

# RSPCA AUSTRALIA SCIENCE UPDATE

## ISSUE 32 – APRIL 2011

The aim of the animal welfare science update is to keep you informed of developments in animal welfare science relating to the work of the RSPCA. The update provides summaries of the most relevant scientific papers and reports received by the RSPCA Australia office in the past quarter.

### COMPANION ANIMALS

#### The heritability of premature heart disease in Cavalier King Charles Spaniels

Mitral Valve Disease (MVD) is the most common heart condition in dogs, and many studies have reported that Cavalier King Charles Spaniels are especially susceptible to this disease. In MVD, the valves that separate the two left chambers of the heart become progressively thickened and stiff, allowing some blood to travel in the reverse direction with each beat of the heart. This abnormal flow of blood can be heard as a distinct 'murmur' by a veterinarian, through a stethoscope. The disease usually becomes increasingly severe with time, often leading to congestive heart failure, and sometimes sudden death.



In this study, the researchers tried to determine if premature MVD, i.e. MVD occurring in young animals, can be inherited genetically. Using the medical reports and Kennel Club pedigrees of over 1,200 dogs, the researchers mathematically determined the likelihood that premature MVD could develop in an individual, given a particular family history. 4-5-year-old animals were examined in the study, as the presence of an audible murmur at this age indicates that the disease started developing around the early age of 1-2 years. It was found that that MVD had a high level of heritability, and that the severity of the disease was also heritable (animals whose parents had severe MVD were more likely to develop severe MVD). The authors suggest that the statistical measures developed in this study be used to selectively prevent high-risk animals from breeding. However, care must be taken to ensure that breeding away from premature MVD does not inadvertently increase any other diseases in Cavalier King Charles Spaniels, such as syringomyelia. Too high a selection intensity can lead to a loss of genetic diversity which also needs to be taken into account when developing breeding programs.

Lewis T. *et al.* (2011) Heritability of premature mitral valve disease in Cavalier King Charles spaniels, *The Veterinary Journal*, 188: 73-76.

#### Treating separation anxiety in dogs



Some dogs may become stressed or anxious when their owners are absent, and this can lead to unwanted behaviours such as excessive barking, soiling the house and other destructive activities. Separation anxiety-related behaviours can be common reasons for relinquishment to shelters. In this study, the researchers investigated the effectiveness of a behavioural therapy, called systematic desensitization, on a group of eight dogs, and recorded the behaviour of the animals at times of separation before, during and after treatment. The animals' owners were instructed to initially expose the dogs to short periods of separation,

and gradually increase the time of separation over several weeks. The owners were also asked to provide food to their dogs while preparing to leave, at the time of departure and when returning home (but only if the dog had behaved well in their absence). This was meant to be a positive reinforcement, called counter conditioning to counteract the fear associated with the anticipation of the owner leaving.

The researchers found marked improvements in the behaviour of all dogs, even in cases when the owners had not been consistent. The authors suggest that systematic desensitization, even in the absence of counter conditioning, can help to reduce the unwanted behaviours associated with separation anxiety.

Butler, R., Sargissona, R.J. & Elliffe, D. (2011) The efficacy of systematic desensitization for treating the separation-related problem behaviour of domestic dogs. *Applied Animal Behaviour Science*, 129: 136-145.

## FARM ANIMALS

### The outcomes of two spaying techniques used on yearling heifers

The spaying of heifers is an important procedure carried out by cattle breeders to control stock numbers and reduce land degradation. The live cattle export trade with Southeast Asia also has a strict requirement that females not be pregnant. As a result, spaying not only makes cattle herds more manageable, but also has significant economic advantages. In this study, the outcomes of two commonly-used spaying procedures were compared. One group of Brahman heifers was spayed by an incision in the flank, which was the standard practice in Australia until the late 1990s. Another group was spayed by a technique known as the Willis Dropped Ovary Technique (WDOT), which was introduced from North America in 1996. This technique is less invasive and causes no visible injury, but requires considerable technical skill. Both techniques are performed without the use of anaesthetic.

The researchers found that spaying, regardless of the technique used, compromised the health and welfare of some animals for up to 3–4 days and significantly reduced body weight gains to at least 42 days post-treatment. Overall, WDOT spaying resulted in lower morbidity and short-term mortality compared with flank spaying.

McCosker, K. *et al.* (2011) Morbidity, mortality and body weight gain of surgically spayed, yearling Brahman heifers, *Australian Veterinary Journal*, **88**(12): 497–503.

