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Early transfer of mated females into the maternity unit reduces stress and increases maternal care in farm mink

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ABSTRACT

Mated mammals on farms are typically transferred to another housing environment prior to delivery. We investigated whether the timing of this transfer – EARLY (Day −36), INTERMEDIATE (Day −18), or LATE (Day −3) relative to the expected day of birth (Day 0) – affects maternal stress, maternal care and the early kit vitality in farmed mink. We hypothesized that early transfer is beneficial for mink mothers and their offspring in comparison to intermediate or late movement closer to delivery, being the current practice in the commercial production. We used 180 double mated female yearlings in three equally sized groups ($n = 60$): (i) 'EARLY', transfer to maternity unit immediately after the end of the mating period, March 23; (ii) 'INTERMEDIATE', transfer in the middle of the period, April 10; (iii) 'LATE', transfer late in the pregnancy period, April 25. Data collection included weekly determination of faecal cortisol metabolites (FCM) and evaluation of maternal care: nest building, in-nest temperature, plus kit-retrieval behaviour, kit mortality and growth day 0–7 postpartum. We document that mated mink females build and maintain a nest at least 1 month prior to delivery when transferred to an environment with free access to nest building material. During the weeks before delivery, INTERMEDIATE females had 50% higher FCM concentrations than the other two groups ($P = 0.002$), indicative of stress. After delivery, late moved females had, in average, 2.7 °C colder nests compared to early moved females ($P = 0.002$). Additionally, the mortality in group LATE tended to be higher ($P = 0.085$) in affected litters ($N = 92$). Kits from early transferred females displayed less vocalization (17% vs. 40–41% in the two other groups, $P = 0.015$), when tested away from the nest. This indicates enhanced offspring vitality from early moved females. In conclusion, transfer into the maternity unit early after mating, rather than later during the pregnancy period, reduces stress and increases maternal care in farm mink.

1. Introduction

The period after mating and during gestation is regarded as particularly sensitive for stress in the mammalian female (e.g. reviews by Liptrap, 1993; Mulder et al., 2002; Parker and Douglas, 2010; Weinstock, 2001). Therefore, mated females on farms are typically transferred from one housing environment to another – more suitable birth environment – at some point prior to delivery. Likewise, in mink production, females are moved from the mating compartment into a cleaned cage with additional nest building material and nest boxes prepared for delivery. In practice, the timing of transfer varies considerably between

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mink farms, thus from c. 36 to a few days before delivery. The timing of transfer may influence the stress response, the birth process and the maternal behaviour as reported in pregnant laboratory rats (Leng et al., 1987, 1988) and in production sows (Lawrence et al., 1992; Pedersen and Jensen, 2008). However, this has not previously been studied in mink.

The American mink (*Neovison vison*), farmed for the production of fur, has one yearly reproductive season. On average farms, litters of five to six kits per female at weaning are reported, although larger litters are present at birth, based on video recordings of deliveries (Malmkvist et al., 2007). The early period around delivery is critical for survival of mink kits. Birth problems contribute to offspring mortality, and females in intermediate body condition (as opposed to being thin or fat) have quicker deliveries and improved offspring survival, including fewer stillbirths (Malmkvist et al., 2007). Mink are considered altricial as they are born relatively underdeveloped; for example the onset of eye-opening and first signs of hearing begins after 28 days of life (Brandt et al., 2013). In addition, their thermoregulatory and motor abilities are poorly developed during the first weeks of life (Rouvinen-Watt and Harri, 2001; Harjunpää and Rouvinen-Watt, 2004), making younger kits prone to hypothermia when away from the warm nest. Consequently, maternal care – including nest building, nursing, and protection – is crucial for the offspring during the first four to six weeks of life. In line with these results, the importance of giving the dam access to suitable nesting material prior to delivery has been documented. If the mink dam is given the opportunity to nest-build before delivery, this will result in a larger nest, reduced dam stress and fewer birth problems, in combination with increased maternal behaviour and offspring survival during the first week after delivery (Malmkvist and Palme, 2008).

