KnE Life Sciences

DonAgro
International research conference on Challenges and Advances in Farming, Food Manufacturing, Agricultural Research and Education
Volume 2021

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Conference Paper

Physiological Features of the Reproductive System of Female Nutria

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Abstract

This article provides information about a promising alternative field of animal husbandry – nutria breeding. This involves the production of fur and high-quality meat products, which contain a large amount of nitrogenous extractives and muscle hemoglobin. This study examined the sexual system of female nutria, and the dynamics, duration and features of each stage of the female nutria's sexual cycle, including estrus, sexual arousal, hunting, braking and phase balancing. The methods of observation, clinical examination, research of smears and fingerprints, and analysis of the cytogram of the vaginal epithelium at different stages of sexual and physiological maturity of female nutria were used. When analyzing the cytogram of the vaginal epithelium, the structure, color, and percentage of basal, parabasal, superficial, and keratinized cells were indicated. Information about the timing of sexual and physiological maturity, their features, processes and signs of manifestation, and different timing of sexual and physiological maturity in summer and winter is provided.

Keywords: nutria, female, puberty, physiological maturity.

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Published: 5 April 2021

Publishing services provided by Knowledge E

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Selection and Peer-review under the responsibility of the DonAgro Conference Committee.

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1. Introduction

In the modern world, for the uninterrupted supply of the population with full-fledged meat products, taking into account the existing biological, economic and social risks, it is necessary to improve the system of alternative livestock production. In this regard, it is worth paying attention to the non-traditional for Russia livestock industry— nutria farming. From nutria, high-quality meat is obtained, which in terms of nutrition and dietary properties is not inferior to rabbit and poultry meat.

Nutri breeding specializes not only in the production of high-quality meat products, but also contributes to the expansion of the fur assortment. A feature of the nutria fur

is the strength of the outer hair, the silkiness of the fluff, its lightness and high heat-shielding properties. The quality of the nutria fur is not inferior to that of the silver-black fox and blue fox, and is about ten times superior vs. rabbit fur [1].

The development efficiency of the nutria breeding industry of livestock is primarily due to the high reproductive qualities of these animals. Nutria are multiparous animals and are able to breed and produce prolific offspring throughout the year. In female nutria, a combination of two physiological periods is possible: pregnancy and lactation. A female nutria can reproduce from 6 to 10 pups during the year, which in the same year can already participate in breeding. An analysis of the results of using pedigree nutria on farms showed that the potential breeding abilities of these multiparous animals are not fully used [2].

The onset of physiological maturity is a complex process, including the maturation and interaction of not only the gonads, but also absolutely all the neuroendocrine mechanisms that are involved in controlling the secretion of gonadotropins. [3].

It is believed that the onset of puberty is due to a series of interrelated events that contribute to the establishment of a stable relationship between the hypothalamus, pituitary and gonads, which until that time functioned relatively fragmented, and their interdependence and interdependence determine the period of puberty. [4].

Animals for breeding purposes are not used immediately after puberty, but after some time after the first signs of its onset. The period of time from the onset of puberty to the start of insemination of the animal is called physiological maturity [5]. It is known that female nutria reach puberty at the age of 4–5 months, and the period of physiological maturity and the possibility of fertilization occurs at the age of 7–8 months, when the body weight of the females reaches 4–4.5 kg [6].

Physiologically mature individuals differ from their young relatives in the completed process of body formation, the acquisition of an exterior, and a gain of about 70% of the body weight characteristic of the breed and sex of the animal [7]. The physiological maturity of females and males is recorded by age, live body weight and the degree of development of the organs of the reproductive system. As a rule, the age of insemination of nutria is 7–8 months, and with an intensive method of growing young animals, the period of physiological maturity accelerates [8].

An important point before the onset of physiological maturity of females is the need to cause them to regularly manifest sexual cycles, which indicate the good development of their genital organs and guarantee a high level of fertility and fertility. [9].

The sexual cycle is a complex neurohumoral reflex process, which is accompanied by a complex of physiological and morphological changes in the organs of the reproductive

system and throughout the female's body over a period of time from one stage of excitation to another. In this period of time, changes occur in the female's body, which are either subtle or elusive even in modern conditions using the finest microscopic, chemical and biological research methods [10].

The rhythm of the reproductive cycles, that is, their alternation and duration, is characteristic and specific for females of each animal species. On this basis, animals were divided into monocyclic and polycyclic individuals. [eleven].

