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Interactions between parasitic infections and reproductive efficiency in sheep

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ABSTRACT

This review article summarises the many reports in the literature, confirming that, in sheep, parasitic infections can adversely affect reproductive efficiency; examples, which refer to all parts of the reproductive cycle of sheep, are as follows: trichostrongylosis in ewe-lambs (which can lead to delayed attainment of puberty), myiosis of the prepuce (which can cause impediment of mating), chorioptic mange or trypanosomosis in rams (which can lead to testicular degeneration or azoospermia, respectively), trypanosomosis or sarcoptic mange in pre-conceptual ewes (which can lead to poor conception rates or reduced number of ovulations, respectively), toxoplasmosis or neosporosis in pregnant ewes (which are causes of abortion), trichostrongylosis or trematode infections in lactating ewes (which can cause reduction of milk yield and can be a risk factor for mastitis, respectively), cryptosporidiosis in newborn lambs (which can be a cause of deaths), coccidiosis in growing pre-weaned lambs (which can cause suboptimal growth rate). In other cases, the reproductive status of the animal can influence the parasitic infection; examples are as follows: the increase in faecal parasitic output during the peri-parturient period (as a consequence of the peri-parturient relaxation of immunity), the heavier trichostrongylid infections of twin lambs compared to lambs from single parities (as a consequence of developmental origin issues in twin lambs). All the above examples support the idea of presence of interactions between parasitic infections and reproductive efficiency in sheep.

1. Introduction

In sheep, 'reproductive efficiency' includes the ability of ewes to ovulate, be mated, conceive with semen from fertile rams, carry foetuses to term and, finally, lamb live-born lambs, which will be weaned in the appropriate time at an optimal bodyweight. The term implies efficient conception through active gametes, uninterrupted pregnancy, normal delivery of the newborn(s) ('eutocia'), unimpaired lactation of the ewes and survival and optimal growth of the lamb(s). In sheep flocks, increased reproductive efficiency is the cornerstone for profitability; the naturally occurring anoestrus period (the duration of which differs according to the location of flocks) can impede the reproductive efficiency. Hence, maintenance of high reproductive performance of sheep should be a priority for everybody involved (Amiridis and Fthenakis, 2012).

Parasitic infections are widespread in sheep (Papadopoulos and Fthenakis, 2012). A variety of endo- or ecto-parasites can affect these animals and their adverse effects on health, production and welfare have been repeatedly documented (Taylor et al., 2007; Sargison, 2009).

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Within this frame, trichostrongylid gastrointestinal infections currently are among the major challenges in sheep health management, due to the widespread anthelmintic resistance in many parts of the world (Papadopoulos et al., 2012; Torres-Acosta et al., 2012), which increases potential adverse effects in health and welfare of animals.

The present paper reviews and discusses interactions between parasitic infections and reproductive efficiency in sheep. The article focuses only on direct effects of parasites on the reproductive efficiency of sheep. Nevertheless, it is noteworthy that many arthropods (flies, midges, ticks, etc.) can transmit various infective agents, which may adversely affect the reproductive efficiency of sheep. Examples of such agents include *Anaplasma phagocytophilum* (Stuen and Longbottom, 2011), as well as various viruses, e.g., the Bluetongue virus (Osburn, 2007), the Rift Valley Fever virus (Bath, 2007) and the Schmallenberg virus (Lievaart-Peterson et al., 2012), which have a foetopathic and/or abortifacient effect. In this article, the topics are organised in a pattern according to the reproductive cycle of small ruminants.

