live export

SBMR.001

Investigation of cattle deaths during sea transport from Australia

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Executive Summary

The live cattle trade from Australia to the Middle East has expanded rapidly since 1995. Although death rates have been low overall, there has been no scientific investigation into the causes of ill health or mortality or of the predisposing factors. Recent incidents of excessively high mortalities during sea transport have focused attention on the lack of scientific information about the live cattle trade. The present report describes an investigation into the health and welfare aspects of cattle during sea transport from Australia.

The investigation was conducted in three parts: analysis of ship Master's reports; analysis of veterinary reports; and a voyage to North Africa. Ship Master's reports for cattle voyages between 1995 and 1998 were examined to define the mortality during sea transport and to identify predisposing factors. Several shipments of cattle to the Middle East region were accompanied by a veterinarian or stockman in the latter part of 1998. The reports were examined for information about causes of ill health and mortality, and husbandry of the cattle during the voyage. A large shipment of cattle to North Africa was accompanied by a veterinary pathologist in December 1998. The purpose was to conduct detailed necropsies of cattle that died, and to investigate causes of ill health during the voyage.

Approximately 2.5 million cattle were exported live by sea from Australia between 1995 and 1998. The overall death rate was 0.22% during the shipping phase. The highest death rates were on long haul voyages; Mexico (0.80%), Middle East and North Africa (0.68%), North Asia (0.22%) and South East Asia (0.09%).

The investigation focused on the live cattle trade to the Middle East and North Africa because of the rapid expansion of this trade and concerns about the welfare of the cattle on voyages to this region. Although the live cattle trade to the Middle East and North Africa has doubled in size each year since 1995, the annual death rate has remained remarkably constant.

Fremantle was the major port of loading for voyages to the Middle East and North Africa followed by Darwin, Adelaide and Portland. The average death rate of cattle exported from southern ports was approximately 3 times that of cattle exported from northern ports (mean death rate 0.74% from southern ports and 0.26% from northern ports). A seasonal difference in death rates was identified. There were more deaths on voyages from southern ports than northern ports between May and November.

Several veterinary clinical observations indicated that Bos Indicus cattle coped better with the hot humid conditions encountered during sea transport than Bos Taurus cattle. Clinical signs of heat stress were observed in the Bos Taurus cattle, and they had higher respiratory rates and higher death rates than the Bos Indicus cattle. However, there was insufficient information to determine whether there are differences in the performance of various breeds of Bos Taurus cattle.

Several ships were identified as having relatively poor performance in terms of cattle death rates or animal welfare. On one ship, the same area of the animal house was identified as being a problem by different veterinarians on successive voyages.

Several veterinarians considered that poor ventilation predisposed to heat stress, however it was recognised that the problem is multi-factorial. Further, it was considered that lack of air

flow was more important than temperature and humidity alone except in extreme conditions. There is a need to identify those cattle pens where air flow is minimal or nil, particularly on ships with a history of poor performance.

The voyage in December 1998 was a low mortality voyage. The main cause of death was from bacterial infections followed by lameness and/or trauma of the lower legs. Bacterial infections and lameness/trauma were also observed on other voyages, together with other conditions such as pink eye, bloat, scours, coughing and failure to eat. However, the relative importance of these conditions in causing cattle deaths or ill health during sea transport requires further investigation.

There are significant animal welfare problems involved during the unloading of cattle at some ports of discharge. Authorities at Egypt frequently impose a feed and water curfew on the cattle immediately before discharge from the ship. In addition, the unloading facilities used by some ships at Egypt are inadequate and may result in injury or death of cattle during discharge. The presence of cattle that are out-of-specification has resulted in Egyptian authorities requiring individual examination of many cattle on the ship, leading to additional stress and risk of injury to both cattle and stockmen.

A number of recommendations were proposed to improve the health and welfare of the cattle during live export or to seek further information. A protocol was proposed to ensure standard necropsy (post mortem) examination of cattle during sea transport. An essential additional step is to undertake laboratory examination of relevant samples, preferably under the supervision of the same pathologist to allow consistent interpretation of the findings.

The present report is considered as one step in an ongoing process to improve the health and welfare of cattle during live export. The recommendations in the report are based on current information. Additional studies are planned and it is likely that present recommendations may be modified and extra recommendations made in the light of new information.

General Introduction

Background

The live cattle trade from Australia to the Middle East has expanded rapidly since 1995. Although death rates have been low overall, there has been no scientific investigation into the causes of ill health or mortality or of the predisposing factors.
Recent incidents of excessively high mortality levels during sea transport have focused attention on the lack of scientific information about the live cattle trade, and led to several initiatives aimed at improving animal welfare and minimising death rates. The present report describes an investigation into the health and welfare aspects of cattle during sea transport from Australia.

Objectives

The aims of this investigation were to:

1. Determine the cause(s) of cattle illness and deaths during sea transport from Australia to North Africa.
2. Identify factors that contribute to illness and deaths of cattle during sea transport.
3. Make recommendations to reduce cattle illness and deaths during and following sea transport.
4. Develop a post mortem protocol for use by shipboard veterinarians on other voyages.

Methodology

The investigation was conducted in three parts: analysis of ship Master's reports; analysis of veterinary reports; and a voyage to North Africa. The ship's Master is required to submit a report (Master's report) to the Australian Maritime Safety Authority on the completion of each voyage of livestock from Australia. Master's reports for cattle voyages between 1995 and 1998 were obtained and analysed to define the mortality during sea transport and to identify predisposing factors.

Several shipments of cattle to the Middle East region were accompanied by a veterinarian or stockman in the latter part of 1998. This became a requirement by the Australian Quarantine Inspection Service following an incident during a voyage in July 1998. These reports were examined for information about causes of ill health and mortality, and husbandry of the cattle during the voyage.

A large shipment of cattle to North Africa was accompanied by a veterinary pathologist in December 1998. The purpose was to conduct detailed necropsies of cattle that died, and to investigate causes of ill health during the voyage.

Ship Master's Reports

Destination

The countries of destination for Australian cattle were grouped into major regions as shown in Table 1. The trade to South East Asia, mainly the Philippines and Indonesia, is characterised by small consignments on short voyages with very low death rates. The overall death rate to this region was 0.09%, with no death reported on 59% of almost 1,500 voyages involving 1.9 million cattle.

Voyages to the Middle East, mainly Egypt and Libya, involved longer duration and higher death rates than those to South East Asia. The overall death rate to the Middle East was 0.68%, with no death reported on 23% of 227 voyages involving 0.5 million cattle.

The highest death rate overall was on voyages to Mexico, although the maximum death rate on any individual voyage was less than to other destinations.

Table 1. Number of voyages and cattle exported, and mortality for voyages to major destination regions from 1995 to 1998

Parameter	ME/N Africa	SE Asia	NE Asia	Mexico	Other*	Total
Voyages (No.)	227	1,493	35	6	8	1,769
Cattle (No.)	479,944	1,882,978	47,865	32,482	8,102	2,451,371
Death rate overall (%)	0.68	0.09	0.22	0.80	0.51	0.22
Death rate range (%)	0.0 - 41.5	0.0 - 8.8	0.0 - 1.2	0.4 - 1.1	0.0 - 1.4	0.0 - 41.5
Voyages with nil deaths (No.)	53	882	6	0	2	943

* includes the following countries: Turkey, Romania, Mauritius, Samoa and the Solomon Islands.

Middle East and North Africa

The rest of this report focuses on voyages to the Middle East and North Africa because of interest in the welfare of the cattle on these voyages.

