bulls of the Siling Trajune Rokita line were more tolerant, their sperm production was more stable. In all lunar phases, they had the greatest stability.

References

[1] Komarovskih, K F and Komarovskih N I 2019 On cosmophysical effects on water and all life on the planet Innovative Science 3 9–16
[2] Afanasjev V A, Simonov G A, Maklakhov A V and Zoteiev V S 2019 Cosmophysical activity and productivity of animals Agriculture in the Mountains 3 125–128 DOI: 10.25691/GSH.2019.3.026
[3] Shestakov V M, Yermoshina E V and Cheremukha E G 2020 Correlation dependence of gametogenesis of sire bulls on heliophysical factors Dairy Farming Bulletin 3 (39) 109–120
[4] Anbaza, Yu V 2018 Factors affecting the qualitative and quantitative indicators of native sperm production of bulls of JSC “Krasnoyarskagroplem” Bulletin of KrasSAU 2 (137) 286–293
[5] Abilov A I, Amerkanov H A, Korneyenko-Zhilyayev Yu A et al 2017 Qualitative and quantitative indicators of semen from sire bulls, depending on atmospheric pressure on the day of taking ejaculates Agricultural Biology Vol. 52 2 314–322 DOI: 10.15389/agrobiology.2017.2.314rus
[6] Murphy E M, Kelly A K, O’Meara C, Eivers B, Lonergan P and Fair S 2018 Influence of bull age, ejaculate number, and season of collection on semen production and sperm motility parameters in Holstein Friesian bulls in a commercial artificial insemination centre Journal of Animal Science Vol. 96 2408–2418 DOI: 10.1093/jas/sky130
[7] Sabés-Alsina M, Lundéheim N, Johansson A, López-Béjar M and Morrell M J 2019 Relationships between climate and sperm quality in dairy bull semen: A retrospective analysis Journal of Dairy Science Vol. 102 6 5623–5633 DOI:10.3168/jds.2018-15837
[8] Rahman B M, Schellander K, Llamas N and Van Soom A 2018 Heat stress responses in spermatozoa: Mechanisms and consequences for cattle fertility Theriogenology Vol. 113 102–112 DOI: 10.1016/j.theriogenology.2018.02.012

[9] Afanasjev V A, Nikishov A A, Belov A V and Kostitsina E A 2017 A new direction of scientific research on the study of animal productivity in connection with different cosmo-physical activity Bulletin of the Peoples Friendship University of Russia Series: Agronomy and Livestock Breeding Vol. 12 3 253–260 DOI: 10.22363/2312-797X-2017-12-3-253-260

[10] Afanasjev V A, Simonov G A, Maklakhov A V and Zoteyev V S 2019 Synchronicity of milk yield of cows and chemical composition of milk at different cosmo-physical activity Agriculture in the Mountains 4 108–111 DOI: 10.25691/GSH.2019.4.017

[11] Fuerst-Waltl B, Schwarzenbacher H, Perner C and Sölkner J 2006 Effects of age and environmental factors on semen production and semen quality of Austrian Simmental bulls Animal Reproduction Science 95 27–37

[12] Shitikov A Yu 2005 Productivity of black-and-white cows at different levels of cosmophysical activity: specialty 06.02.04 “Veterinary surgery”: dissertation for the degree of candidate of agricultural sciences (Moscow) p 200

[13] Staub C and Johnson L 2018 Review: Spermatogenesis in the bull Animal Vol. 12 27–35 DOI: 10.1017/S1751731118000435

[14] Fedoseyeva N A, Sanova Z S, Myshkina M S et al 2019 Animals Breeding Efficiency According to the Phenotype of their Offspring International Journal of Innovative Technology and Exploring Engineering Vol. 8 9 S3 1501–1510 DOI: 10.35940/ijitee.I3314.0789S319

[15] Garcia-Vazquez F, Gadea J, Matas C and Holt W 2016 Importance of sperm morphology during sperm transport and fertilization in mammals Asian Journal of Andrology Vol. 18 844–850 DOI: 10.4103/1008-682X.186880

[16] Yeste M, Codony F, Estrada E, Lleonart M, Balasch S, Pena A and Rodriguez-Gil J E 2016 Specific LED-based red light photo-stimulation procedures improve overall sperm function and reproductive performance of boar ejaculates Scientific Reports Vol. 6 DOI: 10.1038/srep22569

[17] Emelyanov E G and Botvinova S L 2020 Assessment of the use of genetic resources of the black-and-white breed in dairy cattle breeding in the Novgorod region. IOP Conference Series: Earth and Environmental Science 012032 DOI: 10.1088/1755-1315/613/1/012032