2. Attainment of puberty by ewe-lambs

Puberty is the end point of a series of events affecting the development of the 'hypothalamo–pituitary–gonadal' axis leading to reproductive competence. From a practical point of view, puberty for females is the age at which the animal can support pregnancy to term. Puberty is a complex mechanism involving primarily the reactivation of the gonadotropin-releasing hormone (GnRH) secretory system, affected by various factors (Senger, 2003; Ebling, 2005). Among those, energy-deprived animals have been found to have a delayed puberty that has been attributed to a lesser frequency of GnRH pulses and accordingly of luteinizing hormone (LH) pulses (Foster and Olster, 1985; Foster et al., 1985; I'anson et al., 1997; Polkowska et al., 2003). The age at which ewe-lambs are mated, is crucial for productivity of a flock, since cost is high for maintaining unbred animals in a flock. Management of ewe-lambs for enhanced reproductive performance requires increased energy availability. This can be achieved by either increasing energy intake by the animal (i.e., availability of high-energy ration or increased quantity of feed) or by reducing its energy drains (e.g., anthelmintic treatment) (Valasi et al., 2012). Possibly therefore, parasitic infections can have an effect in attainment of puberty through interaction with energy intake as discussed herebelow.

There is evidence that parasitic infections, specifically gastrointestinal trichostrongylid (Mavrogianni et al., 2011) or *Trypanosoma congolense* (Osaer et al., 1999) infections, can adversely affect onset of puberty and age at first lambing by depressing weight gain of affected animals. Administration of a long-acting nematocide anthelmintic, which effectively protected treated ewe-lambs for up to 85 days post-ram introduction, allowed treated animals to exhibit their full reproductive potential during that time (Mavrogianni et al., 2011). Treated ewe-lambs showed earlier reproductive activity, as expressed by short 'interval to first mating after ram introduction' and increased 'cycling rate'; this resulted in significantly younger 'age at first mating' (Mavrogianni et al., 2011). Anthelmintic-treated ewe-lambs reached heavier bodyweight, which is a determinant for puberty in sheep (Valasi et al., 2012); thus, they were mated and conceived earlier than untreated controls. There are also similar findings in cattle, showing that nematode-infected heifers reach puberty with a delay compared to uninfected animals (Díaz-Torga et al., 2001).

3. Mating

Genital myiosis caused by various dipteran insects, can lead to vulvar oedema and subcutaneous fistulae around the vulva in ewes and to difficult/partial exteriorising of penis and markedly thickened prepuce with subcutaneous fistulae along the tissue in rams (Fragkou et al., 2013). These lesions can impede mating. Development of myiosis lesions takes place during the summer months (Wall, 2012). At para-Mediterranean areas and other locations of similar (north hemisphere) or of respective (south hemisphere) geographical latitude, summer months coincide with the sheep reproductive season; at more northern (north hemisphere) or more southern (south hemisphere) latitudes, they precede that period (Abecia et al., 2011, 2012).

Tick predilection for the genital organs (vulvar mucosa, scrotum) of sheep has been reported (Fourie and Kok, 1995; Mbuh et al., 2008) and may be responsible for local nuisance and/or inflammatory reaction, which may also adversely affect mating. One may also suggest that ectoparasitic infections with intense pruritus (e.g., heavy lice infestation, mange) could lead to reduced mating activity of rams, as these animals would be busy scratching rather than being sexually active.

4. Testicular function

Ridler et al. (2012) have proposed that parasitic diseases can affect the scrotal circumference of rams and that parasite control is important for keeping rams sound for breeding. Scrotal circumference in rams has been associated with their reproductive performance (Kafi et al., 2004; Gouletsou and Fthenakis, 2010). However, Gaglio et al. (2010) have not identified a significant effect of gastrointestinal trichostrongylid infection to semen parametres in rams.

(Rhodes, 1975, 1976) has presented evidence that extensive chorioptic mange in the scrotum of rams led to reduced quality of their semen, due to seminal degeneration, as a consequence of long-standing increased intra-scrotal temperature due to the inflammation; semen quality was restored after cure of the skin lesions. Lopes et al. (2009) have identified that *Toxoplasma gondii*-infected rams have produced smaller volumes of ejaculate than healthy animals, whilst Sangare et al. (2010) have reported azoospermia in *Tr. congolense*-infected rams. Finally, Sarasa et al. (2011) have reported that sarcoptic mange can cause reduction of the testicular mass in *Capra pyrenaica* (a wild small ruminant); these findings may have implications for sheep, in which species sarcoptic mange is a significant health problem (Doukas et al., 2007).