### Improving the design of farrowing systems for sows and piglets



Around the time of the birth of piglets, sows are housed in farrowing crates, which prevent the performance of natural behaviours. The farrowing crate was initially developed to reduce building space requirements, provide safe working access to the piglets, reduce labour input and improve piglet survival. The authors of this review article argue that, as a result of these (mainly production-driven) considerations, there is now a conflict between the needs of the sow, the needs of piglets and the needs of farmers. Despite the considerable amount of research on the behaviour and biological needs of domesticated pigs, there are a number of trade-offs in operation throughout the phases of farrowing, which makes it difficult to design a suitable farrowing and lactation environment that meets all biological needs.

Nest-making is a behaviour seen in all wild species of pig around the time of late pregnancy and lactation. This behaviour is strongly expressed in domesticated sows as well, which has led many researchers to argue that this behaviour is a strongly hard-wired biological need. Allowing a sow to engage in nest-making has significant benefits not only for the sow's physiology, but also for the survival and well-being of the piglets. Unfortunately, many modern farrowing systems do not allow sows to indulge in this behaviour. Piglets, too, have specialised needs soon after birth, and these needs may or may not be the same as those of the sow. For instance, sows require ambient temperatures no higher than 20–22°C, whereas young piglets prefer far higher temperatures, in the vicinity of 34°C. Keeping such complex interactions in mind, the authors present a range of design recommendations for farrowing systems, for factors such as minimum space requirements for the safety and comfort of the sow and piglets, flooring, wall material, substrate, enrichment, health and hygiene.

Baxter, E. M. *et al.* (2011) Alternative farrowing systems: design criteria for farrowing systems based on the biological needs of sows and piglets, *Animal*, **5**(4): 580–600.

### Preference of dairy cows: indoor feed vs. pasture

It is often assumed that cows will experience better welfare when reared on pasture, as compared to indoor housing systems. Pasture allows cattle to perform natural behaviours, such as graze freely and sit or lie in comfortable positions. However, high yield dairy cows, which are capable of producing upwards of 30 kg of milk a day, have much higher nutritional requirements than their ancestors from the distant past. A diet of grass



alone may not adequately meet these requirements, and this may result in the cows constantly experiencing hunger. While indoor housing removes the problem of adequate intake, it has the disadvantage of restricting natural foraging behaviour, and increasing the frequency of health problems, such as lameness and mastitis.

In this experimental study, the researchers allowed 32 high-yield Holstein dairy cows to choose between a pasture of mixed perennial ryegrass clover sward and indoor housing, where a total mixed ration was freely available. Cows were free to move between the two areas, and the time spent in each location was recorded. It was found that cows chose to go indoors twice as often as the pasture, and also spent significantly more time indoors, especially in rainy weather. The highest yielding cows spent the most time indoors, and cows with a higher body condition score tended to spend more time at pasture. The authors conclude that the provision of a high-energy diet influenced the decision of certain types of cow to remain indoors.

Charlton, G.L. *et al.* (2011). Preference of dairy cows: Indoor cubicle housing with access to a total mixed ration vs. access to pasture, *Applied Animal Behaviour Science*, **130**: 1–9.

### A chemical alternative to lamb mulesing

Flystrike is an important problem in Merino sheep, but the most commonly used treatment, mulesing, brings with it severe welfare concerns. As a result, much research effort has focused in recent years on finding a more humane means of removing the highly wrinkly skin from around the breech and tail area of Merino lambs. In this experimental study, the researchers trialled the injection of a caustic compound, sodium lauryl sulfate (SLS), into the skin that is normally removed by mulesing. A total of 11 lambs were injected with SLS, and observed for 42 days, while being compared to similar numbers of mulesed and untreated control animals.



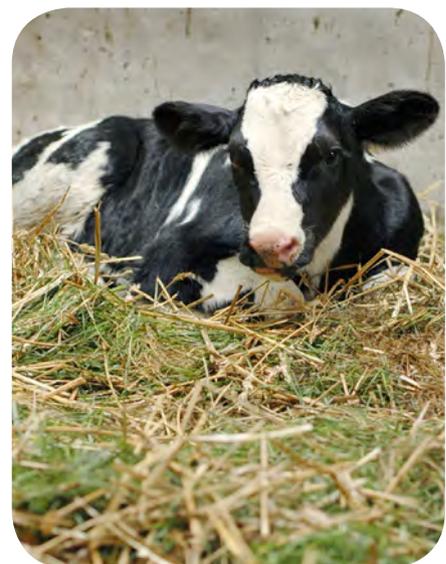
The researchers found that although SLS-treated lambs showed signs of discomfort and a significant physiological reaction to the treatment, the symptoms were much milder than those seen in mulesed lambs. For instance, on the day of treatment, the SLS group spent <5% of their time in total abnormal behaviours, compared with 18% in the mulesed group. SLS treatment caused a thin scab to form at the site of injection, which lifted off the skin over the course of a few weeks.

