

SPECIAL
POINTS OF
INTEREST:

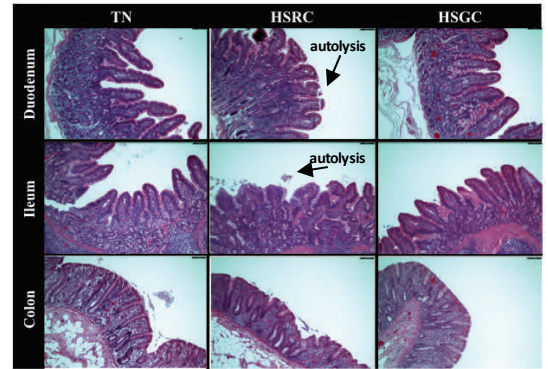
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Rapid or gradual cooling after heat stress?

There are real concerns that climate change will result in more exposure to higher temperatures, for livestock and humans. A potential outcome is greater incidence of heatstroke. Although rapid cooling is regarded as the most effective heatstroke therapy, human deaths still occur due to a systemic inflammatory response that occurs following thermal injury. Unfortunately, our knowledge of the thermal and pathophysiological effects of heatstroke and cooling procedures are often limited to rodent models and it is currently unknown how rapid cooling after heatstroke affects the health of species that share a similar physiology with humans such as pigs. We subjected pigs to three treatments; TN = Thermo-Neutral, HSRC = Heat Stress with Rapid Cooling, HSGC = Heat Stress with Gradual Cooling. Although we confirmed that rapid cooling after heatstroke in pigs reduced rectal temperature, intestinal core body temperature was unaffected and remained above euthermic levels during heat-



stroke recovery. As a result, intestinal damage (see figure) and circulating endotoxin and cytokines were increased in rapidly cooled compared to gradually cooled pigs. In summary, rapid cooling after heatstroke reduced rectal temperature but had no effect on intestinal temperature and this may be linked to increased intestinal damage and a greater systemic inflammatory response.

Tears tell a story...

In stressful situations for rodents, it appears that the Harderian gland beside the eye is activated and a red-brown, iron-containing substance is secreted, resulting in a red-brown tear stain. Our former graduate researcher, Shelly DeBoer, noticed similar staining when her pigs



were moved from enriched to isolated environments. Experimental investigation confirmed that pigs housed in non-enriched pens isolated from other pigs did have greater tear staining than pigs in enriched and non-isolated pens and that the tear staining size was related to other measures of stress such as cardiovascular indicators of sympathetic nervous system activation. Tear staining was also greater in pigs with low positions in the social hierarchy.

Given its conspicuousness, tear staining may be a useful, non-invasive and relatively easy to measure indicator of a pig's welfare on farm. A collabo-

orative study with researchers at the University of Helsinki, Finland measured the tear staining of pigs, on three different farms and included a range of pigs of different ages. The pigs were part of another study investigating the use of various environmental enrichment objects on tail

and ear biting. We found that tear-stain scores correlated with tail- and ear-damage scores, so that those pigs with larger amounts of damage also had larger tear stain scores. We also found that pigs with lots of enrichment had lower tear stain scores and that pigs with higher tear stain scores were slower to approach novel objects. These results confirm that tear staining does appear to be related to the amount of stress, from a variety of sources, and that tear staining has promising potential as a low-cost, easy-to-use welfare indicator for the assessment of pigs on commercial farms.

Calf pre-natal heat stress

Heat stress is an environmental stressor that not only affects the dairy cow, but recent evidence supports an impact on calves born after heat stress during the last months of gestation. Cows



were maintained in a control or heat stress environment for 7 days during the last month of gestation. Although the heat stress was only mild, the cows had greater respiration rates and body temperatures during the heat stress. They also tended to stand more when under heat stress. These data showed that an acute, mild heat stress was achieved. Calves born to these cows had altered acute phase cytokines (immune communication molecules). The white blood cells of those calves had more adhesion molecules, suggesting activation. The phagocytic



cells of the calves, which are essential for their protection during the first weeks of life were greater in the calves from the heat stressed cows and also indicative of an acute response. The alterations of the immune functions of these calves suggests that their immune responses are altered, and that they may already have increased susceptibility to disease. This work provides evidence that dairymen need to alleviate even mild heat-stress to reduce impact on upcoming generations of livestock. This will ultimately improve survivability and thriftiness of the neonate born after a heat event or during warmer weather.

“Award-winning
researchers”

Recent awards

Dr. Heng-Wei Cheng - LBRU Research Biologist - won the 2014 Poultry Welfare Research Award from the Poultry Science Association. Heng-Wei's overall research goal is to explore the cellular and molecular mechanisms of stress-induced neuronal plasticity and behavioral adaptation, and to develop neuroanatomical and neurophysiological quantitative indicators of animal well-being. His research program has benefitted researchers worldwide.