Nutria are polycyclic animals. They do not have a pronounced seasonality in the process of reproduction. Females come to the excitement every 25-30 days, the duration of the sexual cycle is on average 27.15±7.36 days. [12]. But there are animals, such as goats, sheep, in which several sexual cycles following one after another are observed in a certain period of the year, after which a long stage of balancing sets in [13].

In the sexual cycle, three stages are distinguished.

1. The stage of excitement is characterized by a pronounced manifestation of four basic phenomena, such as estrus, sexual arousal, implying a general reaction of the body, the period of excitement and ovulation.

The estrus is a process in which mucus is excreted from the genitals due to morphological changes in the female's reproductive apparatus. [14]. Against the background of estrus, the process of sexual arousal proceeds, in which the behavior of the female changes. The third phenomenon of the stage of excitation of the sexual cycle— excitement —is manifested against the background of estrus and sexual arousal [15].

1. The stage of inhibition arises after the stage of excitement and is characterized by the weakening and disappearance of sexual signs of sexual arousal, the cessation of excitement and structural restructuring of all departments of the female genital organs.
2. The stage of balancing occurs after the stage of inhibition and is characterized by the relative rest of the animal. This stage lasts after the appearance of a new stage of excitation.

2. Methods and Equipment

2.1. Methods

The timing of the onset of puberty and physiological maturity in female nutria at different times of the year was studied in the following experiment, organized by the same

technique in January and June. In a group of 20 females of similar age and body weight (in January: 3 months, weight 1.2-1.5 kg; in June: 3 months, weight 1.5-1.8 kg) of standard breed, an active seven-month-old sample male subjected to epididymectomy at the age of 5 months, was daily placed for 2 hours. Animals in a clearly visible enclosure were monitored for four months. Especially careful observation was during contact of females with the male. The females were weighed once a month to determine body weight (Fig. 1).

Females with signs of puberty and physiological maturity were examined using a general clinical examination. At the first signs of estrus, the vaginal mucus was taken from female nutria until the end of the stage of excitation and on the 13th day of the sexual cycle, from which smears were imprinted, their fixation was carried out, and Pappenheim-stained. After that, cytograms were calculated based on 100 cells, taking into account basal, superficial, parabasal and keratinized cells. In addition, we studied the morphology of neutrophilic leukocytes with a determination of their number per 100 cells of the cytogram. Also, we paid attention to the nature of the location of the stria of mucus relative to each other.

3. Results

The behavior of the females between morning and evening feedings was calm and balanced. Most of the time they laid near each other, or played by touching each other with their front paws or teeth. Some individuals sorted out hay or bit special wood logs. Before eating, animal behavior was more active. After eating, the animals were dispersing in the corners of the box, sitting in a tight group, calmly awake, or were in a half-drowsy state. They had no reaction to the male placed to them or they strayed in the corner of the cage, exhibiting a protective-aggressive reaction when the male approached.

With some periodicity, individual females looked more active and behaved differently with respect to the sample male. A characteristic feature of their behavior was as follows: the female approached the sample male, sniffed him, mowing the mustache, persistently followed him in the box, sniffed at the urination sites of the male, made characteristic invocative sounds, approached him, then reluctantly bounced, as if flirting, and allowed coitus. The female's positive reaction to the male was regarded as characteristic sexual behavior.

Similar females were subjected to a thorough clinical examination. At the same time, swelling of the labia, redness and abundant hydration with mucus of the mucous membrane of the vestibule were noted. By analogy with other animal species, the described complex of morphological and functional characters was considered a manifestation of the stage of excitation of the sexual cycle.

Thus, females that showed the first signs of estrus, sexual arousal, and excitement, established with the help of an operated male probe, sometimes with the possibility of mounting and coitus, were considered mature. According to the same signs, all subsequent cycles were recorded.

Figure 1: Sexual behavior of the male in relation to the female in the excitement.

After analyzing the results of the study, it was found that the sexual maturity of female nutria in the summer period occurs 13-45 days earlier relative to the winter season with the same body weight or 35% lower (2.6 and 4.0 kg, respectively). On average, sexual maturity in female nutria in the summer period with an averaged lower body weight of 19.8% occurs by 20.2% earlier than in winter. It is important that during the formation of groups for observation, the initial body mass of summer females at the age of three months was 22.8% higher than that of winter females.

The first (basic) sexual cycle in the winter season was on average one day longer. At this time, the duration of the second cycle in the summer period was already stabilized and was equal to subsequent cycles, and in winter females the second and third cycles lasted longer than the fourth cycle, which was more stable and closer in duration to summer females for 3-4 days.

