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Contents

Programme

January 28th

11:30 - 12:00 Registration

12:00 – 12:05 Opening of the meeting

12:05 – 12:15 Overview of ISAE

I session: wild animals

12:15 - 13:20 Zoo Animal Welfare: What makes it different – Dr. Geoff Hosey

13:20 - 13:35 Coffee break

13:35 - 14:10 Captive breeding of the European mink (Mustela lutreola) – can training of voluntary sampling improve welfare of female minks? – Lea Tummeleht

14:10 - 14:35 Male neighbour density independently affects stereotypic behaviour and copulatory success in European mink. – M. Díez-León L. Tummeleht, K. Nemvalts, T. Maran

14:35 – 15:00 Does weaning age and mode affect adult male copulatory success in European mink? – K. Kiik, T. Maran, M. Díez-León

15:00 – 15:25 Broiler chicken behaviour in dependence on housing conditions and welfare. – V. Ribikauskas

15:25 – 15:40 Coffee break

15:40 – 16:00 Maternal behaviour in gilts – The effect of genotype, social rearing environment and mixing after weaning. – P. Roulaux, L. Bolhuis, L. M. Hannius, A. Wallenbeck

16:00 – 16:25 Rearing Yorkshire gilts in different social environments – effects on social interaction and general behaviour. – L.M. Hannius, L. Keeling, P. Gullstrand, E. Verbeek, A. Wallenbeck

16:25 – 16:50 Which types of rooting material give weaner pigs most pleasure? – M. Ocepek, R. C. Newberry, I-L. Andersen

January 29th

8:30 – 9:00 Registration

II session: laboratory animals

9:00 – 10:05 Design of animal studies: increasing reproducibility and animal welfare. – Prof. Adrian Smith

10:05 – 10:30 A discussion of selected challenges to the welfare of cull sows in the Danish pre-slaughter logistic chain. – M. S. Herskin, K. Thodberg

10:30 – 10:55 Behaviour of cull sows kept in lairage at the slaughterhouse. – A. Bonnerup, K. Thodberg, L. Gould, J. Klaaborg, M. S. Herskin

10:55 – 11:10 Coffee break

11:10 – 11:35 Improved pig welfare at slaughter – pigs' responses to air- or nitrogen foam. – A. Wallenbeck, E. Sindhöj, R. Brattlund Hellgren, C. Berg, C. Lindahl

11:35 – 12:00 Why are cows culled in Estonian Dairy herds? – T. Rilanto, K. Reimus, T. Orro, A. Viltrop, K. Mõtus

12:00 - 13:00 Lunch

III session: farm animals

13:00 - 14:05 Management of farm animal welfare – Prof. Harry Blokhuis

14:05 - 14:40 Animal welfare legislation in Estonia – Kadri Kaugerand (Ministry of Rural Affairs)

14:40 - 15:15 Surveillance of animal welfare requirements in Estonia – Hele-Mai Sammel (Veterinary and Food Board)

15:15 - 15:30 Coffee break

15:30 – 15:55 Implementation of precalving vaccination programme against rotavirus, coronavirus and enterotoxigenic E. coli (F5) and effect on dairy calf survival. – D-A. Viidu, C Kuningas, K Mõtus

15:55 – 16:20 The ethology of turkeys. – R. C. Newberry

16:20 – 16:45 A dustbathing buffet – preference for dustbathing materials in broiler chickens. – R. V. Holt, J. Vas, G. Vasdal, R. C. Newberry

16:45 – 17:10 Effects of a varied light environment on the behaviour of laying hens. – A. Wichman, H. Wall, O. Håstad

19:00 Dinner at Trikster Tihane (Address Kastani 42)

January 30th

8:30 - 9:00 Registration

IV session: pet animals

9:00 - 10:05 Fear and welfare in dogs – Dr. Björn Forkman

10:05 - 11:10 Animal Assisted Interventions and animal welfare – Prof. Lena Lidfors

11:10 - 11:25 Coffee break

11:25 - 11:50 Sheep housing choices at cool temperatures. – G. Marcone, T. Kaart, P. Piirsalu, I. Nutt, D. R. Arney

11:50 – 12:00 Closing

12:00 - 13:00 Lunch

Zoo Animal Welfare: what makes it different?

Geoff Hosey

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The welfare of animals in captivity has been a concern for at least the past four or five decades, and during that time a great deal of research has been conducted to establish general principles (for example, what does welfare mean and how do we recognise different welfare states) and practice (for example, how can we minimise poor welfare and enhance good welfare). Much of this research has been achieved in agricultural and laboratory contexts, but the body of knowledge which has resulted usually has clear relevance to other contexts as well, such as with companion animals, zoo-housed animals and, indeed, animals in the wild. But all of these different contexts also have their own unique characteristics which must be taken into account when considering the advancement of animal welfare theory and practice. In this talk I will consider four features of the zoo environment which make zoo-based animal welfare particularly challenging: firstly, species diversity, which confronts us with a huge number of species whose basic biology, either in the wild or in captivity, is poorly known; secondly, difficulties of data interpretation that come partly from the diversity of zoo housing and husbandry, and partly from issues of standards in what are essentially still 'wild' (i.e. undomesticated) animals; thirdly, the chronic presence of people, in particular crowds of daily zoo visitors; and fourthly, the fact that in attempting to implement different aspects of good welfare, the 'wild' nature of our animals sometimes presents us with conflicts with other aspects of the zoo mission (such as conservation and education) which are not easy to resolve. Hopefully I can also show examples of how we can deal with some of the issues raised by these features.

