

Some behavior features of a female *Panthera pardus tulliana* during pregnancy and at first parturitions

MAKHAR M. ERTUEV[✉], UMAR A. SEMENOV^{✉✉}

Sochi National Park, Kurortnyy Prospekt, 74, Sochi 354002, Krasnodarskiy kray, Rusia. [✉]email: mr.ertuev38@gmail.com, hapugin88@yandex.ru; ^{✉✉}umar-semenov@rambler.ru

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Abstract. Ertuev MM, Semenov UA. 2019. Some behavior features of a female *Panthera pardus tulliana* during pregnancy and at first parturitions. *Biodiversitas* 20: 1333-1338. The present paper reports the results of the behavioral study of a female *Panthera pardus tulliana* during pregnancy, and before, during and after parturitions. The study was conducted in the Center of leopard recovery in the Caucasus, located in the mountain zone of the Sochi National Park, Russia. The behavior of *Panthera* was observed using surveillance cameras. During pregnancy, there is a significant shift in the level and ratio of hormones in the female's body. These internal changes can cause reorganization of the brain divisions which participate in the formation of the behavioral reaction, including female's behavior. We have shown that significant changes occur in the manifestation of individual behavior forms along with the increase of the pregnancy age and the intensification of fetal growth: a decrease in the level of anxiety and fear, and an increase in feed intake. At the end of pregnancy, the frequency of sleep and rest periods increases, but they are short-term. Before parturition, a female experiences painful sensations due to increase motor activity of the fetus, accumulation of toxins, possible hypoxia.

Keywords: Anatolian leopard, estrous cycle, hormonal status, maternal behavior, parturition, pregnancy

INTRODUCTION

At various stages of ontogenesis of an animal body, significant changes occur in the level and ratio of hormones. It has a significant effect on their behavioral responses. The greatest changes in the hormonal status are associated with the formation and maturation of the sexual function of animals, the cyclic changes in the reproductive system, as well as with the pregnancy and lactational activity of the mammary gland of females (Munro et al. 1991; Andrews et al. 2019; Naidenko et al. 2019).

In recent years, interest in the problem of the effect of sex hormones on neurons and brain neuroglia has increased. According to Wunder (1973), Rozen (1983), Zadornaya (2012), Babichev (2013), Akhmadeev and Kalimullina (2016), in animals, the increased estrogens secretion precedes the estrous onset. Under the influence of estrogens, the brain eroticization, the awakening and aggravation of the sexual instinct, coordination of sexual behavior of females, the enhancement of her receptive components occur. It has been shown (Babichev 2013; Etgen 2003; Hussain et al. 2011; Tang et al. 2004; Tetel 2009; Toran-Allerand 2005) that sex steroids affect many specific structures of the animal's brain both inside the hypothalamic-pituitary-gonadal system (HPGS) and outside it, modulating behavioral responses therein.

Since the fertilization and implantation of the egg have occurred, there has been a significant shift in the hormonal status in the maternal body of mammals. A complex neurohormonal relationship arises between the maternal organism and the embryo. In particular, together with estrogen, progesterone and its derivatives, produced by

yellow bodies, contribute the implantation of a fertilized egg in the uterus and the formation of the placenta that provides delivery with maternal blood of oxygen, plastic and energy substrates. In addition, the placenta during pregnancy secretes a number of hormones, including growth hormone. The physiological role of progesterone and its derivatives is to maintain and develop pregnancy by suppressing the ovulation process and preventing the contraction of the smooth muscles of the uterus (Verstegen et al. 1993; Adachi et al. 2011; Putnam et al. 2015).

The present paper presents the results of the study of the behavior of a female leopard during pregnancy and first parturition.

MATERIALS AND METHODS

The study has been carried out in the Center of the leopard recovery in the Caucasus, Sochi, Russia, located in the mountain zone of the Sochi National Park at an altitude of about 600 m. The Center covers a total area of 0.12 km² and consists of functional sectors with 12 breeding aviaries (345-412 m²) (Figure 1) and six aviaries for release preparation (about 10000 m²).

Genetic analysis of animals has been carried out during the formation of the Centre of breeding stock. It has determined the taxonomic status of the subspecies that historically inhabited southern Russia. As a result, it was found that the leopard inhabiting the south of Central and Near Asia, including the Caucasus, is characterized by larger size and belong to the same subspecies. In Russia, it was originally described under the name *Panthera pardus*

ciscaucasicus Satunin, 1914 (Persian Leopard). However, the name *Panthera pardus saxicolor* Pocock, 1927 became more widespread. But a question on the taxonomy and nomenclature of the leopard inhabiting the entire Caucasus region needs to be clarified due to its similarity to that inhabiting Turkey. It was described as *Panthera pardus tulliana* Valenciennes, 1856 (Anatolian Leopard). Perhaps, this name should be extended to all animals of this region in accordance with the international rules of the taxonomic nomenclature (Semenov 2002; Rozhnov et al. 2011).

