

NC1170 Accomplishments Report

Project Title: Advanced Technologies for the Genetic Improvement of Poultry

Period Covered: January 13, 2019 to January 12, 2020

Annual Meeting Dates: 1/11/2020-1/12/2020; **Date of Report:** March 8, 2020

Institutional Stations (Institutional Abbreviation: Members)

Beckman Research Institute at the City of Hope (**COH**^{1,2}: M. Miller^{1,2}), Cornell University (**CU**¹: P. Johnson¹), Iowa State University (**IA**¹: S. Lamont^{1,2,3}, J. Dekkers), Michigan State University (**MI**¹: G. Strasburg^{1,2,3}), Mississippi State University (**MS**: C. McDaniel, B. Nanduri³), North Carolina State University (**NC**: C. Ashwell, J. Petite), Pennsylvania State University (**PA**: A. Johnson, R. Ramachandran), Royal Veterinary College (**RVC**¹: A. Psifidi^{1,2}), Texas AgriLife Research (**TX**¹: G. Athrey^{1,2,3}, R. Walzem^{1,2}), University of Arizona (**AZ**¹: F. McCarthy³, S. Burgess), University of Arkansas (**AR**¹: A. Alrubaye², W. Kuenzel^{1,2,3}, B. Kong^{1,2,3}, D. Rhoads^{1,2,3}), University of California, Davis (**CA**¹: M. Delany^{2,3}, H. Zhou^{1,2,3}), University of Delaware (**DE**¹: B. Abasht^{1,2,3}), University of Florida (**FL**¹: M. Edelmann), University of Georgia (**GA**¹: S. Aggrey^{2,3}), University of Maryland (**MD**: T. Porter^{2,3}, J. Song), University of Minnesota (**MN**¹: K. Reed^{1,2,3}), University of Tennessee (**TN**¹: B. Voy^{1,2,3}), University of Wisconsin (**WI**¹: G. Rosa¹, R. Sunde^{1,2,3}), USDA-ARS-Avian Disease and Oncology Lab (**ADOL**¹: H. Cheng², H. Zhang), Virginia Tech (**VA**¹: E. Wong^{1,2,3}, E. Smith), Western University (**WU**¹, Yvonne Dreshler^{1,2}).

1. Written annual report submitted.
2. Oral annual report given at the meeting.
3. Attended the annual business meeting.

Abridged version of minutes from annual business meeting

- **Approval of agenda, and opening remarks by Sue Lamont.** Meeting started with appreciation of the group in attendance and a few non-members who were in attendance. Acknowledgement of excellent leveraging. **Reminds people to submit the annual report using the NIMSS system.** Membership includes 32 individual members of NC1170, representing 19 states (US), and one international member (RVC, UK).
- **Administrative update from Lakshmi Matukumalli:** Provided updates about delays in processing awards and also RFAs. NRSP8 is funded up to 2023, and there is some news that it may not continue in the current form. NIFA will try to follow blueprint and is accepting comments and input from industry and academic stakeholders.
- **NRSP8 update from Huaijun Zhou:** NRSP8 has been supporting student travel and small grants for research. Encourages member of NRSP8 to avail of support available. Also provide support for invited speakers for NRSP8 (Broad institute). Encourages members to communicate requests for funding for generating preliminary data. NRSP8 also has separate annual report, so advising members to submit the separate report for that project. Update from Hans Chang. Hans says there are no inside champions for poultry in NRSP8, so advising about potential change in project emphasis in the future. Has to be written again in 2022.
- In depth discussion about how to expand the membership and also be inclusive of other researchers with overlapping programs, including international institutions. Various solutions put forth by members including – shortening time for presentations, separating business

meeting, limitation of funds to invite speakers. Also comments and suggestions about how to appeal to and attract international researchers.

- Election of NC1170 and NRSP8 chairs and secretaries. Giri Athrey (TAES) elected chair of NC1170, advance from Secretary. Bindu Nanduri (MS) elected chair for NRSP8 representative. Brynn Voy (TN) elected for secretary of NC1170. Byungwhi Kong (AR) elected for NRSP8 secretary.
- Doug Rhoads moved to have annual meeting Saturday and Sunday at PAG 2021. Unanimously approved.