Captive breeding of the European mink (*Mustela lutreola*) – can training of voluntary sampling improve welfare of female minks?

Lea Tummeleht

Estonian University of Life Sciences

There may not be always an equal sign between species conservation and animal welfare. Conservation does address the whole population while animal welfare is always the study of one. Nevertheless, those two approaches do not have to exclude each other.

One important facet of captive species conservation is captive breeding. The subject of the current talk is breeding of European mink (*M. lutreola*) at the Tallinn zoo. Tallinn Zoological Gardens harbours the largest captive population of endangered European minks and serves also as captive breeding centre for this species. Every spring, 10-25 females are assigned for breeding. To determine "the right time", assigned females will be daily sampled for their vaginal fluid. This talk will introduce how positive reinforcement based training can be involved into this procedure to give animals choices to participate voluntarily in the sampling.

Design of animal studies: increasing reproducibility and animal welfare

Adrian Smith

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Despite EU Directive 2010/63's ultimate aim of complete replacement, societal concerns about the reproducibility, replicability and validity of animal studies, we continue to use animals for research and testing in large numbers. The Directive's system for classification of procedures according to their severity has led to even greater concerns about the humanity of these studies. Today, these concerns are being levelled at scientists not just by the general public: they are being voiced by scientists themselves, led by a group of eloquent experts who, in particular, are experts on the more "mathematical" aspects of experimental design. It is common to hear that the so-called "reproducibility crisis" should be tackled by better reporting in the scientific literature.

Norecopa believes that the reporting phase is far too late to achieve any improvement in the quality of animal studies, and that much more than the purely "mathematical" aspects must be addressed if experimental design is to become better. Norecopa, in collaboration with British colleagues, has therefore produced guidance for planning animal studies from day one, called PREPARE. The guidance consists of a checklist, supported by a website offering comprehensive guidance on each of the 15 topics on the list. The website contains links to quality resources from all over the world, and it is updated continuously (https://norecopa.no/PREPARE).

It is now widely accepted that animals which are in harmony with their surroundings serve as better research "subjects". Lower stress levels mean that animals deliver data which is closer to baseline levels, making it, in turn, easier to identify the effects of a treatment. Thus, animal welfare and good science go hand in hand.

This presentation will offer some practical advice on how to increase validity and improve animal welfare. It is based upon long experience in managing animal facilities, planning animal experiments and training scientists in laboratory animal science. Hopefully it will give participants insight into where they can find the resources they need to replace, reduce or refine experiments which appear to involve the use of animals - whether it be in research, testing, or for training purposes.

Management of farm animal welfare.

Harry J. Blokhuis

Swedish University of Agricultural Sciences

Ever since the second half of the 20th century there has been growing societal concern regarding the welfare of the animals. Nowadays the general public and consumers expect animal food to be produced with good care for the animals.

Due to public concerns as well as the obvious effects on production and quality aspects, animal welfare is increasingly recognized as an important aspect to ensure societal acceptance and economic profitability of the animal production sector. This means that welfare has to be managed throughout the production chain and outcomes demonstrated to market partners and consumers.

To manage welfare actively, farmers and other actors in the production chain need information about the welfare status of their animals. Such information is in the first place gathered by skilful farmers and operators during daily practice but also through formal assessments in the context of welfare assurance schemes. Moreover, modern technology more and more allows for (continuous) monitoring of relevant welfare parameters and becomes therefore more applicable as a management tool and for market communication.

To allow welfare issues to be handled adequately, farmers and others also need knowledge about the relation between welfare and the husbandry environment/practices. This knowledge may be available from experience of the manager or from advisors (e.g. the farm's veterinarian) or require actual assessment of the quality of resources. Finally, the combined information and available knowledge leads to management decisions.

In the farm's welfare plan the different management steps should be thoroughly analysed and welfare assessment methods and frequencies as well as sources of relevant knowledge should be defined.

Surveillance of animal welfare requirements in Estonia.

Hele-Mai Sammel

Veterinary and Food Board

The Veterinary and Food board is a governmental agency that is carrying out its tasks under the government of the Ministry of Agriculture. VFB functions as a supervising body and sees to that that the requirements stipulated by the legislation that governs veterinary, food safety, market regulation, animal welfare and farm animal breeding are followed and executes supervision over fulfilment of these requirements and applies enforcement by state pursuant to the procedures and in the amount prescribed by law. The tasks of the Veterinary and Food Board include:

- plan and organize the prevention and control of infectious animal diseases

- protect humans from diseases common to both people and animals

- protect animals from factors endangering their welfare and demand that the animals are kept and treated as appropriate.

Supervision over fulfilment of requirements has two approaches – risk based controls and controls based on complaints. All establishments keeping production animals must be registered in the ARIB databases (Estonian Agricultural Registers and Information Board). There are about 12000 registered establishments and VFB carries out risk-based controls in about 3500 farms each year. Controls include requirements about animal health, animal welfare, feeding and production hygiene (milk, honey, fish). Animal health requirements inspected include registration of buildings, identification of animals, registration of animal movement, biosecurity, surveillance of diseases etc. Animal welfare requirements controlled include buildings, equipment and other facilities on the farm, microclimate, feeding and watering of animals, breeding, treatment and veterinary procedures etc.

