Impact of sea transport on animal welfare: Assessing the welfare and feeding behaviour of horned and polled sheep and cattle during export

C.A. Stockman and A.L. Barnes, School of Veterinary and Biomedical Sciences, Murdoch University, MURDOCH WA 6150, a.barnes@murdoch.edu.au

Abstract

The social and feeding behaviours of sheep and cattle segregated according to whether they had horns were investigated during live shipment, to determine the effects of mixing animals with and without horns within specification. Two voyages, one each of Merino sheep and *Bos indicus*-cross cattle, were monitored using video surveillance and retrospective analysis of footage from specific times to determine the number of behavioural interactions and feeding events within two pens each of polled, horned (up to one full curl in sheep or 12cm in cattle), and mixed polled and horned animals. Concurrently, shipboard personnel recorded behaviour, daily feed intake, daily injury, death and disease of these animals. There was no evidence from the video footage that mixing polled and horned animals within specification resulted in negative health or behaviour outcomes for these animals. This was also the conclusion from the real-time observations made by shipboard personnel, although there were some differences in absolute number of interactions recorded by the two methods. Further observational studies of similar design were conducted on 15 short haul cattle voyages with shipboard personnel recording behaviour, daily feed intake, injury and death of animals in the experimental pens. Eleven of these voyages yielded usable data for analysis, and there was no indication from the records of any difference between experimental pens.

Introduction

The live export of sheep and cattle from Australia is regulated by government and the Australian Standards for the Export of Livestock (ASEL, 2006) give guidelines for the process. Before loading of a vessel, a plan is designed, which must be compliant with the ship safety standards, and give due consideration to the handling, holding and husbandry needs of different species and classes of animals (ASEL 2006, Standard 4). One aspect of the Standards relates to the carriage of horned and polled animals, and the original interpretation of the guidelines allowed cattle and sheep with horns within nominated specifications (cattle - less than 12 cm and blunt, and sheep - less than one full curl and a shape that will not cause eye damage or restrict feeding) to be mixed with polled animals in pens on board ship, if that was deemed appropriate, within the finite options for penning of the animals. However, subsequent re-interpretation by the Australian Quarantine & Inspection Service (AQIS) uncovered an anomaly where although it allowed the mixing of horned animals within the specification for selection, the standards for land transport, assembly and loading, and shipboard transport stipulated the segregation of "animals with, from animals lacking horns". The assumption by industry had been that "animals lacking horns" meant horns within specification, which were considered by industry not to hinder loading or affect animal welfare within the environs of a livestock vessel. The re-interpretation and segregation of horned and polled animals required additional handling, drafting, and alteration of previously formed social groups,

with concerns about the potential for additional unnecessary stress on the animals. For instance, drafting prior to transport causes a significant increase in plasma cortisol levels (Hargreaves *et al.* 1990). The development of a social hierarchy can result in increased activity of catecholamine – synthesizing enzyme (Mounier *et al.* 2005), indicating that the animals are stressed. There can be general turmoil during the development of the hierarchy so that the animals lack rest (Jarvis and Cockram 1995), and it can take several days for threats to replace physical interactions (Kondo and Hurnick 1990). One concern about mixing animals with and without horns is whether those dominant animals with horns might be more likely to cause injury, and whether there is more physical injury if some animals do not have horns.

The industry felt that these other considerations had sufficiently important impacts on the well-being of exported animals to warrant an investigation of the potential for injury and harm within mixed groups of animals. Mixed groups of animals, some with and some without horns (within specification) were compared to segregated groups, to determine the behaviour and feeding of the animals.

Materials and Methods

In all shipments used within this study ASEL guidelines were followed with the exception that in each shipment two of the experimental pens were composed of animals with mixed horn length (within specification). This study was approved by the Murdoch University Animal Ethics Committee.

Video recording of shipments

One sheep and one cattle voyage from Fremantle, Western Australia to the Middle East were monitored through video recording of animals in the experimental pens, with the footage from the voyage viewed and analysed subsequently.

Video equipment

The long period of continuous monitoring required for the duration of a voyage dictated the type of equipment that could be used, and a surveillance system was chosen. Two cameras (Digital CCD Colour Dome Camera, JayCar Western Australia QC3290) were fitted for each experimental pen, facing inwards from two different sides of each pen to capture as much detail as possible (Figure 1, 2). The cameras were attached to an enclosed polycarbonate box in which the connecting wires could be safely packed. The unit was attached to pillar walls using cable ties silicon sealant. Each camera unit had a cable providing power, and a coaxial cable connecting it to the digital video recorders (DVRs) (JayCar Western Australia QV3076). The cameras were initially set and launched using a Video Server computer programme to ensure they were facing the correct direction and focused, then set to record on a high quality setting at 25 frames per second for the duration of the voyage.