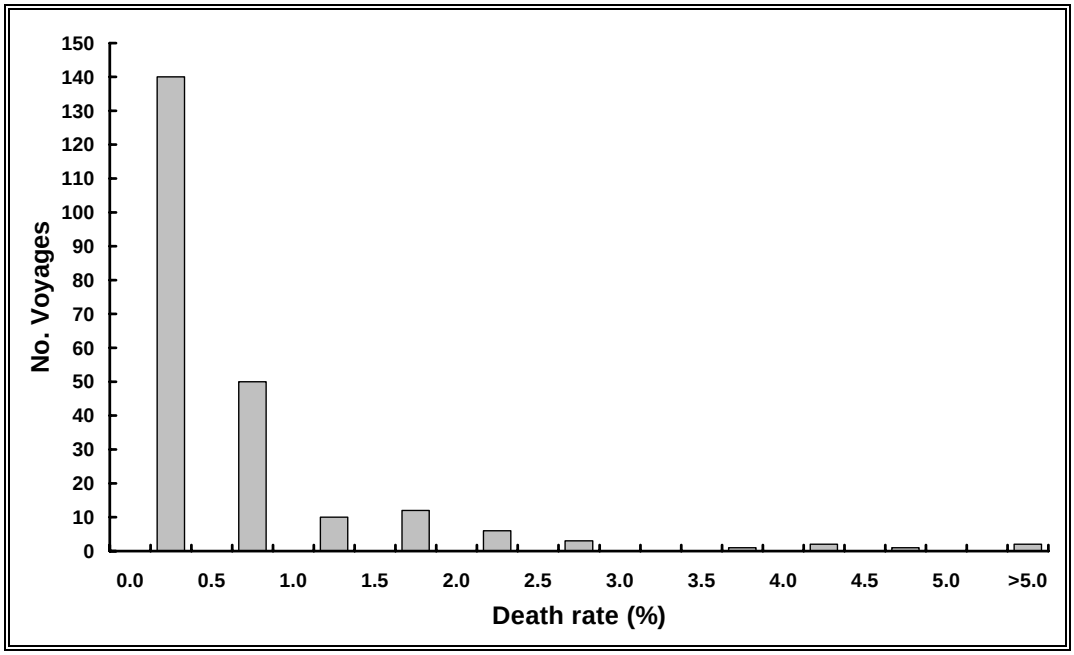
The cattle trade to the Middle East and North Africa has expanded rapidly over the last four years, with the number of voyages and number of cattle exported doubling every year (Table 2). Despite the rapid expansion of the trade however, the overall death rate has remained remarkably constant at approximately 0.7% annually.

Table 2. Death rates for cattle exported to the Middle East and North Africa from 1995 to 1998

Parameter	1995	1996	1997	1998
Voyages (No.)	11	36	62	118
Cattle (No.)	14,577	65,066	137,869	262,432
Death rate overall (%)	0.67	0.65	0.67	0.69
Death rate range (%)	0.0 - 2.1	0.0 - 5.0	0.0 - 4.2	0.0 - 41.5
Voyages with nil deaths (No.)	2	14	15	22

There were few or no deaths on most voyages to the Middle East and North Africa (Figure 1). Death rates were below 0.5% on 60% of all voyages. Although death rates were low on most voyages, there were six voyages with death rates greater than 3.5%. These voyages (2.6% of all voyages) accounted for 17% of all cattle deaths to the region.

Figure 1. Number of voyages in various death rate categories for cattle exported to the Middle East and North Africa from 1995 to 1998



Ship

The voyages of each ship from Australia to the Middle East and North Africa were classified into the following mortality categories; nil (no deaths reported), low (death rate up to 0.5%), medium (death rate greater than 0.5 to 1.0%) and high (death rate greater than 1.0%). Table 3 shows the number of voyages in the various mortality categories for each ship (ship names were coded to protect their identity). Ignoring ships that have been scrapped or have made only a single voyage, ships 33 (50% of voyages) and 13 (42%) had a high proportion of voyages in the high mortality category. If the medium and high categories are combined, ships that feature prominently are Numbers 33 and 68 (100% of voyages), 84 (83%), 31 (59%), 78 and 92 (50%). In contrast, most voyages of Ships 72, 75 and 95 were in the low category with few or no voyages in the high category.

Table 3. Number of voyages in nil, low, medium and high mortality categories for shipments to the Middle East and North Africa from 1995 to 1998

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0-0.5%	Medium >0.5-1.0%	High >1.0%	
1	3	0	0	1	4
3	2	0	0	0	2
7	2	0	0	0	2
9	6	0	0	2	8
11*	1	4	3	2	10
13	7	0	0	5	12
17*	0	0	0	1	1
18	0	0	1	0	1
22	4	10	7	2	23
27	7	4	1	2	14
29	0	6	2	1	9
30	6	1	0	3	10
31	0	9	10	3	22
32	4	0	1	2	7
33	0	0	2	2	4
51	3	1	2	0	6
54	0	1	0	0	1
59	0	8	0	3	11
65*	0	0	0	1	1
68	0	0	2	0	2
71	0	2	0	1	3
72	0	10	2	0	12
73*	0	2	0	0	2
75	2	12	3	0	17
77	2	1	1	0	4
78	1	4	2	3	10
79	2	2	2	0	6
82	0	1	0	0	1
84	0	1	4	1	6
86	0	1	0	1	2
89*	0	0	1	1	2
92	0	1	1	0	2
93	0	3	2	0	5
95	1	4	0	0	5
Total	53	88	49	37	227

* Ship has been scrapped

Port of loading

For voyages to the Middle East and North Africa, the greatest number of cattle were exported from Fremantle, followed by Darwin, Adelaide and Portland (Table 4). Death rates were lowest from Broome and Port Hedland, increasing from Wyndham and Darwin. Death rates were approximately 0.7% from the major ports of Fremantle, Adelaide and Portland. The exceptionally high figure for Bunbury reflects an incident on one voyage. Half the voyages from Portland were in the high death rate category (Table 5).

Table 4. Death rates of cattle exported from various ports to the Middle East and North Africa from 1995 to 1998

Port	Voyages (No.)	Cattle (No.)	Deaths overall (%)	Deaths range (%)
Darwin	30	56,866	0.3	0.0 - 1.8
Wyndham	5	15,442	0.2	0.0 - 0.2
Broome	15	26,507	0.1	0.0 - 0.6
Port Hedland	2	4,175	0.1	0.0 - 0.2
Dampier	2	3,715	0.4	0.2 - 0.6
Geraldton	2	3,157	0.6	0.2 - 0.8
Fremantle	129	209,598	0.7	0.0 - 11.1
Bunbury	2	1,421	36.7	1.2 - 41.5
Esperance	1	296	0.0	0.0 - 0.0
Adelaide	12	49,643	0.6	0.0 - 2.9
Portland	9	41,397	0.8	0.0 - 1.7
Devonport	5	15,173	0.5	0.3 - 0.9

Excludes voyages with more than 1 port of loading.

Table 5. Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to the Middle East and North Africa from 1995 to 1998

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0-0.5%	Medium >0.5-1.0%	High >1.0%	
Darwin	3	18	8	1	30
Wyndham	1	4	0	0	5
Broome	5	9	1	0	15
Port Hedland	0	2	0	0	2
Dampier	0	1	1	0	2
Geraldton	0	1	1	0	2
Fremantle	37	45	21	26	129
Bunbury	0	0	0	2	2
Esperance	1	0	0	0	1
Adelaide	1	2	6	3	12
Portland	2	1	2	5	10
Devonport	0	3	2	0	5
Total	50	86	42	37	215

Excludes voyages with more than 1 port of loading.

Loading region (North vs South)

Death rates were compared between voyages from selected ports in the north and south of Australia. The average death rate from southern ports was approximately 3 times that from northern ports (Table 6). An exceptional voyage from Bunbury was excluded from this comparison.