Risk-based inspections are also carried out in establishments that require authorization from central authority to operate. These are high risk establishments, where animal welfare could easily be compromised. They are inspected once a year, about 140 inspections each year. These companies include animal transport companies, companies that keep test-animals, slaughterhouses, fur animal keepers.

In addition to annual risk based inspections, about 400 inspections are carried out each year based on complaints, mostly about companion animals and exotic animals. In 2019 over 200 inspections concerning companion animals were carried out. About 7000 certificates are issued by VFB each year for trading or export of animals. Before the transport animal welfare checks are carried out, both animals and vehicles are controlled.

Animal welfare surveillance is carried out routinely in Estonia and promoting animal welfare to the best possible level is essential for VFB.

Fear and welfare in dogs.

Björn Forkman

University of Copenhagen

Fear, and behaviours caused by fear, is arguably one of the largest welfare problems in much of the dog population today, and is one of the major behavioural reasons for euthanasia. Fear related problems include but are not limited to, noise phobia, separation anxiety and aggression. The way in which many dogs are bred, the selection criteria used, may increase the size of the problem since there are indications that an emphasis on breeding for conformity will result in more fearful dogs. Fear will affect the relationship between the human and the dog. While it may seem counterintuitive some results indicate that a certain level of fearfulness, especially social fear, can be attractive to dog owners. Severe fearfulness leading to aggression, phobias or separation anxiety are however perceived as costs to the owner. Various tests have been created to assess dog temperament; the results show a large breed variation in level of general fearfulness. While genetics have a large effect on the level of fearfulness early experiences have also been shown to be important, enrichment strategies during the first months of the puppy/young adult dog's life have a strong effect on e.g. the tendency to separation anxiety. For the adult dog there are behavioural treatments that are specific for the different fear related problems. Recently there have also been indications that it is possible to affect the general level of fearfulness through training with positive reinforcement as well as problem solving.

Animal Assisted Interventions and Animal Welfare.

Lena Lidfors

Swedish University of Agricultural Sciences

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Animal Assisted Intervention (AAI) is according to the International Association of Human-Animal Interactions Organization (IAHAIO) (White paper, 2018[1]) "a goal oriented and structured intervention that intentionally includes or incorporates animals in health, education and human services (e.g., social work) for the purpose of therapeutic gains in humans". AAI is carried out within the 'One Health One Welfare' framework and IAHAIO (2018) lists a number of guidelines to protect both human and animal welfare. The person delivering AAI or the person handling the animal during AAI "must have adequate knowledge about the behavior, needs, health and indicators of stress of the animals involved" (IAHAIO, 2018). The aim of this presentation is to highlight the risks to animal welfare, how these can be avoided and guidelines for good welfare when animals are used in AAI.

Research has shown that dogs may show behaviours indicative of stress and increased saliva cortisol during AAI. When dogs are working within AAI towards a third person, the handler must decide how long sessions and how many sessions per week the dog works. The handler can also interrupt a session if the dog shows signs of stress or discomfort. There are several educators of dog-handler teams within AAI in the Nordic countries today and each of them set up guidelines based on what they believe is the best practice. The Scandinavian Care and Therapy Dog Organisation is a network for social working dogs (http://svth.se/) and they recommend dog-handler teams to use the guidelines that have been developed.

Cats often live permanently in nursing homes for elderly or other care facilities. Some cats come there with their owner, while other cats are brought there by the personal to increase the welfare of the elderly. A veterinary inspection of 19 cats in Swedish nursing homes showed that obesity and teeth health were the biggest problems. Additionally, lack of knowledge about cats among the personal at the nursing homes and lack of organization of who is responsible for the cats was a concern. If cat shelters could offer older cats that are difficult to rehome to nursing homes for elderly, with the additional support to the personal, this could be a win-win concept.

A literature review on the welfare of horses during AAI found that the behaviour and attitude of humans involved and environmental factors, such as novel stimuli and social separation, can affect the horse's welfare. The breed, experience and temperament of the horse can also influence how well the horse will manage challenging situations and thus how its welfare is affected by AAI. In Sweden the Organisation for Equine Assisted Interventions is a network for those offering AAI, but they need some national support on horse welfare.

IAHAIO have on-going task forces working on developing recommendations for the use of all species within AAI. These could be used as guidelines for countries around the world when developing regulations for the use of animals within AAI. In conclusion, the Nordic countries who are well known for their high animal welfare standards should consider developing regulations for the use of animals within AAI.

Male neighbour density independently affects stereotypic behaviour and copulatory success in European mink.