Colditz, I.G. *et al.* (2011) Physiological and behavioural effects of intradermal injection of sodium lauryl sulfate as an alternative to mulesing in lambs, *Australian Veterinary Journal*, **88**(12): 483-489.

### The use of anaesthesia during the disbudding of calves

The horns of female dairy calves are routinely removed at an early age by a technique known as thermal disbudding, where a device heated to 600°C is applied to the horn buds for around 30 seconds. This kills all the deep tissue of the developing horn, but may also cause serious damage to the surrounding flesh. This study investigated the effect of combining an anti-inflammatory drug, carprofen, with a local injection of lidocaine on the pain responses of young dairy calves subjected to thermal disbudding.

The researchers found that disbudding causes severe pain during the procedure and for at least 3 hours afterwards. The most commonly observed signs of distress after the procedure were ear flicking, head rubbing and head shaking, which are reliable enough to be used in the future for identifying calves in pain. The injection of lidocaine at the horn base successfully reduced pain signs for the first hour, but was not able to prevent pain-distress beyond that time. The combination of the local anaesthetic lidocaine with intravenous carprofen reduced all pain signs for 24 hours, and the authors conclude that this can ensure good welfare in dehorned calves.



Stilwell, G. *et al.* (2011) Effects of hot-iron disbudding, using regional anaesthesia with and without carprofen, on cortisol and behaviour of calves, *Research in Veterinary Science*, doi:10.1016/j.rvsc.2011.02.005.

## Welfare issues in broiler breeders

Broiler chickens have historically been selectively bred to enhance traits such as large body size and high growth speeds. Modern-day broiler breeders often suffer from poor welfare as a result of this selective breeding, as they have constant access to food, and frequently become overweight. This leads to serious health problems, such as lameness and premature death, and also negative production outcomes, such as poor laying performance and poor fertility. To counter this issue many commercial breeders practice severe feed restriction during the rearing of broilers, which means that the birds are constantly hungry, and in a state of stress. The authors of this review article suggest that a more humane strategy might be to provide high-fibre feed to the birds, in combination with an appetite suppressant, such as calcium propionate.

Another serious welfare issue is that male broiler chickens tend to be highly aggressive during mating. This often results in serious injury to the hens, and a high incidence of forced copulations. Again, the strategies used to deal with this phenomenon – the trimming of males' beaks and spurs – also has serious welfare implications. The authors suggest that such problems can be overcome humanely by rearing males and females together from an early age, and by keeping group sizes and stocking densities low. Although breeding companies are now taking such welfare issues into consideration, the authors suggest that the effects of selective breeding should be studied under a range of housing conditions.

de Jong, I.C. & Guemene, D. (2011) Major welfare issues in broiler breeders, *World Poultry Science Journal*, **67**: 73-81.

## Sheep's physiological reactions to three anti-flystrike procedures

Mulesing is a routine procedure carried out to prevent flystrike in Merino sheep. However, this procedure is extremely distressing to the animals, as it is often done without anaesthetic, and leaves large, open wounds. More humane methods are being researched by the wool industry, and these include the injection of chemicals such as cetrimide into the skin of the breach, causing the formation of a scab, and the use of plastic clips, which restrict the bloodflow to the breach skin, and cause it to fall off after a few weeks.

In this study, the researchers examined the physiological reactions of different groups of sheep to three different anti-flystrike procedures, namely mulesing without anaesthetic, cetrimide injection and clips. They measured the blood concentrations of various compounds that could reliably give an indication of the level of distress experienced by an animal undergoing one of these procedures. The researchers found that mulesing caused the most marked changes to the blood chemistry, closely followed by cetrimide, while the clip group showed only mild changes. Importantly, the mulesed and cetrimide injected animals also showed weight loss during the first week post-treatment. The authors conclude that clips have short-term advantages over the other procedures.