Dr. Gabriela Morello - a recent LBRU PhD graduate - has been awarded a 2016 Endeavour Research Fellowship. Endeavour Fellowships are internationally competitive, merit-based scholarships funded by the Australian Government that support citizens around the world to undertake study, research and professional development in Australia. Gabriela will follow up on some of her PhD work, investigating the effects of environmental factors such as light and temperature on sow and piglet behavior and welfare in open

farrowing systems, at the University of Melbourne, where she will work with another LBRU alumnus, Dr. Jean-Loup Rault.

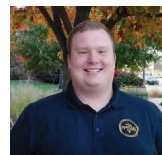
Dr. Morello also placed 2nd in the Purdue University 3-minute Thesis competition which supports the development of students' capacities to effectively explain their research in language appropriate to an intelligent but non-specialist audience. She had 3 minutes to present a compelling discussion on her research topic, its significance and relevance to the general public and the presentation can be viewed here: <https://youtu.be/786dol62giY>

Kevin Shade - one of our undergraduate aids - placed third in the undergraduate poster competition at the Midwest Section ASAS conference in Des Moines, IA in March 2016. His poster was based on his independent research

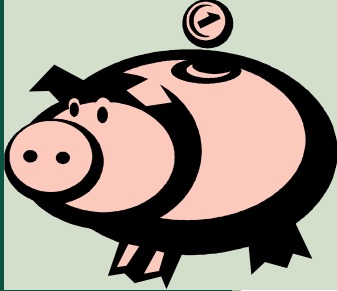
titled “Characterizing body temperature and movement differences at the onset of estrus in replacement gilts” supervised by Dr. Johnson.

Feifei Yan received the Certificate of Excellence for Presentation at the annual Poultry Science Association meeting, 2015. Feifei's presentation was entitled “The effects of dietary supplementation of probiotics on performance, eggshell quality, cecal microflora composition, and skeletal health of White Leghorn hens”. Her work is under the supervision of Dr. Cheng.

Dr. Susan Eicher's important work on tail-docking in dairy cattle was recently recognized by the Journal of Dairy Science. In response to the National Milk Producers Federation's announcement that tail-docking will be banned under its assurance scheme, JDS released its 10 top papers on tail-docking, including 4 from Dr. Eicher: www.journalofdairyscience.org/taildocking.



Grants awarded



- **Cheng, H.W.** and **Lay Jr., D.C.** Probiotics prevent feather pecking and cannibalism in laying hens. *USDA Post-Doctoral Fellowship*. \$140,000.
- **Eicher, S.D.** 2014 MVA Summer Internship Minority Grant. *USDA-ARS*. \$2000
- **Eicher, S.D.** 2015 MVA Summer Internship Minority Grant. *USDA-ARS*. \$2000
- **Johnson, J.S.** Evaluating the effects of heat stroke recovery methods on physiology, metabolic health and reproduction in a porcine model. *Data Sciences International*. \$21,536
- **Johnson, J.S., Lay Jr., D.C.** Evaluating the welfare of piglets after weaning and transport during different seasons. *National Pork Board*. \$45,714
- **Johnson, J.S., Richert, B.T., and Lay Jr., D.C.** Evaluating the effects of mitigation strategies on piglet welfare and future productivity after transport during different seasons. *National Pork Board*. \$76,155
- **Lay Jr., D.C., and Rault, J.-L. and Gates, R.** A novel two-step gas system to allow for humane on-farm euthanasia. *NIFA*. \$495,284.
- **Sapkota, A., and Lay Jr., D.C.** and Richert, B.T. Effect of short term high tryptophan diet fed to sows on subsequent piglet behavior. *National Pork Board*. \$74,300.
- **Sapkota, A. and Lay Jr., D.C.** Using conveyor belt to load and unload pigs to promote self-movement of piglets. *National Pork Board*. \$34,028.
- **Schinckel, A., Ajuwon, K., Boregowda, S., Johnson, J.S., Marchant-Forde, J.N., Richert, B., Stewart, K., Stwalley, R., and Winslow, E.** Development and evaluation of cooling pads to improve sow productivity, reproductive performance and animal well-being. *Purdue University AgSEED*. \$75,000.

Arrivals LBRU Welcomes....

Dr. Jay S. Johnson joined as a Research Animal Scientist in Nov 2015 to study the effects of climate change and production stress on livestock physiology and metabolic health. The overall goal of his research is to develop mitigation strategies that will improve animal wellbeing and productivity. Jay received his BS in Animal Science (2009) and MS in Environmental Physiology (2011) from the University of Missouri, his PhD in Nutritional Physiology (2014) from Iowa State University, and completed a post-doc at Purdue University in 2015.