The cameras were removed and the recording from the DVRs retrieved after the voyages. The recording was viewed directly from the DVR via a laptop using the Video

Server viewing programme, which included a digital timer for all footage, so the correct sections could be viewed.

For the sections of video viewed, the following records were made for both sheep and cattle pens:

- Number of feeding events: Number of animals that put head in feeder during the monitored time period
- Number of animals lying down: Number of animals that lay down during the monitored time period.
- Number of physical interactions:
    - Number of mounting events
    - Number of pushing events: Number of times an animal pushed passed another animal
    - Number of bunting events: Number of times an animal pushed or bunted another animal with its head (on either the side or head-to-head).
- Number of non physical interactions (threats): A display of threatening behaviour leading to the recipient animal retreating
- Difficulty in putting head in feeder due to horn length (horned and mixed pens)

A repeated measures analysis of behavioural observations was used to determine effect of day and time between and within treatments.

Real-time observations

A detailed proforma was developed for use by stockmen and veterinarians to record the behaviour and interactions of the animals. The groups were observed for five minutes three times per day, just after feeding in the morning and afternoon, and in the middle of the day. These observations took place on the first four days, on 2 days thereafter midway through the voyage, and then on the day prior to unloading at the destination port. Video footage for these times was also viewed and numbers of interactions counted for comparison.

Behavioural observations were similar to those made using the video footage:

- Number of physical interactions (sum of number of pushes, mounting and bunting)
- Number of non physical threats (sum of non physical threatening behaviour causing the other animal to retreat)
- Number of feeding events
- Difficulty in putting head in feeder due to horn length (horned and mixed pens)

Daily injury, mortality and disease were recorded in each of the experimental pens during the voyage. Dry bulb temperature, humidity, wet bulb temperature and any problems with ventilation were also recorded daily. Daily feed intake (total per pen) was recorded.

Shipboard personnel that were designated to record results from the trial were also asked for any additional general comments on the proforma and the trial.

A number of other voyages used real-time observation only to record the behaviour of cattle grouped as above.

Sheep shipment

A commercial live shipment of sheep in January 2007 was used for the video recording. Two hundred and twenty-five four-tooth Merino wethers, from southern Western Australia, were assigned to the experiment. The sheep averaged 61 kg, condition score 2-3, and they were penned according to whether they had horns, at stocking rates that gave them the minimum pen area of 0.367 m2/ head (ALES 2006), as shown in Table 1.

Table 1: Pen treatment according to horn character of wethers during live shipment

Pen number	Pen size (m2)	Number of sheep in pen	Horn character of wethers
1	15.45	42	Mix of polled and horned
2	15.45	42	Mix of polled and horned
3	15.76	43	Horned only
4	15.76	43	Horned only
5	15.60	43	Polled only
6	15.45	42	Polled only

All pens were single tiered, enclosed and ventilated and were next to one another.

The sheep were fed a standard sheep shipper pellet at 2.2% body weight (as fed). Sheep are normally fed via automatic feeders while onboard; however, for purposes of monitoring feed intake, feed was given manually twice a day in experimental pens. Water was available *ad libitum* in automatic watering troughs.

The cameras recorded continuous footage for 16 days from when sheep were loaded until the end of the voyage, when sheep were unloaded upon reaching the Middle – East.

Video footage was viewed and the observations recorded for days 1, 5, 10 and 15 for 15 minutes four times a day at 000; 0600, 1200 and 1800; and also for five minutes a day morning, midday and afternoon on the same days that real-time observations were recorded.

Cattle shipment

Video and real time monitoring were carried out on one commercial live shipment of cattle in July/August 2007. Forty-two *Bos indicus* x *Bos taurus* bulls from Western Australia

were assigned to the experiment. The bulls averaged 425 kg, condition score 3-4, and they were penned according to whether they had horns, at stocking rates that gave them the minimum pen area of 2.2 m2/ head as shown in Table 2. This stocking rate was 20% less that the ALES (2003) standard, due to the time of the year, with hot conditions expected during the voyage.

Table 2: Pen treatment according to horn character of cattle during live shipment

Pen number	Pen size (m2)	Number of cattle in pen	Horn character of cattle
1	15.45	7	Mix of polled and horned up to 12cm
2	15.60	7	Mix of polled and horned up to 12cm
3	15.76	7	Horned only (up to 12cm)
4	15.76	7	Horned only (up to 12cm)
5	15.60	7	Polled only
6	15.45	7	Polled only

Animals were fed manually a standard shipper pellet at 3% body weight (as fed). Water was available *ad libitum* in automatic watering troughs.

