THE STUDY OF MOOSE BEHAVIOR ON THE KOSTROMA MOOSE FARM

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ABSTRACT: We studied 35 adult farm moose-cows, about 50 wild bulls (in the breeding season), and more than 250 newborn and developing calves. We used the "Los-2" radio-tracking system, the "Los-3" radio-telemetry system, radio-communication between experimenters, photo, film, and video recording of behavior, and magnetic recordings of moose vocalizations. Various aspects of moose behavior and corresponding changes of their heart rate and breathing rate were studied during 1977 to 1990 on the Kostroma experimental moose farm. The results and advantages of farms for the study of animal behavior are listed and discussed. Findings include work with specific time intervals, first behavioral reactions, bonding behaviors, and passive and active defensive mechanisms. The time interval from a calf's birth to first standing varied from 12 to 58 minutes. The developmental sequence of the first functional behavior in a newborn calf is not preprogrammed genetically but is determined by the actual circumstances of the newborn.

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Experimental moose farms offer new opportunities for studying species-specific moose behavior (Bogomolova and Kurochkin 1987a). The animals on these farms do not sever connections with the natural environment because they inhabit the forest and do not essentially alter their behavior under the influence of the initial process of domestication. Working with such tamed animals gives scientists the following advantages:

1. Biologists can always find the radio-tagged animal in the forest and investigate its behavior in its natural environment. Tame moose get accustomed to human beings so much that they do not pay attention to their presence, even during such important events as parturition, suckling, protection of calves, and sexual and competitive interactions.
2. Besides behavioral patterns, the corresponding emotional reactions of moose may be investigated by measuring heart rate and breathing dynamics because tame moose allow staff to equip them with detectors and radio-telemetry transmitters, which is convenient for investigators.
3. Observing tame, radio-tagged moose allows the opportunity to simultaneously study the behavior of interacting wild animals such as wild moose-bulls during the rutting period or wild calves that grew up in the forest.

METHODS

Postnatal development and physiological mechanisms of suckling, feeding, defense, breeding, and other activities, as well as mother-calf bond consolidation and subsequent separation were studied in 1977–1989 on the Kostroma moose farm (Bogomolova and Kurochkin 1984, 1987b, 2002). Heart rate and breathing dynamics

were studied to estimate the emotional states of animals during various behavioral activities. We studied 35 adult farm moose-cows, about 50 wild bulls (in the breeding season), and more than 250 newborn and developing calves. We used the radiotracking system "Los-2," radio-telemetry system "Los-3" (Minaev 2002), radio-communication between experimenters, photo, film, and video recording of behavior, and magnetic recordings of moose vocalizations. The gathered data were processed on a computer.

RESULTS

For the first time the entire parturition activity pattern of mixed-aged cows was investigated in detail (Bogomolova and Kurochkin 1984). We observed and studied parturition in more than 60 cows. In some cases, ECG and breathing patterns were recorded during the various stages of parturition. Duration of parturition (time from the appearance of the amniotic sac to delivery) was extremely variable: from 4 to 136 min and on the average, 31–41 min.

The time interval from a calf's birth to its first standing varied from 12 to 58 minutes. There was no significant difference in the average duration of this interval between calves born single or the first of twins (29.2 min) and those born second of twins (25.2 min). The first standing up, the first achievement of a functional behavioral sequence, is a decisive moment in the integration of efferent and afferent activity of nervous, muscular, vestibular, visual, jointal, and other components in the whole, integrated system. Once the calf stands up on 4 legs for the first time and keeps its feet, it is able to stand up the next time in only 1–3 seconds.

The average time interval from birth to the first milk sucking in calves born single or the first of twins was 65.5 ± 5.1 min; in those born second of twins, the interval was 69.8 ± 7.1 min. The difference is not significant. There was no correlation between the interval from birth to first standing and that from birth to the first milk sucking ($r = 0.076$, $n = 32$). The time from birth to the first sucking varied widely from 8 minutes to 3 hours. But, as soon as the calf found the mother's nipple and obtained milk the first time, the calf found the nipple later practically at once. These results suggest that learning plays an important part in the development of such innate behavior (just as it does in standing up).