Lepherd, M. *et al.* (2011) Assessment of the short-term systemic effect of and acute phase response to mulesing and other options for controlling breech flystrike in Merino lambs, *Australian Veterinary Journal*, **89**(1-2): 19-26.

## Simulation of long-haul voyages for Merino wethers

During the live shipment of sheep from Australia to the Middle East, the animals have to frequently encounter conditions of high temperature and humidity. A typical voyage from Australia to the Middle East is usually around 14 days but can often extend up to 19 days, and the sheep's welfare may be seriously jeopardised during this time. The physiological responses of sheep to extreme conditions are known from previous studies, but there, the animals were only subjected to high temperatures for a few hours at a time. In this study, Merino sheep were



exposed to more realistic long-haul travel conditions in specially designed climate-control rooms for a period of 17 days. Eight Merino wethers were exposed to continuous high temperature and humidity, along with two periods of exceptionally high temperatures of around 34°C for 3-4 days each, with one day of cooler temperatures in between. Overhead lights remained on throughout the study, typical of ship conditions during live export.

The core temperatures and respiratory rates of Merino wethers increased during both heat exposures, with openmouthed panting observed during both exposures. The blood chemistry of the sheep also showed fluctuations in keeping with the increased respiratory rate resulting from the panting, but returned to normal soon after the temperature dropped. Feed intake was maintained during the heat exposures, and there were no large alterations in blood electrolyte concentrations attributable to the effects of the heat. The authors conclude that although Merino wethers are temporarily adversely affected by heat and humidity, they are able to cope physiologically with such conditions.

Stockman, C. *et al.* (2011) Effect of prolonged exposure to continuous heat and humidity similar to long haul live export voyages in Merino wethers, *Animal Production Science*, 51: 135–143.

### Alternatives to antimicrobial growth promoters for broilers

The routine addition of antibiotics (antimicrobial growth promoters, or AGP) to farm animal feed has been standard practice for decades, as this was shown to greatly increase animal growth, while minimising the incidence of disease outbreaks. In recent years, however, public opinion regarding this practice has shifted significantly, primarily due to fears of antibiotic-resistant strains of bacteria being passed on to humans. In some countries at least, the regular use of antibiotics has been banned, and this has resulted in some animal performance problems, reduction in growth, and an increase in the incidence of certain diseases such as (subclinical) necrotic enteritis. One disease syndrome that is clearly emerging in the European Union broiler industry is often referred to as ‘dysbacteriosis’. This is a poorly described condition of the gut, and may be synonymous with conditions such as ‘wet litter’, ‘small intestinal bacterial overgrowth’, ‘malabsorption’, and ‘feed passage syndrome’. The common symptoms are thinning and ballooning of the small intestine, increased water content of faeces and reduced digestibility of feed with undigested residues visible in the faeces.



The authors of this review article point out that there are a number of alternative strategies available to poultry farmers to keep up original growth rates in their birds, and to counteract the effects of stopping AGP use. These include the addition of enzymes to the feed to help in the breakdown of hard-to-digest chemicals that may be present in large quantities in grains such as rye and corn. Organic acids are able to reduce the growth of bacteria in the gut, and also have a beneficial effect on the intestinal lining, while probiotics and prebiotics can help the growth of beneficial bacteria in the gut, as well as stimulate the immune system. Finally, herbs and etheric oils such as those derived from clove, mustard, cinnamon and garlic also reduce the number of harmful microbes. However, the authors stress that in order to be good alternatives for AGP, these strategies need to be cost-effective. Currently, the cost of the chemicals described above ranges from 2-25 Euros per tonne.

Huyghebaert, G. *et al.* (2011) An update on alternatives to antimicrobial growth promoters for broilers, *The Veterinary Journal*, 187: 182–188.

### The development of tail-biting in piglets

Tail-biting is an unwanted behaviour that is often seen in domesticated pigs, and has the ability to cause serious injury to the tails of the affected animals. This behaviour often starts off with individuals merely holding the tail of another pig between the teeth, which the recipient often tolerates. Soon, this benign behaviour can become far more aggressive, and there are even reports of ‘fanatic’ biters that spend much of their time violently biting one tail after another.