Table 6. Death rates, numbers of voyages and of cattle exported from selected northern and southern ports to the Middle East and North Africa from 1995 to 1998

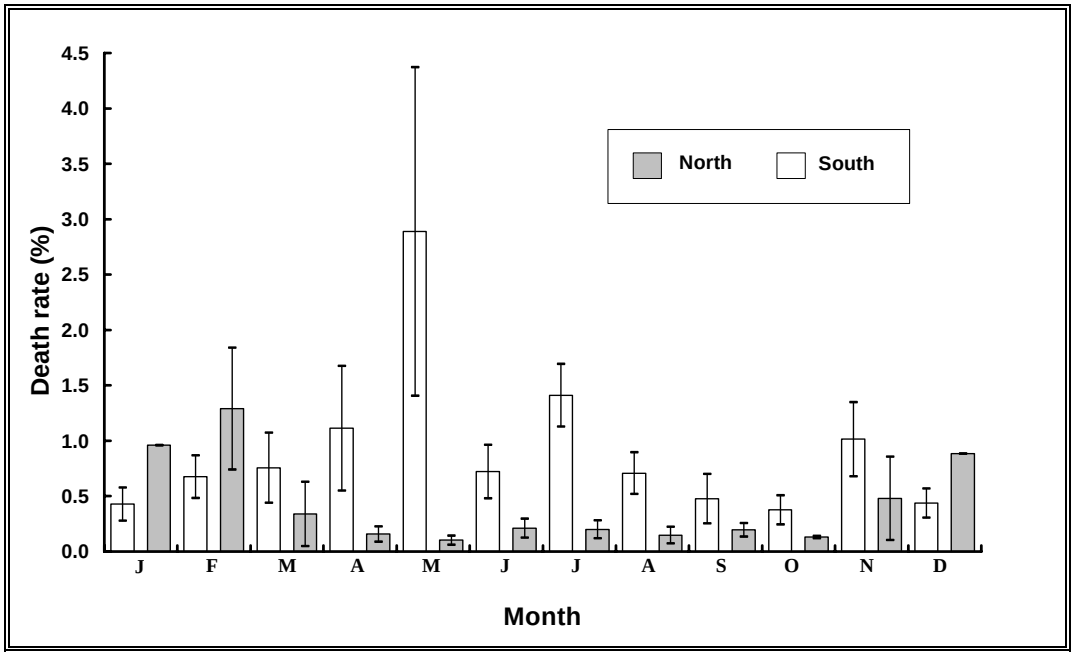
Region	Voyages (No.)	Cattle (No.)	Deaths mean (%)	Deaths std. error (%)
North	50	98,815	0.26	0.05
South	157	316,274	0.74	0.10

North Darwin, Wyndham, Broome.
South Fremantle, Bunbury, Esperance, Adelaide, Portland, Devonport.

Season

Monthly death rates were compared between selected northern and southern ports (same ports as in previous section) after excluding an exceptional voyage from Bunbury (Figure 2). In the first two months of the year and in December, average death rates were higher from northern ports than from southern ports. However, from March through to November, death rates were substantially higher from southern ports. The high average mortality for May from southern ports results from several relatively high death rates in small numbers of cattle on several voyages (1 death/24 cattle shipped, 4/140, 7/54). The large error bar for May also indicates that mortality has been highly variable in this month.

Figure 2. Average monthly death rate on voyages from selected northern and southern ports



Analysis of Veterinary Voyage Reports

Introduction

From late August 1998, the Australian Quarantine & Inspection Service required that shipments of cattle from Australia to the Middle East region be accompanied by a veterinarian or a stockman. A number of reports arising from these voyages were made available for analysis.

Results

A total of 13 reports were examined, involving 11 different ships, 9 veterinarians and 2 stockmen (Table 7). Ship 84 was accompanied 3 times (Voyages 1, 10 and 13) by 3 different veterinarians. Vet 2 undertook Voyage 2 and Voyage 12. Most voyages began in August or September, and five of them were from southern ports. Egypt was the main destination. The breed(s) of cattle were described on 7 of the voyages but there was no estimate of the number of cattle in each breed on any voyage.

The numbers of cattle deaths and the number loaded are shown in Table 7. There were relatively few deaths from northern ports. Voyages where there were more than 40 deaths all originated from southern ports. There was a good description of the gross pathology at necropsy on Voyages 4, 6 and 12, limited description on Voyages 5, 7 and 13, and none on the remaining voyages. Samples were collected for subsequent examination (mainly tissues fixed in formalin for histopathology) on some voyages, few were examined in a laboratory, and no useful information resulted.

Several conditions were diagnosed clinically or on the basis of gross pathology at necropsy. The main conditions are listed in Table 7. Where there was sufficient information available, the frequency of each condition is shown either as a percentage (based on the estimated prevalence in live animals) or as a number (based on the number of deaths diagnosed at necropsy). However in many cases, the condition was observed but there was no information to indicate the frequency, and such cases are indicated by a “Y” in the table. The main conditions are described in more detail below, together with other observations about the management of the cattle.

Table 7. Summary information about voyages accompanied by an Australian veterinarian or stockman to the Middle East

Voyage	1	2	3	4	5	6	7	8	9	10	11	12	13
Ship	84	75	68	59	73	22	78	82	31	84	51	33	84
Vet/S-man	Vet 1	Vet 2	S-man 1	Vet 3	Vet 4	Vet 5	Vet 6	S-man 2	Vet 7	Vet 8	Vet 9	Vet 2	Vet 10
Departure	Apr-98	Aug-98	Aug-98	Aug-98	Aug-98	Sep-98	Sep-98	Sep-98	Sep-98	Sep-98	Oct-98	Oct-98	Nov-98
Port	Darwin	Pt H/Wynd	Broome	Portland	Dampier/ Broome	Fremantle	Broome	Darwin	Adel/F'tle	Dampier	Broome	Fremantle	Fremantle
Destination	Egypt	Egypt	Egypt	Aqaba	Egypt	Egypt	Egypt	Egypt	Aqaba	Egypt	Egypt	Aqaba	Egypt
Cattle-breed	Brahman-X			H/ford, Angus, S/horn, Santa	Brahman, Bmn-X Santa, S/horn	H/ford, Angus, M/grey, S/horn, Lim, Sim, Brahman	D-mr, S/horn, D-mr/Bmn-X		S/horn Friesian				H/ford-, S/horn-X, D-mr
Mortality	6/2098	2/3502	5 R/888	20/1541	3/1330	15/3412	3/2062	5/??	45/7000	10/2050	2/1254	55/4698	48/2290
PM-details	Nil	Nil	Nil	Detailed	Some	Detailed	Some	Nil	Nil	Nil	Nil	Detailed	Some
Lameness	Y	0.2%	Y	1	Y	0.5%	0.5%	Y	4%	1%	1%	0.2%	0.2%
Shy feeder		0.03%		4	Y	0.7%	0.4%		2%		0.4%	0.8%	Y
Heat stress	Y			12	S/horn	Y	Y		Y	Y	Y	Y	Y
Pneumonia												Y	Y
Pink eye		0.5%					6%		1%	6%	Y	0.6%	2%
Bloat		0.06%				Y					0.1%		
Scours						0.1%			4%		0.6%		Y
Feed (kg/hd)			7	10	7			9-11		7	7		
Water (L/hd)				20-30	27			20-38			26		22-35

Table 8. Cause of death based on gross necropsy findings

Cause of death	Voyage 4	Voyage 6	Voyage 7	Voyage 12*
Pneumonia		1	1	23
Heat stress	12	4		23
Rumenitis				27
Lameness/trauma	1	1	1	4
Inanition	4	3	1	1
Calving				12
No diagnosis	3	3		1
Total	20	12	3	53

* Note: more than one condition seen at necropsy (consequently, total number of conditions exceeds total number of cattle deaths).