The behavioral study of these animals is of great scientific and practical importance, since they are more susceptible to stress factors in captivity conditions. Among them are prolonged anthropogenic impacts and habitat restriction, and consequently, lack of exercises. Each of these factors is able to activate the hypothalamic-pituitary-gonadal system, and consequently contributes to the glucocorticoid increase in animals' blood. It is known that a high concentration of these hormones inhibits the sexual function of animals (Rozen 1983; Tsigos and Chrousos 2002; Turner et al. 2002).

To study the daily behavior of animals, we used surveillance cameras Axis Camera Station and infrared illuminators Axis. The equipment is able to zoom animals so close that it enables us to see separate hairs on their body. The use of TRASSIR software enables us to record images at any time intervals and then view them at different speed.

Observations have been conducted by the method of continuous recording, by marking the animal's name, weather conditions, date, time of observation and behavior types. It has allowed us, subsequently, to distinguish research, playing, marking and sexual behavior types. The study of the animal behavior dynamics during the year has been conducted daily during daylight hours, or around the clock during periods of increased sexual activity and parturition. To assess the female reaction after fertilization, four forms of individual behavior were identified: sleep, rest, locomotor activity and eating behavior.



Figure 1. Breeding aviary in the Centre of the leopard recovery in the Caucasus, Sochi, Russia

RESULTS AND DISCUSSION

Previous studies showed that female behavior changes at two days before the estrous beginning. In particular, locomotor and general motor activity, their duration, and marking behavior increase. For a more detailed analysis of the behavioral response of the female leopard during the estrous period, the whole estrous cycle was conditionally divided into the proestrus, the estrus, and the metaestrus, depending on the sexual behavior form. During the estrous cycle, the male made 233 matings, but not all of them were successful. In total, 153 successful matings were recorded (Ertuev and Semenov 2016).

Nevertheless, 35 days after the last successful mating, the female behavior again changed. In particular, the general and locomotor motor activity, and the marking behavior increased again. Thus, even after so many successful matings, the female remained unfertilized. The reproductive success of male Alous and female Chery also turned out to be zero after their multiple matings during the second estrous cycle. The individual behavior of the female at 43 days after the estrous phase of the second estrous cycle indicated the onset of the third estrous cycle.

To understand the eating behavior of the female Chery, it is necessary to conduct a comparison with behavior of other animal individuals. For instance, the male Alous and the female Andrea, hearing a click of the automatic lock of the entrance in the zone of accommodation of the animals in aviary, rushed to the pull-out troughs, lying down next to them and waiting for the feed delivery. With the arrival of employees with food, both animals put front paws on the feeder tray and began raking a feed, quickly fingering legs, that made it difficult to push a feeder tray. To divert the animals from the feeder tray and put food in it, an employee took a piece of meat and went along the fence away from the feeder tray, demonstrating that the feeding will be in a different place. Both Alous and Andrea, being not far from the feeder tray, quickly eat the food. If the ration of animals includes quails, Alous takes at once 3-4 quails and eat them here, near the feeder tray.

Unlike these animals, Chery, hearing a click of the automatic lock of the entrance in the zone of accommodation of the animals in aviary, stayed in the lair or in the back corner of the aviary, covered with thick plywood shields, where nobody could see her, and she saw no one. She came to the feeder tray only after hearing a click of the automatic lock behind the departed employees, and took the meat into the lair or into the thickets. With Chery's arrival to the feeder tray, all quails ran away and hid in thickets of tall grass. She walked, listened to the sounds emanating from the quails, then caught and ate them.

On the 35th day after the estrous phase of the last estrous cycle, the eating behavior of Chery had changed significantly. She came to the feeder tray and was present at the feeding. This was a first and sure sign of her pregnancy.

The question has arisen: what caused the cautious and timid female leopard to overcome a fear of a person and not hide when he appears? In accordance with the classical

medicine views, with sufficient food intake, the glucose level increases in the blood and affects the hypothalamic center of saturation. And it leads to inhibition of the food center.

In this regard, we note that with the intensive fetus growth during fetal period, its need for nutrients is progressively increasing, including glucose, which is the only energy substrate for the fetus. It can be assumed that in these conditions, the glucose level declines in the maternal body. The general pattern of hunger (appetite) development is the following: the hypothalamic appetite center is excited either due to a decrease in the glucose concentration in blood of a female leopard under conditions of insufficient food intake, or due to an increase in the nutrients needed for growth and development of the fetus during pregnancy. Presumably, it was the nutrients deficiency in the female's body has prompted her to overcome the fear of man.