The cameras recorded continuous footage from when cattle were loaded till day 13 of the voyage, two days before reaching the destination port. The decision was made by the shipboard veterinarian to end the video monitoring at that time because the gates were opened between replicate pens to allow more room for cattle to move around, due to the hot conditions experienced during the voyage. Allowing the cattle to move freely between the pens is a standard response under such conditions.

Video footage was viewed for days 1, 3, 5, 7 and 10, for 15 minutes 4 times a day at 000; 0600, 1200 and 1800; and also for five minutes a day morning, midday and afternoon on the same days that real-time observations were recorded.

Observation-only shipments

Fifteen cattle shipments nominated to be part of the experiment. Twelve shipments were ten days or less, to Indonesia or Malaysia, and three shipments were 15 or 16 days, two to the Middle East and one to Japan.

Onboard stockmen used the proforma as previously described to record real-time observations of cattle which had been penned as follows on each shipment:

- 2 pens of polled and horned animals, horns up to 12 cm
- 2 pens of only horned animals, horns up to 12cm
- 2 pens of only polled animals.

Cattle were fed manually each day to enable determination of daily feed intake per pen. Daily feed intake was recorded (total per pen, fed manually) as well as any injury, mortality and disease for each experimental pens during the voyage. Dry bulb temperature, humidity, wet bulb temperature and any problems with ventilation were also recorded daily.

Results

Sheep shipment

The shipment departed Fremantle on d 0 and stopped to unload at two ports (Muscat d 11 and Bahrain d 13) before the remaining sheep, including the experimental sheep, were unloaded at the final destination port in Kuwait (d 16).

Wet bulb temperature during the voyage reached a maximum daytime average of 28˚C on d 9 (Figure 1).

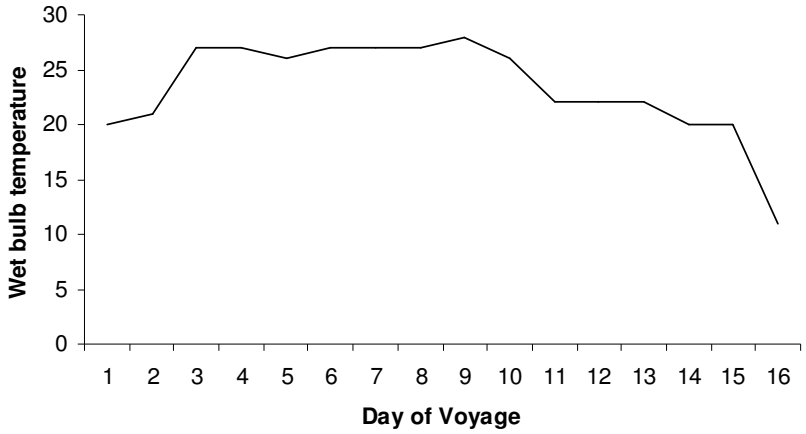

Figure 1: Average daily wet bulb temperature during sheep voyage

Total mortality rate for the shipment was 0.47%. There were no mortalities in the experimental pens. No injuries resulted from physical interactions within any of the experimental pens. Feed intake (per day) was between 70 and 100% of offered feed during the voyage (Figure 2) and there was no significant difference in feed intake between groups.