Based on this, it was found that the physiological maturity of rearing female nutrias in the summer period of time, on average, came 44 days earlier, which is 10% than that of females in the winter season. The number of reproductive cycles that have passed from the onset of puberty to the formation of physiological maturity in the summer period was 0.15 less than in individuals in the winter season.

Thus, in the summer, the sexual maturity of the female nutria occurs at the age of 110-122 days with a body weight of 2.6-3.1 kg. Physiological maturity, that is, the age of mating of females, occurs at the age of 182-212 days. In winter, the sexual maturity of a female nutria occurs at the age of 135-155 days with a body weight of 3.0-4.0 kg. Physiological maturity occurs at the age of 224-245 days.

3.1. Sexual cycle and sexual behavior of physiologically mature rearing females

In order to study the dynamics of the formation of the stage of excitation of the sexual cycle and the duration of its individual phenomena, as well as to study the stages of the sexual cycle, we used the same rearing females as in the previous experiment, but at the final stage, when the experimental animals reached physiological maturity.

The estrus onset period was established by daily monitoring of the females at intervals of 4 hours. The start and end of estrus was considered the average time between two checks. Using daily clinical studies of females, general sexual arousal was established every 2 hours.

The excitement period was recorded using the sample male subjected to epididymectomy. At the end of every two hours for 10 minutes, with constant careful observation, the sample male was placed to the female nutrias with signs of estrus and sexual arousal. If in a given period of time the female favored the approach and courtship of the male and allowed the mounting, the excitement was considered established. By the same method, the end of the excitement was determined. The excitement was considered complete when the female ceased the mounting of the male.

Ovulation was studied by slaughtering females 8, 10, 12, 15, 18, 20, 24, 26 hours after coition. The number of copulations was 3–4 with a 10–15-minute interval. 8 and 10 hours after coition in both ovaries, no ovulated follicles were found in the female ovaries.

The duration of the excitation period was set from the beginning of estrus to the end of ovulation, the inhibition stage was determined from the moment ovulation was completed until the signs of estrus disappeared, and the stabilization stage was recorded from the end of estrus to the beginning of the next period of sexual arousal.

When analyzing the cytogram of the vaginal epithelium at the resting stage, cells of the deep layers, called basal cells, were identified (Fig. 2). They have a rounded shape, a large and chromatin-rich nucleus, the cytoplasm is evenly colored in the form of a narrow strip between the nucleus and the cell membrane. Their number is 25.2%. The cells of the middle layers are called parabasal (Fig. 3). They are winged, have an oval

shape, in comparison with basal cells they have a slightly smaller nucleus and a wider stria, also uniformly stained with cytoplasm with outgrowths. Their number was 51.4%. Cells of surface layers that are capable of adsorption are called superficial (Fig. 4). Their number was 22.0%. The keratinized cells of the surface layers are called flakes (Fig. 5). They have no cores and are painted in uneven pink. Their number was 1.4%.

The first signs of the stage of excitation in female nutria are practically not noticeable. But, despite this, a slight increase in locomotor activity and weak anxiety in some female nutria can be distinguished. Some females, on the contrary, tried to retire. An external examination of such females showed a clinical manifestation of the onset of estrus. The onset of estrus in a female was manifested by a weak, barely noticeable edema of the labia, a slight secretion of transparent mucus, as a result of which the vulva becomes moist, but there is no hyperemia of the labia and mucous membrane of the vestibule. These signs appeared on average 2-3 days before the start of the hunt.

When analyzing the cytogram of the vaginal epithelium, it was found that the number of cells of the deep layers (basal) was 12.2%; that of middle layers (parabasal, winged) was 15.8%; for surface layers (superficial) it was 46.4%; the number of keratinized cells of the surface layers (flakes) was 25.6%. One hundred epithelial cells accounted for 3 to 7 segmented neutrophilic leukocytes. The mucus strands were stained pale pink and arranged randomly relative to each other.

The sample male, during this period, also became more active. He sniffed the air around the females, their genitals, persistent courtship of the male was observed, which was manifested by characteristic touches and invocation sounds. The female, to which the male showed persistent interest, behaved uneasily, made characteristic loud noises, but remained inaccessible, showing aggression in response to the courtship of the male.

After 24 hours, along with a slight increase in the edema of the labia, a slight hyperemia of the vestibule was observed. The vulva was moistened, the release of clear mucus to the outside intensified. At the same time, the sample male continued to persistently court the female. This time, the female reacted favorably to the touch of the male, while making loud lingering sounds, however not allowing coitus and running away from him. Such signs were observed approximately 24-30 hours before the start of the excitement.