The developmental sequence of the first functional behavior in a newborn calf is not preprogrammed genetically and is determined by the actual circumstances of the newborn. For example, as a rule, calves learn at first to stand up and walk on 4 feet, and only after that do they learn to find their mother's nipples. But in 6 cases of 55, we observed that at first calves began to suck the milk and only after that did they learn to stand up.

The analysis of a calf's emotional behavior on the first and following milk sucking reveals that here, too, the decisive moment is the first achievement of a functional result. Only after the first sucking do calves show marked, emotional reaction to obtaining milk.

One of the most important behaviors of newborn calves is the "following response", which we usually interpret as an inborn, genetically preprogrammed behavior that is essential for attachment to their mother. Through this behavior, the calf learns step by step to recognize its mother and distinguish her from other objects. Only afterward will the following response manifest itself in the closely formed "mother-infant" bond. During the first days of calves' lives, our experiments show that newborn calves follow not only their mother but also any human being. Moreover, calves can easily follow humans in the presence of their calm

mother. In our study we observed some cases in which newborn calves left their mothers for other moose-cows and cases in which the moose-cow accepted a calf of another cow and raised it.

These data testify against widespread opinion about the existence of mutual mother-newborn imprinting in moose. We are convinced that the calf's attachment to its mother is built essentially on the basis of its food behavior: when we succeeded in teaching wild calves captured at the age of 2–3 weeks to suck milk through a rubber nipple, later on they revealed the same attachment to human beings as the calves on the farm that were removed from their mother before first sucking and brought up by people. We found that the moose-cow and calf finally learned to recognize one another only after 7–8 days of permanent interactions at the place of parturition (Bogomolova and Kurochkin 1984, 2002).

These features of moose behavior may be well explained from the point of view of Anokhin's concept of systemogenesis. According to this concept, every species has its own laws of ontogenetical development, which must exactly correspond to the ecological factors of the species-specific environment. Actually, rapid establishment of the close mother-newborn bond is not ecologically necessary for moose because they are solitary forest animals. On the first days of life in a natural environment, the moose calf does not see anyone except its mother, and therefore cannot mistake her for anybody else. Both creatures have enough time to learn little by little to recognize each other.

Working with reared calves, we had an opportunity to study their active and passive defensive behavior. The calves revealed both during the first hours of life. However, the first is formed gradually by active learning, while the second reveals itself in full form within the first hours of a calf's life. The features of this specific behavior are the following: in response to a rapid approach of a frightening object from which the calf cannot run away, the calf's muscular tonus weakens abruptly, the calf falls down to the ground and sprawls with stretched head and closed eyes. At the first moment of fright, for a few seconds (when the calf often tries to run away) the calf's heart rate (HR) and breathing rate (BR) increase abruptly (from 190–200 up to 230–240 bpm and from 70–80 up to 130–140 per minute, respectively). After that, HR and BR fall rapidly and become 1.5–2 times as low as baseline levels (up to 140–150 bpm and up to 40–45 per minute, respectively). The calf may remain in this state 10–15 minutes. The behavior described disappears in normally developing calves after 8–10 days of life, and they begin to react to danger by flight or by attack. But weak or sick calves continue this behavior even at the age of 1 month.

Only because the tamed animals allowed us to approach very near them could we record and describe practically the whole vocalization repertory of moose in various situations, including the sounds of wild males in the rutting period (Bogomolova et al. 1984).

Having radio-tagged animals, we could investigate the complex behavioral organization of sexual interactions among moose living in the study area. We studied ethological and physiological features of male and female behavior at different stages of breeding, such as the onset of the rutting period, characteristics of forming, and subsequent disintegration of breeding pairs, the entire pattern of the breeding ritual up to copulation, ontogenesis of breeding ritual elements, characteristics of male interactions at various ages and dominance, the circumstances of the beginning, and entire pattern of tournament battles. Moose sexual activity appeared to fit into the whole sys-

tem of social interactions of moose in the study area.

It was found that moose-cows inhabit rather restricted and stable home range areas up to 60 km^2 (Bogomolova et al. 2002).

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