Lameness/trauma was observed on all voyages within the first few days after loading. Lameness/trauma includes deaths from broken limbs or animals unable to rise, as well as less severe cases that recovered. The prevalence of the problem was frequently not quantified but ranged up to 4% on Voyage 9.

Shy feeder (inanition) cases were observed on 8 voyages. When detected, animals were moved to hospital pens and offered hay/chaff in addition to pelleted feed. Again, the prevalence was frequently not quantified but ranged up to 2% on Voyage 9. Inanition was considered the second most frequent cause of death on Voyages 4 and 6 (Table 8).

Heat stress was responsible for 12/20 deaths on Voyage 4. This involved an incident in an area of Deck 1 on Ship 59. In the opinion of Vet 3, "temperature alone did not seem to be the critical factor since far higher temperatures were experienced later in the voyage without the same result. The most respiratory distress was observed in pens with "sub-optimal ventilation" (close to the engine room). Reducing the number of cattle in these pens diminished the signs of distress, but the signs continued even when as few as 2-3 head remained in difficult pens".

On Voyage 6, the major problems with heat stress began when Ship 22 entered the Gulf of Aden and the Red Sea. The temperature and relative humidity in the cattle pens reached the mid-30sC^{o} and 80% or more. The cattle showed "poor fodder consumption, rapid respiratory rates (above 120/min) and severe open mouth panting. Water consumption doubled that of the initial days of the voyage, and the animals' condition seemed to melt away. A few animals collapsed. The response to cooler less humid weather was very marked, with a huge increase in fodder consumption". On Voyage 9, about 75% of all deaths occurred in the first 48 hours in the Red Sea. On Ship 84 (Voyage 13), cattle with signs of heat stress in an area of Deck 2 improved when moved elsewhere and otherwise healthy animals moved into this area developed signs of heat stress. On a previous voyage of the same ship (Voyage 10) Vet 8 commented that ventilation needed to be improved, particularly on Deck 2.

Breed Brahmans, Brahman-infused and Santa Gertrudis cattle travelled well on Voyage 5, but Shorthorn cattle were "panting when none of the other cattle around them were" regardless of which deck they were on. The Brahman cattle on Voyage 6 were less affected by heat stress than Bos Taurus breeds; the respiratory rates of the Brahman cattle did not exceed approximately 80/min compared to in excess of 120/min for the Bos Taurus breeds. The Brahman cattle "camped" closely together and did not seem to trample over each other as much as the Bos Taurus breeds.

Electrolytes were used on several voyages and some veterinarians considered that the electrolytes conferred a benefit to the cattle. However, there was no objective assessment of the benefits of using electrolytes, and no description of the ingredients in the electrolytes used.

Stocking density the cattle on Voyage 6 were loaded at 15% below the Australian Maritime Safety Authority (AMSA) standard. This allowed animals to "rest later in the trip when it got hotter as the whole pen could lie down", and the cattle were easier to observe.

Feed consumption was recorded for six voyages, and averaged 7 kg/hd/day on four voyages (Table 7). On Voyage 3, feed intake averaged 7 kg per head from day 7 onwards increasing up to 10 kg/hd on day 23. On Voyage 4, feed consumption remained constant at approximately 10 kg/hd from day 3 onward.

Water consumption was recorded on five voyages and ranged from 20 to 38 L/hd/day. Water intake averaged 20L/hd in the first 5 days of Voyage 4 and increased steadily up to 30L/hd on day 21 (discharge).

Water supply was limiting on Ship 73 (Voyage 5) such that the ship needed to take on additional water at Djibouti. Before taking on additional supplies, water was offered once daily (consumption was approximately 35 tonnes daily), and after additional supplies were loaded, water was offered twice daily (consumption was 45 tonnes). Ship 73 has now been scrapped.

Water consumption on Voyage 8 increased steadily from 18 to 33L/hd by day 8 and remained steady at about that level until increasing to 36 to 38L/hd during the last 4 days of the voyage.

Quality control was lacking on some voyages. On Voyage 12, 12 deaths were attributable to difficulties with calving (Table 8). Before discharge at the completion of Voyage 11, several "obviously old, heavy bullocks" were rejected by importing authorities as having 6 teeth or more. Doubts about the upper age of the cattle resulted in importers requiring individual animals to be "mouthed" to determine their age. The lack of facilities on the ship for this purpose, resulted in stress and injury to some of the cattle and the ship's personnel.

Discharge facilities were poor at Egypt for Voyage 5 with cattle unloaded onto the back of a small truck, from which two trucks were loaded simultaneously from each side. The sides of the small truck were not firmly fixed and were only 150 cm high. Five cattle jumped out of the discharge area; two drowned, one broke its leg and another died after falling from the discharge area.

Curfew at discharge authorities at Adibiya, Egypt ordered a complete withdrawal of feed and water during discharge at the end of Voyage 7 under the threat that discharge would be suspended. This resulted in cattle on the ship being without water for up to 18 hours in hot conditions. Veterinary authorities at Egypt also imposed a feed and water curfew at the end of Voyage 11.

Discussion & Conclusions

Although the veterinarians and stockmen described their findings as they considered appropriate, there was substantial variation in the scope and detail provided in the reports examined. For example, one report consisted of two pages of text with statements such as "Shorthorn cattle were sometimes affected by the heat". Conversely, another report contained a reasonable description of the gross findings for each necropsy together with objective assessments of some of the health conditions affecting the cattle. Such a variation between reports makes interpretation of findings and comparisons between voyages very difficult for others.

There is a need for a standardised method for such voyages. The method should aim at recording objective measurements where possible so that a performance history can be built up over time. This will allow comparison with other voyages as appropriate and will allow the effects of changes in management to be assessed objectively.

If it is required that veterinarians accompany cattle shipments in future, it is imperative that they are thoroughly briefed beforehand. The briefing should clearly indicate the purpose of the study and the information that is to be collected on the voyage. This should include an explanation of the standardised method, and the current state of knowledge regarding cattle ill health/mortality/welfare problems. Some knowledge of epidemiology (problem definition and identification of causes) and pathology would be a distinct advantage. Limited training should be provided if necessary.

There is also a need for a thorough de-briefing after each voyage to discuss the findings and to clarify details where necessary. The findings from each voyage should be reviewed by an appropriate person/group who would consider making further recommendations to improve the welfare of the cattle.

The standardised method should include a suitable description of the gross pathology of animals necropsied, together with a procedure for examination of suitable samples at the diagnostic laboratory. Laboratory examination of samples is an essential step in reaching a diagnosis for many diseases. For example, "rumenitis" may easily be confused with post mortem change which occurs rapidly in the hot humid conditions found during sea transport. Even an experienced pathologist would require laboratory examination of rumen tissue before confirming a diagnosis of rumenitis. Mis-diagnosis of some conditions may result in (potentially) expensive and unnecessary changes in management that are ineffectual in improving the welfare of the cattle. See post mortem protocol in Appendix 7 and draft "clinical observations" protocol in Appendix 8.

The reports indicate that Bos Taurus breeds are struggling to cope with the hot humid conditions encountered during sea transport. Clinical signs of heat stress were observed, and death from heat stress was diagnosed. However, further investigation is needed to determine whether there are differences in breed susceptibility to heat stress. A useful parameter to measure could be respiratory rate.