The authors of this study analysed video recordings between piglets in 14 different pens that experienced outbreaks of tail-biting. The piglets were individually marked, and the researchers were able to tell who was doing what to whom. In this way, the researchers were able to determine that tail-biting behaviour started appearing in the pen as early as six days before the first visible signs of damage appeared, indicating that biting-induced tail damage is a cumulative process. Moreover, most piglets performed and received tail bites at this early stage. Once tail damage

was present, almost all piglets in the pen became involved in the biting process. One or a few pronounced biters could be identified in most pens. Though less obvious, bitten piglets (victims) could also be identified. Finally, biters did not prefer to bite a specific penmate, even if it had a damaged tail. The authors conclude that the removal of the biter would be a more effective remedy than removal of the bitten pig.

Zonderland, J. *et al.* (2011) Individual piglets' contribution to the development of tail biting, *Animal*, 5(4): 601-607.

### The effects of social isolation in dwarf goats

Many animal species are social, and individuals may experience fear and stress when separated from the rest of the group. Sometimes, the stress of separation can be somewhat alleviated by allowing an isolated individual to see the rest of the group, even if it cannot interact with them. Different species deal with separation in subtly different ways, however, and in this study, the effect of isolating individual dwarf goats was investigated.

A total of 48 animals were individually exposed to either complete isolation (the isolated animal could not see, smell or socialise with the rest of the group) or partial isolation (individuals were socially and visually isolated, but could hear and smell the rest of the group) on six consecutive days for 30 minutes. During each isolation session both behaviour and vocalisation were recorded. Complete and partial isolation induced differential behavioural and vocalisation responses in goats. Completely isolated animals were less active, showed lower rates of rearing and fewer high bleats than partially isolated animals. These behavioural reactions could be attributed to the perceived emotional distress associated with isolation. Importantly, the goats did not become habituated after repeated isolation sessions. The authors conclude that social isolation should either be avoided completely or only applied in exceptional cases (e.g. essential veterinary treatment), and if possible, the isolated animals should be allowed to hear and smell the rest of the group to provide social support.

Siebert, K. *et al.* (2011) Degree of social isolation affects behavioural and vocal response patterns in dwarf goats (*Capra hircus*). *Applied Animal Behaviour Science*, 131: 53-62.

## ANIMALS USED FOR SPORT, ENTERTAINMENT, RECREATION AND WORK

### Whip use in thoroughbred races

Whipping has a very long tradition in horse racing, but changing public perceptions have brought about the regulation of this practice in many countries. In Norway, whipping is now totally banned, but in Australia, jockeys can still use whips in the last 400 metres of a race, provided that their horse is 'in contention'. At the outset, the prevalence of whipping is a puzzling phenomenon, for learning theory predicts that a horse that is running fast will not be encouraged to run any faster by applying a negative reinforcer. Instead, whipping should simply inhibit any acceleration that the horse currently very little scientific data horse speed, this study investigated, races held at the race track in

The researchers found that jockeys final 400 and 200 metre positions in frequently. However, horses mostly the 600 to 400 metre section, the increased whip use was most sections of the race, when horses slow down. The increased whip use



associated with any significant change in the horses' speed. The researchers conclude that the strongest predictor of racing success was how a horse performed in the section of the race that it wasn't being whipped and that whipping was not associated with an increased likelihood of finishing in the first three placings.

was about to perform. As there is regarding the effect of whipping on in detail, the last 600 metres of five Canterbury, NSW.

in more advanced placings at the the races whipped their horses more achieved their highest speeds in when there was no whip use. Thus, frequent in the final two 200 metre were fatigued, and had started to at this time was not found to be

Evans, D. & McGreevy, P. (2011) An investigation of racing performance and whip use by jockeys in thoroughbred races. *PLOS One*, 6(1): e15622. doi:10.1371/journal.pone.0015622.

## Demand for exercise in stabled horses



Regular exercise is a very important requirement for horses, but in many cases, the animals are confined to small spaces for long periods of time. For example, mares used in commercial estrogen production may have poor welfare, as they are confined for six months of the year, with access to a paddock only once every two weeks. The vast majority of horses are privately owned, and here too, they may receive insufficient amounts of exercise.

In this study, horses were first trained to let themselves out of their stall by pressing an electronic panel with their nose a given number of times. Using this set-up, the researchers investigated the horses' motivation to leave their stall, and walk to an area that contained food, an empty paddock or a companion. Food was found to be the most important motivator in this experiment. Next, the horses were trained to walk into a maze – one arm of the maze held a treadmill, where they were exercised for 20 minutes, while the other arm led to their stall. When later tested for their preference, the vast majority of horses chose to go to their stalls. Finally, the researchers tested the horses' preference to be either alone or with 3 other companions in a paddock, by allowing each test animal to return to its stall at will. On average, the horses stayed in the paddock for twice as long when other horses were present, than when they were alone. After being deprived of the paddock for 2 days, these animals preferred to remain outside with their companions for even longer. In contrast, there was no increase in time spent

outdoors after deprivation, when the horse was led to the paddock alone. The authors conclude that the social context of voluntary exercise is important; horses are willing to stay out of their stalls longer if other horses are present, and will show compensatory behavior only if other horses are present. Forced exercise on a treadmill is also not very attractive to horses, and it is far more beneficial to turn horses out into a paddock in a group, and for 30 minutes at a time.

