
The Effect of Long Transportation Stress on Young Calves Born from Cows and Animal Ecology

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Abstract

This article deals with the stress effect of long transportation, experienced by young calves born from cows on arrival to animal ecology located in the Amur Region. The stress effect is associated specifically with the duration of transport. This article analyses the newborn calves from the perspective of different ecological factors; their general condition, stillbirth, and patterns of body weight change. As it was revealed, long-term effect of transport stress in pregnant cattle causes negative response of not only female adults, but also the fetuses. By negative, one should understand abortions (7%), stillbirth (9.3%) and birth of hypotrophic baby calves (10.3%). With abortions and stillbirths (13.3%), only 86.7% of calves were born alive. The growth pattern of newly born calves was found to be linked to the effect of transport duration on their mothers, which causes the adults to give birth to lightweight calves, and baby calves to gain less in average daily weight.

Keywords: calves, animal ecology, transport, stress

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INTRODUCTION

In modern animal ecology, transport of highly productive farm animals is one of the priorities. At that, farm animals are introduced not only from different regions of the Russian Federation, but also from abroad. Each farm is forced to purchase and transport fresh livestock numbers if it tends to improve breed and productive qualities. Some producers buy bred heifers to avoid management and insemination costs. The animals are typically transported in the last terms of pregnancy (Deev 2008, Guskov 2004, Kukhareno et al. 2015).

Prolonged transportation of animals is the most stressful factor causing some negative welfare consequences in animals, including profound disorders that affect multiple systems, and cause productivity reduction (Balash 2010, Fyodorova and Kukhareno 2015, Kukhareno et al. 2015).

The stress effect of transport is linked not only on to transport distance and duration, but also to the mechanism of animal resistance to associated negative aspects. With long duration and low resistance, cattle have a rapid stress response, which weakens the body's resistance to pathogenic factors that cause health deterioration and a drop in milk production and fertility (Fyodorova and Sirpionovav 2015, Kashin and Kashina 2009, Plyashchenko and Sidorov 2011).

Pregnant animals from highly productive breeds are sensitive to stress due to intensive metabolic processes, so eventually metabolism patterns will take change. Such animals have high energy requirements, fulfilling which is stressful not only for the circulatory system, but also for other systems. The result is that pregnant animal subjected to transport stress simply needs more energy to maintain two body systems (one's and the fetus), to accumulate some for calving, and simultaneously to adapt to new conditions associated with transportation and new environment. With a decrease in natural resistance and energy loss, various diseases occur in those animals accompanied by abortions or difficult calving with some postnatal complications (Jang et al. 2015, Kassil 2011).

Long transportation causes an acute stress response defined as weight loss (by 6-10% or greater). Aside from that, resistance rates fall down to a limit when it becomes a problem causing death. Reason behind weight loss is dehydration sparked by utilization of carbohydrates and fats. The increased journey duration leads to increased weight loss due to lack of food and water. The result is that a producer loses both the female adult and its child, so money spent on them will not return with potential milk, meat, etc. (Kukhareno et al. 2015a, 2015b).

The purpose of this research is to investigate the effect of transport stress in animal ecology as well as to analyze the development of calves born from those cows

Table 1. Head of Animal Species Introduced to MiS Agro, LLC from Other Regions

Animal Species	Season	Transport Mode	Purchase Location	Bovine	Journey Duration, days
Cattle (heifers)	Spring, 2008	Railroad	Belorussia, Vitebsk Region	100	21
Cattle (heifers)	Fall, 2010	Railroad	Krasnoyarsk Krai	70	11
Cattle (heifers)	Summer, 2014	Road	Irkutsk Region	100	4

Table 2. Timing of Pregnancy in Introduced First-Calf Cows

Indicators		Cattle from Belorussia, n=100		Cattle from Krasnoyarsk Krai, n=70		Cattle from Irkutsk Region, n=100	
		number	%	number	%	number	%
Calving	at term	90	90	63	90.0	95	95
	early	5	5	3	3	2	2.9
Total head of calves		95	95	66	94.3	97	97
Progression	normal	85	85	58	82.9	91	91
	difficult	10	10	8	11.4	6	6

Table 3. Calving Output after Prolonged Transportation

Indicators		Belorussian Calves, n=100		Krasnoyarsk Calves, n=70		Irkutsk Calves, n=100	
		number	%	number	%	number	%
Abortion		5	5	4	5.7	3	3
Number of calves	alive	85	85	58	82.9	91	91
	stillborn	10	10.5	8	11.6	6	6
sex	female	47	55.3	26	44.8	41	45.0
	male	38	44.7	32	55.2	50	55.0
Normothrophic		80	80	55	78.6	89	89
Hypotrophic		5	5	3	4.3	2	2

who experienced long-term transport stress being at last terms of pregnancy.