Stacy Enneking joined as a Research Associate in late 2015. She completed her BS (2007) and MS (2010) at Purdue University focusing on Animal Behavior and Welfare. She has worked in multiple labs throughout Purdue's Animal Sciences Department, mostly with poultry, and is now working in Dr. Lay's lab focusing on swine behavior and welfare.

Ryan Kilgore holds a BS in Ag. Communication from Purdue University. Ryan's USDA career started in our location admin office as a student employee then he moved to the NSERL and assisted in rainfall studies. He next worked for the CPPCRU assisting with soybean genetics research. After graduating in Dec. 2013, Ryan began work with the LBRU as a Biological Science Technician, based mainly on campus.

Bill DeBoer returned to the LBRU as a Biological Science Technician in Winter 2015, having previously worked with us on a sow aggression project. Bill holds BS and MS degrees from Purdue University and is sup-

porting all our programs as well as maintaining our Farm Animal Behavior Laboratory.

Torey Roberts graduated from Purdue in May 2015 with a BS in Animal Science Animal Agribusiness and a BS in Public Health Promotion. Torey worked for the USDA as a student employee for the NSERL, assisting in field and lab work. She began working with the LBRU as a Biological Science Technician in Fall 2015.

Tara Temkar earned her BS in Biology with a concentration in Molecular Biology from the University of Tampa in May 2015. Most recently living and working in California, Tara joined the LBRU in Feb 2016 as a Biological Science Technician and will support all our programs primarily based in our laboratory on campus.

Nichole Chapel joined the LBRU in August 2014 to pursue a PhD with Dr. Don Lay in swine welfare. She completed her BS in 2012 and her MS in 2014 at North Dakota State University under the direction of Dr. Sarah Wagner. Nichole's research was focused on dairy cow lameness. Her current research interest includes understanding the relationship between the auditory environment of sows and piglet crushing.

Chris Byrd joined the LBRU in Aug 2015 as a Ph.D. student under the direction of Dr. Lay. Chris obtained his BS in animal science at Iowa State University before coming to Purdue University in 2013 to complete a MS focused on poultry lameness. His current interests focus on evaluating the effect of stress on disease susceptibility in pigs.



Current personnel

Dr. Don C. Lay, Jr. - Research Leader

Dr. Heng-wei Cheng - Research Biologist

Dr. Susan D. Eicher - Research Physiologist

Dr. Jay S. Johnson - Research Animal Scientist

Dr. Jeremy N. Marchant-Forde - Research Animal Scientist

Dr. Ediane Silva - Post-doctoral scientist

Stacey Enneking - Research Associate

Larla Moore - Program Support Assistant

Ryan Kilgore - Biological Science Technician

Bill DeBoer - Biological Science Technician

Torey Roberts - Biological Science Technician

Tara Temkar - Biological Science Technician

Jiaying Hu - Graduate Researcher

Elizabeth Petrosus - Graduate Researcher

Feifei Yan - Graduate Researcher

Nichole Chapel - Graduate Researcher

Chris Byrd - Graduate Researcher

Xiaohong Huang - Graduate Researcher

Weichao Wang - Graduate Researcher

Jacob Richert - Undergraduate

Kenzie Lucas - Undergraduate

Kevin Shade - Undergraduate

Jake Allrich - Undergraduate

Alexis Weldon - Undergraduate

Sow post-mixing aggression

Pregnant sows are conventionally housed in individual gestation stalls. More countries and states are moving to change from individual housing to group housing for pregnant sows. The main disadvantage with group housing is aggressive behavior displayed by sows. Inherently, sows maintain social hierarchy when housed in groups. For this reason, when sows are introduced for the first time, they fight with each other and express their social behavior to establish a hierarchy. Different approaches have been taken to reduce aggression in group housing which include altering group size, dietary modification and supplementation, and facility (pen) design and modifications; with variable success. The aim of this research was to examine the effect of different dietary fibers on aggressive behavior of sows when mixed in small groups. In addition, heart rate variability, stereotypic behaviors, blood metabolites, and production of sows were also evaluated. The diets included a control (corn-soybean meal based with no additional fiber sources), resistant starch (10.8% resistant starch), beet pulp (27.2 % sugar beet pulp), soyhulls (19.1% soybean hulls) or soyhulls with an additional feed amount (14.05% soybean hulls). All diets included the same amount of energy. Resistant starch could reduce aggres-



sion in the 1st hour of mixing but might not be different from control diet or other sources of fiber in terms of affecting overall behavior in their stall, peripheral blood metabolites, aggression at mixing, skin lesions after mixing, heart rate variability and production. The sows on beet pulp diet stood more compared to control, resistant starch, soy hulls and increased intake. Soy hulls could be added to the diet to reduce heart rate. In conclusion, including resistant starch and soy hulls in a proper proportion in the diet fed three weeks prior to mixing might be effective in overall reduction of aggression, restlessness, and heart rate and improve sow welfare during mixing. Producers aiming to group house sows should consider diet alterations which can help decrease aggression and thus increase sow welfare.