M. Díez-León[1], L. Tummeleht[2], K. Nemvalts[3], T. Maran[2,3]

[1] *Royal Veterinary College, University of London*

[2] *Estonian University of Life Sciences*

[3] *Tallinn zoological Gardens*

European mink (Mustela lutreola) are critically endangered and undergoing ex situ breeding, yet a large proportion of captive-bred males fail to breed, behaving abnormally towards receptive females. They also display stereotypic behaviours (SB) which have been linked to impaired copulatory success in another mustelid species. Ex situ, these solitary carnivores are housed next to conspecifics at close proximity year round, whereas in the wild male mink territories overlap with those of several females and conspecific interactions occur predominantly during breeding season as males actively search for females. We hypothesised that male European mink SB result from frustrated motivations to either search, access females, and/or fight intruder males in captivity, and that this underlies their copulatory failure. We recorded SB (frequency, severity) and number and sex of neighbours within visual range of 79 mink (34 males, 45 females) during breeding season (ON) and of 83 mink (40:43) outside breeding season (OFF); 51 mink (25:26) were recorded both times. We also recorded whether males successfully copulated or not. Consistent with motivational frustration, both males and females were three times as likely to stereotype ON than OFF ($F_{1,49}$=9.83, $p<0.01$) with their stereotypies also being harder to interrupt ON ($F_{1,49}$=11.22, $p<0.001$). ON, males stereotyped more than females ($F_{1,75}$=14.7, $p<0.001$), and the more male neighbours, the more both sexes tended to stereotype ($F_{1,75}$=3.08, $p=0.08$). Male neighbour density also positively correlated with severity of males' SB ($F_{1,32}$=5.35, $p<0.05$). In contrast, OFF, there were no sex or neighbour sex effects on either SB levels or severity. Male neighbour density appeared to have opposite effects on copulatory success: males surrounded by more male neighbours increased their likelihood of copulating successfully (Chi-squared=3.33, $p=0.07$), with SB not having any mediating or direct effect (N.B. our sample size was greatly reduced for these analyses due to not all males being recommended for breeding; n=13). Our results suggest that male competition cues induce frustration while also increasing chances of successful copulation in males. This is of importance for conservation breeding managers, who might need to trade-off welfare and reproductive success.

Does weaning age and mode affect adult male copulatory success in European mink?

K. Kiik[1], T. Maran[1,2], M. Díez-León[3]

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The survival of the critically endangered European mink (Mustela lutreola) is fully reliant on the success of the captive breeding programme; however, up to 89% of captive-born male mink fail to successfully reproduce, for reasons consistent with deleterious effects of captivity on their behaviour. One way in which these effects might occur is through early life husbandry that differs from natural biology. For example, juvenile mink in captivity are weaned earlier and abruptly, rather than experiencing gradual dispersal as they would in the wild. In other carnivore species, early weaning leads to performance of abnormal repetitive behaviours in adulthood, and opportunities to interact with opposite-sex siblings during the juvenile period also affects reproductive performance in another mustelid species. Thus, the aim of this research project is to evaluate whether weaning age and mode impact the reproductive performance of male European mink. We predict that male mink who are weaned later and gradually will display less abnormal mating behaviour. We will assess this in two ways: first, retrospectively, by compiling weaning ages for all males in the last 20 years of the programme and regressing it against their reproductive success (# of attempted copulations, # of successful copulations, # of litters); and, second, experimentally, by manipulating the time and mode of weaning, with half the litters (c.10-15) being abruptly weaned at the current weaning time (10 weeks; artificial weaning), and the other half (c. 10-15) being weaned in a more naturalistic way (later, at 14 weeks, and gradually, providing opportunities - e.g. by use of platforms and access to added space - for both dam and offspring to gradually separate, as it occurs in the wild). Variables recorded will include levels of aggression between litter mates and between litter mates and the mother, and play behaviour. Results from this study will help refine the husbandry of the captive population of this critically endangered species to increase the success of the conservation programme.

Broiler chicken behaviour in dependence on housing conditions and welfare.

V. Ribikauskas

Lithuanian University of Health Sciences

The main aims of the study were to evaluate the behaviour and health of broiler chickens in the event of possible enrichment of the shed equipment (wood chip briquettes). Aim was to find out whether (and how) the behaviour and health of birds depends on the age and housing. The study was carried out using video cameras that filmed birds for 24 hours. The farm was tested weekly from chicken age day 2 totally for 4 times. The enrichment of the environment was mainly influenced in the first days of bird life, when briquettes were used as a cover for lying down, and the number of resting birds increased. Bird behaviour studies have shown an increasing frequencies of age-related lie down and grooming behaviours, as well as a decrease in feeding and drinking behaviours. The poultry farm has set the appropriate basic housing conditions for the birds. The environmental measurements revealed an increase in indoor air concentrations of ammonia and carbon dioxide in the last weeks of the study. The health and well-being of the birds were well assessed and no major health and behavioural disturbances have been identified.

Maternal behaviour in gilts – The effect of genotype, social rearing environment and mixing after weaning.