Although poor ventilation was frequently considered to predispose to heat stress, it was recognised that the problem is multi-factorial. Except in cases of extremely high temperature and relative humidity, it was considered that temperature and relative humidity were less important than air flow. There is a need to define the minimum ventilation standards required for cattle during sea transport and to ensure that ships meet such standards, particularly when carrying Bos Taurus breeds from southern

ports during the Australian winter. It may be useful to examine research findings from the North American cattle industry or from the pig and poultry industries.
On one ship the same deck was identified as a problem area on separate voyages. This vessel has a poor record on other voyages (see Table 3 of the analysis of Master's reports). Further investigation of the ship is needed, and appropriate prevention strategies should be implemented before the onset of the northern hemisphere summer.
There are serious animal welfare problems involved during discharge at Egypt. The imposition of a curfew on feed and water exposes the industry to another mortality incident, particularly during hot weather. Immediate action is required to resolve this problem.
Unloading facilities at Egypt are inadequate to handle the cattle in a manner that does not increase the risk of injuries or death. Consideration should be given to the design and use of an unloading trailer such as the MOVOR that was deployed at various Gulf ports for unloading sheep from Australia.
There is a need to improve quality control of the cattle exported. Improved procedures are needed to ensure that cattle in an advanced stage of pregnancy are not exported. Cattle should be within importers' specifications, particularly for age, thus avoiding the need for restraint and examination of individual animals before discharge.

Voyage to the Middle East in December 1998

Objectives

The objectives of the study were to determine the causes of mortality and ill-health in a shipment of cattle exported live to the Middle East.

Methods

General: The study was undertaken aboard a fully enclosed, force-ventilated ship which left Fremantle on December 8, 1998 and arrived at Tripoli, Libya 18 days later on December 25. The ship carried 12,966 two-to-four-tooth steers having an average liveweight of 420 kg. The cattle were sourced from both pastoral and high rainfall areas of Western Australia and included various Bos indicus and Bos taurus breeds. Producers were requested to apply tail tags to the cattle before trucking to identify the property.

Necropsy Technique: Cattle were necropsied as soon as practical after death (usually within 2 hours of death). A standard necropsy technique was performed and tissues from the following organs were fixed in formalin: liver, kidney, lung, small and large intestine, spleen, rumen, abomasum and heart. Any lesions in other tissues detected during the necropsy were also sampled. The brain was sampled in cases where the cause of death was not determined by gross pathological examination, or where the history suggested neurological clinical signs. A full description of gross pathology was recorded following each necropsy on a standardised form (see Appendix 1). Fixed tissues were returned to Australia for histopathological examination at Agriculture WA's Animal Health Laboratories. The necropsy form is shown.

Ship and Deck Layout: The ship is a converted car carrier and is fully enclosed. There are 12 livestock decks and each deck is divided into 4 holds. The pens are laid out lengthways within each hold in 3 paired lanes separated by walkways. A schematic representation is provided in Appendix 2. There are 1,400 pens varying in area from 15 to 22m^2. The cattle were penned at densities 10 to 12% below those recommended by the Australian Maritime Safety Authority (Appendix 4).

Environmental Monitoring: Temperature and relative humidity were recorded every 15 minutes by data loggers placed in 8 separate locations throughout the cattle pens (Appendix 3).

Additionally, a hand-held temperature-relative humidity meter was used to take measurements at specific locations (the aft-most pens) within the holds. These sites were predetermined on Day 1 and therefore were not necessarily the hottest or most humid within the vessel. All measurements were taken between 0600 and 0900 hours except for Days 16 & 17 when recordings were made between 1200 and 1500 hours.

Clinical Signs: Respiratory rates were taken of both Bos Indicus and Bos Taurus breeds within a pen on Decks 9, 10 and 11. The most rapid breathing animal in the pen was selected and the results recorded. Cattle were also observed by the 5 stockmen employed by the company to check for abnormal breathing patterns, leg injuries, diarrhoea, bloating, eye infections and to assess the extent of nasal discharge and coughing.

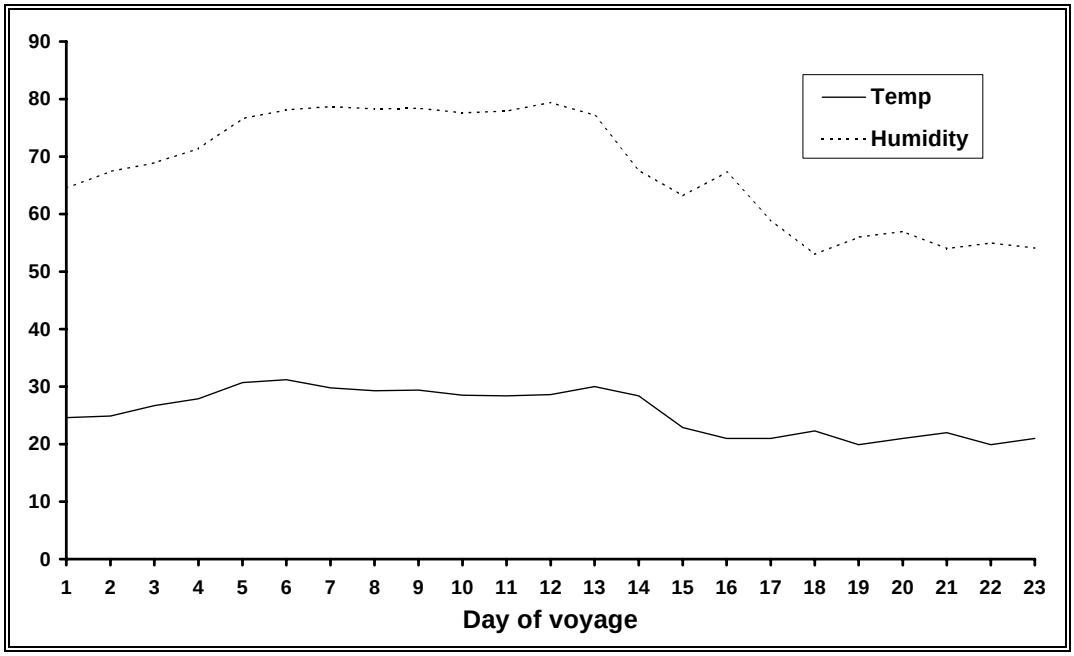
Results

Husbandry and Environment on Ship

Husbandry: The feed used on the voyage was a commercial lupin-based pellet with a metabolisable energy of 8MJ/kg dry matter. Additional fodder comprising lucerne chaff and oaten chaff was also available when needed. A reverse osmosis system provided ample quantities of high quality drinking water. Electrolytes, the composition of which is not known, were added to the water troughs between location 10 degrees south of the equator to the Red Sea on Days 6 to 13.

Environmental Factors: Sea conditions were calm throughout the voyage. Temperature and relative humidity levels were moderate on departure (Figure 3), elevated from the equator northwards to the Gulf of Aden and Red Sea, and then fell north of Jeddah in the Red Sea (Day 13).

Figure 3. Average daily temperature and humidity recorded on Deck 10 (Hold 2)



Airflow within holds: The ventilator outlets were located at cattle-head-height along the sides of the ship adjacent to lanes A (port side) and F (starboard). The vents dispersed a forceful 30 km/hr airflow, the velocity of which dissipated rapidly with increasing distance from the outlet. Much of the airflow was deflected above the heads of the stock and ran along the ceiling of the hold. Air that passed horizontally across the pen was deflected as it reached cattle further from the outlet. Consequently, airflow was barely perceptible in sections of the central lanes. The location of these ventilation "dead spots" was ephemeral and moved as cattle located in the outer lanes moved or lay down.