Departures....

Dr. Rachel Dennis departed in the winter of 2015 after nearly 10 years with us as a graduate student under Dr. Cheng, a post-doc and a Research Animal Scientist. Her current position is Assistant Professor in the Department of Animal and Avian Sciences, University of Maryland. Rachel has conducted ground-breaking research on the links between serotonin and aggression in poultry and pigs and was an award-winning researcher during her time with us. We look forward to her continued success!

Dr. Avi Sapkota left in the fall of 2015 to pursue a career as a Data Analyst in Chicago. Avi had a successful few years with the LBRU and leaves with

a 4 refereed journal articles published or in preparation and several external-grant-funded projects in progress.

Dr. Gabriela Morello completed her PhD under Dr. Marchant-Forde on the effects of micro-environments on piglet mortality in December 2015. Gabi now has a quite unique skill-set combining agricultural engineering with animal behaviour and welfare science, and is next headed to the University of Melbourne, Australia as an Endeavour Fellow. She has won numerous awards during her time with the LBRU and we are excited to see where her career takes her.

Gary Nowling served as one of the LBRU's Biological Science Technicians for over 10

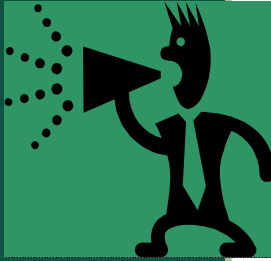
years before returning to one of our sister USDA-ARS units here in West Lafayette in February 2015. He is now serving as an Agricultural Science Research Technician with the Crop Production and Pest Control Research Unit.

Rita Lockridge served as a Biological Science Technician in the Unit for 8 years before leaving in April 2014 to return to her vet tech roots and a position as Large Animal Medicine Technologist in the veterinary school of Purdue University.

Rebecca Strong completed her MS under Dr. Eicher in Dec 2014 and is now employed as a Quality Assurance and Control Analyst at Cook Inc., in Indianapolis.

Goodbye!

Invites & media coverage



- Cheng, H.W.** (2014) Thermal cooled perch reduced heat stress in laying hens. Talk to researchers at Zhejiang University, China, Nov 2014.
- Cheng, H.W.** (2014) Osteoporosis in white leg-horns: The effect of mechanical loading during the life cycle of the laying hens. Talk to researchers at Zhejiang Ag. and Forest University, China, Nov 2014.
- Cheng, H.W.** (2015) Effect of probiotics on skeletal health in laying hens. Talk to researchers at Zhejiang University, China, Oct 2015.
- Cheng, H.W.** (2015) Thermal cooled perch reduced heat stress in laying hens. Talk to researchers at Zhejiang Ag. and Forest University, China, Oct 2015.
- Cheng, H.W.** (2015) Treating birds for aggression before they hatch. *AgResearch Magazine*. Nov. 2015. <https://agresearchmag.ars.usda.gov/2015/nov/birds/>
- Marchant-Forde, J.N.** (2014) Post-natal piglet husbandry practices: can we influence the pain using alternatives, anesthesia & analgesia? Talk to researchers at University of Helsinki, Finland, Oct 2014.
- Marchant-Forde, J.N.** (2015) Current research program at USDA-ARS, LBRU. Talk to researchers at University of São Paulo – Pirassununga Campus, May 2015.
- Marchant-Forde, J.N.** (2015) Tear staining as a welfare indicator. Talk to researchers at Aarhus University, Denmark, June 2015
- Munsterhjelm, C., **Marchant-Forde, J.N.**, and Valros, A.E. (2015) The behavioural detail in tail-biting events. Talk to researchers at FareWellDock progress meeting, Paris, France, Apr 2015.
- Marchant-Forde, J.N.** (2015) Use of animal welfare indicators. Talk to attendees at 2015 International Conference on Pig Welfare, Copenhagen, Denmark, Apr 2015.
- Marchant-Forde, J.N.** (2015) Methodologies to evaluate and measure the interaction between the animal and the environment. 1st International Workshop on Precision Environmental Control, Campinas, Brazil, May 2015.
- Marchant-Forde, J.N.** (2014) Implementation of animal welfare in US Pig production. Perspectives and Challenges. Talk to stakeholders, Workshop on Good Practices for Animal Welfare in Sustainable Systems in Swine Production, Brasilia, Brazil – Nov 2014
- Marchant-Forde, J.N.** (2015) Can diet affect swine behavior? Talk to swine industry stakeholders, MidWest Swine Nutrition Conference. Indianapolis, IN, Sept 2015.
- Rault, J.-L. and **Lay Jr., D.C.** (2014) Nitrous oxide for piglet euthanasia. Talk to stakeholders at the AVMA Symposium: Humane Endings - In search of best practices for euthanasia, humane slaughter, and depopulation of animals. Chicago, IL, Nov 2014
- Schumacher, C.** (2014) Oxytocin for pig hostility studied. *Feedstuffs*. Oct. 29th, 2014. P. 15. <http://feedstuffsfoodlink.com/story-oxytocin-pig-hostility-studied-0-119721>
- Vinyard, J.** (2015) Does group size matter? *Hoard's Dairyman*. June 2015. P.410. <http://www.hoards.com/T15june-calf-group-housing>

