



LBRU Update

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Special points of interest:

- Research News
- Grants awarded
- New arrivals
- Presentations
- Visitors
- Publications

New alternative to molting hens addresses hunger

The first study ever to attempt to measure the hunger experienced by hens subjected to molting diets was recently completed (Koch et al., 2007) by our lab in collaboration with Dr. M. E. Wilson of West Virginia University. This study is pivotal to address the welfare of hens who are subjected to molting diets because it provides a method to determine if alternative diets are successful in reducing hen hunger and it shows that some alternative diets already in use do not reduce hunger in hens.

Inducing hens to molt increases egg quality, egg production and extends the productive life of hens. Until recently, an acceptable method of molting included a 10 to 14 day period of feed deprivation. Due to consumer concerns, in 2000 McDonald's (purchaser of over 1 billion eggs each year) stated that they will no longer purchase eggs that are produced by hens that have undergone feed deprivation-induced molt. Therefore, recent research has examined alternatives that do not include feed deprivation.

The current alternatives with potential for application include feeding diets with altered nutrient content. These include low nutrient density diets such as 94% wheat middling diet, or diets with alterations in mineral content (i.e., low calcium, low sodium or high zinc). These alternatives appear to address hen well-being by providing hens with some type of feedstuff during the molting process. However, these alternative



Measuring hunger: A laying hen receives a food reward for pecking the operant over 150 times

practices have also been shown to increase hen paralysis, result in kidney and adrenal damage, dehydration and extreme loss of body weight.

Recently Koch et al. (2005, 2006) developed a method of inducing rest using melengestrol acetate (MGA) which allows the hen ad libitum access to a nutritionally balanced ration. This new method results in regression and rejuvenation of the reproductive tract, and increases post-molt performance. The need exists, as with any alternative to traditionally induced molt, to evaluate whether the alternative diet allows the hen to feel fully satiated. Using operant conditioning, an animal can be trained to perform a specific task in order to receive a reward, in a manner designed to measure an animal's motivation. (continued p2).....

LBRU welcomes Dr. Andrew Janczak

We are very pleased to announce that **Dr. Andrew Janczak** joined us in January 2007 as a Post-Doctoral Research Animal Scientist, specifically for the 3-year USDA-NRI heart rate variability study. Andrew holds Masters and Doctorate degrees from the Norwegian University of Life Sciences though he is originally from California. He is an ethology expert having completed his Dr. Agric. thesis on "Fear, anxiety and coping styles – validity and implications for maternal ability in pigs." Since graduating, Andrew has been a post-doctoral researcher in Norway, working on pre-laying stress in hens and the influence on subsequent chick behavioral development. He is particularly looking forward to expanding his physiological skills and to getting involved in the multidisciplinary opportunities that exist with the LBRU.



New alternative to molting (continued)

Thus we used operant conditioning to train hens to work for food. The harder she worked to obtain food translates into the hen experiencing a higher level of hunger. We found that hens fed a molting diet of wheat middlings and rewarded with a layer diet worked for feed as much as hens deprived of feed for 8 days. These data show that hens on this molting diet are experiencing a significant level of hunger.

The two most important factors in evaluating a potential alternative to molting are that the alternative induces a molt sufficient to allow for an increase in egg quality following the molt, and that the alternative does not increase hunger in the hen. Previously, we demonstrated that incorporating an orally active progestin into a balanced layer diet will cause reversible regression of the reproductive tract (Koch et al., 2005). Furthermore, both the internal and external quality of the eggs produced by hens molted utilizing MGA is dramatically increased compared to non-molted controls (Koch et al., 2006). In this study we add the final piece, demonstrating that utilizing MGA to induce a molt does not increase hun-

ger in the molted hen, unlike alternatives that involve feeding bulk low nutrient density diets which increase hunger in the molted hen at least as much as in hens completely deprived of feed.

Resulting Publications

Koch, J.M.; Moritz, J.S.; Smith, D.L.; Lay Jr., D.C.; Wilson, M.E. (2005) Melengestrol acetate as an effective alternative to induce a decline in egg production and reversible regression of the reproductive tract in laying hens II. Effects on post-molt egg quality. *Poultry Science* 84: 1757-1762.