METHODOLOGY

Research target was calves born from the first-calf Holstein cows with black-and-white color patters, who were seasonally imported to MiS Agro, LLC (Amur Region) (**Table 1**): from Belorussia and the Irkutsk Region (100 head of cattle); from the Krasnoyarsk Krai (70 head of cattle).

Confidence level was calculated using a table introduced by Nikitin (2014).

RESULTS AND DISCUSSION

The newborn calf viability, physical condition, further development and growth are linked to calving condition that depends on the welfare of a female cow and on the external factors the cow facing with during pregnancy. Pregnant cows are often subjected to constant and prolonged stress factors that cause negative physical consequences in adult cows and fetus, calving complications and poor yield quality. Calving itself is very stressful for both the mother and the newborn, and it needs a large amount of energy to end well. Constantly stressed body is an unfavorable environment for fetal development, so the calf will born

weak. Since weak calves are born with underdeveloped digestive organs, nervous, circulatory and other systems, they lie on their sides, and have poor sucking reflex. They respond to colostrum intake and environmental conditions worse. Progression and timing data associated with pregnancy in cattle introduced from other regions are presented in **Table 2**.

Five days after transportation, early calving events occurred in 10 head of cattle: 5 head of Belorussian cattle, 5 head of Krasnoyarsk cattle, and 2 head of Irkutsk cattle. Difficult calving events occurred in 24 cows; along with this, the greatest number (10%) of cases were associated with those introduced from Belorussia, who experienced 21 days journey. Krasnoyarsk cattle, who experienced 11 days journey, went through difficult calving in 11.4% of cases (8 head of cattle). This figure reduced to 6% in cows introduced from the Irkutsk Region (journey duration: 4 days). These data relate to the summer period when transportation is the most challenging. All difficult cases ended with stillbirth (**Table 3**).

On the road and arrival, 12 head of pregnant cattle had abortions. The greatest number of abortions (5 animals) occurred in animals introduced from

Table 4. Survival Rate of Calves born from Cows Introduced from Other Regions

Indicators		Belorussian Calves, n=85		Krasnoyarsk Calves, n=58		Irkutsk Calves, n=91	
		number	%	number	%	number	%
1th month	mortality	5	5.9	3	5.2	2	2.2
	survival	80	94.1	55	94.8	89	97.8
2th month	mortality	-	-	-	-	-	-
	survival	45	55.3	24	44.8	41	45.0
3th and 4th months	mortality	-	-	-	-	-	-
	survival	45	100	24	100	41	100
5th and 6th months	mortality	-	-	-	-	-	-
	survival	45	100	24	100	41	100

Table 5. Overall Survival Rate among Calves born from Cows Who Experienced Long-Term Effect of Transport Stress

Indicators	Abortion		Alive		Stillborn		Total Number, head
	number	%	number	%	number	%	
Belorussian Calves	5	5	85	85	10	10.5	100
Krasnoyarsk Calves	4	5.7	58	82.9	8	11.6	70
Irkutsk Calves	3	3	91	91	6	6	100
Total	12	4.4	234	86.7	24	8.9	270

Belorussia (journey duration: 21 days). There were four cases among the Krasnoyarsk cattle (journey duration: 11 days), and three – among the Irkutsk cattle (journey duration: 4 days). However, these heifers were transported in in mid-July, when transportation is the most challenging.

Heifers introduced from Belorussia gave birth to only 95 calves, and that 10 calves (10.5%) were stillborn, 5% were born hypotrophic. In total, only 80% of newborns were normal.

Heifers introduced from the Krasnoyarsk gave birth to 66 calves, and that 11.6% (8 head) were stillborn, 4.3% (3 head) – hypotrophic, and only 78.6% (55 head) – normal.