The sleep and rest were prevailing in the individual behavior of a female leopard after the estrous cycle end (Figure 2). Thus, the proportions of the sleep: rest duration were 50.7:37.1% on the 10th day of pregnancy, 61.6:24.2% on the 15th day of pregnancy, and 76.0:19.4% on the 20th day of pregnancy. After the 20th day of pregnancy, a gradual decrease in the percentage of sleep duration was registering. Before the 25th day of pregnancy, the female locomotor activity was low (3.8-5.4%). Subsequently, the duration of this behavior form was increasing. And on the 35th day of pregnancy, its share was 25%. Thus, the analysis of the dynamics of various behavior forms, except the eating behavior, has shown that these largely depend on the pregnancy age.

These data show that in the first month after female's fertilization, the total duration of her sleep and rest was significant, on average 85.8-95.4% of the daylight time. It should be noted that the hormonal status shift and, consequently, the deviation of the constancy of the internal environment, the increased locomotor and general motor activity, the emotional female state during the estrous cycle are stressors. They require metabolic costs and participation of all defense systems of the body. It can be assumed that significant energy and plastic reserves of the body were expended to maintain increased locomotor and general motor activity, as well as intense emotional state. In addition, by the end of the estrous cycle, the female was severely fatigued. Sleep and rest were needed to restore the body's reserves, as well as her mental state.

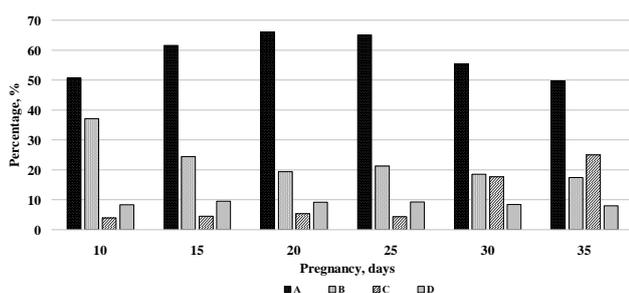


Figure 2. The ratio of the forms of individual behavior of a female leopard over the first 35 days of pregnancy (A. sleep; B. rest; C. locomotor activity; D. eating behavior).

By the end of pregnancy, significant changes in the functional activity of endocrine glands occur. It is associated with the preparation of the maternal organism for the generic act. In particular, the concentrations of estrogen, progesterone and its derivatives (oxytocin, glucocorticoids, relaxin) increase substantially in blood. The effect of mentioned hormones is directed to lysis of the cartilage of the pubic symphysis of the haunch bones, relaxation of the lower pelvis ligaments and uterine cervix, as well as to stimulation of the uterine musculature contraction, and development of the mammary gland. These changes in the endocrine system at late pregnancy have a significant effect on the behavioral responses of a female.

So, two days before parturition, the female behavior changed dramatically. Although she often went to bed, asleep was short and restless. Locomotor activity has increased, but it was short-term: sometimes its duration was only 2-3 min. Frequency of comfortable behavior has increased. Apparently, the washing of the genital area (Figure 3), abdomen, nipples are associated with the desire to relieve pain in these parts of the body. The female leopard often came to the drinking-place and drinks water for a long time, then lay down on her left side, then on her right side. Despite being hungry every day, during the evening feeding, the female twice passed by the feeder tray without touching the meat. Apparently, such female behavior should be considered as a result of the influence of a complex of stress factors. Among them, there are significant changes in the neuroendocrine system observed at the end of pregnancy in mammalian females and leading to a violation of the constancy of the internal environment. In addition, directly before parturition, the female leopard experienced painful sensations due to the increased motor activity of the fetus, coupled with accumulation of toxins and possible hypoxia.

In a body, in response to stressors different in the intensity and action duration, there is a series of stereotypical adaptive reactions aimed at ensuring its protection. Maintenance of dynamic balance and homeostasis constancy are provided due to inclusion of the nervous, endocrine, enzymatic and other systems in the mechanism of adaptive reaction (Borodin 1975; Oskina et al. 2008; Kelli 2011; Möstl and Palme 2002; Tsigos and Chrousos 2002; Turner et al. 2002; Wirth et al. 2007). It contributes to the mobilization of energetical and structural reserves (glucose, amino acids, lipids). However, an adaptation includes not only the mobilization of the energetical and structural resources of the body, but also the redistribution of them from the systems, which do not participate in the realization of adaptive reactions to a stressor into the organs, tissues, and systems providing the adaptation (Rozen 1983). In this case, the following is important: by redistributing mobilized energy and structural resources into stress-realizing systems of the body, the functions, which are not directly related to the animals' adaptation, are oppressed. In particular, the functions associated with growth and development, appetite, digestion, etc., are suppressed.