Lee, J. *et al.* (2011) Preference and demand for exercise in stabled horses, *Applied Animal Behaviour Science*, **130**: 91–100.

## RESEARCH ANIMALS

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### Measuring motivation in fish

Recent research has revealed that fish are capable of experiencing subjective feelings. Since animal welfare can be related to what animals feel, knowledge of what they want has been regarded as one of the most useful approaches to understand an animal's perception of their own needs. One way to understand the subjective states of animals (and to therefore determine their welfare status) is to measure their level of motivation, i.e. the amount of effort the animal will put into obtaining rewards such as food, territory and potential mates. In this study, motivation in a cichlid fish, the Mozambique tilapia, was measured by presenting a food reward or a mate on the far side of a clear plastic 'door', which the fish could push open using its snout, and swim through. In the control trials, there was only empty space on the other side of the door. The task could be made more challenging by adding small weights to the door. The researchers measured the time it took for fish to open the door (latency), and the proportion of time spent working at the door before it opened (work attention).

The researchers found that latency to open the door increased with increasing difficulty of the task, with the highest latency for the control reinforcer. Work attention was constant with increasing difficulty for mates and food, and higher than the control. Work attention decreased for the control as difficulty increased. The fish were therefore putting in far more effort to get to the food and mates, compared to when only empty space was available. The authors conclude that this experimental setup can be used to accurately gauge motivation in this species of fish.

Galhardo, L., Almeida, O. & Oliveira, R.F. (2011) Measuring motivation in a cichlid fish: An adaptation of the push-door paradigm. *Applied Animal Behaviour Science*, **130**: 60–70.

## HUMANE KILLING

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### On-farm killing of turkeys



Animals that are sick or injured are routinely killed on farms to reduce suffering, or to prevent the spread of disease. Birds such as turkeys present special problems to farmers, as their large size makes it difficult to handle and kill them in a quick and humane way. Techniques include captive bolt or blunt trauma to the head, neck stretching and neck crushing (by means of Burdizzo castrators), but their effectiveness and humaneness can vary greatly, and also depend on the skill of the person performing the procedure.

In this study, the researchers examined the effects of the above methods of killing on the skull and brain of turkey hens, toms and broilers. In general, the percussive bolt caused far more damage to the skull and the brain than manual blunt trauma (swinging an iron bar at the turkey's head). Microscopic brain damage was present in all turkeys killed by percussive bolt shooting and blunt trauma, but in only one of four turkeys killed by neck crushing and one of four turkeys killed by neck stretching. Percussive bolt shooting and blunt trauma most likely caused death by directly disrupting brain function, whereas neck stretching and neck crushing probably resulted in death from the interruption to the brain's blood supply. Based on this and previous research, which showed that percussive bolt and blunt trauma were the quickest to render turkeys unconscious, the authors recommend these two techniques as effective and humane ways for the on-farm killing of turkeys.

Erasmus, M. *et al.* (2011) Brain and skull lesions resulting from use of percussive bolt, cervical dislocation by stretching, cervical dislocation by crushing and blunt trauma in turkeys, *Veterinary Record*, **167**: 850-858.

## ARTICLES OF INTEREST

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Andersen, H.M.-L. & Pedersen, L.J. (2011) The effect of feed trough position on choice of defecation area in farrowing pens by loose sows, *Applied Animal Behaviour Science*, **131**(1-2): 48-52.

Andersen, M. (2010) Improving pig welfare by decreasing social hierarchy stress, Essay selected for The Veterinarian Magazine Prize for Written Communication for Sydney University third-year veterinary science students, *The Veterinarian*, December 2010, page 19.

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Blackie, N., Bleach, E., Amory, J. & Scaife, J. (2011) Impact of lameness on gait characteristics and lying behaviour of zero grazed dairy cattle in early lactation, *Applied Animal Behaviour Science*, **129**(2-4): 67-73.

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