Heat Stress: Between Days 6 and 13, the respiratory rates of Bos Taurus cattle ranged from 54 to 72 respirations per minute (Figure 4). Brahman cattle in adjoining

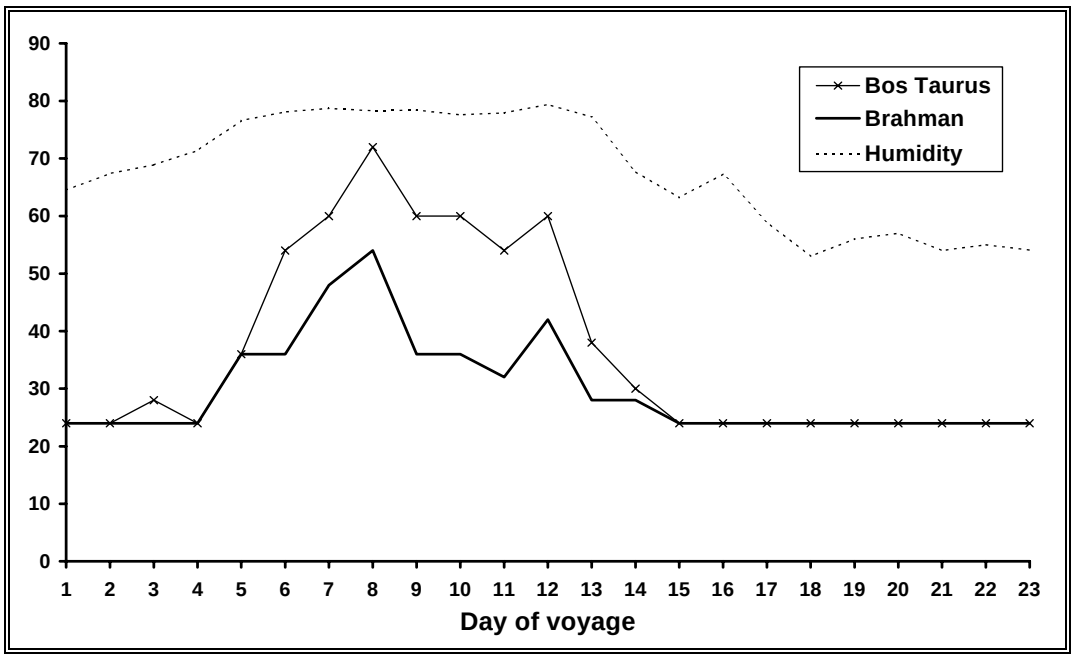
pens of Deck 10 Hold 3 showed a similar increasing trend during this period although respiratory rates did not exceed 54 respirations per minute. Brahman cattle were regularly observed to intersperse resting respiratory rates (20-30 respirations per minute) with short periods of rapid respiration (48-54 respirations per minute). Bos Taurus cattle maintained the elevated rates for much of the 7-day observation period. Clinical observations suggest that airflow strongly influenced the respiratory rate. On Day 6, the ship encountered hot humid conditions. At 0600 hours, 3 Angus cattle from a property south of Perth were observed lying in sternal recumbency in a pen on Deck 2 Hold 3. The cattle were lying in the aft area of the pen, with their heads extended and with respiratory rates of 52-72 respirations per minute. The rectal temperature of one steer was 41.5C. The temperature and relative humidity at the aft end of the pen were 32.9C and 83.9% respectively. Eight Hereford and Hereford/Angus cattle at the fore end of the pen had respiratory rates of 40-48 respirations per minute, and the ambient temperature and relative humidity were 31.3C and 82.9%.

The aft end of the pen was adjacent to a bulkhead of the aft pellet hold which contained machinery for transferring pellets to upper decks. The heat from the pellet hold radiated through an open hatch directly into the affected pens. Two portable fans were installed to direct air into the aft end of the pen. The 3 Angus cattle were forced to stand, and recovery ensued uneventfully over the next 4 hours. Although the increased airflow from the fans reduced signs of heat stress in the cattle, there was minimal impact on temperature and humidity levels.

One animal died of uncomplicated heat stress on Day 9 of the voyage. Three additional steers in this pen, with similar coat colour and breeding as the dead steer also showed respiratory distress, recumbency and elevated rectal temperatures (41.5C, 41.3C and 40.9C). The 3 steers recovered when moved to a well ventilated hospital pen (see Case 6, Appendix 6 for details).

Another incident occurred on Day 10 and involved 6 animals on Deck 2 Hold 3 Lane F approximately 10 meters from the incident with the Angus cattle. At 0300 hours, 1 steer was found dead (Case 7, Appendix 6), 2 were in sternal recumbency and 3 had rapid respirations (60+ per minute). The rectal temperatures of the “downers” were 39.9C and 41.1C. An additional hole was cut in the ventilation duct which dramatically improved air flow in this area of the pen. The cattle improved and respiration rates fell to 42 per minute. Their rectal temperatures fell by 0.5C after they were forced to stand.

Figure 4. Respiratory rate variations between Brahman and British breed cattle



Temperature and humidity on Deck 3 Hold 2: Temperature and humidity varied throughout the hold. Measurements of Deck 3 Hold 2 recorded on December 13 revealed a range between min/max temperature and relative humidity of 1.9°C and 3.5% respectively within the 45 meter long deck (Table 9). In all decks, the centrally located pens (those in lanes C and D) consistently showed the highest temperature and humidity.

Table 9. Temperature and relative humidity measurements within Deck 3

Location	Temperature (°C)	Humidity (%)
A8	30.9	78.9
A7	29.8	76.5
A6	29.9	76.1
A5	29.8	75.7
B8-C8	30.8	**79.9**
B7-C7	30.8	79.8
B5-C5	30.4	78.8
D8-E8	**31.0**	78.5
D7-E7	30.9	78.3
D6-E6	29.9	77.5
D5-E5	29.7	77.1
F8	29.4	78.2
F7	**29.1**	**76.2**
F6	29.7	76.4
F5	29.7	75.8

Mortalities

A total of 44 deaths occurred in the consignment of 12,966 steers (death rate 0.34%).
Breed: Highest death rates were recorded in Shorthorn cattle (2.1%) followed by Charolais and Limousin (Table 10). Brahman cattle from similar properties of origins (Pilbara and Kalgoorlie) had low mortality rates (0.06%). Both deaths in Brahman cattle were due to fractured legs.

Table 10. Relationship between cattle breeds and mortality rates

Cattle Breed	Estimated total number of cattle of that breed	Number of deaths	Deaths %
Shorthorn	750	16	2.10
Charolais	150	2	1.30
Limousin	150	2	1.30
Simmental	150	1	0.66
Angus – Murray Grey	4,500	13	0.28
Hereford	3,700	8	0.21
Brahman	3,250	2	0.06
Other breeds	50	0	0.00
Total	12,700	44	0.34

Cause of death: Complete necropsies were performed on 35 animals. Necropsies were not undertaken immediately on 9 cattle that died whilst unloading at Tripoli and post mortem autolysis made interpretation difficult when these cattle were subsequently examined. Causes of mortalities are shown in Table 11, and a detailed description of the necropsy findings is given in Appendix 6.

Table 11. Cause of Death

Cause of Death	No of Deaths
Pneumonia	14
Leg Trauma or Leg infections	6
Septicaemia	5
Enteritis	4
Abomasal Ulcer and Perforation	4
Heat Stress	1
Inanition	1
Bloat	1
No diagnosis made	8
Total	44

Length of time aboard ship: Loading at Fremantle was completed over 3 days and discharge at Tripoli took 5 days. The maximum time cattle spent on the vessel was 24 days. The chronological order of deaths in the different mortality categories is shown in Table 12.

Leg Injuries: most deaths occurred during the first 8 days. This involved 3 fractured legs and a penetrating weldmesh wound with subsequent systemic bacterial infection.

Wounds received earlier in the voyage also resulted in deaths due to septicaemia secondary to a hock abscess on day 12 and from gangrene on day 18.