Koch, J.M.; Moritz, J.S.; Lay Jr., D.C.; Wilson, M.E. (2007) Effects of melengestrol acetate as an alternative to induce molting in hens and on the expression of yolk proteins and turnover of oviductal epithelium. *Animal Reproduction Science* In Press

Koch, J.M.; Lay Jr., D.C.; McMunn, K.A.; Moritz, J.S.; Wilson, M.E. (2007) Motivation of hens to obtain feed during a molt induced by either feed withdrawal, wheat middlings or melegestrol acetate. *Poultry Science* 86: 619-620.

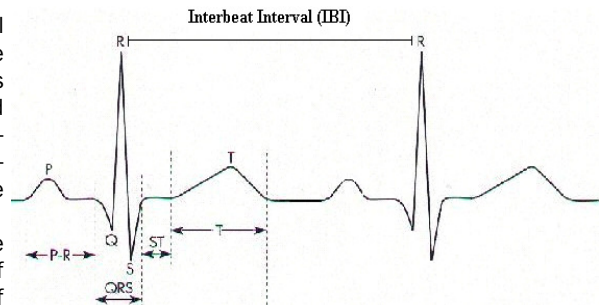
Heart rate variability in pigs

Animal welfare science continues to call for new methods that give quantitative and qualitative information on an animal's internal state of being when confronted with stress. The LBRU has just begun experimental work on a major 3-year, USDA-NRI-funded study investigating heart rate variability in pigs.

Changes in mean heart rate (HR) have long been reported for most species of farm animals exposed to a variety of stressful challenges. For example, mean heart rate can increase in response to isolation, transportation, handling, novelty, social stress and pain. While informative in themselves, mean HR parameters have limited application in quantifying well-being. For example, positive states of arousal result in similar alterations in mean HR as those of negative origins.

To tease out more information on well-being from cardiac activity, we need to examine the underlying mechanisms controlling heart rate. HR is controlled by the autonomic nervous system, comprised of two branches—the sympathetic and parasympathetic. Mean HR will be dependent on the relative activities of the two branches. By using heart rate variability (HRV) analytical techniques, we can begin to quantify the relative activities of these branches and thus get a clearer understanding of why the animal's heart rate is at a given level.

Put simply, HRV analysis elucidates patterns in the time interval between successive heartbeats.



In healthy animals, this beat-to-beat time interval is not of fixed duration but varies, reflecting the continuous interplay between various cardiac controls. HRV analysis can be used to investigate patterns of activity within the autonomic branches of the nervous system that are detectable in cardiac signals. In human sciences, HRV analysis has been widely used to investigate the psychophysiology of pain, stress, and affective states such as anxiety and depression.

Ruth Marchant-Forde has been pioneering the application of HRV to stress in farm animals and has already published papers dealing with important methodological challenges that must be overcome in farm animal HRV studies. The primary goal of this next project is to further our understanding of autonomic regulation of cardiac activity with the ultimate goal of applying HRV analysis to the assessment of stress and well-being in pigs.

Finding new methods to quantify stress

A brief history of (LBRU)
time....

A history of the LBRU

During interactions with stakeholders, we are often asked how the Livestock Behavior Research Unit came about and why are we based where we are? Here is a brief synopsis of the life and times of the LBRU:

- **1991:** Proposal was initiated to establish a Center of research excellence jointly through Purdue University and USDA-ARS. It was proposed that ARS permanently assign four Research Scientists to Purdue University and that the following disciplines be represented: Animal Ethology/Behavior; Neurophysiology; Endocrinology; and Immunology. Research objectives would be to:

1. Identify internal states of animal awareness and well being
2. Establish indicators which accurately reflect animal well-being
3. Determine how animal well-being relates to animal health and production efficiency

Congress appropriated funds to establish the USDA-ARS Livestock Behavior Research Unit.

- **1992:** The FY '92 Appropriation Bill passed by Congress and signed by the President contains an increase for research on animal well-being. Amount of new funds \$450,000.