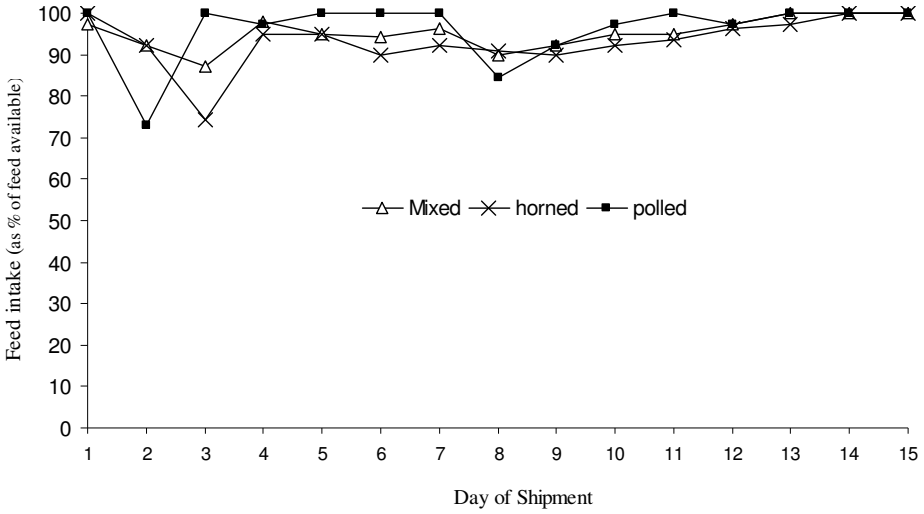

Figure 2: Mean feed intake of sheep in the mixed, horned or polled pens

Analysis of video footage found no significant differences in the number of sheep lying down, feeding, pushing, mounting, or non-physical threats between each of the experimental pens (Figure 3). However, there was significantly more bunting in the horned pens than in the mixed pens ($p<0.05$).

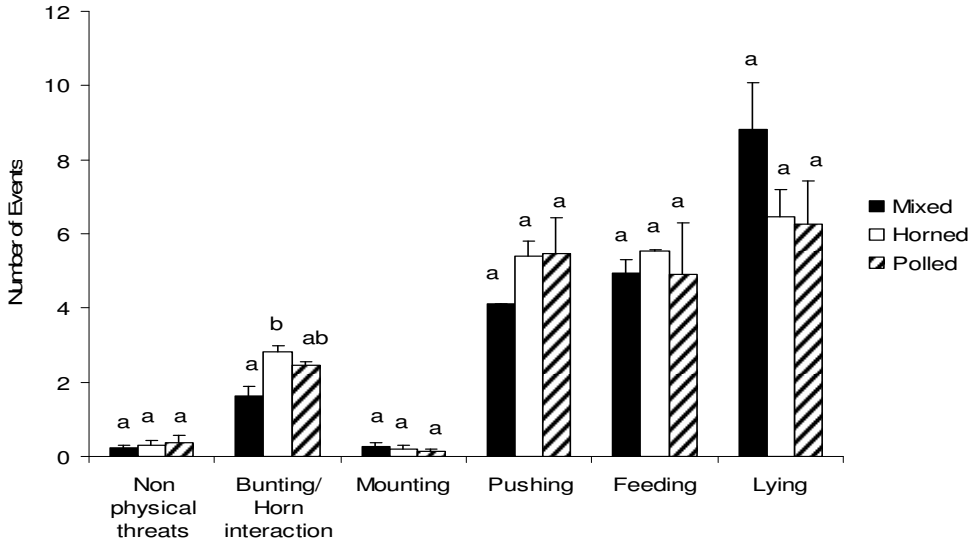

Figure 3: Mean number of events during 15 minute periods (Means are for 15 minute observational periods at 0600, 1200, 1800 and 000 on d 1, 5, 10, 15 for each treatment group ± SEM). Within each activity, different letters indicate significant difference $p< 0.05$.

Real-time observations versus video recording

There were no significant differences between the groups for numbers of behavioural events recorded in real time. There were no observations recorded either by shipboard personnel or via video footage of sheep having difficulty in accessing feed due to horn length.

There were no significant differences in the number of threatening, non physical interactions recorded in real time by shipboard personnel compared to that observed on video footage. However, there were significant differences in the number of aggressive interactions and feeding events recorded by shipboard personnel when compared to that observed on video footage ($p < 0.05$, $r2 = 0.0143$ and $p<0.01$, $r2 = 0.2878$ respectively).

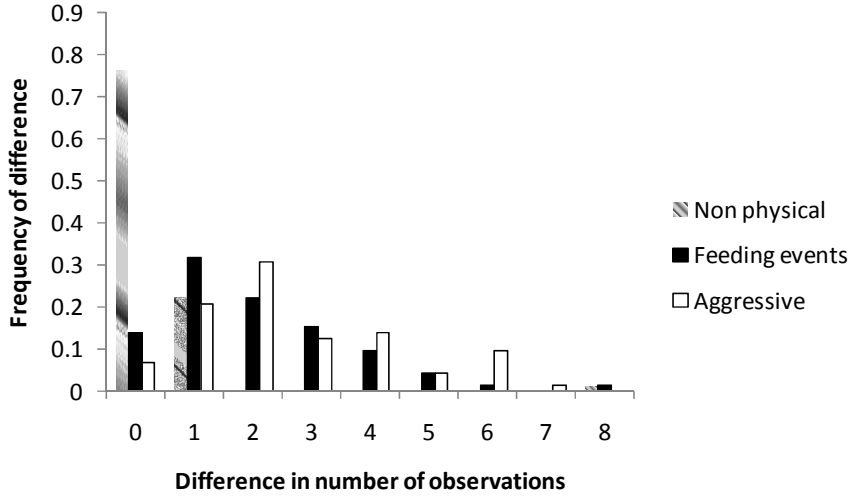

Figure 4: Frequency of the number of differences in observations of sheep behaviour using video footage compared to real time.