When analyzing the cytogram of the vaginal epithelium, it was found that the number of basal cells was 6.2%; parabasal, winged cells amounted to 10.0%; superficial cells, to 47.4%; scaly cells, to 36.4%. There were 25-30 segmented neutrophilic leukocytes with uniformly stained cytoplasm and clearly defined nuclei per hundred epithelial cells.

The mucus strands stained a more intense pink color and were arranged more orderly relative to each other.

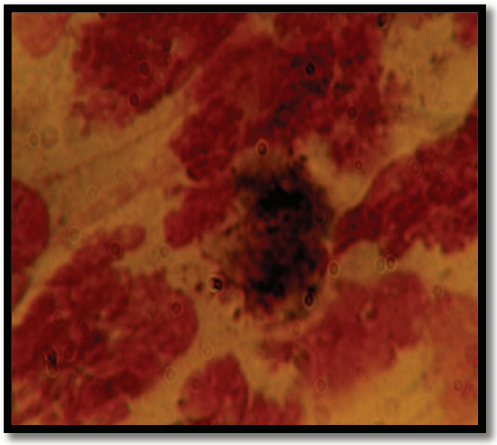

Fig 2. a)

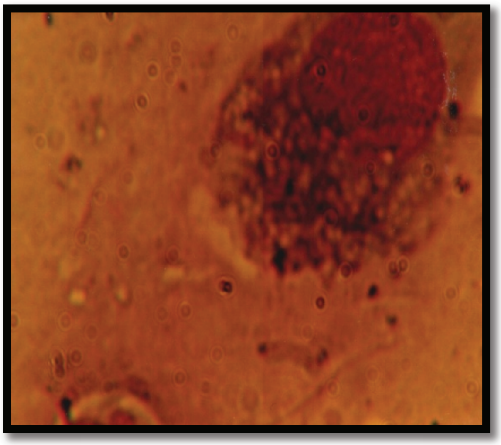

Fig 3. b)

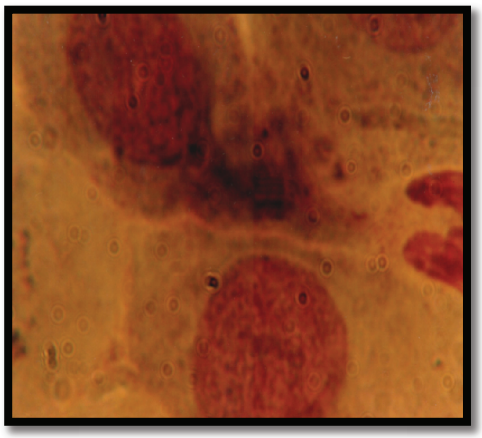

Fig 4. c)

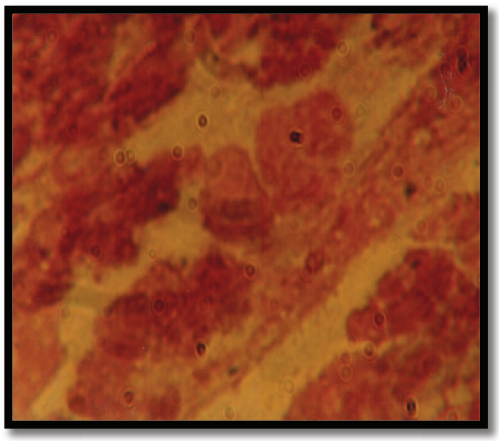

Fig 5. d)

Figure 2: **Microphoto.** Pappenheim stain (10x ocular, 90x objective). Smear-imprint of the vaginal epithelium: a) basal cell among horny scales; b) parabasal cell; c) superficial cells (surface layers with the ability to adsorb); d) nuclear-free cells of desquamated integumentary epithelium (horny scales).

After another day, the female showed marked edema of the vulva, abundant moistening of the transparent, and—in some females, slightly turbid—mucus. A small amount of mucus accumulated in the form of a small mucous cord in the vestibule area. Hyperemia of the mucous membrane of the vestibule of the vagina (pink, in some females of a bright pink color) was noted.

When analyzing the cytogram, the number of basal cells was 2.0%; parabasal cells amounted to 4.4%; superficial cells amounted to 45.2%; flake cells amounted to 48.4%. During this period, 55-60 neutrophilic leukocytes were counted per hundred epithelial

cells. In some of the neutrophilic leukocytes, the nuclei were fragmented and disintegrated; in others, there were inclusions. Mucous striae were painted in an intense pink color and were parallel to each other.