- **1994:** Two scientists were hired to begin work at the Unit in 1994. Dr. Gary Weesner was a molecular biologist who studied gene regulation. Dr. Julie Morrow-Tesch, Research Leader, was an animal ethologist.

- **1995:** SY-95 Appropriation Bill passed by Con-

gress and signed by the President contains an increase for research on well-being of food animals.

- **1996:** Dr. Susan D. Eicher - Immunologist - joined the LBRU.

- **1997:** A fourth scientist joined the team in 1997. Dr. Margaret Shea-Moore was a cognitive ethologist who studied behavior and information processing. Our research facility was built, a 13,000 sq ft all-weather metal building with a specially designed floor system and 32 video cameras mounted in the ceiling.

- **1999:** Dr. Margaret Shea-Moore, Research Leader. Lab renovation of the office space in the Poultry Science building began to accommodate expansion. Dr. Heng-wei Cheng, neuroscientist joined the LBRU. Pre-harvest food safety added to portfolio.

- **2000:** Dr. Susan D. Eicher Acting Research Leader, headed the construction of an animal housing room at the LBRU research facility.

- **2001:** Dr. Donald C. Lay Jr. - Ethologist/Stress Physiologist - joined the LBRU as the Research Leader. Dr. Jeremy Marchant-Forde - Ethologist - joined the LBRU.

- **2004:** Construction of a state of the art 3200 sq ft laboratory beside the LBRU animal research facility was complete. Facility named as Farm Animal Behavior Laboratory (FABL)

- **2005:** Dr. Marcos Rostagno -veterinarian/microbiologist - joined the LBRU expanding on the LBRU's Pre-Harvest food safety research.

Research Briefs

- **Ractopamine and finish pig behavior**

Rosangela Poletto is seeking a better understanding of the behavioral and neuroendocrine effects of ractopamine (RAC) on pig welfare. Ractopamine is a β -adrenergic agonist widely used as a feed additive to increase lean meat and decrease fat deposition. Her first major study has evaluated the effects of a "step-up" RAC feeding program on behavior of finishing pigs. Pigs were assigned to either control or RAC treatment. Treated animals were fed RAC at 5ppm for 2 weeks, then 10ppm for 2 weeks until slaughter. RAC pigs spent less time inactive but more time alert, bar biting, sham-chewing and sitting than control pigs. Involvement in agonistic interactions was also higher in RAC pigs. It is likely that the increased aggression seen with RAC pigs is a consequence of the higher activity. The greater incidence of oral behaviors proposed as stereotypic may be related to neuroendocrine effects of the compound, and this is being investigated.

- **Exercise and gestating sow welfare**

Erin Schenck has been researching the link between gestation housing and lameness in sows and examining whether exercise during gestation would decrease lameness measures and affect

bone parameters, productivity and behavior. All sows were gestated in conventional stalls, but two treatment groups were given either high or low levels of exercise, consisting of being taken out of the stalls and walked either 1500m or 600m over the course of 5 days per week. Preliminary results suggest that bone density is increased by exercise and that posture-changing behavior is also influenced. Further data analysis is ongoing, including bone breaking strength, hoof damage scores and cartilage scores.

- **Chronic stress in laying hens**

Alan Fahey is investigating the effects of chronic social stress on immune function and longevity of different genetic strains of caged laying hens. Chronic social stress was induced by swapping out 2 of the 8 hens in each cage, every 2 weeks. Alan compared the responses of a commercial strain (DXL) with a strain selected for high production but high survivability (HGPS). He found that DXL hens had higher mortality, heavier adrenal weights and altered lymphocyte ratios. The results suggest that chronic social stress may adversely affect the immune function and longevity of DXL hens relative to HGPS hens. Further analysis is ongoing.