Cattle shipment

The shipment departed Fremantle late on d 0 and unloaded at the destination port in Kuwait on d 15.

Wet bulb temperature during the voyage reached a maximum daytime average of 29˚C WB on d 7, 11 and 12 (Figure 5). Temperatures beyond day 12 were not recorded but were sufficiently high that the shipboard veterinarian opened the gates between replicate pens to allow more room for cattle to move around as they wished.

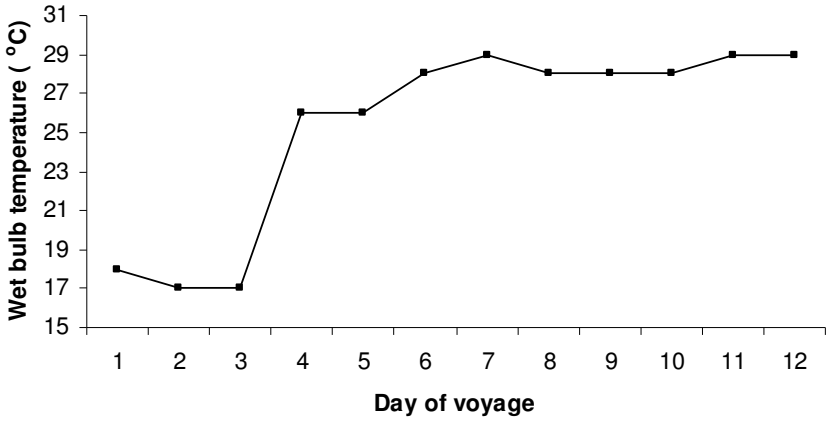

Figure 5: Average daily wet bulb temperature during the cattle voyage

There were 151 cattle in total on board this shipment and there were no mortalities. No injuries were recorded within any of the experimental pens. The only disease recorded in the experimental pens was lameness in one bull in one mixed pen (pen 1), observed on d 4. This bull was also off feed and was treated by the veterinarian.

Feed intake (per day) increased from d 1 to 3 and then remained between 1.5 and 2.5% of initial body weight from d 3 to d 12 as shown in Figure 6. There was no significant difference in feed intake between treatments.

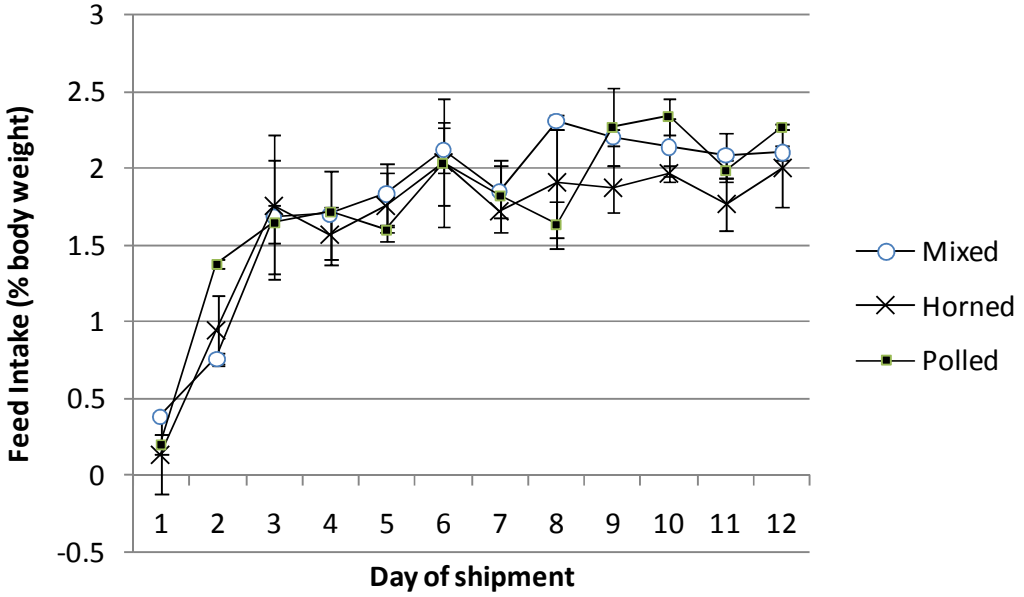

Figure 6: Mean feed intake of cattle in the mixed, horned or polled pens as a percentage of mean initial body weight (mean of 425 kg)

Analysis of video footage found that there were no significant differences between treatment groups in any behaviours measured (Figure 7). There was no significant effect of day on the behaviours observed. Real-time visual observations made by the onboard veterinarian also found no significant differences in any of the behaviour between pen treatments.

