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Review

The welfare of livestock transported by ship

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ABSTRACT

The transport of livestock by ship is growing in importance, but there are concerns about the welfare impact on the animals. Short sea journeys are usually completed in the vehicles that are used to transport the animals by road, and injury and stress can result. Long sea journeys require offloading of the animals into pens, where they are mixed and provided with feed, water and sometimes artificial ventilation. In addition, animals are often exposed to high stocking densities, elevated temperature and ammonia concentration, as well as noise and changes in photoperiod and light intensity. Mortality rate is the main measure of welfare used by the Australian live export industry for long distance shipments, and the rate is higher at sea compared to the same period of transport on land.

Heat stress often challenges livestock when they are transported from cold to hot regions at high stocking densities with no diurnal temperature fluctuation. Sheep cope with heat stress better than cattle, but can still develop respiratory alkalosis if hyperventilation ensues. *Bos taurus* cattle cope less well with heat stress than *Bos indicus* breeds. High ammonia concentrations may accumulate on long voyages, causing mucosal irritation and pulmonary inflammation. Some sheep and goats do not adapt to the pellets provided after extensive grazing in Australia, resulting in inanition, often in combination with salmonellosis, which together are the main cause of high mortality rates. Long distance transport may also result in disease transmission to the recipient country and high standards of biosecurity are necessary. It is concluded that there are significant risks to the welfare of livestock caused by transporting them in ships, especially over long distances.

Introduction

The economic value of exported ruminant livestock worldwide has been growing at about 4% per year (Phillips, 2008). Much of the export process involves transportation by ship, although some countries, such as New Zealand, have restricted this trade because of concerns about animal welfare. The major worldwide regions exporting livestock by ship are Australia, USA, Southern South America, the Horn of Africa and Ireland (Phillips, 2008). Australia is the leading exporting country, sending in 2011 a total of 2,529,028 sheep and 718,025 cattle overseas, mainly to the Middle East and South East Asia, respectively (Fisher and Jones, 2008; DAFF, 2012).

Livestock are transported by ship both as breeding animals, including dairy cows, and also for slaughter as meat animals (Phillips, 2008). Transport over short distances is usually required to traverse a sea between the region in which they were produced and the region in which they will be marketed (for example, the English Channel). In such situations the livestock transporter in which they arrive at the port is usually placed directly onto the ship. Although no direct comparisons have been undertaken between short ship and road transport, it appears that the welfare problems faced in the two systems of transport are similar, even if the extent of the consequences is different.

However, long distance transport of livestock by ship poses a different set of challenges to welfare. Here, ship transport is used to export animals because it is the most appropriate way to move them, compared with road or rail transport. Usually the animals are offloaded from their vehicle because of the need to feed, water and ventilate them in the ship if the journey lasts for several days. For example, livestock are carried by ship from South African ports, principally Durban, to Mauritius, a journey of 7–10 days, and the principle welfare issues are overloading and an inability of the livestock to feed, drink or rest (Menczer, 2008).

Exposure to high levels of noise, handling by humans, changes in photoperiod and light intensity, and forced movement up ramps could also affect the welfare of animals transported by sea. However, there has been no research to identify the importance of these components, which in the case of long distance transport can be differentiated from handling of animals for other purposes because of the increased risk of cumulative stress during the extended period. The response to the various stressors relevant to ship transport has been well studied under different circumstances, in

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particular land transport and handling for slaughter (see, for example, Grandin, 2007).

The high cost of shipment usually necessitates high stocking densities, similar to those found in intensive housing, which produces a need to deal with waste products. Long distances increase the likelihood that animals will enter climatic regions to which they are unadapted, and any risk of heat stress will be exacerbated by the high stocking densities unless these are accompanied by increased ventilation. Such journeys involve a change in diet, stocking density, social grouping, microclimate and housing, compared with their previous habitat, which was often pasture or rangeland.

In considering the welfare impact of the ship journey, it is important to recognise that it is a part of a much longer transport process. This usually includes mustering the animals, usually from rangelands, holding them before loading onto a transporter, transfer to an assembly depot near the port, holding for a few days to adapt to pellets and high stocking densities before loading onto another transporter to transfer to the port, offloading to enter the ship, the ship journey itself, offloading from the ship and loading onto another transporter, and finally travel to a feedlot, where they remain for at least a few weeks before transport to an abattoir (Phillips, 2008).

This paper reviews the scientific research that has been published which examines the impact of sea transport of livestock on their welfare. The focus has been on cattle and sheep, but a small number of articles addressing goats are included.

