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Validation of automated electronic oestrus detection in sheep as an alternative to visual observation

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ABSTRACT

The objective of this work is to determine the efficiency of the electronic oestrus detection system Alpha-Detector (AD) in sheep. Males are equipped with a harness carrying the electronic device. This original system consists of a custom RFID reader which is triggered at the time of mounting to read the transponder that is placed on the females' rump. This detector stores the ID number of ewe together with date and time of each mount. Two trials were developed with Merinos d'Arles sheep. In Trial 1, visual observations (VO, i.e., continuous video records) were compared to readings made by 2 rams on 12 ewes. Ewes were allocated into two groups and were followed up for a period of two oestrous cycles i.e., hormonally induced oestrus (C1) and natural oestrus (C2). In Trial 2, 30 ewes tagged with a caudal transponder were naturally sired by a ram equipped with AD. In Trial 1, despite a widespread of the number of mounts per ewe (i.e., from 2 to 83), the AD allowed detection of 100% of the females that came in oestrus (11/12 in C1 and 8/12 in C2). Hence, when considering only standing oestrus, the coincidence of true mounts reaches 94% (342 readings/364 observed mounts). With regard to males' sexual activity, the first ram M1 did 242 mounts, while only 110 mounts were recorded for the second male M2. Overall Khi-2 analysis confirmed highly significant ($p < 0.0001$) difference in male activity both due to a male difference (M1 > M2) and to a cycle effect (C1 > C2). This decline of sexual activity is assumed to be due to the onset of seasonal anoestrous.

In Trial 2, oestrus occurrences, signaled by frequent mountings of the ram, were constantly distributed along time. All ewes displayed an oestrus during the first cycle (C1 i.e., 17 days with the first ram). There is also a wide range in the number of mounts per ewes (from 3 to 205). Remarkably, 2 ewes that were mounted during first cycle came back in oestrus 17 days later as revealed by frequent mountings of the second ram in C2. Lambing dates confirmed the time of conception observed with the AD. As observed in Trial 1, it is however necessary to discard isolated mounts that occurred just after male introduction and did not correspond to standing oestrus (no further readings within 6 h).

With the AD device 100% of oestrus ewes were detected. Many researches on reproductive physiology and behavior that can be developed with this device are presented for small-ruminants at large.

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1. Introduction

Efficiency of reproduction in a sheep flock depends on both male and female factors. On the male side it is well known that ram sexual behavior is rather different among individuals although the general behavioral pattern is conserved (Price et al., 2000; Bench et al., 2001). This has been confirmed by the beneficial effect on the overall fertility of controlling ram libido before servicing in the flock (Alexander et al., 2012). On the female side, it is of major concern to reliably detect females in estrus especially when Artificial Inseminations (AI) are to be performed. The only field indicator that a female is in oestrus is her acceptance of the male in mounting. Using this indicator, the most widely used technique for recording the occurrence of oestrus employs a marker crayon on the male (Radford et al., 1960), along with periodic visual observations of the females. At best it is inconvenient to observe mating directly and under field conditions it is usually impossible to do so, not to mention of the time this required to make repeated observations, errors due to poor or improper marking, and the inability to

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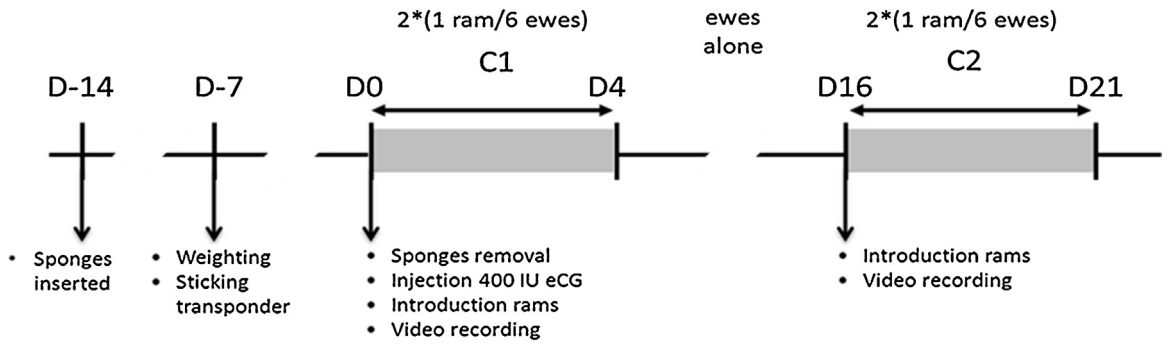

Fig. 1. Schematic representation of the experimental design (D, day). Two groups of 6 Merinos d'Arles ewes were placed with a vasectomized ram, equipped with the electronic device, either at their first oestrous cycle (C1), i.e., just after oestrus synchronization (FGA and eCG), or during their following natural oestrus (C2).

determine the number of mountings per oestrus period. Other techniques include video recording for continuous monitoring, these technics also have obvious disadvantages. Furthermore, for males and females of small-ruminants an important peculiarity is that sheep and goats are seasonal breeders (Ortavant et al., 1988). This further re-inforces the interest of estimating females' sexual activities (ovarian cyclicity and estrous behavior) along the year.