The first-calf heifers introduced from the Irkutsk Region gave birth to 97 calves, and that six calves were stillborn, 2% were born hypotrophic, and 89% were born normal. Physiologically, not mature early born calves (**Table 2**) did survive even for ten days (**Table 4**).

This particular farm does not keep small bulls for a long time – they are sold during the first month after birth, so the survival index is presented in respect for the female calves (**Table 4**).

During the first month after birth, 5.9% of Belorussian calves died (5 head), so have the 5.2% (3 head) of Krasnoyarsk calves, and 2.2% (2 head) of Irkutsk calves. During the period between 2 and 6 months, deaths were not observed, so the survival rate is 100%.

These data show that with prolonged exposure to transport stress on pregnant heifers, their fetuses also experience stress causing negative consequences associated with intrauterine growth. This results in the birth of underdeveloped baby calves, difficult calving and stillbirth.

Table 5 shows data on the overall survival rate among calves born from those cows, who experienced long-term effect of transport stress.

Long transportation of pregnant heifers resulted in 4.4% of abortions (12 cases), 8.9% of stillbirth cases (24 head), and in a death of 36 calves (13.3%) after birth. Calf survival rate is 86.7% (234 heads). We believe that calf survival depends on not only physical condition and resistance of a female organism in pregnancy, but also on the road duration.

Our data coincide with results obtained by Mishchenko (2005), who investigated highly productive big horned Holstein cattle, and pointed out that cow survival depends on pregnancy terms the heifers are at when introduced to the environment. According to him, all the heifers and cows were introduced to animal environment when reached the term over six months. Introduced females died 1-46 days after calving, and he assumed that that was caused by stressful transportation, change of diet and new management conditions (Mischenko 2005).

Normal calves born at the term had a normal sucking reflex; they were active and tried to get up immediately after birth. Calves that were born from introduced cows weighted lighter, and got sick more

Table 6. Pattern of Weight Gain in Calves Born From Introduced Cows, $M \pm m$

Indicators		At Birth		10 Days After		30 Days After		60 Days After	
		head	Average weight	head	Average weight	head	Average weight	head	Average weight
Belorussian Calves	male	38	24.9±0.41	35	26.9±0.40	sold			
	female	47	24.8±0.30	45	25.5±0.31	45	29.0±0.30	45	35.3±0.34
	Total	85	24.8±0.30	80	26.2±0.30	45	29.0±0.30	45	35.3±0.34
Krasnoyarsk Calves	male	32	26.6±0.30	31	27.6±0.30	sold			
	female	26	25.4±0.20	24	27.5±0.21	24	30.6±0.23	24	35.8±0.23
	Total	58	26.0±0.22	55	27.6±0.30	24	30.6±0.23	24	35.8±0.23
Irkutsk Calves	male	50	28.8±0.30	48	30.9±0.30	sold			
	female	41	29.2±0.51	41	31.4±0.50	41	36.5±0.51	41	39.5±0.50
	Total	91	29.0±0.50	89	31.1±0.50	41	36.5±0.51	41	39.5±0.50
Local Calves	male	43	36.8±0.42	43	41.3±0.30	sold			
	female	57	34.6±0.40	57	37.8±0.43	57	46.8±0.40		55.2±0.50
	Total	100	35.7±0.53	100	39.5±0.47	100	46.8±0.40	100	55.2±0.50