Cooled perches

During summer, high ambient temperature is one of the most important environmental stressors adversely affecting poultry health and welfare, and economic profitability. Hens' ability to lose heat is limited due to feathering and the absence of sweat glands. A hen can tolerate and adapt to ambient temperatures up to 25°C (77°F); temperatures above this level can lead to heat stress (HS) as a combination of hen's physical heat production plus the environmental heat load is greater than its ability to lose heat, leading to an increase in body core temperature, and possibly death. Especially during heat waves without acclimation, a chicken can die of heat stroke. Various means of providing supplemental cooling to hens in facilities are available, including evaporative cooling from either pads or fogging systems. These systems have drawbacks. Allowing access to cooled perches during hot months may help alleviate heat stress for laying hens, because hens have a natural tendency to perch for resting and protection and more than 25% of the heat produced by hens can be lost through their feet by



modulating blood flow in hot environments. This study was conducted in Indiana during the summer of 2013 to determine if providing a thermally cooled perch improves hen immunity during hot summer months. In this study, heterophil to lymphocyte ratio, a stress indicator, was reduced in hens from the thermally cooled perch group compared to control hens without thermal cooled perches. There were no treatment effects on the other measured physiological and immune parameters. These results indicated that the thermally cooled perch system used in this study prevented some of the heat stress reactions. However, the natural ambient temperatures of the 2013 summer in Indiana were not severe enough to evoke significant physical and physiological changes. Further studies are needed to evaluate the effectiveness of thermally cooled perches on hen health under higher ambient temperatures. These results can be used by egg producers and scientists to develop management guidelines for improving hen welfare.

The long and short of it...



The LBRU has been collaborating over the last 2½ years with eight European partners in a project investigating tail-docking and tail-biting in pigs. The overall aim of the [FareWellDock](#) project, led by Prof. Anna Valros of the University of Helsinki, is to supply necessary information for quantitative risk assessment and stimulate the development towards a non-docking policy in the EU. From our perspective, our major input is into one part of one of the three work packages:

- To determine the characteristics of individuals for reliable identification of pigs at risk of becoming a tail biter or victim, including tail-biting related and social behavior, and tear staining
- We have been applying sequential behavioral analysis to examine whether there are identifiable patterns of behavior that predict a tail-biting event and partners have also been using our tear-staining scale to see if it is related to tail damage.



Much of the work is ongoing and will be reported in later Updates. There is a great amount of interest in tail-docking and tail-biting within the EU given that the legal requirement is that no routine docking should be being carried out, but that the practice of tail-docking is still quite widespread. A number of other collaborative projects on this issue have been initiated in Europe and the LBRU will continue to be actively engaged with European partners on this topic.

Visitors



Valter Santos from UNICAMP, Brazil spent summer 2015 with us.



Valter is part of an active link between the Faculty of Agricultural Engineering at UNICAMP and the LBRU established by Gabriela Morello.

Valter had been participating remotely in one of our piglet mortality projects and was able to come over and spend time on multiple projects and also initiate his own project investigating whether mirrors placed in farrowing crates would affect crushing. Analysis of those data are ongoing.

André de Albuquerque visited us from Universidade Federal Rural de Pernambuco

(UFRPE), Brazil over the summer of 2015 after some time spent at University of Wisconsin – River Falls. André helped in multiple projects over the course of his visit and was also a major contributor to the



mirror project.

Diya AL-Ramamneh from Private University, Jordan was here between Nov 2013 and Oct 2014. Diya worked on the effect of partial comb and wattle trim on pullet behavior and thermoregulation.

Usama Mahmoud from Assiut University, Assiut, Egypt, was here from Apr 2013 – Apr 2015. Usama was a long-term

visitor and carried out a major part of his PhD studies here, investigating the use of propolis - a natural resinous substance

collected by bees from plants buds and exudates - on the welfare of poultry. This resin is masticated by adding salivary enzymes, and then mixed with beeswax and other compounds and is thought to have biological functions as an antioxidant, antibacterial, immune-stimulant and growth promoter.