A day before parturition, the frequency of the comfortable behavior of the female increased 3.5 times, compared with that for two days before parturition. In that time, the duration of sleep and rest were 6 h. 25 min. in sum. The sleep and rest were restless and short-term. These were interrupted often (17 times) by the locomotor activity of the female. She often overturned through the back from side to side, stretched out her legs (Figure 4), lay down on her back, stretching her paws in different sides (Figure 5), often washed out her genital area. Apparently, such forms of female behavior are associated with the pain experienced before parturition and with the search for a more comfortable body position to reduce pain.

It should be noted that contacts with the male Alous (the pair of the female), who was kept in the neighboring aviary, have continued to exist after mating. A day before parturition, the contacts have become both more frequent and pronounced. Once the female was coming to the fence, the male was coming, too (Figure 6). And both leopards began to rub by their heads, napes, and touching each other by their paws, poking them through the net. After a short contact with male, Chery went in the depth of the aviary, then she lay down to rest in her lair or on the tower, often got up, changed her position, washed, walked, etc. Walking for some time near the dividing fence, Alous moved to the opposite part of the aviary, continuing to walk, or he was lying down on the upper tier of the wooden structure. After 1-2 h, the procedure was repeated. It should be noted that the male activity at the night of the kittens birth had not decreased until the sounds of the newborn kittens had subsided and the walking of the female had stopped. Moreover, Chery never showed interest in the aviary, where another male (Zadig) was living.

At 00 h 19 min, the female lay on right side in the middle part of the aviary. Strong dilating pains and fetus' movement in the cranial and caudal directions were observed. The female rose, then moved 5-6 m ahead and again lay down on the ground, a minute later got up, walked away and lay down again. Using microphones placed in the lair, the sharp and coarse meowing of the newborn kitten was heard. Chery looked around and looked at the place where the sound came from. Then she stood up and began to approach carefully. Once she approached, looking for a long time, and then several times she tried to turn over crawling kitten by the paw. Then, voice of her cub rang again. And the female jumped back in a fright. Then, she has turned and went to the drinking-place. She drank water for a long time, then went into the lair, where being half-sitting she washed the genital area for a long time. The kitten continued to meow loudly, and excited the other leopards. However, the female was not responding to the call of the kitten. Being exhausted and tired, she fell asleep in the lair.

Chery gave birth for the first time. But she showed no interest in the newborn kitten and did not pay any attention to his cries. In order to prevent the death of the kitten, after 2 h 45 min, the staff of the Center decided to withdraw it from the aviary. The use of two paired aviaries for keeping of pregnant females together with remotely controlled bypass gates have allowed the staff to block the female's

access to the aviary with her kitten. However, a noise of the mechanism has alerted Chery, and she went to the artificial grotto lair (Figure 7). After that, the employee freed the kitten strongly entangled by umbilical cord in thorns, and then brought him out of the aviary. Subsequently, the kitten was called «Grom». He was artificially fed and handed over to the zoological park in France.



Figure 3. A washing of female in genital area



Figure 4. In the last days of pregnancy, a female often lies, constantly turning over



Figure 5. In search of a comfortable position of the female lies on the left side.



Figure 6. In the last days of pregnancy, number of tactile contacts between the female and male has increased



Figure 7. The female is on the stone grotto. The kitten is below at the age of about 30 days.

On this night, Chery did not come out of the grotto. The next day it was determined that there was another kitten in the grotto. The time of his birth was not fixed. However, it was found that the female washed and fed him. The kitten was called «Akhun». Chery has completely nourished him. Then the kitten was prepared for an independent life and released on the territory of the Caucasian Biosphere Reserve, where he has successfully adapted.

In conclusion, there are the following features of behavioral reactions of the female leopard during pregnancy and first days after parturition: (i) individual behavior forms depend on the period of pregnancy; (ii) sleep and rest prevailed in early pregnancy (the total duration of these behavior forms in the first month after female's fertilization averaged 85.8-95.4% of the light-day time); (iii) with the increase of both the period of pregnancy and the fetal growth, the stereotype of the eating behavior of female has changed significantly (for instance, the excitation of the hypothalamic centre of hunger due to a possible deficiency of nutrients in the mother's body prompted her to overcome fear of a human and be present at the feeding); (iv) in a day before parturition, the frequency of comfortable behavior has increased by 3.5 times, in comparison with that for two days before; sleep and rest were short-term and restless, being often interrupted by locomotor activity; (v) because of inexperience and fatigue of the female at first parturitions, the later manifestation of the maternal instinct can lead to the death of one or few newborn kittens.

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