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ScienceDirect
Theriogenology 72 (2009) 190–197
Theriogenology
www.theriojournal.com

Variation in gestation length among captive reindeer (*Rangifer tarandus tarandus*)

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Received 1 October 2008; received in revised form 16 January 2009; accepted 26 January 2009

Abstract

An estimated 90% of reindeer females are mated in a 10- to 21-d interval and give birth in an equally synchronized manner. Reported gestation length in reindeer is highly variable (range, 203 to 240 d), almost twice the reindeer estrous cycle length. Previously, we identified a significant, negative relationship between gestation length and conception date in a small group of reindeer. In the current study, the negative relationship was investigated in a switchback design, where reindeer were divided into two groups synchronized for early and late mating over a 2-yr trial. Regression analysis of 11 paired observations produced a negative ($P < 0.001$) association between gestation length and conception date (slope = − 0.31). Dam weight at breeding and prior to parturition, calf birth weight, and calf sex were not significant variables in the regression. Regression analysis of a larger data set from two University of Alaska Fairbanks reindeer herds, where conception date (verified by systemic progesterone) and gestation length were recorded (historical data set), supported previous conclusions ($n = 70$; slope = −0.37; $P < 0.001$). Although the calf sex ratio did not differ with gestation length, there was a positive relationship ($r^2 = 0.19$; $P = 0.014$) between male birth weight and gestation length in the larger data set. The negative relationship between conception date and gestation length enhanced calving synchrony, though the limits of gestation plasticity and underlying mechanisms are not clear. The potential role of photoperiod on early embryonic development is discussed.

Keywords: Calving synchrony; Gestation length; *Rangifer tarandus*; Reindeer

1. Introduction

In temperate and higher latitude environments, survival of ruminant offspring is strongly influenced by synchronized parturition [1,2]. This is particularly evident among reindeer and caribou populations constrained by the highly seasonal circumpolar environment. Among free-ranging *Rangifer* an estimated 90% of females are mated in a 10- to 21-d period [3–5] and give birth in an equally synchronized manner the following spring [6]. Although calving within a population remains highly synchronized, the timing of calving among different populations may be spread over ≥4 wk [7–9]. Differences in timing of calving have been related to latitude and the onset of breeding [6], plant phenology [7,10], predation [10], and maternal nutrition and condition [11,12]. Gestation length is considered a physiologically fixed or genetic parameter [4,6,8,11,13]. Despite this, estimates of gestation length

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0093-691X/$ – see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.theriogenology.2009.01.022

in reindeer vary from 203 to 240 d, a range that is almost twice the length of the estrous cycle [14]. Variability in gestation length among free-ranging reindeer has been associated with factors such as maternal age and undernutrition in late gestation [8,11], although we reported gestation lengths varying from 203 to 229 d in a cohort ($n = 8$) of well-nourished, primaparous, 3-yr-old reindeer [15]. Further analysis of the data for captive reindeer at the University of Alaska Fairbanks (UAF), where conception, confirmed by systemic progesterone (P_4) concentrations, and calving date were known ($n = 39$), produced a significant, negative correlation between length of gestation and date of breeding. Females bred early in the season had a longer gestation than that of females bred later in the fall [16]. This phenomenon in reindeer was reported anecdotally in the Russian husbandry literature in 1939, cited in Ref. 3. More recently, a negative correlation between gestation length and conception date has been reported in Finnish reindeer [17] and red deer [18,19].

In this study we further investigated the negative relationship between conception date and gestation length by (a) manipulating conception date in captive reindeer using a switchback design and (b) analyzing a data set of paired conception/parturition dates collected over the past 20 yr from two UAF reindeer herds.

2. Materials and methods

2.1. Switchback study

Captive reindeer from the Robert G. White Large Animal Research Station, Institute of Arctic Biology, UAF, were used in this study. The reindeer were born at the research station, halter broken as calves, and fully accustomed to handling by humans. Reindeer were fed a balanced reindeer ration ad libitum. All study procedures were approved by the UAF Institutional Animal Care and Use Committee (protocol no. 06–35).

In the first year, 17 reindeer were divided into two groups balanced for age and weight. Estrus was synchronized in the first group for an early breeding (Gr 1-E; $n = 9$) and in the second group estrus was synchronized for a late breeding (Gr 2-L; $n = 8$). Estrus synchronization in both groups was accomplished using modified bovine intravaginal progesterone-releasing CIDRs (EAZI-BREED CIDR; Pfizer Animal Health, New York, NY, USA; modified according to manufacturer's instructions to accommodate the smaller reindeer vagina). The CIDRs were removed 7 d after insertion, and the reindeer were treated with Lutalyse (dinoprost tromethamine 15 mg im; Pharmacia & Upjohn Co., Kalamazoo, MI, USA). In Year 1, reindeer in Gr 1-E were placed in a pen with a fertile male immediately after the synchronization protocol on 24 August. Reindeer in Gr 2-L were added to the same pen immediately after the synchronization protocol on 21 September, and the bull remained with both groups until he was removed on 25 October. The 17 females remained as a single group until calving. Females that either failed to conceive to the synchronized estrus or failed to produce a live calf the following spring were eliminated from the second year of the study. In Year 2, the groups were reversed: Gr 2 reindeer were synchronized for early breeding (Gr 2-E; $n = 6$) and placed in a harem with the same bull from the previous year on 23 August. Reindeer from Gr 1 were synchronized for late breeding (Gr 1-L; $n = 7$) and added to the same pen on 20 September. The bull was removed on 25 October, and the females remained in a single group until calving.

In Year 1, jugular blood samples were collected every week from each group, beginning with CIDR insertion and continued weekly over the winter as part of another study. In Year 2, blood samples were collected twice weekly from both groups beginning 8 August and continued until 3 November. Plasma was extracted from the samples within 1 h of collection and frozen at $-20\ ^{\circ}C$ until assayed by radioimmunoassay for P_4. Elevated systemic P_4 for 6 wk after bull introduction was considered indicative of pregnancy. Systemic P_4 concentrations during the first 6 wk of pregnancy were compared between E and L groups.

Females were weighed each time blood sampling occurred. Date of calf birth, calf weight, and calf sex were recorded within 24 h after birth.

2.2. Progesterone assay

Plasma P_4 from the switchback study was determined by radioimmunoassay using commercial kits (Coat-A-Count; Siemens Medical Solutions, Malvern, PA, USA). Samples were run in five assays. Assay sensitivity was 0.02 ng/mL. High, medium, and low reference pools of reindeer plasma were used to calculate CV. Intra-assay CVs averaged 5.19%, 4.98%, and 10.74%, and interassay CVs were 6.97%, 7.52%, and 23.47% for high (11.18 ng/mL), medium (1.02 ng/mL), and low (0.33 ng/mL) pools of reindeer plasma, respectively.

Plasma P_4 was used to verify conception after estrus synchronization. Elevated P_4 concentrations calculated from the last low P_4 concentration, followed by a sustained rise lasting $\geq$42 d, were indicative of pregnancy [14].