During this period, the female favored the approach and courtship of the sample male. The female allowed to sniff her external genitals; she took her tail aside, taking a characteristic pose, as a result of which she allowed coitus. This was the manifestation of the excitation, which was characterized by readiness for coitus.

When analyzing the cytogram of the vaginal epithelium one day after coitus: the nuclei and cytoplasm of parabasal and superficial cells were vacuolated, colored unevenly and weakly, their borders were not clearly defined; the nuclei of most neutrophilic leukocytes decomposed into lumps, were poorly stained, and there were no basal cells. The mucus in the smear was in the form of a compact mass (individual cords are indistinguishable) and painted in an intense pink color.

12 hours after coitus, it was noted that in the right ovary there was one ovulated follicle (hemorrhagic follicle), in the left, two females had none; 1-3 in the left ovary, 1-2 in the right ovary in the other three females. After 15 hours, ovulated follicles were found in both ovaries of all five killed females: from 3 to 4 follicles in the right one, from 2 to 4 in the left one. Over time, more ovulated follicles were found. After 18 hours from 5 to 7 follicles were in the right ovary and from 4 to 7 in the left one;

After 20 hours, there were from 6 to 8 follicles in the right ovary and from 9 to 11 in the left one. After 24 hours, the number of ovulated follicles reached a maximum: in the right ovary, there were 9-12 follicles, in the left one, there were 11-13 follicles. Females were killed 26 hours after coitus, no more than 12 hemorrhagic corpus lutei were found in the right ovary, and no more than 13 hemorrhagic corpus lutei, in the left. It follows that ovulation in experimental females occurred between 12 and 24 hours after coition.

In females with all signs of estrus and a general sexual reaction, but without coitus, as they were contained in the cage and had no contact with the male, and those killed at the beginning of the balancing stage of the sexual cycle, no corpus lutei were found in both ovaries, which indicates anovulatory cycles against the background of lack of coitus. Thus, these studies confirm that ovulation in female nutria is provocative, that is, it occurs only after coition with the male.

4. Discussion

The implementation of national agricultural political activity implies the formation of modern production technologies based on fundamentally new theoretical research and

scientific and technical solutions that can ensure the active development of various areas of livestock. In recent years, the destructuring of agriculture in the Russian Federation has intensified the formation of branches of alternative livestock farming, especially nutria breeding.

The current state of nutria breeding, especially in the southern regions of the Russian Federation, and the emerging trends towards its subsequent formation suggest good prospects for this sector of animal husbandry. Breeding nutria is a cost-effective and exciting field of activity for people of different ages and specialties. They can be grown on farms of different sizes and forms of ownership, including on small household farms. The latter has important social significance: it increases the employment of the population in villages and small towns and contributes to the self-sufficiency of people with meat and fur products.

Interest in nutraceuticals is increasing year by year, especially in the southern regions of the country. In particular, they are engaged in breeding of this heat-loving animal in the Krasnodar Territory and the Rostov Region, since in these areas the most favorable climate for nutria is. In recent years, there has been a tendency towards the formation of medium-sized and even large nutraceutical farms containing more than 500 females.

However, the widespread introduction of this sphere has its own limiting conditions. Thus, it was found that the basis for the effective formation of each sphere of animal husbandry is the reproduction of the herd. The reproduction of nutria has not been studied enough, as evidenced by isolated reports in the literature.

5. Conclusion

1. A female nutria is a polycyclic animal with a sexual cycle ranging from 24.5±0.40 to 24.6±0.16 days. The stage of excitation varies from 4.6±0.58 to 4.9±0.38 days. The inhibition stage lasts from 1.5±0.17 to 1.6 ± 0.16 days. The stabilization stage lasts from 18.2±0.42 to 18.6±0.37 days. Excitation in females lasts from 18.6±0.37 to 83.8 ± 6.52 hours. Provoked ovulation in females occurs 12-42 hours after coition with a male.

2. In the summer, the sexual maturity of a female nutria occurs at the age of 110-122 days with a body weight of 2.6-3.1 kg. Physiological maturity—the age of mating of females—occurs at the age of 182-212 days. In winter, the sexual maturity of a female nutria occurs at the age of 135-155 days with a body weight of 3.0-4.0 kg. Physiological maturity occurs at the age of 224-245 days.

Funding

This work was supported by the Don State Agrarian University

Acknowledgement

The authors would like to thank their colleagues for their contribution and support to the study. We are also grateful to all the reviewers who made a valuable contribution to the work on the manuscript and helped in its completion.

Conflict of Interest

The authors have no conflict of interest to declare.

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