P. Roulaux[1], L. Bolhuis[1], L. M. Hannius[2], A. Wallenbeck[2]

[1] *Wageningen University*

[2]*Swedish University of Agricultural Sciences*

Maternal behaviour in pigs is influenced negatively by stress, and may therefore be linked to social behaviour of gilts (first litter) and sows that are kept in group housing during gestation. Gilts and sows in group housing are often aggressive towards each other, which causes stress and possibly injuries or even death. Measures to improve their social skills could lead to more positive social behaviour, which would reduce stress and could lead to better maternal behaviour. Swedish Yorkshire gilts may have better social skills than Dutch Yorkshire gilts, because the Swedish genotype has been kept in and selected for group housing for a longer period of time. Furthermore, additional opportunity to practice social behaviour may improve later social skills. We studied three factors in a 2x2x2 factorial design, being genotype (Swedish versus Dutch Yorkshire), rearing environment (access farrowing pen allowing socialization with another litter versus control in standard farrowing pen) and group mixing (grouping after weaning with unfamiliar gilts or control grouped with sisters only). Sixty gilts were exposed to the treatments from birth and video recorded when their first litter of piglets was separated from them and after their piglets were returned. We analyzed the first three minutes the gilt spent alone and the first three minutes after reunion with the piglets using the 'Qualitative Behaviour Assessment' (QBA) from the Welfare Quality® Assessment Protocol. Furthermore we recorded the occurrence of nursing after reunion, the gilt's responsiveness and piglet growth. Responsiveness associated with the original QBA scores for distressed during alone time ($P=0.007$) and reunion time ($P=0.008$) in two independent samples t-tests. We then analyzed the QBA scores by Principle Component Analysis (PCA), which yielded two components. Neither were significantly affected by any treatment factors. Treatment factors also did not significantly affect piglet growth, responsiveness or the occurrence of nursing, but low responsiveness did associate with a high likelihood of nursing in a Chi-square test ($\chi2=11.2$, $P=0.001$, $df=1$). No conclusions about our treatment factors affecting maternal behaviour can be drawn, but this study does raise questions on what constitutes good maternal behaviour. High responsiveness is often seen as good maternal behaviour, though the stress that these gilts experience at separation from their piglets may affect their maternal behaviour negatively.

Rearing Yorkshire gilts in different social environments – effects on social interaction and general behaviour.

L.M. Hannius[1], L. Keeling[1], P. Gullstrand[2], E. Verbeek[1], A. Wallenbeck[1]

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[2] *Department of Animal Breeding and Genetics, Swedish University of Agricultural Sciences*

There is an ongoing transition from single housed to group housed sows in the European pig production. The aim of this study was therefore to investigate differences in behaviour between two lines of Yorkshire gilts indirectly selected for single (Dutch Yorkshire, DY) or group housed systems (Swedish Yorkshire, SY) and reared with or without the opportunity to socialise from 2 to 5 weeks of age with piglets from another litter. Sows and their litters (n=26) were kept in individual loose housed nursing pens (6 m2) and half of the litters had access to the neighbouring pen via a pop-hole (access pen, AP). Behaviours were scan and continuous sampled only for the female piglets in the litters (45 SY and 54 DY gilts), who will be recruited into the breeding pool, during the first 10 weeks of their life using direct observations. The results indicated that SY gilts were more active and performed more social nosing behaviours than DY gilts. When SY gilts were the recipients of a social interaction, they were more likely not to respond to the interaction compared to gilts of the DY breed. Regarding different treatments, gilts held in an AP slept less and were more active directly after weaning. It was also found that AP stimulated gilts to perform a larger variety of social behaviours. Therefore, the breed as well as providing opportunities for a varied social environment may shape gilts' social development early in life.

Which types of rooting material give weaner pigs most pleasure?

M. Ocepek, R. C. Newberry, I-L. Andersen

Norwegian University of Life Sciences

Provision of rooting material as enrichment for pigs has been primarily oriented towards reducing negative aspects of welfare. Information is needed on the impact of different types of rooting materials in promoting positive affective states. We hypothesised that repeated addition of fresh rooting material, especially different types provided in combination, would stimulate positive affect in weaned pigs. We offered pig litters 10 l of rooting material (silage, straw or peat, or a combination ("combo") of all three) twice daily, in comparison to no additional rooting materials (control condition, sawdust present in all pens). Behaviours considered indicative of positive affective states in this context (exploration, play, tail curled, tail wagging), as well as behaviours associated with harm (ear/tail manipulation, aggression, tail down), were quantified from video recordings by 1-0 sampling. Over five weeks, 10 litters of weaned pigs were assigned to one condition weekly (order balanced across litters), and behaviour was assessed during the 30 min before and after delivery of rooting materials on Days 1 and 4 each week. The effect of condition (control, silage, straw, peat or combo) on positive and negative behavioural expressions was analysed using a generalised linear mixed model that also accounted for period (before vs after), time of day (morning vs afternoon), day of week, condition by period, condition by time of day, sex, bodyweight, litter size, and week. The peat and combo conditions resulted in higher levels of exploration, play, tail curled and tail wagging, and lower levels of ear/tail manipulation, aggression and tail down, compared to control, with the silage and straw conditions mainly giving intermediate results. Pigs showed more exploration, tail curled and wagging after than before provision of silage, straw, peat and combo, whereas an increase in play after material provision occurred only in the peat and combo conditions. Exploration occurred at similar levels on Day 1 and 4 of exposure to the peat and combo conditions whereas it declined across days in the other conditions, and ear/tail manipulation and aggression increased in the silage condition. Exploration, play and tail wagging declined with increasing age. Sex, bodyweight and litter size were not consistently associated with positive or negative behavioural expressions. Our results suggest that the peat, and peat in combination with straw and silage, conditions were the most consistently effective for inducing positive affective states, and reducing behaviours associated with harm, in weaned pigs.

A discussion of selected challenges to the welfare of cull sows in the Danish pre-slaughter logistic chain.

M. S. Herskin, K. Thodberg

Aarhus University, Denmark

In commercial pig production, up to 50% of the sows are slaughtered each year. Internationally, pig production is characterised by increasing herd sizes, and fewer and larger slaughterhouses. Thus, transport distances from farm to slaughter are increasing. The movement and management of cull sows through the pre-slaughter logistic chain are, however, not well described, and may differ considerably between countries. In this presentation, we discuss selected challenges to the welfare of Danish cull sows in the period from the farmer decides to cull them, and until they arrive at the slaughterhouse.