In ruminants, most of progresses in monitoring oestrus occurrence have been made in dairy cows probably because the costs of subfertility (Boichard, 1990) are far higher than in small ruminants. The second cause may be the extensive use of hormonal treatments in sheep and goats in developed countries that allows mating or insemination at fixed time, i.e., without checking occurrence of oestrus in the females (Colas, 1979 in the ewe; Corteel et al., 1988 in the goat) whatever the season. In cattle, available oestrus detection devices are based on measurements of changes in sexual behavior through individual mountings among cows (HeatWatch®; Peralta et al., 2005; DEC®; Saumande, 2002) or through activity-meters (HeatTime: At-Taras and Spahr, 2001; Valenza et al., 2012). Camera-software systems sometimes replaced direct visual observations of female behavior (Bruyère et al., 2012; Peralta et al., 2005). For this purpose, direct endocrine parameters of the oestrous cycle have also been used including milk progesterone (Firk et al., 2002) or indirect ones like changes in body temperature (Geers et al., 1997). The heat detection rate of most of these devices is above 70% with a specificity of detection generally above 90% (Saint-Dizier and Chastant-Maillard, 2012; Firk et al., 2002).

Based on automated measurements of males and females sexual behaviors, an original device has been developed for heat detection in sheep (Bocquier, 2005). Due to the flock size in small ruminant equipping each female, like in cattle, would be prohibitive. This is probably the reason why no device has been yet proposed. In addition, up to now, AI are mostly performed on females that have been previously synchronized. This however is not allowed in organic farming system, preventing breeder from performing AI. The only possibility would be to carry out insemination of females possibly synchronized by a male effect (Bocquier et al., 2009) if oestrus detection could be done easily.

The objective of the present work is to evaluate the efficiency and specificity of this original electronic device that records males' mountings of females in estrous. For this aim, rams, that were equipped with the electronic device, were put with ewes that were either hormonally synchronized (Trial 1) or naturally mated (Trial 2).

2. Materials and methods

All experiments were approved by INRA and Regional Ethic Group Montpellier and were compliant with the Animal Research Act 1985 in accordance with ethical principles that have their origins in the European Union directive 2010/63/EU.

2.1. First trial (T1)

2.1.1. Animals and treatment groups

This experiment was conducted in SupAgro domain du Merle (Lat. 43.64°N, Long. 5.02°E) in southeastern France. Twelve multiparous Merinos d'Arles ewes (45.2 ± 6.2 kg, mean ± SD) were allocated in two groups and their cycles were blocked with progestagen (20 mg fluorogestone acetate (FGA) impregnated vaginal sponge for 14 days, (Chronogest CR, Intervet) and synchronized with an injection of gonadotropin (400 IU equine chorionic gonadotropin (eCG), Intervet) at time of sponge removal. Ewes were followed up during their two cycles (C1 induced and C2 natural) in spring (starting on the 5th of April). Two vasectomized rams (one male per group: i.e., M1 and M2) equipped with Alpha Detectors (AD) were introduced at the time of sponge removal. They were kept 4 days (C1), then removed for 12 days and then re-introduced in the opposite group of females for a 5-days period (C2) (Fig. 1). The experimental barn was equipped with two video cameras. These cameras were connected to a computer that continuously recorded video files in order to follow the behavior of animals thanks to painted identification on the back of ewes. Noted behaviors were mount attempts (the ram raises his front feet but it does not settle firmly over the female) and standing mounts (the ram settle soundly on the ewe). Artificial lighting allowed night recordings. These ewes were normally fed with hay and straw. They had free access to water.

2.2. Second trial (T2)

2.2.1. Animals and treatment groups

This trial was conducted in INRA experimental station of Fréjorgues near Montpellier (Lat. 43.59°N, Long. 3.96°E). Thirty adult Merinos d'Arles ewes were randomly chosen in the flock for having previously lambed (bodyweight 53.9 ± 4.2 kg). These ewes were normally fed twice daily and had free access to water. A fertile ram (no. 6061), equipped with the electronic device (AD), was introduced at the beginning of the trial (October 21th) and was further removed after 17 days and being immediately replaced by another equipped fertile ram (no. 1429) until the end of observations (November 14th). Animals were considered to be in their sexual season (i.e., Fall). Blood samples were taken on day 30 and 62 after the end of trial to obtain an early pregnancy diagnosis by mean of dosing plasma PSPB (El Amiri et al., 2003). In addition lambing dates allowed determining if ewes were fertilized during their first or their second oestrus.

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