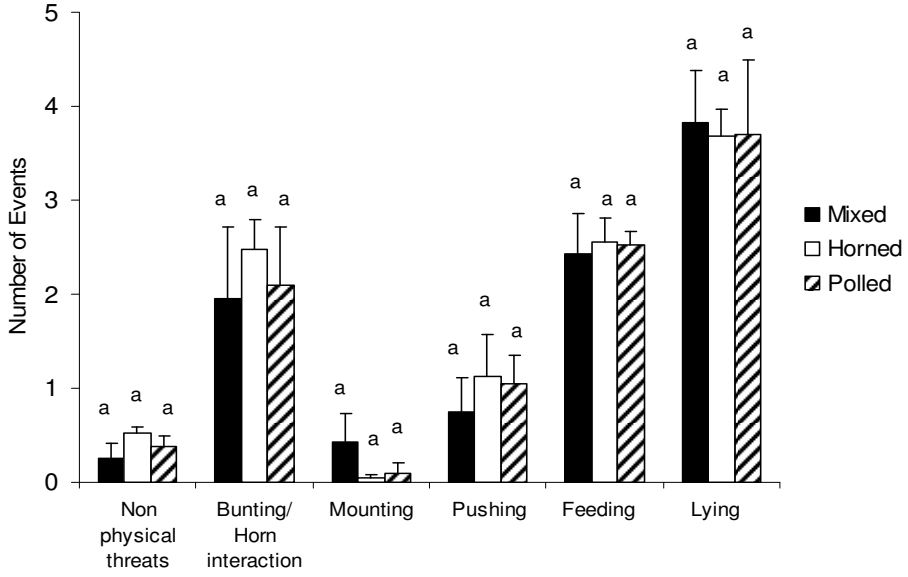

Figure 7: Mean number of events during 15 minute periods of video footage (Means are for 15 minute observational periods at 000, 0600, 1200 and 1800 on d 1, 3, 5, 7 and 10 for each treatment group ± SEM). Within each activity, treatment groups with different letters indicate significant difference $p < 0.05$.

Real-time observations versus video recording

There were no significant differences in the number of feeding events, number of animals lying down, and number of non physical threats recorded in real-time by the shipboard personnel compared to that observed on video footage. There were no observations recorded either by shipboard personnel or via video footage of cattle having difficulty in accessing feed due to horn length. Similar to the sheep shipment, there were significantly less aggressive interactions recorded by shipboard personnel compared to the number observed by video footage ($p < 0.01$, $r2 = 0.002$). However, for many observation periods, there was no difference between the numbers of observations recorded by either method (Figure 8) with there often being no aggressive or physical interactions recorded by either method.

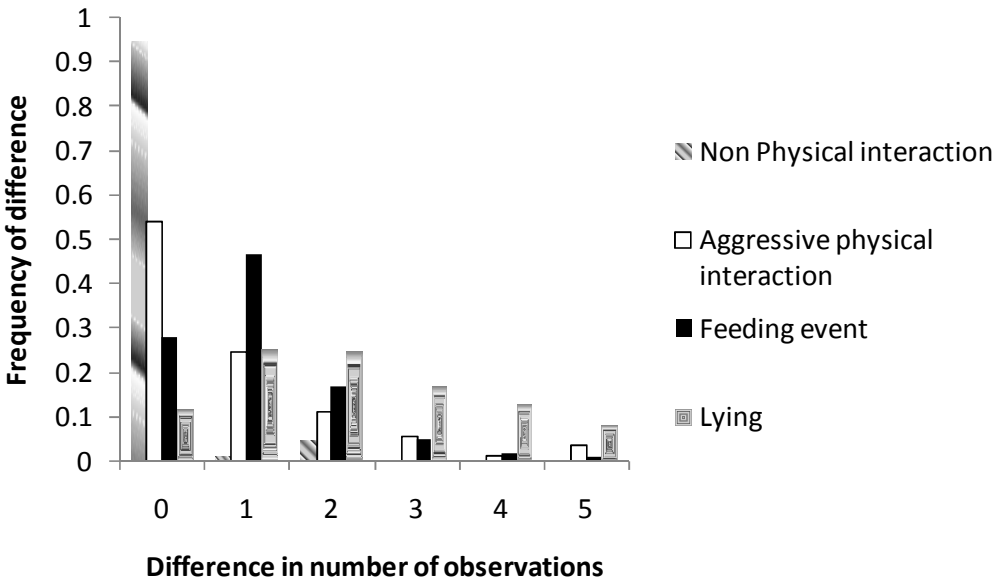

Figure 8: Frequency of the number of differences in observations using video footage compared to real time.