One major challenge when sending sows to slaughter is the vulnerable clinical condition of some sows. Typical culling reasons are reproductive problems, reduced health and age. Hence, as a consequence of the productive life in the herds, cull sows may be weak or prone to injuries, and thus less fit for transport than other types of pigs (Fogsgaard et al., 2018). In the EU, the concept of fitness for transport is vaguely defined and difficult to handle for the different stakeholders. Many cull sows show signs of clinical abnormality, which makes dealing with the concept of fitness for transport is even more complicated.

For reasons of biosecurity commercial trucks often have limited access to farms. According to Danish regulations, sows can be kept in stationary transfer vehicles away from the farm for up to two hours before being loaded onto the commercial truck. Herskin et al. (2017) studied behaviour of sows during their stay in these vehicles before transport and suggested that this stage in the pre-slaughter logistic chain may be a challenge for sow welfare, due to increased aggression and lack of rest.

The journey to the slaughterhouse may be a challenge as well. Thodberg et al. (2019) reported significant deterioration of the clinical condition of cull sows from pre- to post-transport (up to eight hours), such as increased occurrence of wounds, superficial skin lesions and higher gait score. Among the risk factors underlying this deterioration were interactions between temperature and transport duration, duration of stationary periods during the journey and while waiting before unloading.

Taken together, results of recent studies suggest that the Danish pre-slaughter logistic chain involves several challenges to the welfare of cull sows. Further research is needed to develop new management strategies in order to protect these animals.

Behaviour of cull sows kept in lairage at the slaughterhouse.

A. Bonnerup[1], K. Thodberg[1], L. Gould[1], J. Klaaborg[2], M. S. Herskin[1]

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In commercial pig production, around half of sows are transported to slaughter each year. However, the movement and management of cull sows through the pre-slaughter logistic chain are not well described. The study underlying this Master's thesis will focus on the behaviour of cull sows kept in lairage at the slaughterhouse - a topic where almost no behavioural data exist. Cull sows seem to stay for a longer period in lairage compared to finishers, mostly due to the logistics at the slaughterhouse. For the slaughterhouse it is important to be efficient, to maximize the slaughter capacity and to be competitive at an international level. In addition, sows may be more challenged upon arrival at the slaughterhouse than finishers as a consequence of their productive life on-farm and their increased sensitivity toward heat stress. Based on video recordings and data from temperature loggers installed in a lairage pen at a Danish slaughterhouse, the study will aim to describe the behaviour of cull sows while in lairage; including changes in their behaviour during an interval of up to 18h post-arrival during overnight lairage at the slaughterhouse and relations between sow behaviour and clinical characteristics of the sows (e.g. lactating vs not-lactating at the time of arrival). Special attention will be given to aggressive behaviour, drinking behaviour and lying behaviour. The behaviour of cull sows will be discussed in relation to the clinical condition of the sows, the duration of the stay and the welfare of the sows. The goal is to collect data (video recordings and temperature) from at least 10 overnight replications in lairage (approximately 200 sows). The cull sows originate from different farms in Denmark. In each replicate the lairage pen (31.3 m2) will house up to 30 sows depending on the availability of sows during the data collection period leading to a maximum stocking density of approximately 1 m^2 per sow, corresponding to the national guidelines. Knowledge obtained in this study can form the basis of further studies examining behaviour and welfare of sows at this stage of the pre-slaughter logistic chain.

Improved pig welfare at slaughter – pigs' responses to air- or nitrogen foam.

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The most commonly used stunning method in commercial slaughter of pigs is carbon dioxide, which has been criticized for inducing pain and discomfort before stunning is completed. One potential alternative is nitrogen, reported to have less aversive effects. An innovative technique dispersing the nitrogen gas in soap foam bubbles resulted in 2.7 times quicker oxygen depletion than when only using free nitrogen gas. The objectives in this study were to assess the behavioural and physiological responses of pigs to air-filled and nitrogen-filled foam to discern if the pigs have negative aversions to the foam, and to map the stunning process when pigs are exposed to nitrogen-filled foam.

In the experiment pigs were exposed to either air-filled foam, nitrogen-filled foam or no foam (control). The experiment included 60 pigs (20 per treatment; 9 weeks old and 27.8 ± 3.4 kg) and was conducted at SLU's pig research facilities. The results showed that using nitrogen-filled foam resulted in 2.7 times quicker oxygen reduction than when only using free nitrogen gas. The pigs did not show any strong aversive behaviours when exposed to the foam, regardless if it was air-filled or nitrogen-filled foam. However, they seemed to avoid putting their heads and snouts into the foam as the foam levels rose and the number of escape attempts through the top increased when the box was filled with foam. Physiological responses (e.g. increased heart and respiratory rate) was detected as the oxygen level decreased, which was expected. Mean time to loss of posture was 57.9 s., followed by vigorous convulsions which went over to more irregular, milder movements. Mean time to last observed convulsion was 131.2 s. Quality of stunning was checked five minutes after the start of the nitrogen foam production. The pigs were at that occasion recorded to be in deep unconsciousness or dead.

Why are cows culled in Estonian Dairy herds?

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Culling is a major cost for dairy farms but also an essential part in managing herd productivity. The study aimed to identify the culling rates of Estonian dairy cows, identify the farmers´ stated reasons and risk factors for culling. This observational study used registry data of all cows from herds with ≥20 cow-years in 2013-2015. Cow lactation-level analyses included data of 86,373 primiparous cows and 177,561 lactations of 109,295 multiparous cows. Weibull proportional hazard regression models were used to identify risk factors for culling due to slaughter or death.