Abomasal Ulcers: two cases of abomasal ulcerations and perforations (day 11 and 16) were due to pre-existing trichobezoars. The remaining 2 cases occurred on day 5 and 17.

Heat Stress: only one death was considered to be the result of heat stress. This occurred on day 9, following 48-60 hours of hot, humid conditions (described in Appendix 6, Case 6).

Bloat: only one fatality occurred and this animal died in the afternoon following a morning washdown. Feed intake generally was observed to increase following the washdown, and the increased consumption is considered to be responsible.

Septicaemia: deaths due to septicaemia began 4 days after hot, humid weather was encountered and occurred in low numbers thereafter. Histologically, there were changes consistent with infection by *Salmonella sp*.

Enteritis: the first case of enteritis occurred towards the end of the hot weather during which time feed intake fluctuated markedly. Periods of depressed appetites were interspersed by heavy feeding immediately following washdowns. The remaining 3 cases occurred during the cooler period after day 14 when feed intakes were greatest. Histologically, the bacterial enteritis was consistent with Salmonellosis.

Pneumonia: all cases of pneumonia occurred during the cooler weather after day 14. Histologically, the changes were typical of Pasteurellosis (Shipping Fever).

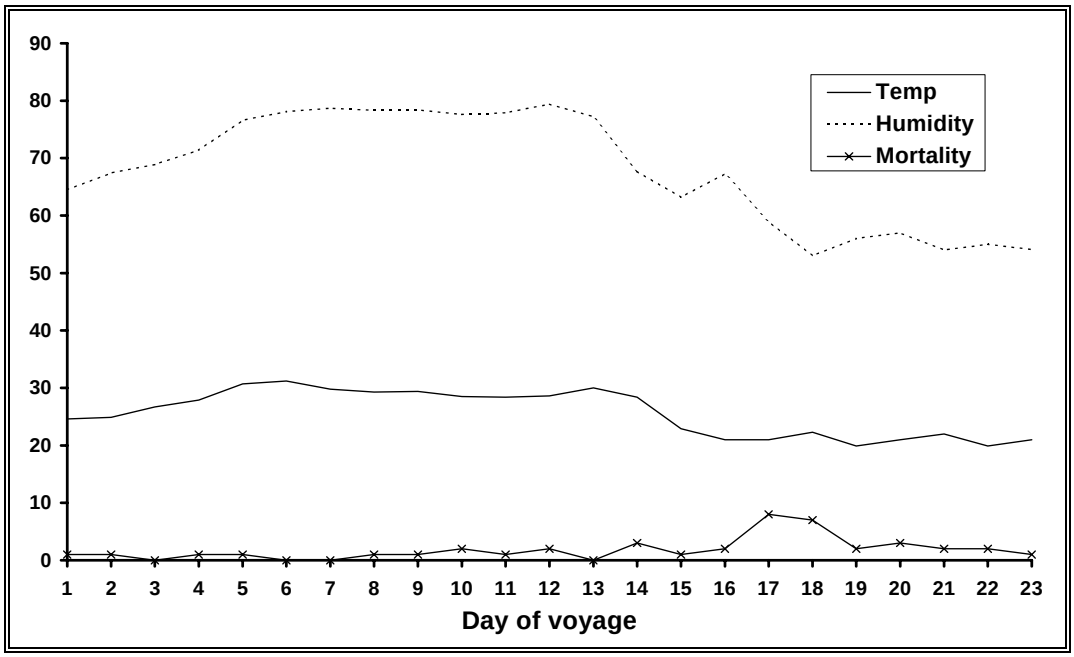
Inanition: one diagnosis of inanition was made during the voyage and involved a shy feeder that had been overlooked at previous inspections.

Table 12. Chronological order of cause of deaths

	Days on board ship																						
Disease	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Leg Injury	1	1		1				1										1					
Abomasal Ulcer					1						1					1	1						
Heat Stress									1														
Septicaemia										1		1		1	1		1	1					
Bloat										1													
Enteritis												1		1			1	1					
Pneumonia														1		1	5	4	2			1	
Inanition																		1					
No Diagnosis																				3	3	2	
Total	1	1		1	1			1	1	2	1	2		3	1	2	8	8	2	3	3	2	

Temperature and relative humidity: Although temperatures and relative humidity were elevated between Days 5 and 12 of the voyage, there was no increase in daily death rate Figure 5). However, increased mortalities were observed on Days 17 and 18 following a sharp fall in temperature and humidity previously.

Figure 5. Mortalities related to temperature and humidity



Location within hold: The location of deaths is summarised according to lane in Table 13 and according to deck in Table 14. Air flow was weakest and often imperceptible in the central lanes (C and D) in all decks, and 19 deaths (43% of all deaths) occurred in these lanes. All cases of septicaemia and enteritis and the only case of heat stress occurred in these two lanes. In contrast, all but two of the 14 cases of pneumonia occurred in the outer lanes (A and B, and E and F) and all happened during the latter, cooler stages of the voyage (Figure 5).

Table 13. Number and causes of deaths according to lane

Location (Lane)	Total deaths	Cause of death
A (Port)	6	Fractured leg(2), gangene
B	1	Pneumonia
C	10	Abomasal ulcer, septicaemia(3),pneumonia, enteritis
D	9	Septicaemia(3), enteritis(3), pneumonia, heat stress
E	8	Pneumonia(7)
F (Starboard)	10	Leg injury(2), abomasal ulcer, bloat, inanition, pneumonia

Death rate was highest on deck 3 (Table 14). Agriculture Western Australia has records of death rates on decks 1 to 4 for 19 previous voyages of this ship since mid 1995. The highest death rate has occurred on deck 4 on 11 occasions (58% of 19 voyages), and decks 1 and 2 on 3 occasions each (16%). The highest death rate has never previously been observed on deck 3.

Table 14. Number of deaths according to deck

Deck	No cattle	No dead	Dead %
1	545	0	0.00
2	538	3	0.56
3	582	7	1.20
4	632	2	0.32
5	590	1	0.17
6	1611	5	0.31
7	1522	2	0.13
8	1705	6	0.35
9	1776	13	0.73
10	1705	2	0.12
11	1760	3	0.17
Total	12966	44	0.34

Health conditions not involving death

Leg Problems and Trauma: approximately 5% of cattle showed signs of foot soreness in the first 24 hours after loading onto the ship. Pastoral cattle that had spent 24 hours on trucks prior to loading were most affected. Approximately 1% of cattle suffered swollen hocks and pasterns during the voyage, with occasional severe cases involving the entire limb. The prevalence appeared to increase after washdowns. The factors that contributed to this condition probably include direct trauma from pen-mates, from the weldmesh flooring or from pieces of broken off weldmesh which penetrate the foot or skin and often cause an infection.

Nasal Discharge and Coughing: many cases of coughing were observed during the first few days after loading and a watery nasal discharge was seen in approximately 100 animals during inspections. The affected animals appeared bright and alert and continued to eat and drink normally. This condition is considered be a reaction to the dusty feed. Those cattle coughing sporadically later in the voyage were treated with a prophylactic antibiotic injection on the grounds that there may be an underlying early pneumonia. None of those treated died.

Pinkeye: during the first few days of the voyage approximately 2% of the shipment was affected with weeping eyes. Several cattle had arrived on board with mild conjunctivitis seen clinically as reddened conjunctiva and ocular serous discharge. Most cases resolved without treatment. Approximately 1% of animals developed keratoconjunctivitis that was sufficiently severe to require treatment. One animal with severe pinkeye subsequently died from the effects of a bacterial septicaemia.

Bloat: bloating was seen throughout the voyage and was responsible for the death of one animal. The tendency of the feed to powder is believed to be the major causal factor. Treatment by addition of chaff to the diet appeared to be effective in most cases. Intra-rumenal injection of bloat oil was required in approximately 10 cases of bloat.