Observation-only shipments

Wet bulb temperatures for the short voyages reached a maximum between 27 and 29ºC; on the two voyages to the Middle East higher maxima were recorded, up to 31ºC wet bulb towards the end of the voyages. Three voyages contained heifers, the others were steers or bulls, generally around two years old. Stocking rates conformed to industry standards for the type of animals and time of year.

There were no mortalities in the experimental pens in any of the examined shipments. In one shipment there was one lame animal observed in a mixed pen and one in a polled pen, and pink eye was recorded in one animal in a polled and mixed pen. These animals were treated. Rhinitis was recorded in up to 2 animals in each experimental pen in a different shipment, and respiratory heat stress was observed in a mixed pen in another shipment.

There was no significant difference in feed intake between treatments in any of the shipments examined. Feed intake also did not vary with day in any of the shipments examined. Mean feed intake for each voyage was above 90% of feed available in all treatments and in all shipments examined.

Behavioural observations from four voyages could not be included in the analysis due to inadequate and incomplete recording of animal behaviour. Visual observations made by the onboard stockmen/ veterinarians on the other shipments found no significant differences in any of the behaviours between pen treatments (Figure 9).

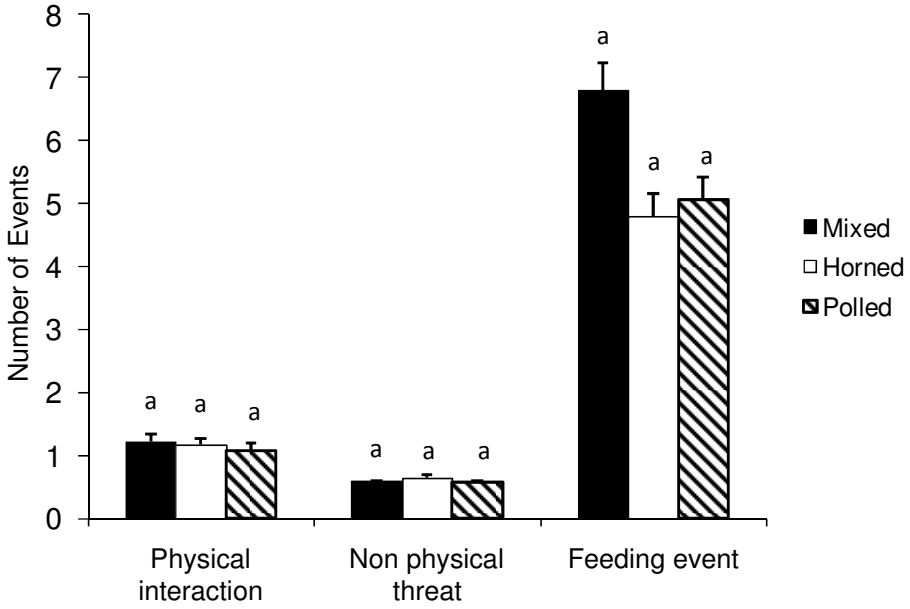

Figure 9: Number of behavioural events records on observation-only shipments for cattle (n= 11 shipments)

Discussion

There was no indication from this work that mixing animals with and without horns, within specification, caused more problems than segregating them. There was no more aggressive interaction, injury, mortality or disease in the mixed pens, nor did the animals experience greater difficulty accessing feed.

The numbers of interactions were quite low for both the cattle and sheep. Previous researchers have reported that there is minimal aggression between sheep; mostly such interaction involves pushing to gain access to the feed trough (Arnold and Maller 1974; Squires and Daws 1975; Houpt 1998). The significantly higher incidence of bunting in the all-horned pens may be because the animals had similar physical attributes, which meant establishment of the hierarchy took longer (Stolba *et al.* 1990; Houpt 1998). This was not evident with the cattle, but as these cattle were from the same mob, they may already have had an established hierarchy; it is unclear whether the sheep were from just one mob, or whether there was mixing before penning. The *ad libitum* availability of feed and water would also have limited the reasons for competition or aggression between the animals, and the lower than usual stocking rate for the cattle (due to the expected high environmental temperatures) may also have contributed to the low number of interactions.

