

## PARTURITION ACTIVITY OF MOOSE

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**ABSTRACT:** Behavior of female moose (*Alces alces*) during parturition was studied in 1977–1990 on the Kostroma experimental moose farm. We found that moose parturition behavior is organized on the systems principle and aimed at the calf's survival. The corresponding system is formed only at the time of parturition on the basis of inherent elements of behavior. We report the results of our investigation of cardiac and respiratory dynamics (as indicators of emotional states) during parturition.

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The concept of systemogenesis suggested by Anokhin (1948) reveals aspects in an organism's prenatal development that specifically prepare it for the postnatal encounter with species-specific factors of the environment. As a result of this series of events, the bases of functional systems of newborn behavior are formed that must help the newborn adequately fit into its new environment (Bogomolova and Kurochkin 1984, 1985, 1987). Our data revealed that the adaptive abilities of the newborn are necessary, but obviously insufficient, for its survival and normal development after birth. Even such precocial newborns as moose calves need their mother's specific care during the first period of their lives. This species-specific maternal care, along with the newborn's innate adaptive behavior, is designed strictly to prepare the calf for the critical timing of its main biological tasks.

There have been few studies of the parturition behavior of moose (Altmann 1963, Stringham 1974, Cederlund 1987). We designed the present study to investigate ethological and physiological aspects of moose activity, especially those aspects that enhance the normal species-specific develop-

ment of newborn calves. We used the systems approach before, during, and just after labor.

### METHODS

This study was conducted in 1977–1990 on the Kostroma experimental moose farm in natural or near-natural environments. The behavior and heart rate (HR) characteristics of moose cows before, during, and after labor were studied, as well as those of their fetuses and newborn calves. Emotional reactions of animals were characterized on the basis of HR and respiratory dynamics in biologically important situations. The study animals were 30 female moose, which had many births during the investigation period, and 225 newborn calves. Behavior before, during, and several hours after parturition was investigated in large (0.5–2 ha) enclosures with natural vegetation or directly in the forest. We observed the entire parturition and postpartum interaction of mother and newborn in 62 situations. In 32 other cases, the observation of mother-newborn interaction began shortly after labor.

Radiotracking systems "Los-2" and bioradiotelemetric systems "Los-3" (de-

signed by F. M. Minaev) were used, as well as night-vision apparatus and radio communication between observers by means of portable radiostations ("Lastochka-M"). Animal responses were captured using still photography, film, and videorecording, and moose vocalizations were recorded on magnetic audiotape for subsequent sonographic analysis. To estimate heart rate dynamics, HR diagrams were made either by averaging the 3–5 RR-intervals or by calculating without averaging.

### RESULTS AND DISCUSSION

Our findings demonstrated the seasonal character of moose parturition. In the Kostroma region, moose generally give birth in May; 70% of calves are born during the first half of May (Bogomolova and Kurochkin 1984). This is a cornerstone of the entire systemic organization of moose cow parental behavior. In early May the growth of green plants begins, which are the main food for moose calves and their mothers. Thus, the offspring gain access to forage as early as possible and have the opportunity to procure the optimal mass to survive during winter.

Moose in the last period of pregnancy revealed the same specific alterations in their behavior and physiological state described in other ungulates: swelling of the udder, appearance of colostrum, and refusing preferred food. Additionally, we found an increase in the locomotor activity of cow moose 2–3 days before labor.

Having the opportunity to observe the behavior of radio-tagged animals, we found 2 typical features of moose prepartum behavior. First, moose seem to remember the location of previous births and every year, before their next labor, they returned to the same area of the forest. We found 4 subsequent birthing locations of radio-tagged moose that were less than 200 m from each other (the whole area of the cow's home

range is about 60 km<sup>2</sup>). Second, 1–3 days before labor, cows became aggressive to yearlings and drove them away. At the same time, however, cows not pregnant continued to stay with their yearlings for several more months. These behaviors, well-timed to the moment of labor, increase the probability of newborn calf survival, therefore, they are useful for the species.

Breathing rate (BR) of moose in the late period of pregnancy fluctuated between 15 and 60 respirations per minute; often there were breathing delays for 10–25 seconds. Generally the HR of cows in normal circumstances was relatively regular. There were short bursts (5–30 sec) of rapid HR, increasing up to 100–105 beats per minute (bpm) during strong muscular efforts and in response to significant external signals. The HR and BR indices of pregnant cows in a quiet state were much more variable than moose that were not pregnant.