The onset of maternal nest building in mink may occur several weeks before delivery, as indicated in a study reporting lower temperatures in nests of unmated than in nests of mated females already three to four weeks before delivery (Malmkvist and Lund, 2009). Thus movement to the maternity unit three to four weeks prior to delivery could be favourable. However, disturbances around implantation may increase the risk of embryonic loss, reducing the number of kits born. The fertilized eggs implant in the uterus between 16 and 24 days before delivery, concurrent with a peak in progesterone and blastula growth approximately 20 days before delivery in mink (Sundqvist et al., 1989; Stoufflet et al., 1989). Today, we lack knowledge of the optimal time of moving mated female mink to the whelping cage; optimal for both animal welfare and the reproductive output. Therefore, we investigated whether timing of movement before delivery – EARLY (Day −36), INTERMEDIATE (Day −18) or LATE (Day −3) relative to the expected day of birth (Day 0) – affects maternal stress, maternal care, and the early kit vitality (estimated by e.g. growth and calls). We hypothesized that early movement to an environment with extra nest building material is beneficial for mink mothers and their offspring, in comparison to intermediate or later movement closer to the time of delivery.

2. Materials and methods

2.1. Animals

We used 180 one-year-old female mink of a brown colour type, each individual mated twice with the same male. The mink were mated according to standard farm procedures, cf. description in Malmkvist et al. (1997), with a ratio of one male to five females. The experimental females were all mated for the first time between March 5 and 9 2012, and for the second time eight days later. The mink were exposed to natural lighting at the farm of Aarhus University, DK-8830 Tjele, Denmark. Breeding mink were housed in wire cages (from Hedensted-Gruppen, DK-8722 Hedensted, Denmark; W: 30 cm, H: 45 cm, L: 91 cm) connected to a wooden nest box with wire ceiling (W: 28 cm, H: 20 cm, L: 23 cm) with access to a layer of chopped barley straw on the top of each nest box. In addition, each cage was equipped with a shelf – one wire tube cylinder (l: 32 cm, diameter: 11 cm) fixed to the cage ceiling – in accordance to the Danish legislation (Ministry of Food, Agriculture and Fisheries of Denmark, 2006). Standard commercial wet feed (Holstebro Minkfodercentral, DK-7500 Holstebro, Denmark; Energy Density 122.7 kcal/g, ME: 50.1% protein, 39.9% carbohydrate, 10.0% fat) and water were available ad libitum.

2.2. Study design and treatment

The 180 mated females were randomly allocated – however with no sisters within each group and distributing half-sisters evenly with 4 females per group – to three equally sized treatment groups ($n = 60$) with different timing of transfer to whelping cages:

(i) 'EARLY', transfer to maternity unit early in the pregnancy period, early after the end of the mating period, March 23.
(ii) 'INTERMEDIATE', transfer to maternity unit in the middle of the pregnancy period, April 10.
(iii) 'LATE', transfer to maternity unit late in the pregnancy period, April 25.

Group EARLY was moved in average on Day −36, INTERMEDIATE on Day −18, and group LATE on Day −3 relative to the day of expected delivery (Day 0), calculated as 45 days after the date of the second mating (cf. study time line, Fig. 1). The timing of the transfer in relation to the actual day of delivery is illustrated in Fig. 2 for all treatment groups.

At the morning of transfer, mink were individually trapped (using wired trapping cages from Hedensted-Gruppen, DK-8722 Hedensted, Denmark) and moved by hand to the maternity unit, in a different shed – larger and more closed, i.e. offering more thermal and wind protection – at the farm, within a distance of 50–200 m. The treatment groups were evenly dispersed within this shed. The size of cages and nest box in the maternity unit was as previously described, but cages were cleaned and nest boxes were additionally prepared for delivery (i.e. lined with barley straw and nest-opening protected by a wind breaker), and the caged bottom equipped with a removable