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Dissemination of parasites by animal movements in small ruminant farms

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ABSTRACT

The present paper discusses the spread of parasites by animal movements in small ruminant farms; it focuses in dissemination of parasitic forms that would lead to subsequent infection of sheep or goats. Systems of small ruminant production involve a component of animal movement (e.g., grazing) as part of routine husbandry, which favors spread of parasitic forms; that refers mainly to parasites of the digestive system (nematodes, trematodes, cestodes, protozoa), as well as helminthes of the respiratory system, although dissemination of the various parasitic forms in the environment would not always result to subsequent infection; external parasites may also be disseminated during movements, e.g., to inhabit wooden poles used in fencing. New livestock into a farm constitutes a biosecurity hazard and the most common means to introducing new parasitic pathogens into a farm; in contemporary small ruminant health management, this contributes in dissemination of anthelmintic resistant parasitic strains; other parasitic disease agents (e.g., mange mites, ticks) may also be spread into a farm that way. Often, especially in small scale farming, visits of rams or bucks take place from one farm to another during the mating season; in such cases, ectoparasites (e.g., mange mites) can be disseminated through direct contact of animals, as well other pathogens (e.g., *Toxoplasma gondii*, *Neospora caninum*) via the semen. During transportation of sheep/goats, parasitic forms can also spread, as well as during movement of sheep or goats to slaughterhouses, in which case dogs present in these places would contribute to their dissemination. Spread of life forms of various parasites can also occur from animal species present in the environment of sheep or goats; these include animals present within a farm, stray dogs roaming around a farm (e.g., for spread of *Multiceps multiceps*, *Echinococcus granulosus*, *Taenia hydatigena*, *N. caninum*), cats commanding the environment of a farm (e.g., for spread of *T. gondii*), cats or rats responsible for dissemination of fleas, which may also be spread by humans as well, and, finally, wildlife animals. Finally, life forms of parasites of small ruminants may be also spread indirectly, by material associated with sheep or goats (e.g., materials of humans visiting farms, animal feeds) that had been contaminated by faecal material of animals.

1. Introduction

In sheep/goat production, animal movements are part of the farm management and pose biosecurity risks as populations mix for transfer of pathogens, including parasites. Biosecurity risks may arise from movements of same species (intra-farm or inter-farm), as well as of other animal species; humans may also be involved in biosecurity problems.

Most management systems involve a component of intra-farm sheep/goat movement as part of routine husbandry (EFSA Panel in Animal Health and Welfare, 2014). This can be of smaller or greater extent, i.e., ranging from grazing of the animals in a small radius around the shed for part of the day (depending on grass availability and weather conditions) to continuous grazing in a large area throughout the year. Further, in some systems, different production groups (e.g., breeding ewes/does, fattening lambs/kids) are maintained separately, but still mix at some time-point, e.g., when replacement animals join the breeding females. Finally, the habit of transhumance is widely practiced in sheep flock/goat herds in many countries around the world; animals are transported at significantly large distances (even up to 500 km), hence commanding greatly varying territories and regions (Rancourt et al., 2006; Galanopoulos et al., 2011).

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Inter-farm movements of small ruminants may involve communal grazing in shared land, often at the same time. Other movements may also occur for various purposes, which are integral part of the agricultural business, e.g., animal sales to markets or directly to farms, as well as transports of animals to slaughterhouses. Further, the nature of the sheep or goat industry around the world includes various small scale movements of animals for specific purposes, e.g., visits of rams or bucks from one farm to another during the mating season, transports of animals to agricultural shows or to veterinary practices/hospitals.

There is increased evidence in the literature regarding dissemination of microbial agents by animal movements in small ruminant farms, mainly as the result of reduced biosecurity measures practiced in the farms. Nevertheless, there is a paucity of publications related to parasitic agents, which are widespread in small ruminants. A variety of endo- or ecto-parasites can affect these animals and their adverse effects in health, production and welfare have been repeatedly documented (Taylor et al., 2007; Sargison, 2009). The present paper discusses spread of parasites by animal movements in small ruminant farms; it is organized according to animal species involved (i.e., small ruminants or other species) and the type of movement and focuses in dissemination of parasitic forms that would lead to subsequent infection of sheep or goats. Apart from those, of course, risk of dissemination also depends on parasites involved: e.g., parasite type (endo- or ecto-parasite), biological cycle of parasites (direct or with intermediate hosts) etc.