Fetal HR in the last month before parturition was about 2 times higher and more variable than the mother's HR. Short-term (2–5 sec), sudden increases of fetal HR up to 190 bpm were observed episodically. They do not correlate with the mother's and other fetus' HR alterations. Fetal ECG revealed long-term (up to 30–40 min) periods of rather stable basic HR; for example, 100–120 or 120–130 bpm. Relative independence of mother and fetus HR was found by comparisons in different situations. Such autonomy of fetal heart activity may provide the optimal conditions for its development.

One peculiarity of moose prepartum behavior, important for successful calf survival, is the tendency to find the most solitary place for labor. Only 2 of 140 labors that we observed happened in the presence of other cow moose. Such behavior of a solitary forest animal is obviously purposeful from the biological point of view, especially because the other cows may be ag-

gressive against newborn calves.

Most commonly, moose bore 2 calves. Exceptions were moose in their first pregnancy and the old (13–15 yrs) cows, which usually bore 1 calf. Triplets were very rare and usually 1 of the 3 calves was not viable. Triplets appeared to be genetically determined: we observed 3-fetus pregnancies many times in the same moose cows.

Duration of parturition (from the appearance of amniotic sac to delivery) varied from 4 to 136 min; on the average it was 31–41 min. Moose HR during labor activity was the following (Fig. 1): at rest, 68–85 bpm; during labor, 95–120 bpm; in delivery, 90–130 bpm; and just postpartum, 65–90 bpm. Newborn calf HR just after birth was 190–230 bpm.

In the case of twins, the second calf parturition occurred 5 times as fast as the first one (the difference is significant at  $P < 0.001$ ). The average parturition duration for the single calf was 68–128 min, for the first of twins 45–66 min, and for the second calf 10–11 min.

As soon as the calf leaves the body of the mother, the cow begins to salivate abun-

dantly; she usually stands up, turns to the calf, and starts smelling and then licking it. Instead of usual aggressiveness against little moving objects, moose revealed the tendency to approach the newborn calf willingly after delivery. Immediately after birth the moose cow demonstrates the pronounced positive reaction to the odor and taste of amniotic fluid; this reaction facilitates the cow's approach to the newborn and the beginning of licking it.

Licking of the newborn calf is of importance because it dries its hair, massages its body, improves blood circulation, and stimulates breathing. The most important thing is that during the licking the first direct mutual acquaintance of mother and calf takes place. It is accompanied by sound signals from both sides which facilitate their bonding. After delivery the mother exhibits pronounced positive reactions to the calf's squeaks, which occur most often during the maternal licking of the calf. Furthermore, just after delivery the sound repertoire of the cow moose enriches itself by specific short and low call sounds.

Another important form of moose

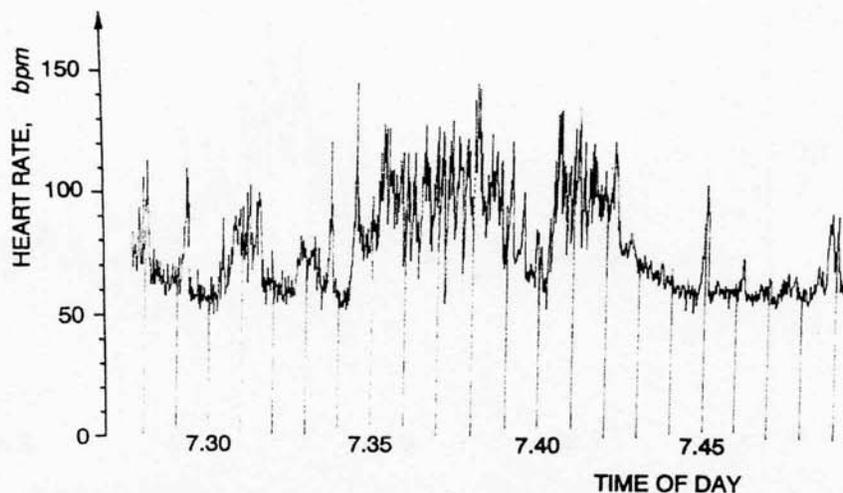


Fig. 1. The dynamics of moose-cow Lapka's heart rate during labor. The important points: 7.28.00 – appearance of amniotic sac; 7.30.20 - 7.40.10 – series of contractions in standing and laying cow's position; 7.41.00 – appearance of foetus head; 7.41.15 – extrusion of calf; 7.41.30 – cow stands up and licks the calf; 7.42.10 – lays down and continues to lick the calf.