The overall culling rate of Estonian dairy cows was 26.24 (95% CI 26.02; 26.46) per 100 cow-years. The most common farmers´ stated reasons for culling were feet/claw disorders (26.4%), udder disorders (22.6%), metabolic and digestive disorders (18.1%) and fertility problems (12.5%). Animal-level risk factors for culling were Holstein breed, older parity, lower milk yield breeding value, older age at first calving, longer previous calving interval, having assisted calving, stillbirth and birth of twins/triplets. Lower milk yield, somatic cell count over 200,000 cells/ml and fat/protein ratio over 1.5 at first test-milking after calving were associated with greater culling hazard during the lactation. Cows from larger herds, herds with decreasing size and higher milk yields had higher culling probability.

This study emphasises the need for improved management of hoof health and prevention of mastitis and metabolic diseases. It is essential to ensure easy calving and good health of cows around calving in order to lower the culling hazard.

Implementation of precalving vaccination programme against rotavirus, coronavirus and enterotoxigenic E. coli (F5) and effect on dairy calf survival.

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Calves are born agammaglobulinemic and cannot withstand infections on their own for the first weeks of life. The passive immunity acquired from colostrum is therefore vital for the calf health and survival. Diarrhea is one of the most common diseases and cause of death in neonatal calves whereas rotavirus is often reported as the most prevalent viral cause of diarrhea. Vaccinating cows and heifers before calving enhances the potential passive immunity gained by the calf and increases the probability of survival. The current study investigated the implementation of the precalving vaccination programme against rotavirus, coronavirus and enterotoxigenic Escherichia coli (F5 antigen) in Estonian dairy farms and its effect on calf survival.

The study included 13 dairy cow herds (herd size ranged from 242 to 2457 cows) that were known to apply precalving vaccination against bovine rotavirus, coronavirus and enterotoxigenic E. coli (F5) (defined as PV). For each herd a questionnaire was filled out where the information about the vaccination procedures and calf feeding practices were asked. Farms were divided into correct and incorrect users (CU and ICU, respectively) of the PV based on the compliance with the product directions and colostrum feeding practices. To qualify as a CU the farm had to vaccinate all cows and heifers 3-12 weeks before expected calving and feed the calves whole milk from vaccinated fresh (up to four days in milk) cows at least during the first two weeks of calves´ life. Five herds met the requirements of CU and six farms were classified as ICU. Four of the six ICU farms did not vaccinate heifers and four fed the calves whole milk from vaccinated fresh cows 7 days or less.

In order to analyse the effect of PV the survival analysis was used comparing calf mortality rates in pre-vaccination (V-) and vaccination (V+) periods by using the registry data of Estonian Agricultural Registers and Information Board. The V+ period started one month after the farm started vaccinating their animals and lasted for one year. The V- period was determined as exactly one year prior to V+ period. Farms were enrolled to the analysis only if they ear-tagged their calves during the first 4 days of life and if there was registry data available for the whole study period. Due to these restrictions, data of 4 CU and 4 ICU farms could be included in the statistical analysis. The number of observations was 9406 in CU analysis and 3994 in ICU analysis.

In three out of four ICU farms, calf mortality rate was not significantly different in V- and V+ periods and was higher in V+ period compared to V- period in one farm. On average, the calf mortality rate increased amongst the ICU farms during the vaccination period (hazard ratio (HR) = 1.52, 95% CI 1.18; 1.96, $p = 0.001$) according to the mixed-effects Cox regression model (herd included as random effect). Among the CU farms the calf mortality rate decreased in three farms and remained unchanged in one farm. On average, calf mortality rate was significantly lower during the V+ period compared to V- period among the CU farms (HR = 0.67, 95% CI 0.59; 0.76, $p < 0.001$).

The study revealed that vaccination protocols and practices of feeding calves colostrum from vaccinated cows vary in the farms. Also, we confirmed a positive field effect of PV on dairy calf survival in the herds that followed vaccination directions and fed calves colostrum from fresh cows at least during the first two weeks of life.

The ethology of turkeys.

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Despite rising production worldwide, there are few publications on the ethology of domestic turkeys (*Meleagris gallopavo*). Nevertheless, inferences can be drawn from the behaviour of wild turkeys and effects of domestication and selection for greater body mass. Wild turkeys have colonised habitats varying widely in climate but retain a need for high trees for perching. Motivation to perch persists in domestic turkeys though their mobility is limited by heavier weights. Young wild turkeys are semi-precocious, relying on their mother for protection and guidance. In commercial production, young turkeys may benefit from imprinting upon a robot to guide their movement to different resources. Juvenile wild turkeys have a voracious appetite for live insects (e.g. grasshoppers), suggesting that their domestic relatives could benefit from incorporation of such stimuli as environmental enrichment. Sufficient space is needed to accommodate their locomotory play behaviour when confined indoors, and provision of attractive pecking stimuli reduces the risk of injurious pecking. Wild turkeys form leks with brothers to attract females and, although commercial turkeys are promiscuous due to artificial insemination, synchronised strutting by males is likely a positive welfare indicator. The importance of clean, functional plumage in wild turkeys suggests that plumage maintenance (i.e. dustbathing and preening) is also a priority for domestic turkeys. Turkey uropygial gland secretions have antimicrobial properties and may contribute to individual recognition. Given the rich vocal repertoire of wild turkeys, attention to the sound ecology of poultry houses could facilitate communication within flocks as well as automated recognition of vocalisations indicating flock welfare status. Research is lacking on turkey cognitive abilities. These examples illustrate how a focus on turkey ethology could be beneficial for enhancing the welfare and productive efficiency of commercial turkeys.