Hui Chen visited from Henan Agricultural University, China, between July 2014 and July 2015. Hui worked on the effects of acute ammonia exposure on laying hen health.

Guangtian Cao visited from Zhejiang University, China be-



tween February 2015 and August 2015. Guangtian worked on the effects of probiotics on injury behaviors in laying hens.

Li Yan was with us from April 2015 - March 2016. From Northeast Agricultural University, Li worked on the use of vocalization to evaluate stress in laying hens.

Yanan Wu is with us now from Nanjing Agricultural University. Yanan arrived in August 2015 and will be here until September 2016 working on the effects of chronic ammonia exposure on laying hen health.

Ahmed Mohammed from Assiut University, Assiut, Egypt has been with us since February, 2016. Ahmed is working on a study which is investigating the effect of dietary supplementation of probiotics on heat shock protein 70 expression and its relation to welfare of heated stressed broiler chickens.

Dr. Heng-Wei Cheng again acted as coordinator, for arranging a "Summer Research for Chinese Students" with the Animal Science Department of Purdue University. There were 8 students from Zhejiang University and National Taiwan University for the 9th (2014) and 10th (2015) year, respectively.

Recent publications



Abdelfattah, E.M., Karousa, M.M. Schutz, M.M., **Lay Jr., D.C., Marchant-Forde, J.N.** and **Eicher, S.D.** (2015) Acute phase cytokines, TAC1, and Toll-like receptor 4 mRNA expression and health associated with group size in veal calves. *Journal of Vet. Immunology and Immunopathology* **164**: 118-126. doi:10.1016/j.vetimm.2015.01.008

Albino, L.A.A., **Rostagno, M.H.,** Hungaro, H.M. and Mendonca, R.C.S. (2014) Isolation, characterization, and application of bacteriophages for *Salmonella* spp. biocontrol in pigs. *Foodborne Pathogens and Disease* **11**: 602-609. doi:10.1089/fpd.2013.1600

Boddicker, R.L., Seibert, J.T., **Johnson, J.S.,** Pearce, S.C., Selsby, J.T., Gabler, N.K., Lucy, M.C., Safranski, T.J., Rhoads, R.P., Baumgard, L.H. and Ross, J.W. (2014) Gestational heat stress alters postnatal offspring body composition indices and metabolic parameters in pigs. *PLOS ONE* **9**: e110859 doi:10.1371/journal.pone.0110859

DeBoer, S.P., Garner, J.P., McCain, R.R., **Lay Jr., D.C., Eicher, S.D.,** and **Marchant-Forde, J.N.** (2015) An initial investigation into the effects of social isolation and enrichment on the welfare of laboratory pigs housed in the PigTurn System assessed using tear staining, behaviour, physiology and haematology. *Animal Welfare* **24**:15-27. doi:10.7120/096277286.24.1.015

Dennis, R.L. and **Cheng, H.W.** (2014) Differential serotonergic mediation of aggression in roosters bred for resistance and susceptibility to Marek's disease. *British Poultry Science* **55**: 13-20. doi:10.1080/00071668.2013.871383

Dennis, R.L., McMunn, K.A., Cheng, H.W., Marchant-Forde, J.N. and **Lay Jr., D.C.** (2014) Serotonin's role in piglet mortality and thriftiness. *Journal of Animal Science* **92**:4888-4896. doi:10.2527/jas.2014-7835

Gupta, C., Prakash, D., **Rostagno, M.H.** and Callaway, T.R. (2014) Synbiotics: promoting gastrointestinal health. *Phytochemicals of Nutraceutical Importance* p61-78. doi:10.1079/9781780643632.0000

Hester, P.Y., **AL-Ramamneh, D.S.,** Makagon, M.M. and **Cheng, H.W.** (2015) Effect of partial comb and wattle trim on pullet behavior and thermoregulation. *Poultry Science* **94**: 860-866. doi:10.3382/ps/pev066

Hester, P.Y., Garner, J.P., **Enneking, S.A., Cheng, H.W.** and Einstein, M. E. (2014) The effect of perch availability during pullet rearing and egg laying on the behavior of caged White Leghorn hens. *Poultry Science* **93**: 2423-2431. doi:10.3382/ps.2014-04038

Jiang, S., Hester, P.Y., **Hu, J.Y., Yan, F.F., Dennis, R.L.** and **Cheng, H.W.** (2014) Effect of perches on liver health of hens. *Poultry Science* **93**: 1618-1622. doi:10.3382/ps.2013-03659