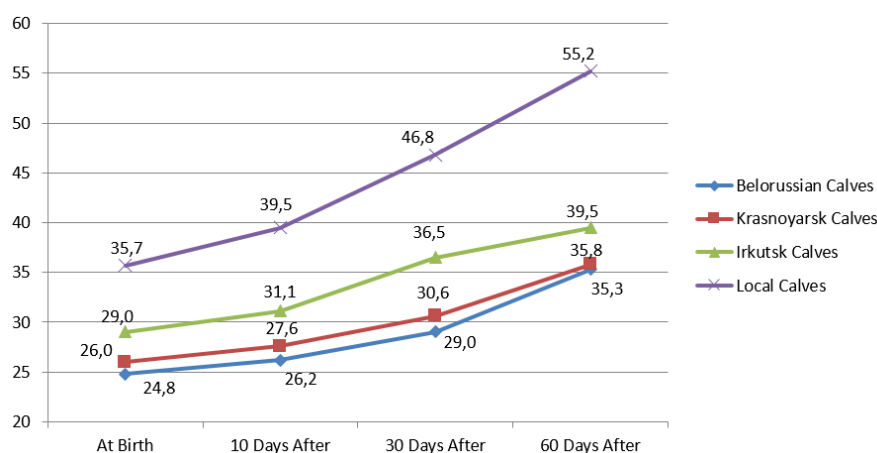


Fig. 1. Weight Gain in Calves: Average Values

often compared to other newborns. The growth patterns were compared between calves born from introduced cows and from local ones (Table 6, Fig. 1).

From the literature, we know the weight of Holstein-Frisian newborn female (38-42 kg) and male (45 kg) calves (Kovalchikova 1996). For the environment we targeted on, newborn calves weighted in the range of 35.7 kg.

All calves born from those cows, who experienced long-term effect of transport stress, had low birth weights: 24.8 kg average – Belorussian calves (10.9 kg (30.5%) less compared to local newborns); 26.0 kg average – Krasnoyarsk calves (9.7 kg (27.2%) less compared to local newborns); 29.0 kg average – Irkutsk calves (6.7 kg (18.8%) less compared to local newborns).

After 30 days, Belorussian calves weighted 29.0 kg, so they gained 4.2 kg in one month, assuming that the average daily gain was 0.14 kg (140 g). Krasnoyarsk calves weighted 30.6 kg, which means that these calves gained 4.6 kg in one month with a daily average of 0.153 kg (153 g). Irkutsk calves weighted 36.5 kg, so they

gained 7.5 kg, assuming that the average daily gain was 0.25 kg (250 g).

After 60 days, Belorussian calves weighted already 35.3 kg, but they did not catch up with the local calves: the total weight gain was 10.5 kg, assuming that the average daily gain was 0.175 kg (175 g). Irkutsk calves are the same case – each calf also gained 10.5 kg average during the period from birth through to two months. On the contrary, Krasnoyarsk calves reached 39.5 kg, so the total weight gain was 9.8 kg, assuming that the average daily gain was 0.163kg (163g).

The birth weight of local calves was 35.7 kg, and they reached 46.8 kg in one month, so each calf gained 11.1 kg average, assuming that the average daily gain was 0.37 kg (370 g). After 60 days, local calves reached 55.2kg, so each calf gained 19.5 kg average in 2 months, assuming that the average daily gain was 0.325 kg (325 g). The results show that calves, whose mothers experienced a stressful long transportation, were born normal, but still were far behind in growth throughout the entire observation period. This resulted from a stress effect of transport that was experienced by them during fetal development.

Thus, obtained results once again confirm that weight loss in calves is linked not only to the physical condition of a cow, but also to the road duration. Heifers, who were on the road for 11-21 days, have experienced a long-term stress while being on the road and after arrival, which in turn has affected fetal development of calves at its last stages. These data coincide with the opinions expressed by other authors, who state that the physical condition of newborn calves, their viability, further development and growth are linked to conditions in which fetal development took place. Housing conditions, feeding and psycho-emotional state of a maternal organism are important at all stages of fetal development, especially during last months of intrauterine life (Masalov 2007, Nevskaya 2012, Preobrazhensky 1993).

Some ecologists have found that fetus grows 70-75% larger during the last two months of pregnancy, with that all organs, immune, protective and enzymatic systems develop, so is the newborn body's resistance (Bolgov et al. 2003, Nikitchenko 1988). Based on the above, we assume that calving consequences result from the negative impact of long transportation causing physiological suppression in pregnant cows, difficult calving, abortions, stillbirth and birth of weak calves.

We agree with other zoologists who believe that oxytocin together with other hormones raises the tone of the uterine musculature in normal calving, causing the uterus to contract and expel the fetus, in other words – it stimulates childbirth. However, increased release in oxytocin under stress neutralizes other hormones (estrogen) regulating the blood supply to the uterine cervix, its opening, and relaxation of the pelvic ligaments. The longer various stressors affect a pregnant animal, the more damage they cause to fetal growth and development, individual organs and tissues. Aside from that, researchers found that almost all calves that died during difficult calving had changes near stomach and intestines, which are known as symptoms of an alarm reaction in general adaptation syndrome. At the same time, stress results from oxygen deficiency experienced by the fetus when moving through insufficiently opened birth canal (Kashin and Kashina 2009, Kassil 2011, Kositsky and Smirnov 2010).