behavior concerning parturition is the reaction of active defense of the birthing ground against approaching animals or persons. The cow's HR increases from 60–70 up to 150–180 bpm during this sometimes very aggressive defense reaction (Fig. 2). The control experiments showed that in the first 7–8 days, the mother protects not only the calves but also the place of parturition, and she does it even when the calves are removed from the place. In natural environments this reaction perfectly secures the calves' safety.

When the moose was removed by force from the delivery place, she demonstrated the powerful will to return, which suppressed all other motivations. If we attempted to reunite the mother and calf outside the delivery place, the cows did not accept the calves; moreover, they often became aggressive against their own calves and they even kicked them with their front legs. We inferred that moose cows imprint the delivery place, which is probably necessary for the newborn calf's safe and favorable de-

velopment. We suggest that the development of a close "mother-newborn" bond requires a long-term period of constant contact at the place of labor and only after the first 5–6 days postpartum, they learn to recognize each other and respond appropriately to the behavior of the other.

Thus, we can distinguish a number of species-specific reactions in the moose's maternal behavior, which form in the period of perinatal development of the calf. These reactions are very closely linked with each other and are integrated in the whole functional system of parturition behavior, which is aimed at the calf's survival. The existence of this system is confirmed by cases of its total failure when even 1 of these elements is absent (e.g., in cases of immaturity in young cows). We observed situations when some first-bearing young cows refused to accept their newborn calves because of immaturity of some behavioral element, such as salivation after delivery, or positive (instead of usual aggressive) reaction to little moving objects, and so on. They

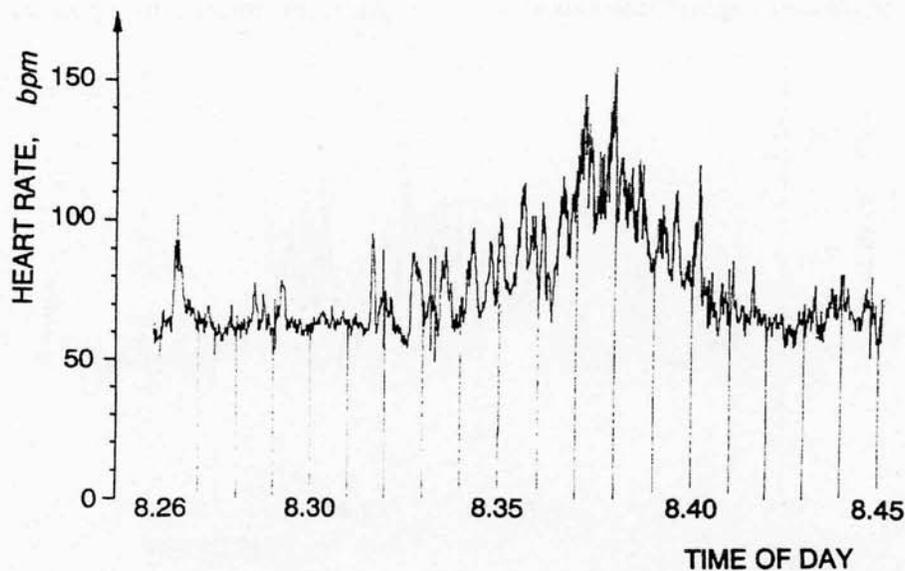


Fig. 2. The dynamics of moose-cow Lapka's heart rate during the attack by another cow, which approached the birth site. The important points: 8.30.00 – Lapka lays and licks the calf; 8.32.30 – arousal reaction to the noise 50 m away; 8.34.10 – Lapka stands up with moan; 8.36.35 – attacks the approaching cow; 8.39.30 – lays down, licks the calf.

showed excitation, displayed threatening facial expressions, and sometimes kicked their calves with the front legs.

Each calf's survival is guaranteed not only by its mother's behavior, but also by the set of its own inherent reactions (oral automatism, following response, etc.).

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