Diarrhoea: several cases of scouring were seen during the voyage, and were considered to fall into different categories. Several cattle showed a copious projectile diarrhoea having the green-yellow colour of the pellets. These animals remained bright and alert and their appetite remained unaffected. Some shy feeders were hospitalised and provided with a diet almost solely composed of lucerne chaff. The chaff appeared to induce a watery scour that resolved when oaten chaff and pellets were added to the ration. Haemorrhagic enteritis involving blood within a watery, often foetid diarrhoea was observed in approximately 20 animals throughout the voyage. Affected animals appeared inappetent and depressed. Animals with hemorrhagic enteritis were treated with antibiotics and most recovered.

Discussion and Conclusions

Main cause of death: of the 36 diagnoses made on this voyage, 23 cattle died from bacterial infections. These infections were probably due to *Pasteurella haemolytica* and *Salmonella* sp. Culturing of bacteria was not undertaken on this voyage. Such bacteria are considered to be opportunistic invaders in animals under stress. *Pasteurella haemolytica* has been implicated in shipping fever in cattle, and salmonellosis is a well known cause of death in cattle and sheep under feedlot conditions. Bacterial infections resulting in death have been observed by veterinarians on some other voyages of cattle. However, the relative importance of bacterial infections in cattle deaths during sea transport remains to be determined.
Trauma: lower leg trauma was the next most important cause of death and the most important health condition. Several factors may contribute to injury. These include lameness following trucking, injuries during loading, bruising from the weldmesh flooring, penetrating wounds from broken weldmesh, and injuries from other cattle. Although the stocking densities were substantially below the maximum levels recommended by AMSA, there was still not sufficient floor space for cattle to lie down without being trodden on by pen mates. Further investigation is needed to determine the extent of traumatic injuries in the trade, and to identify the relative importance of the predisposing factors.
Breed: there was strong evidence that Brahman cattle travelled better than other breeds on this voyage. Death rates were lowest in Brahman cattle and the animals had substantially lower respiratory rates than Bos Taurus breeds during a period of heat stress in the first half of the voyage. Veterinarians on other voyages have also observed that Bos Indicus have adapted better than Bos Taurus to the heat and humidity encountered during shipping.
The finding that death rates were highest in Shorthorns, followed by Charolais and Limousin breeds may be due to property-factors rather than genuine breed differences. There were only small numbers of these breeds loaded, and they may

have come from few properties. Further observations are needed to identify whether some Bos Taurus breeds travel better than others during shipping.

Property factors: tail tags were used on approximately 50% of the consignment to identify the property of origin. However, only 16 (36%) of the dead cattle could be identified to property. The remainder had lost their tags or were not tagged before loading onto the ship. Consequently, it was not possible to determine whether there are differences in mortality of cattle between properties. In the live sheep trade, property-factors have a major influence on death rates during shipping, with approximately half of all deaths occurring in only 13% of farm groups of sheep.

Ventilation: air flow was considered to have a major influence on mortalities on this voyage. In the middle stages of the voyage, most deaths were in the central lanes of pens and were mainly from septicemia and enteritis. Air flow was minimal or nil in these lanes, and the air was warm to hot and humid. The lack of air flow in these pens and the elevated respiratory rates were considered to have contributed to the deaths. However in the latter part of the voyage, most deaths were in the outside lanes and were mainly from pneumonia. Air flow was strong in these lanes and the air was cool to cold. Consideration should be given to using ducts to divert some of the ventilation directly into the central lanes on this ship.

Necropsy methods: a major effort was made on this voyage to ensure that necropsies were performed as soon after death as practical. This is because rapid post mortem autolysis in samples obtained from two previous voyages (in which post mortem intervals ranged from 4-8 hours) had made histopathological and probably gross pathological interpretation difficult. All necropsies were performed in the pen where the cattle lay, usually between 0300 and 0600 hours. Conditions under which necropsies were performed were not ideal. Most cattle died at the back of pens where light was poor and torchlight was necessary to visualise lesions. The pens contained 10 cms of faecal material making contamination of the equipment and carcases common. Brains were removed in cases where a diagnosis was not apparent from the gross findings. Subsequent histopathology of brains provided no further useful information.

It is essential that necropsies are undertaken in a standard manner with appropriate examination of samples in a laboratory, and that there is consistent interpretation of the findings. Otherwise, comparisons between voyages will be difficult and potentially misleading.

Recommendations

The present report is considered as one step in an ongoing process to improve the health and welfare of cattle during live export. The recommendations below are based on current information. Additional studies are planned and it is likely that the recommendations may be modified and extra recommendations made in the light of new information.

1. Immediate action is required to stop authorities at Egypt imposing a feed and water curfew on cattle before discharge from the ship.
2. Facilities for unloading cattle from ships onto trucks at Egypt need to be improved to minimise the risk of injury or death of cattle during discharge. Consideration should be given to the design and use of an unloading trailer, similar to the MOVOR that was deployed at various Gulf ports for unloading sheep from Australia.
3. Cattle for live export should be sourced from northern areas of Australia in preference to southern areas between March and November. Cattle should be sourced from southern areas in preference to northern areas between December and February.
4. Bos Indicus and Bos Indicus-infused cattle should be sourced in preference to Bos Taurus breeds preferably throughout the year, but particularly during the northern hemisphere summer.
5. Quality control needs to improve such that all cattle exported meet importers' specifications and that advanced-pregnant animals are not exported.
6. There is a need for a standardised protocol for further investigations of cattle welfare during sea transport (see draft in Appendix 8). The protocol should aim at recording objective measurements where possible so that a performance history can be built up over time. This should include the prevalence of various conditions affecting the health or mortality of the cattle.
7. There should be investigation of various factors that may affect the performance of cattle during long haul voyages. These factors should include different breeds, distance trucked to the wharf, property of origin and other factors (yet-to-be-determined) in the previous management of the cattle. The investigations should include recording of death rates and appropriate objective measures of performance such as respiratory rates, particularly during conditions of heat stress.
8. The causes of death should be investigated on a number of shipments from southern Australia. This should include detailed descriptions of the gross pathology and laboratory examination of appropriate samples, overseen by a veterinary pathologist to ensure consistent interpretation of findings. A minimum target of 200 necropsies in total is recommended, undertaken on at least 4 voyages.
9. The causes of injury and lameness following loading onto ships require further investigation. This should include defining the prevalence of injury and lameness on different ships, description of the floor surface on various ships to identify the better surfaces, and closer examination of the role of weldmesh in predisposing to injury or lameness.

10. Ships with a record of poor performance in terms of cattle mortality or welfare should be investigated closely to determine the reasons and to implement corrective strategies.
11. There is a need to investigate the role of ventilation, particularly air flow, in predisposing to heat stress and pneumonia. This may include a need to define the minimum ventilation standards required for cattle during sea transport and to ensure that ships meet such standards, particularly when carrying Bos Taurus breeds from southern ports during the northern hemisphere summer.
12. There is a need to identify those cattle pens where air flow is minimal or nil, particularly on ships with a history of poor performance. There is a need to investigate the use of ducts or other methods to improve ventilation in cattle pens where air flow is minimal or nil.
13. Ships should not be licensed to undertake long haul voyages from Australia if they need to call into another overseas port to replenish supplies en route to their destination.
14. The cattle carrying capacity of ships should be restricted, if necessary, such that they can supply sufficient drinking water per head per day to all cattle during the voyage.
15. If it is required that a veterinarian accompany cattle shipments in future, there must be a thorough briefing beforehand and a de-briefing after the voyage. The findings should be collated and reviewed closely by an appropriate person or group so that further recommendations can be made if necessary.