Johnson, J.S., Abuajamieh, M., Sanz-Fernandez, M.V., Seibert, J., Stoakes, S.K., Keating, A.F., Ross, J.W., Selsby, T., Rhoads, R.P. and Baumgard, L.H. (2015) The impact of *in utero* heat stress and nutrient restriction on progeny body composition. *Journal of Thermal Biology* **53**:143-150. doi:10.1016/j.jtherbio.2015.10.002

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Kilbride, A.L., Mendl, M.T., Statham, P., Held, S., Harris, M.J., **Marchant-Forde, J.N.,** Booth, H. and Green, L.E. (2014) Risks associated with preweaning mortality in 855 litters on 39 commercial outdoor pig farms in England. *Preventive Veterinary Medicine* **187**:189-199 doi:10.1016/j.prevetmed.2014.08.004

Mack, L.A., Lay, D.C., Jr., Eicher, S. D., Johnson, A.K., Richert, B.T. and Pajor, E.A. (2014) Group space allowance has little effect on sow health, productivity, or welfare in a free-access stall system. *Journal of Animal Science* **92**: 2554-2567. doi:10.2527/jas.2013-7352

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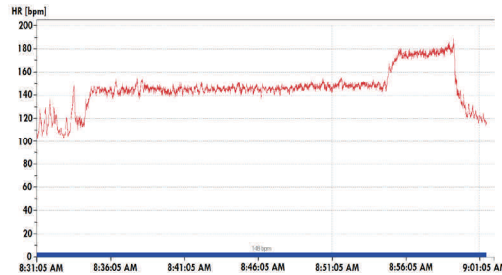
Heat-stressed broilers

Recently with the rapid development of the poultry industry to meet food security and nutrition needs globally, the urgency to improve broiler stocks' performance within hot regions is on the rise. Broiler performance is significantly reduced by heat stress. This phenomenon is becoming more severe as commercial broilers meet their genetic potential for high performance, leading to high susceptibility to heat exposure. Birds exposed to high environmental temperature conditions modify their behaviors and physiological homeostasis attempting to reduce body temperature. Propolis (bee glue) has recently become the subject of intensive pharmacological studies for improving human health. Similar to human research and clinical usage, prop-



olis has been used as a diet supplement in poultry mainly as a growth promoter, immune-modulator and/or an antioxidant. This study aimed to determine the effect of propolis on behavioral exhibition and feather condition in Ross 708 broiler chickens following exposure to high environmental temperature from 15 to 42 days of age. The data indicated that propolis reduced heat stress associated behaviors and feather abnormalities. The results support that propolis may be used as a protective management practice in broiler chickens during hot season to alleviate the negative effects of heat stress. These results can be used by broiler chickens producer and scientists to develop management guidelines for improving broiler welfare.

Information in a heartbeat



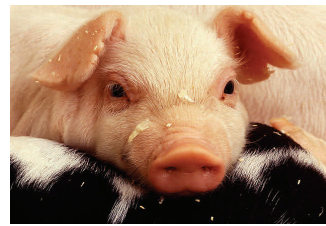
A major objective of our research program is the development of novel, non-invasive indicators of animal welfare. Part of our long-term research program has been the refinement of heart rate variability (HRV) as a tool for assessing stress and welfare in farm animals. The LBRU recently collaborated in 2 studies investigating the use of HRV to investigate motion sickness in sheep undergoing simulated sea transportation, and visceral pain in metritic dairy cows undergoing palpation. In the motion sickness study, led by Dr. Eduardo Santurtun of the University of Queensland, sheep were exposed to the separate ship motions of roll (side to side movement), heave (up and down movement) and pitch (front to back movement) as well as a control treatment of no motion. Measures of heart rate variability showed that heave

reduced the parasympathetic control of heart rate, indicating increased stress. Roll also affected some measures, with sheep showing increased stepping to retain balance and increased heart rates. Pitch did not differ from control. Overall, there was behavioral and physiological evidence that heave and roll caused stress and thus these aspects of motion during sea transportation could result in motion sickness and impacted sheep welfare.

In the dairy cow pain study, led by Jane Stojkov of the University of British Columbia, healthy and metritic cows were monitored during rectal and uterine palpation, using a combination of pain behavior and heart rate variability. A total of 24 metritic cows and 39 healthy cows were monitored during rectal and uterine palpation. Arching of the back was greater during palpation for metritic cows versus health cows and greater during uterine palpation than during rectal palpation. Heart rate variability analysis also showed differences in measures that indicated increased pain both between metritic and healthy cows and between rectal and uterine palpation. Together, these results indicate that the inflammation associated with metritis is painful, and that the pain response can be detected during rectal and uterine palpation. Uterine palpation appears to be more aversive than rectal palpation, suggesting that the former should be avoided whenever possible.