The successful development of a non-invasive method of video surveillance of animals on the ship allowed several weeks of recording, from 12 cameras in this instance, at a quality that was adequate for general observations and indications of animal behaviour

and interactions. The compression of the data on file may not allow more intricate observations, for instance of individual animal expressions.

This method of video surveillance was very effective at providing a record of the animals' interactions and behaviours for the duration of the recording, and in general agreed with the records made by stockmen and veterinarians that there was no difference between the pens. However, there were differences between the actual numbers of interactions and events counted in real-time compared to those counted on the video footage and the correlations between the methods were therefore low.

The number of aggressive interactions observed via video footage was generally higher than observed in real time, most likely because video footage can be slowed down, paused and reviewed to better count the number of perhaps small interactions that may occur at the same time between several groups of animals. The relationship between number of feeding events observed in real-time or via video footage was positive, although the actual number of events recorded was different, indicating that both methods detected similar trends. Feeding events take up more time and are more obvious compared to most interactions between animals, and therefore apparently more easily detected.

Comparisons of the actual number of events recorded in real time or via subsequent observation of the video were made more difficult because the precise time of real-time observation was not necessarily recorded. Interactions, particularly aggressive interactions, may only take a few seconds to happen and due to the low numbers of interactions recorded, missing or including one interaction could have a large effect on numerical comparisons.

Threatening non-physical interactions are difficult to observe as they can be relatively small changes such as lowering of the head that result in an animal retreating. There is also added difficulty in observing small changes in behaviour in groups of animals in close proximity to each other Changes in an animal that are deemed as threatening by other animals are easily missed, resulting in a low number of non physical threats recorded by both video and real time observations.

The differences between the numbers of events recorded in real-time and video observation mean that the actual numbers recorded for the observation-only shipments may also be lower than actually happened; however, the finding that there were no overall differences between experimental pens is supported by the two videoed shipments. Further work could be conducted using a scoring system rather than absolute numbers of events, and comparing multiple observers in real-time to retrospective analysis of video recording, to determine whether such a system is valid, and whether all observers are similarly skilled in detecting interactions, or whether specific training is necessary.

This work has shown that continuous video recording of animals on a ship for several weeks is possible, which could then allow observational trials of other aspects of animal behaviour on commercial shipments. With regard to the specific aim of this work, it appears that within specification, and with regard to other social and animal factors that

also influence hierarchy formation and aggressive interactions (such as size, age, sex, breed, previous social grouping, feed availability and stocking rate), separation according to whether an animal possesses horns within specification or not is not necessary for improved animal welfare.

Acknowledgements

The authors acknowledge the Meat and Livestock Australia/Livecorp Live Export Programme for initiating and funding this work, Dr M McCarthy and Dr D Blache for assistance with the forms and statistics, and the ship owners and personnel for their assistance in conducting the work.

References

Arnold, G. W., and R. A. Maller. (1974). Some aspects of competition between sheep for supplementary feed. *Anim. Prod.* **19**: 309-319.

ASEL Australian Standards for the Live Export of Livestock (2006) Version 2.1 Department of Agriculture, Forestry and Fisheries, Australian Government. http://www.daff.gov.au/animal-plant-health/welfare/export-trade/v2-1.

Hargreaves, A. L. and Hutson, G. D. (1990). Changes in heart rate, plasma cortisol and haematocrit of sheep during a shearing procedure, *Appl. Anim. Behav. Sci.* **26**: 91.

Houpt, K. (1998). Domestic animal behaviour for veterinarians and animal scientists. Masons Publishing: London.

Jarvis, A. M. and Cockram, M. S. (1995). Some factors affecting resting behaviour of sheep in slaughterhouse lairages after transport to farms. *Animal Welfare*. 4: 53-60.

Kondo, S. and Hurnik, J. F. (1990). Stabilization of social hierarchy in dairy cows. *Appl. Anim. Behav. Sci.* **27**: 287-297.

Mounier, L., Veissier, I., and Boissy, A. (2005). Behaviour, physiology and performance of bulls mixed at the onset of finishing to form uniform body weight groups. *Journal of Animal Science* **83**(7): 1696.

Squires, V. R., and G. T. Daws. (1975). Leadership and dominance relationships in Merino and Border Leicester sheep. *Appl. Anim. Ethol.* **1**: 263-274.

Stolba, A., Hinch, G. N., Lynch, J. J., Adams, D. B., Munro, R. K., and Davies. H. I. (1990). Social organization of Merino sheep of different ages, sex and family structure. *Applied Animal Behaviour Science* **27**: 337 - 349.