A dustbathing buffet – preference for dustbathing materials in broiler chickens.

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Opportunities for maintaining good plumage condition through dustbathing are important for chicken welfare. Peat is a more preferred and effective substrate for dustbathing than wood shavings but, due to environmental sustainability concerns, alternatives to peat are sought. We examined broiler chicken preference for seven dustbathing materials (100% peat, 70% peat:30% wood shavings, 100% wood shavings, finely-chopped conifer bark, finely-chopped rape straw, crushed rape straw pellets, oat and wheat straw pellets). We hypothesised that finer materials (e.g. peat and finely-chopped materials) would be preferred for dustbathing over coarser substrates as they would better penetrate the plumage. We observed two consecutive flocks (Ross 308) on a farm in Eastern Norway. The flocks were reared on peat litter and had continuous access to the seven dustbathing substrates in two sets of seven adjacent 1 m^2 boxes (total 14 boxes), with each set located in a different location in the house. Observations were conducted once weekly for four weeks. Each set of boxes was observed for 30 min before and 30 min after adding 5 L of fresh material to each box. Boxes within sets were observed in a pre-determined balanced order. An observation of a box started with an instantaneous scan of the total number of birds in the box, followed by a 1-0 sample to determine the number of dustbathing birds. After 45 s, the observer rotated to the next box (total 24 observations/substrate type/week). Our results showed that wood shavings-boxes attracted the most chickens regardless of freshness, but these boxes were mainly used for resting rather than dustbathing. Finely-cut rape straw was the most preferred substrate for dustbathing in the "before" period, whereas 100% peat, 70% peat:30% wood shavings and finely-cut rape straw were similarly preferred over the other materials for dustbathing after addition of fresh material. In general, more birds entered, and dustbathed in, boxes containing fresh than used material. Our results, thus, indicate that finely-cut rape straw could be a sustainable alternative to peat as a dustbathing material and that adding fresh material is useful for stimulating dustbathing.

Effects of a varied light environment on the behaviour of laying hens.

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Providing laying hens with a suitable light environment can support a good welfare. In a first part in this project some positive effects were found by providing hens with light spectrums that replicated the light in the open areas (Daylight, D) and underneath the canopy (Forest, F) in the natural habitat of the red junglefowl. Based on this, the present study investigated if there would be further benefits on the welfare of hens if they were provided access to both these light spectrums with some variation in intensity, compared to exposure to one spectrum of constant intensity.
Day-old Bovan chicks were housed in 16 pens (3.56 x 3.62 m) with 42 birds/pen. From week 4, 8 pens were lighted with the F light (10 lux) over the slatted area containing perches, nest boxes, feeders and drinkers and the other half of the pen, containing the litter area, was lighted with the D light that varied between 10-30 lux over the day (varied, V). In the remaining pens the whole pen was lit with the D light kept on a constant intensity of around 20 lux (constant, C). Behaviour observations in the home pen, with focus on social interactions and location in the pen were carried out between week 4 and 26. A tonic immobility (TI) test and a novel object (NO) test were done once each. At week 18 a pop-hole leading to an outdoor range were opened in each pen and the number of birds outside were counted regularly for 10 days. No significant differences in the birds´ behaviour in their home pen depending of light treatment were found. In the NO test there was a tendency (GLM; $P=0.057$) that more birds in the V treatment (4.0 ± 0.7; mean±se) approached the NO compared with the C treatment (2.4 ± 0.4). However, there were no significant differences between treatments in their reaction in the TI test, nor in their propensity to go outside. Thus, for these measured behaviours only a slight positive effect of the varied compared with the constant light environment was found.

Sheep housing choices at cool temperatures

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Keeping sheep with access to an outdoor area is increasingly practised in northern Europe, particularly in order to meet requirements for organic production. Threshold temperatures for cold stress in sheep are not well understood, and the literature that is available is somewhat dated and at winter temperatures that are relatively benign. Sheep housing choices, whether to be outdoors or indoors when given free access to both, were investigated in the winter period in Estonia, where temperatures were frequently below freezing, and as low as -23 °C. Two sheep farms were selected, one with free access to a permanent uninsulated, but fully covered, building and one with access to polytunnel shelter. Both flocks also had free access to an outdoor area. Observations were made with a video camera positioned so as to be able to register the numbers of sheep outdoors and indoors at any one time. Results showed that the sheep clearly chose to be outdoors. On all of the observed occasions the majority of the sheep were found to be outdoors, even at temperatures of around -15 °C. There was however a significant decrease in the numbers of sheep choosing to be outdoors when temperatures were lower, at higher relative humidity and with greater wind chill (all $p < 0.001$). The sheep were less likely to be outdoors at night than during the daytime. Therefore, even at cooler temperatures than reported previously, sheep choose to be outdoors rather than indoors. Being outdoors may not be implicitly good for their welfare, and these findings may not be true for lambs or for recently shorn sheep, but being outdoors appears to be where they choose to be when they given the choice to choose.