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Sexually active bucks are efficient to stimulate female ovulatory activity during the anestrous season also under temperate latitudes

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ABSTRACT

Goats are seasonal breeders and photoperiod is the main cue controlling the onset and offset of the breeding season. Nevertheless introducing a sexually active buck in a group of females during anestrous can stimulate their reproductive function and induce ovulation. This "male-effect" is very efficient under subtropical latitudes, when using sexually active males previously stimulated by a photoperiodic treatment. However, there is less evidence of its feasibility under temperate latitudes where the more important variation in day length could be responsible for a stronger inhibition of female sexual activity. The aim of this study was therefore to determine whether intense sexual activity can be induced in alpine bucks during the non-breeding season by a long-day treatment under temperate latitude and if these males could be used to produce an efficient male-effect. Bucks (n = 21) were divided in two groups, one submitted to a photoperiodic treatment from November 1st to January 15th and then switched to natural photoperiod, while the other group remained entirely under the natural photoperiod. The ones submitted to this light treatment exhibit higher testicular volume and testosterone level 6 weeks after the end of the treatment. At the end of March, bucks were used to stimulate anestrous does (n = 41) continuously for 15 days. We showed that (a) light treatment was efficient to induce an increase of sexual activity in bucks and (b) that the introduction of stimulated bucks among females induced a significantly higher proportion of ovulation in anestrous does than control bucks (86% vs 5%). Our results indicate that under temperate latitudes induction of ovulation in females during the anestrous season is feasible using bucks treated with long-days during winter.

1. Introduction

Seasonality of reproduction is a common trait of many domestic species and this has been well studied in goats and sheep from temperate and subtropical latitudes. In seasonal breeds there is an alternation between a season of reproduction characterized in females by a succession

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of oestrus and ovulatory cycles and an anestrous and anovulatory period. In goats from subtropical and temperate latitudes, breeding season in females lasts from early autumn to late winter (Chemineau et al., 1992a), while bucks exhibit intense sexual activity from late summer to late winter (Delgadillo et al., 1992; Shelton, 1978).

Variation in day length has been highlighted as the main environmental cue that determines the time of breeding in goats (Chemineau et al., 2008; Delgadillo et al., 2004). However, other environmental parameters, such as socio-sexual signals, can have an impact on the onset of reproduction (Hutchinson, 1991; Martin et al., 2004; Rodríguez-Martínez et al., 2013). For example, introducing a male in a group of females induces and synchronizes their sexual activity: a phenomenon called the "male-effect".

Interestingly, the success of the male effect can be increased, under subtropical latitudes, by the use of sexually active bucks which have been previously treated with a long-day light treatment, inducing an intense sexual activity during the non-breeding season in March and April (Chemineau et al., 1992b; Delgadillo et al., 2014, 2001). These sexually active males are very efficient to induce ovulations and estrous behavior in does during the seasonal anestrous (Delgadillo et al., 2002; Flores et al., 2000; Luna-Orozco et al., 2012).

Under temperate latitudes, it has been shown for instance that the use of light treatments for both males and females is needed to get an efficient "male-effect" (Chemineau, 1989; Chemineau et al., 1986). Indeed, despite the fact that photoperiodic treatment can stimulate successfully buck sexual behavior (Delgadillo et al., 1991), females do not show an efficient response following the introduction of these males: only 10% of untreated does ovulated when exposed to a stimulated buck from April 15th to May 27th, while 91% of ovulating does were detected in the group treated by light and melatonin at the same time (Chemineau, 1989). Hence, the protocols of induction of ovulation in goats under temperate latitudes always imply a treatment of both sexes before the "male-effect" (Pellicer-Rubio et al., 2007).

Therefore, performing successfully an efficient "male-effect" by using only light-treated bucks (and not females) has never been reported. Study showing the possibility to induce estrous in alpine does using only photo-stimulated bucks were carried under subtropical latitudes (Delgadillo and Vélez, 2010) but its feasibility under temperate latitudes has not yet been demonstrated.

Variation in day length, which is the main cue regulating seasonal breeding in goats, is much more important under temperate latitudes (from 8 to 16 h) than in the subtropics (from 10 to 14 h). This greater variation in the duration of photoperiod may induce, during the non-breeding season, a deeper anestrous in does raised under temperate latitudes and therefore, the response of those females to male stimulation could be less efficient. Therefore, the aim of our study was to test, in goats raised under temperate latitudes, whether photo-stimulated bucks, showing an intense sexual activity are efficient to induce ovulations in anestrous alpine does by the male effect. This hypothesis is based on our previous works performed under sub-tropical latitudes, which have shown the importance of male sexual activity in obtaining a high percentage of does responding to the male effect.

2. Materials and methods

2.1. Animals

Experiments were carried out from October 2013 to August 2014 in Nouzilly, France (latitude 47° 32N and longitude 0° 46E) on adult alpine goats (*Capra hircus*). A total of 62 animals were used, 41 multiparous non-lactating females and 21 males; they were maintained indoors during the experiment. Animals were fed daily with barley straw, lucerne hay and commercial concentrate, with free access to water and mineral blocks. All procedures were performed in accordance with the European directive 2010/63/EU on the protection of animals used for scientific purposes and approved by an ethical committee for animal experimentation (CEEA VdL, Tours, France).

2.2. Photoperiodic treatment

Twenty-one bucks were used and were divided in two groups. One group (n = 11) was submitted to a photoperiodic treatment of long days (16 h of light and 8 h of darkness per day) from November 1st to January 15th. This treatment was provided in a light proof building and the intensity of the artificial light provided was at least 300lx at the level of the eyes of the animals. From January 16th to the end of the study, the light treatment was stopped and the bucks were moved to inside barns exposed to natural light and therefore exposed to the natural photoperiodic conditions (Fig. 1). This treatment is sufficient to stimulate the male reproductive activity, during the non-breeding season in temperate and subtropical goats, after 45–60 days of exposure to natural light variation or to short days (Delgadillo et al., 2014, 2002, 1991). Control males (n = 10) were housed into outside barns and therefore exposed to the natural variation of day length during the whole experiment.

2.3. Measures

To evaluate the efficiency of the photoperiodic treatment, the testicular volume and blood level of testosterone were assessed periodically from October to April following validated methods. Testicular volume was estimated for each buck periodically. The determinations were performed by the same operator to avoid inter-individual variations (Delgadillo et al., 2002; Oldham et al., 1978). Regarding blood samples, all males were collected by jugular venipuncture from October to end of March in 5 mL tubes containing heparin. Plasma was obtained after 30 min of centrifugation at 3500 g. Testosterone concentration was determined in duplicate samples using a radioimmunoassay as described previously (Hochereau-de-Reviers et al., 1990). Sensibility of this assay was 0.1 ng/mL. The mean intra-assay and inter-assay coefficient of variation were respectively <5% and <14%.