Out and About

LBRU scientists have been busy presenting research findings on local, national and international stages. In June 2006, Don Lay, Jeremy Marchant-Forde and Ruth Marchant-Forde attended the North American regional meeting of the International Society for Applied Ethology (ISAE) in Vancouver, BC, delivering a combined 1 oral and 3 poster presentations. Held in conjunction with this meeting was the annual meeting of the NCR-131 regional committee on Animal Behavior & Welfare, attended by Don Lay and chaired by Jeremy Marchant-Forde, which saw final coordination of the committee to a full research committee and planning of collaborative research on behavioral tests.

July 2006 saw a high-profile presence at the joint annual meeting of the American Society of Animal Science and the American Dairy Science Association in Minneapolis, MN. Drs. Don Lay, Susan Eicher, Jeremy Marchant-Forde and Marcos Rostagno all participated and gave a total of 6 oral presentations and 1 poster presentation on such topics as pig transport, calf transport, pre-natal stress and piglet processing.

Late July saw Heng-wei Cheng and Ruth Marchant-Forde attend the Poultry Science Association Annual Meeting in Edmonton, AB, where they presented 4 oral papers on beak trimming research.

Also in late July, Marcos Rostagno

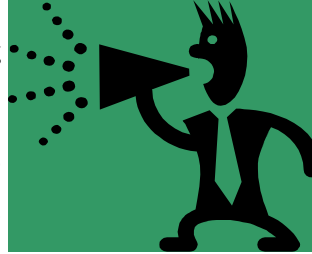
attended the 19th International Pig Veterinary Society Congress in Copenhagen, Denmark, where he presented results of studies on Salmonella incidence in swine at slaughter.

As a result of competitive funding from Purdue University and other external sources, three of our research associates, Alan Fahey, Rachel Dennis and Rosangela Poletto were able to attend and present posters at the 40th International Congress of the International ISAE at the University of Bristol, United Kingdom. This is the most important annual meeting for researchers working in the animal welfare science field and it was a great opportunity for our young scientists to present their research for comment and review, and to interact with international experts.

In November 2006, Susan Eicher and Keelin O'Driscoll attended the 39th Annual Meeting of the Society for Leukocyte Biology in San Antonio, TX presenting one poster.

December 2006 saw Marcos Rostagno and Susan Eicher attend the Conference for Research Workers in Animal Diseases in Chicago presenting 2 papers.

Finally, in March 2007, Marcos Rostagno was invited to the annual meeting of the American Association of Swine Veterinarians to present his research on salmonella prevalence in finishing pigs and the influence of split-marketing.



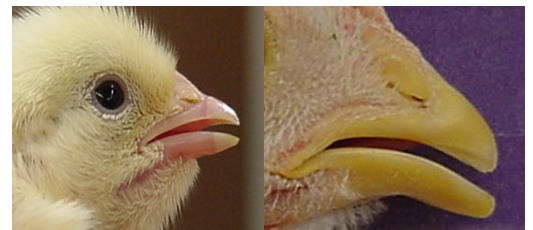
Comparing infrared and conventional beak trimming

Poultry are routinely hot-blade beak-trimmed to reduce and inhibit undesirable behaviors such as inter-bird pecking, aggression and cannibalism. Unsurprisingly, there is a great deal of debate and research concerning the practice in terms of well-being, with beak trimming implicated as a potential cause of chronic pain.

An LBRU study has examined the effects of infrared treatment (IR), hot-blade (HB) beak trimming and no trimming (CTR) in day-old layer chicks. Post-treatment, HB birds had more abnormal normal upper-to-lower mandible length ratio than IR or Controls. Growth and feed intake were lower in HB and IR compared to Controls with IR birds performing least well until the 4th wk of the study. Thereafter they performed similarly to the HB group. Feed waste was lowest in IR birds and was generally greatest in CTR birds. During the first week post-treatment, IR birds were less active and spent less time eating and drinking than CTR birds. Behavior in HB birds often ranked intermediately in duration and incidence, but not significantly different to CTR and IR birds. There

were no effects of treatment on behavior after one week post-trimming.

Results indicate that acute pain occurs with both trimming methods. While the impact of trimming appears greatest in the IR birds initially, these differences disappeared relatively quickly and subsequent performance is similar in both trimmed groups. Ruth Marchant-Forde, Alan Fahey and Heng-wei Cheng are currently carrying out further research on this topic.