Postnatal reactivity of the organism is low, so nonspecific humoral defense factors are not there, or are weak, skin protection is insufficient, and mucosa conjunctiva of eyes and the digestive tract occur. With age, body reactivity improves and gets more complex once endocrine glands develop, metabolism starts to

occur at a certain level, and defense mechanisms against infections, intoxications, and other kinds of defenses improve. With long-term stress during pregnancy, newborns get these processes even more inhibited, so they cannot adapt to new environment quickly, and lags behind in growth and development. Such animals usually get various diseases more often, and since with transport stress, adaptation process lasts 3-4 weeks, calves often have diarrhea and pneumonia developing during this period (Furdui 2007, Meerson 1981).

According to some authors, adaptive capacity of the organism is limited, so calves cannot adapt to several stressors (poor nutrition, low temperatures) at a time. Therefore, newborns are especially sensitive to additional stressors. Stressors that take place at birth and later, during the adaptation period, significantly reduce body resistance. Weak calves are born from those cows, who have an elevated level of ketones in blood. In such calves, bactericidal and lysozyme activities in serum are inhibited, suck reflex is weak, and the muscle tone is lower than it should be. Such calves are not mature enough. At that, their adaptive capacity is much lower. They are often born with depressed functional activity of the adrenal gland. The reason behind this phenomenon hides in the ability of placental barrier to stop the adrenocorticotrophic hormone from passing instead of maternal corticosteroids. As a result, adaptive system of calves deteriorates, and they become sensitive to severe illnesses during some period after birth (Nevskaya 2012, Ustinov 2008).

Calves under long-term stress factors lag behind in growth. This process is regulated by somatotropin and corticotropin – hormones that are stimulating and inhibiting the process. In a healthy body, these hormones are in balance, but stress responses cause corticotropin to release in greater amounts, and stop protein synthesis. At this point, metabolic processes are disrupted, and so the growth slows down. In addition, stress causes vessels to narrow, so tissues do not receive enough blood and turn more sensitive to growth-inhibiting hormones. Thyreotrophin is also involved in the growth process, affecting the growth of tissues through the thyroid hormone (thyroxine), which is one of the most important metabolism stimulants (Balog et al. 2015, Daviu et al. 2014, Kassil 2011).

Our research reveals that of all introduced livestock numbers, mortality cases took place in all groups, regardless of journey duration, but the greatest number of deaths were among calves born from Belorussian cows (5 animals), who were on the road 21 days. Three

death cases took place in the group of Krasnoyarsk calves, while of the Irkutsk calves, only two newborns died (**Table 4**). In total, 10 calves died (6 males and 4 females) (**Table 5**). Some authors believe that adaptation syndrome that occurs after long-term stress is stronger in male calves than in female ones, and the adrenal function also restores slower if calf is a male (Balog et al. 2015, Sapolsky 2015, Yuen et al. 2017).

CONCLUSIONS

Long-term effect of transport stress in pregnant cattle causes negative response of not only female adults, but also the fetuses. By negative, one should understand abortions (7%), stillbirth (9.3%) and birth of hypotrophic baby calves (10.3%). The greatest number of such cases were among calves born from Belarusian and Krasnoyarsk cows, who were on the road 21 days and 11 days, respectively.

Calf survival rate in the first month after birth was 95.7%. With abortions and stillbirths (13.3%), the overall survival rate 86.7%.

The growth pattern of newly born calves born depends on the time of journey on which adult cows experience transport stress causing a weight loss in calves and a lower gain in weight after birth. The average birth weight of Belorussian calves was 10.9 kg lower compared to local newborns. For Krasnoyarsk and Irkutsk calves, this figure was 9.7 kg and 6.7 kg lower. The total weight gain for two months was 10.5 kg (Belorussian and Krasnoyarsk calves) and 9.8 kg (Irkutsk calves). Local calves by contrast gained 19.5 kg in total, which is more by 8.6 kg and 9.7 kg, respectively.

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