International standards

There are no international regulatory standards for the carriage of livestock by sea (Schultz-Altmann, 2008), but guidelines for the welfare of livestock transported by ship have been developed by the World Organisation for Animal Health (OIE)[1] in 2003–2004. These were subsequently incorporated into the OIE Terrestrial Animal Health Code (Norris, 2005), which includes minimum animal welfare and health standards during the pre-journey, loading, journey, unloading and post journey handling stages of sea transport (OIE, 2012). However, the recommendations are necessarily general because of the diverse range of participant countries, and they do not provide specific animal welfare indicators that could be measured. Moreover, they are not compulsory for livestock exporters to follow.

Vessel loading and design

The angle of ramps from the wharf to the ship often varies with the tide. The maximum loading ramp angle recommended for cattle is 20–25°, but sheep can manage steeper ramps (Grandin, 2008). Ship design may be specified nationally; for example, the Australian Maritime Safety Authority Marine Orders Part 43 specify that the maximum pen sizes are 21 m^2 and 40.5 m^2 for cattle and sheep, respectively, in order to reduce the risk of crushing injury and provide adequate access to feed and water (Schultz-Altmann, 2008). Also specified are deck loading capacity, rail strength and spacing (to avoid losing animals overboard on open decks) (Waghorn et al., 1995), passageway width and ceiling height. However, there is no indication that these standards are evidence-based. In particular, there is no empirical evidence for stocking densities on board ship, although it is logical that these should be determined from allometric relationships between bodyweight, space availability and behaviour (Petherick and Phillips, 2009).

[1] See: OIE (2012). World Organisation for Animal Health Terrestrial Animal Health Code: Chapter 7.2. Transport of Animals by Sea. http://www.oie.int/en/international-standard-setting/terrestrial-code/access-online/ (accessed 2 September 2012).

Ventilation

Ammonia accumulation is one of the biggest problems in highly stocked quarters. The concentration of ammonia has been observed to be positively correlated with temperature and moisture content of the air in two voyages from Australia to the Middle East (Pines and Phillips, 2011). Ventilation is usually only provided on closed decks, at 20–30 air changes/h, depending on ceiling height. Air speed, which is negatively correlated with ammonia concentration (Pines and Phillips, 2011), should be at least 0.5 m/s, but existing vessels do not always achieve this (Earley and Murray, 2010; Pines and Phillips, 2011).

Animal welfare indicators that could be used on ships

Behaviour is one of the best indicators of welfare in a system in which physiological indicators cannot be determined easily (Barnett and Hemsworth, 1990). Group structure has a major impact on the exhibition of deleterious behaviours, for example, homosexual and agonistic behaviours in groups of rams transported from New Zealand to Saudi Arabia (Black, 1997). After observing this problem, Black (1997) recommended mixing wethers and rams in a ratio of 1:3.

Evaluation of welfare of livestock in long distance shipments is difficult because there are only one or two stock people on each shipment and possibly one veterinarian, supported by crew, to observe and care for up to 100,000 animals. Thus assessment is usually limited to gross mortality rate figures provided by the veterinarian or observations of obvious disorders, such as limb fracture during loading or unloading (Pines et al., 2007).

A number of suitable welfare indicators specific to heat stress and ammonia accumulation during ship transport have been identified (respiration rate, ammonia concentrations, wet bulb temperature on board), but the people responsible, measurement technique, timing of measurements and position of recording instruments all need careful consideration (Pines and Phillips, 2011). Pockets of high ammonia concentrations are most common in enclosed spaces, on closed decks, near the engine block and at the front of the vessel, i.e. where ventilation is restricted or temperature is increased. Ammonia can be measured on ships by several methods, but fresh air calibration of the measuring device, stability of the reagent in a moving vessel and sampling method all present logistic difficulties (Pines and Phillips, 2011). Attempts to improve sampling methodology have compared different measuring devices and identified relationships between ammonia and climatic variables, faecal pad depth and sampling height above the floor on two voyages from Australia to the Middle East (Pines and Phillips, 2011).

Cattle voyages

The main risks to cattle welfare on long distance shipments from Australia to Asia are heat stress, respiratory disease, trauma and conjunctivitis (Norris et al., 2003). The mortality rate for all shipments from Australia during 1995–2000 was 0.2%, increasing to 0.5% for shipments to the Middle East (Norris et al., 2003). Despite evidence that transport myopathy was sometimes responsible for high mortality rates in cattle exported from New Zealand to South East Asia in the 1960s (Donaldson, 1970), selenium/vitamin E supplementation was not beneficial in correcting this (Andersen and Lowe, 1971). Exports from South Australian ports have the highest mortality rates of any Australian exports, as the cattle are cold-adapted *Bos taurus* type, compared with heat-adapted *Bos indicus* breeds from northern ports (Norris et al., 2003; Beatty et al., 2006).

Core body temperature, acid:base balance and immunity

Livestock on voyages between Australia and the Middle East may be exposed to mean maximum wet bulb temperatures of