+ 4 hours

+ 5 weeks

Changes in beak shape following IR treatment

Is beak trimming using infrared energy better than hot blade trimming?

International researchers
visit the Unit

Visitors



Dr. Jonathan Cooper, Principal Lecturer at the University of Lincoln, UK visited the Unit in August 2006 as part of his Winston Churchill Memorial Trust Traveling Fellowship award. During his visit, Jonathan toured commercial duck operations of Maple Leaf Farms to get a better understanding of N. American production methods relative to European systems. He also gave a Departmental seminar on his own research program which included consumer demand theory applied to poultry and the aquatic needs of ducks.



Keelin O'Driscoll has been on a long-term visit to the Unit since September 2006. Keelin is currently a PhD student at University College Dublin, and a Teagasc Walsh Fellow working at Moorepark on cattle welfare issues. Whilst with the LBRU, Keelin is collaborating with Dr. Susan Eicher, looking at immune measures and locomotion scores during the dry period in dairy cows, to assess the benefits of rubber flooring during lactation. Her visit is funded by her Fulbright Scholarship.



The LBRU was happy to host Dr. Janeen Salak-Johnson, Assistant Professor in Environmental Physiology at the University of Illinois at Urbana-Champaign, during her visit to give a Departmental seminar. Dr. Salak-Johnson toured the LBRU facilities and met with researchers with particular interest in immune function as it relates to stress. She gave a well-received and well-attended seminar entitled "Stress, immunity and well-being: interdisciplinary approach essential" and explored potential for future collaboration.



Dr. Janicke Nordgreen, a PhD student at the Norwegian School of Veterinary Science in Oslo, spent 3 weeks with the LBRU exploring opportunities for a longer-term visit and collaboration with LBRU and Purdue University researchers. Janicke is currently researching pain and nociception in fish, using electrophysiology, immunohistochemistry and learning experiments to investigate how the fish nervous system processes painful stimuli and how the fish perceive different types of stimuli.

Recent Publications

Refereed Journal Articles

Bowers, S.; Gandy, S.; Graves, K.; **Eicher, S.D.**; Willard, S. (2006) The effects of prepartum milking on postpartum reproductive and production performance in first-calf dairy heifers. *Journal of Dairy Research* 73: 257-263

Dennis, R.L.; Zhang, H.M.; **Cheng, H.W.** (2006) Effect of selection for resistance and susceptibility to viral diseases on concentrations of dopamine and immunological parameters in six-week-old chickens. *Poultry Science* 85: 2135-2140

Dennis, R.L.; Muir, W.M.; **Cheng, H.W.** (2006) Effects of raclopride on aggression and stress in diversely selected chicken lines. *Behavioural Brain Research* 175: 104-111

Eicher, S.D.; **McKee, C.A.**; Carroll, J.A.; Pajor, E.A. (2006) Supplemental, vitamin C and yeast cell wall beta-glucan as growth enhancers in newborn pigs and as immunomodulators after an endotoxin challenge after weaning. *Journal of Animal Science* 84: 2352-2360

Eicher, S.D.; **Cheng, H.W.**; **Sorrells, A.D.**; Schutz, M.M (2006) Short communication: Behavioral and physiological indicators of sensitivity or chronic pain following tail docking. *Journal of Dairy Science* 89: 3047-3051

Gustafson, L.A.; **Cheng, H.W.**; Garner, J.P.; Pajor, E.A.; Mench, J.A. (2007) Effects of bill-trimming Muscovy ducks on behavior, body weight gain, and bill morphopathology *Applied Animal Behaviour Science* 103: 59-74

Harris, M.J., Pajor, E.A., Sorrells, A.D., **Eicher, S.D.**, Richert, B.T.; **Marchant-Forde, J.N.** (2006) Effects of stall or small group gestation housing on the production, health and behaviour of gilts. *Livestock Production Science* 102: 171-179

Janczak, A.M.; Haug, A.; Bakken, M. (2007) Evaluation of experimental methods for manipulating chicken egg hormone content using injections. *Journal of Animal and Veterinary Advances* 6: 500-504