2. Dissemination of parasites by movements of sheep or goats

2.1. Generally performed husbandry practices

Sheep and goats are herbivore animals. Grazing is a significant component of their management (bar in intensive systems) and this results in many helminthes being of particular significance as health problems in these species (Taylor et al., 2007; Sargison, 2009). Within this frame, trichostrongylid gastrointestinal infections 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 life-cycle of many parasites includes excretion of parasitic forms (eggs, oocysts or larvae) in the faeces of parasitised sheep or goats. This is the means by which these parasites are disseminated in the environment. These include internal parasites of the digestive system, nematodes (e.g., trichostrongylids [*Teladorsagia* spp., *Haemonchus* spp., *Trichostrongylus* spp., *Cooperia* spp.], *Nematodirus* spp., *Oesophagostomum* spp., *Bunostomum* spp., *Trichuris* spp., *Gongylonema pylchrum*), trematodes (e.g., *Fasciola hepatica*, *Dicrocoelium dendriticum*, *Paramphistomum* spp.), cestodes (e.g., *Moniezia* spp.) and protozoa (e.g., coccidia -*Eimeria* spp., *Cryptosporidium* spp.- and *Giardia* spp.), as well as helminthes of the respiratory system (*Dictyocaulus filaria*, *Protostrongylus rufescens*, *Cystocaulus ocreatus*, *Muellerius capillaris*, *Neostrongylus linearis*) (Reinecke, 1994; O'Connor et al., 2006; Thompson and Smith, 2011; Rojo-Vazquez et al., 2012; Taylor, 2012). In more rare occasions, parasitic forms may be disseminated by other seretions of the animals; for example, *Thelazia* spp. parasitise the eye of small ruminants and their eggs can be found in the ophthalmic secretions (Otranto and Traversa, 2005). Possibly, in cases of concurrent *Mannheimia haemolytica* infection, which is characterized by increased nasal and ophthalmic mucopurulent secretions (Scott, 2011), one may postulate that, perhaps, the secretions, often observed on the ground, might contain parasitic forms of *Thelazia* spp.

The excreted parasitic forms contaminate the environment. Usually, this refers to grazing paddocks, although in some circumstances (e.g., *F. hepatica*) water collections may also be contaminated (Sorensen and Minchella, 2001; Nouri et al., 2008). That way, animals within the flock/herd, as well as animals of other flocks/herds, which are moved through already grazed areas, are infected.

External parasites may also be disseminated during movement of small ruminants for grazing. For example, the various mange agents can inhabit wooden poles used in fencing as affected animals pass near those poles or scratch on them (Bates, 1996; Fthenakis et al., 2000; Arther, 2009). More rarely, lice and keds can attach themselves on various objects when animals pass near them.

Nevertheless, dissemination of the various parasitic forms in the environment does not always result to subsequent infection. In the case of helminthes with a direct life-cycle, presence of parasite eggs or infective larvae is necessary. In the latter case, hatching of the excreted eggs and development of the larvae, a process strongly influenced by environmental factors (Morgan and van Dijk, 2012), is necessary. Hence, grazing of sheep or goats during the summer in areas with increased temperatures (e.g., para-Mediterranean countries) would not always result in presence of infective forms, as the ambient conditions decrease hatchability of eggs and lead to death of larvae (Taylor et al., 2007). In the case of coccidian parasites, infection of adult animals at grazing is of little clinical significance itself. However, these animals will subsequently shed oocysts, often when they will be housed at the immediately post-partum period, which can lead to infection of their offspring (Saratsis et al., 2011). Of course, coccidian infections of growing or fattening lambs or kids occur when these animals graze with the adults before slaughter. In the case of helminthes with an indirect life-cycle, infection of other sheep or goats depends on the presence of the intermediate host, e.g., snails, ants or acari (genus *Oribatidae*) (Taylor et al., 2007). Finally, ectoparasites that have been disseminated in the environment, have a limited life span outside a host, hence after that, they may not infest new animals.

2.2. Introduction of new or returning animals into a farm

2.2.1. Introduction of new stock

Sales of small ruminants may take place through organized markets, as well as directly to farms, from other farmers or traders. Livestock introduction into a farm constitutes a significant biosecurity hazard and the most common means to introducing new pathogens into a farm. In contemporary small ruminant health management, a significant hazard is the potential introduction and spread of anthelmintic resistant parasitic strains into a naïve population; in fact, this is a very common means of dissemination of such strains (Sargison, 2009). In the past, transmissions from country to country or even from continent to continent have been reported (Várady et al., 1994). Other parasitic disease agents (e.g., mange mites, ticks) may also be spread into a farm that way.

As a basic measure to limit spread of resistant trichostrongylid strains, sheep or goats brought into a farm should be treated with a potentially effective antiparasitic agent and stay isolated from the main flock/herd for 14 days (Sargison, 2009, 2012). During that period, faeces should also be contained and destroyed to prevent spread of parasitic forms. Then, ideally, at the end of that period, faecal samples should be collected and examined parasitologically to confirm efficacy of the treatment, after which the new animals could join the main group into the farm.

In case of other parasitic diseases, appropriate treatment should be performed before the animals join the main flock/herd. However, the possibility that parasites may survive for a long period and be transmitted to other animals should be in mind. For example, in cases of sarcoptic mange, mites have been recovered from treated