Piglet euthanasia

Identification and validation of humane methods of piglet euthanasia are critical to address public concern that current methods are not optimal. Humane is usually defined as a process imposed on the animal that induces minimal pain and distress. Blunt force trauma is considered humane for piglets. However, most people find it visually difficult to accept. Carbon dioxide (CO₂) chambers have been widely adopted as an alternative, but CO₂ has received criticism as being aversive to swine, hence the search for a method of on-farm euthanasia that is humane, practical, economical and socially acceptable. Nitrous oxide (N₂O) has been identified as a potentially less aversive gas based on the behavioral response of piglets upon gas exposure in a free-choice, approach-avoidance test. Although behavior is a useful approach to assess perception based on decision-making processes, it becomes inherently limited for procedures such as gas exposure which aims at reducing cognitive function. Electroencephalography (EEG) data can provide information on the state of consciousness as well as providing evidence of pain perception. Combining neurobiological and behavioral data offers a robust approach to assess the perception by animals of their experience as they go through the process of potentially aversive or distressful procedures. This research aimed to evaluate the aversiveness of inhaling N₂O, using a free-choice, approach-avoidance test; and to validate the effectiveness and humaneness of nitrous oxide to induce loss of consciousness by EEG recording. We tested N₂O at a 90% concentration and in combination with 30% O₂



and compared the piglets' responses to exposure to CO₂. Experiments 1 and 2 measured piglet behavior and heart rate to

determine whether the gas mixtures tested were aversive to piglets when they were exposed to them at either full concentration (Experiment 1), or gradients thereof (Experiment 2). Experiment 3 determined whether the gas mixtures were aversive to piglets based on EEG activity. These series of experiments confirmed that exposure to N₂O is not aversive in comparison to CO₂ for piglets. The EEG results backed up the behavioral data by demonstrating that the behavioral changes seen reflect differences in the animal's perceptive experience of the treatments rather than, for example, alterations in motor function. Nitrous oxide at a concentration of 90% with 10% air (hence O₂ around 2%) is effective in euthanizing piglets. Latency to loss of awareness, based on isoelectric EEG, under 90% N₂O exposure is slightly longer than when using 90% CO₂ but because piglets do not show an aversive response to N₂O gas, it is likely more humane. N₂O use at 90% concentration may be a useful tool for humane euthanasia as evidenced by the piglets' mild response to the gas and its relatively quick mode of action.



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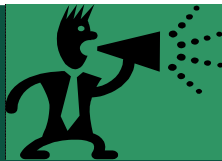
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The mission of the Livestock Behavior Research Unit is to develop scientific measures of Animal Well-being, through the study of animal behavior, stress physiology, immunology, neurophysiology, and cognition; that will allow an objective evaluation of animal agricultural practices. This method of study will allow the improvement of existing practices and invention of new practices that can enhance animal well-being and increase animal productivity. In addition, this unit is dedicated to address Food Safety concerns by understanding how bacteria manifest infestation in livestock and to investigate production strategies by which to limit this infestation to increase animal health and to increase food safety. The optimization of Animal Well-being and Pre-harvest Food Safety will assist in improving animal health, increasing productivity and decreasing human exposure to dangerous pathogens.

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Out & about - disseminating LBRU research

LBRU scientists attended and presented at the following conferences:

- 48th Congress of the International Society for Applied Ethology, Vittoria-Gastiez, Spain, July 2014.
- ASAS/ADSA Joint Annual Meeting, Kansas City, MO, July 2014.
- Poultry Science Association Annual Meeting, Corpus Christi, TX, July 2014.
- NE-1442, Poultry Production Systems and Well-being: Sustainability for Tomorrow. Mississippi State, MS, October 2014.
- AVMA Symposium: Humane Endings - In search of best practices for euthanasia, humane slaughter, and depopulation of animals. Chicago, IL, November, 2014.
- Conference of Research Workers in Animal Disease, Chicago, IL, December 2014.
- Midwest Section ASAS, Des Moines, IA, March 2015.
- International Conference on Pig Welfare, Copenhagen, Denmark, April 2015.
- Experimental Biology, Boston, MA, April 2015.
- 1st International Workshop on Precision Environmental Control, Campinas, Brazil, May 2015.
- ASAS/ADSA Joint Annual Meeting, Orlando, FL, July 2015.
- 2015 Poultry Science Association Annual Meeting, Louisville, KY, July 2015.
- NE-1442, Poultry Production Systems and Well-being: Sustainability for Tomorrow, Raleigh, NC, August 2015.
- American Association of Swine Veterinarians/National Pork Board's working group on Euthanasia, August 2015.
- 49th Congress of the International Society for Applied Ethology, Sapporo, Japan, September 2015.
- 3rd International Meeting of Animal Welfare Researchers, UNAM, Mexico City, Mexico, October 2015.
- Conference of Research Workers in Animal Disease, Chicago, IL, December 2015.