Lindqvist, C.; **Janczak, A.M.**; Nätt, D.; Baranowska, I.; Lindqvist, N.; Wichman, A.; Lundeberg, J.; Lindberg, J.; Torjesen, P.A.; Jensen, P. (2007) Transmission of stress-induced learning impairment and associated brain gene expression from parents to offspring in chickens. *PLoS ONE* 2: e364. doi:10.1371/journal.pone.0000364

Moulton, K.; Lovell, F.; Williams, E.; Ryan, P.; **Lay, D.C.**; Jansen, D.; Willard, S. (2006) Use of glycerol as an optical clearing agent for enhancing photonic transference and detection of *Salmonella typhimurium* through porcine skin. *Journal of Biomedical Optics* 11: Art. No. 054027



USDA-ARS-MWA LIVESTOCK BEHAVIOR RESEARCH UNIT

**Poultry Science Building,
Purdue University,
125 S. Russell Street,
West Lafayette, IN 47907.**

**Phone: 765-494-4604
Fax: 765-496-1993
Email:
Stephanie.brennan@ars.usda.gov**

The mission of the LBRU is to develop scientific measures of animal well-being, through the study of animal behavior, stress physiology, immunology, neuro-physiology, 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 will use and develop its knowledge of stress physiology and animal behavior to address concerns of pathogen contamination of livestock carcasses due to the stress of handling and transportation. The optimization of animal well-being will assist in improving animal health, increasing productivity and decreasing human exposure to dangerous pathogens.

We're on the web:
[www.ars.usda.gov/
mwa/lafayette/lbru](http://www.ars.usda.gov/mwa/lafayette/lbru)



Grants Awarded

The last few months have seen LBRU scientists be very successful in being awarded grants from a variety of governmental, commercial and industry-body sources. Since June 2006, LBRU scientists have been Principal Investigator or Co-Principal Investigator on 6 grants totaling over \$600,000.

- **Ruth Marchant-Forde, Don Lay, Jeremy Marchant-Forde and Heng-wei Cheng.** USDA-National Research Initiative; \$375,000. "Heart rate variability: Unraveling the sympatho-vagal mechanisms of stress responses and well-being status in pigs"
- **Marcos Rostagno, Brian Richert and Paul Ebner.** National Pork Board; \$47,350. "Does pre-slaughter transportation and lairage affect *Salmonella* enteric shedding prevalence and levels in market pigs?"
- **Marcos Rostagno, Susan Eicher and John Patterson.** National Pork Board; \$36,567. "Understanding the relationship between immune response, intestinal microbial ecology and growth performance in nursery pigs fed diets with, or without in-feed antibiotics or a combination of β -glucan and vitamin C."
- **Todd Applegate, Ruth Marchant-Forde, Heng-wei Cheng, Jo Garner, Ed Pajor.** Midwest Poultry Consortium; \$41,556 "Infrared bill trimming in pekin ducks".
- **Susan Eicher, Marcos Rostagno, John Patterson.** Diamond V; \$59,818. "Modulating weaning and transport stressors with yeast products in piglets".

Recent Publications (continued)

Refereed Journal Articles (continued)

O'Reilly, K.M., Harris, M.J., Mendl, M.T., Held, S., Moinard, C., Statham, P., **Marchant-Forde, J.N.**; Green, L.E. (2006) Generating hypotheses for factors associated with pre-weaning mortality on commercial pig farms in England and Wales. *Veterinary Record* 159: 193-196

Rostagno, M.H.; Wesley, I.V.; Trampel, D.W.; Hurd, H.S. (2006) *Salmonella* prevalence in market-age turkeys on-farm and at slaughter. *Poultry Science* 85: 1838-1842

Wesley, I.V.; Harbaugh, E.; Trampel, D.W.; Rivera, F.; **Rostagno, M.H.**; Hurd, H.S. (2006) Effect of pre-slaughter events on the prevalence of *Salmonella* in market-weight turkeys. *Journal of Food Protection* 69: 1785-1793