ACCOMPLISHMENTS

Short-term outcomes: One of the important outcomes is the training of the undergraduate and graduate researchers across member institutions. Other short-term outcomes are the identification of genetic and environmental factors that directly impact production practices and the quality of meat. Among the stakeholders benefiting are breeders and producers who are affected by wooden breast and heat stress in production, who have a better understand of factors driving these economically important conditions.

Outputs: NC1170 members published over 110 reports and peer-reviewed articles in the year 2019. Additionally, nine graduate theses/dissertations were compiled in 2019 as well. These outputs were spread across the spectrum of fields that are key to stakeholder interests – including statistical methods for improving genomic prediction, new foundational knowledge relevant for vaccine development, development of new breeds, determination of factors affecting economically important traits, and identification of important nutritional and housing factors that can improve growth, nutrition and gut health.

Activities

- All member stations are actively engaged in investigating various aspects of the three objectives of the multi-state groups. Many of these activities are highly collaborative. Notable collaborations include those between IA-UCD, as well as those between DE-IA, MI-MN, and COH-RVC stations.
- IA, ADOL and TAES stations maintained research populations to serve as resources for identifying genes, genetic elements and genomic regions of economic importance; as well as defining unique aspects of chicken genomic architecture. Active collaborations utilizing ISU chicken genetic lines or biological materials include H Zhou, UC- Davis (NDV and heat-stress response); C. Schmidt, U Delaware (heat stress); R Coulombe, Utah State (aflatoxin sensitivity); B Abasht, U Delaware (allele-specific expression); Jim Kaufman, Univ Edinburgh (MHC structure). TAES is involved in active collaboration with Uppsala University. TAES established flock of Greater Prairie Chickens for fertile egg production with the aim of isolating primordial germ cells for use in gene editing studies.
- Multiple groups are involved in investigating the muscle biology of chicken, focusing on wooden breast disorder, including DE, TAES, AR, MI. TAES is developing a catalog of the structural variants across commercial broiler breeds.
- Various groups carried out projects focusing on the genetics of infectious diseases in poultry. New member RVC is investigating the genomic architecture of campylobacter resistance. COH is developing genetic maps of the MHC region. ADOL is characterizing the

transcriptional profile and genomic landscape of Marek's disease virus induced lymphomas. CA and IA stations are working together on enhancing resistance to NDV virus.

- Heat stress is an important issue facing the poultry industry and there is intensive research on this topic among NC1170 members. MI and MN stations are focusing on muscle development and thermal challenge in turkeys, whereas CA and IA are focusing on heat-stress in chicken.
- Other important activities included studies on nutritional supplements (WI) on muscle growth, intestinal function (VA, AR), and reproductive physiology (NY). Other significant activities were reported but not included here due to the length of the report.

Milestones: not applicable

IMPACTS

The field of poultry genetics is advancing rapidly, thanks to the explosion of genomics technologies and bioinformatics capabilities. The activities and outputs of the NC1170 group is generating notable impacts for the poultry industry, and for the animal agriculture sector in general. The annotation of regulatory elements in livestock species (CA) is an exemplar effort which is generating new knowledge for chicken and also for swine and cattle. This knowledge has implications for non-domesticated species as well as the technologies and annotations help the broader adoption of the approaches and comparative studies. The development of new statistical methods for genomic prediction is directly improving livestock breeding. The functional data (gene expression, metabolomics, microbiomes) relating nutrition, housing, infection and other factors to poultry performance and health is enhancing the direct translation of research into production practices, which in turn impacts the consumer. Additionally, the group members trained many students and postdocs who will help move the field forward. The combined outputs of the NC1170 totaled over 110 publications and presentations. This level of productivity was also reflected in the ability of member stations to leverage the expertise and impacts into additional funding. The reports show that in total, NC1170 investigators were involved in obtaining a total of **\$61,610,208 in funding** (US and UK members combined).

Publications:

List of publications attached

ADOL

1. Bailey, R.I., Cheng, H.H., Chase-Topping, M., Mays, J.K., Anacleto, O., Dunn, J.R., and
2. Doeschl-Wilson, A. 2020. Transmission from vaccinated hosts can cause dose-dependent reduction in pathogen virulence. *PLoS Biol.*, accepted.
3. Kern, C., Wang, Y., Chitwood, J., Korf, I., Delany, M., Cheng, H., Medrano, J.F., Van Eenennaam, A.L., Ernst, C., Ross, P., and Zhou, H. 2018, Genome-wide identification of tissue-specific long non-coding RNA in three farm animal species. *BMC Genomics* 19(1):684.
4. Dunn, J.R., Black Pyrkosz, A., Steep, A., and Cheng, H.H. 2019. Identification of Marek's disease virus genes associated with virulence of US strains. *J. Gen. Virol.* 100:1132-1139.
5. Umthong, S., Dunn, J.R., and Cheng, H.H. 2019. Towards a mechanistic understanding of the synergistic response induced by bivalent Marek's disease vaccines to prevent lymphomas. *Vaccine* 37:6397-6404.
6. Bai, H., He, Y., Ding, Y., Carrillo, J.A., Selvaraj, R.K., Zhang, H., Chen, J. and Song J. 2019. Allele-specific expression of CD4(+) T cells in response to Marek's disease virus infection. *Genes (Basel)* 10(9). pii: E718.
7. Bai, H., He Y., Ding, Y., Chang, S., Zhang, H., Chen, J. and Song, J. 2019. Parent-of-origin has no detectable effect on survival days of Marek's disease virus infected White Leghorns. *Poult. Sci.* 98:4498-503.
8. Chu, Q., Ding, Y., Cai, W., Liu, L., Zhang, H. and Song J. 2019. Marek's disease virus infection induced mitochondria changes in chickens. *Int. J. Mol. Sci.* 20(13). pii: E3150.5
9. Deng, C., Tan, H., Zhou, H., Wang, M., Lu, Y., Xu, J., Zhang, H., Han, L. and Ai, Y. 2019. Four cysteine residues contribute to homodimerization of chicken interleukin-2. *Int. J. Mol. Sci.* 20(22). pii: E5744.
10. Dong, K., Chang, S., Xie, Q., Zhao, P. and Zhang, H. 2019. RNA Sequencing revealed differentially expressed genes functionally associated with immunity and tumor suppression during latent phase infection of a vv+ MDV in chickens. *Sci. Rep.* 9:14182.
11. He, Y., Han, B., Ding, Y., Zhang, H., Chang, S., Zhang, L., Zhao, C., Yang, N. and Song J. 2019. Linc-GALMD1 regulates viral gene expression in the chicken. *Front. Genet.* 10:1122.
12. Li, H., Wang, P., Lin, L., Shi, M., Gu, Z., Huang, T., Mo, M.L., Wei, T., Zhang, H. and Wei, P. 2019. The emergence of the infection of subgroup J avian leucosis virus escalated the tumour incidence in commercial Yellow chickens in Southern China in recent years. *Transbound. Emerg. Dis.* 66:312-6.
13. Liao, Z., Dai, Z., Cai, C., Zhang, X., Li A., Zhang, H., Yan, Y., Lin, W., Wu, Y., Li, H., Li, H. and Xie, Q. 2019. Knockout of Atg5 inhibits proliferation and promotes apoptosis of DF-1 cells. *In Vitro Cell. Dev. Biol. Anim.* 55:341-8.
14. Lu, H., Zhang, L., Xiao, J., Wu, C., Zhang, H., Chen, Y., Hu, Z., Lin, W., Xie, Q. and Li, H. 2019. Effect of feeding Chinese herb medicine ageratum-liquid on intestinal bacterial translocations induced by H9N2 AIV in mice. *Virol. J.* 16:24.
15. Mays, J.K., Black-Pyrkosz, A., Mansour, T., Schutte, B.C., Chang, S., Dong, K., Hunt, H.D., Fadly, A.M., Zhang, L. and Zhang H. 2019. Endogenous avian leukosis virus in combination with serotype 2 Marek's disease virus significantly boosted the incidence of lymphoid leukosis-like bursal lymphomas in susceptible chickens. *J. Virol.* 93(23). pii: e00861-19.

17. Zhang, X., Yan, Y., Lin, W., Li, A., Zhang, H., Lei, X., Dai, Z., Li, X., Li, H., Chen, W., Chen, F., Ma, J. and Xie, Q. 2019. Circular RNA vav3 sponges gga-miR-375 to promote epithelial-mesenchymal transition. *RNA Biol.* 16:118-32.

AR

Publications for 2019

1. Al-Zahrani K, T Licknack, DL Watson, NB Anthony, DD Rhoads. 2019. Further Investigation of Mitochondrial Biogenesis and Gene Expression of Key Regulators in Ascites- Susceptible and Ascites-Resistant Broiler Research Lines. *PLOS One* 14: e0205480 doi.org/10.1371/journal.pone.0205480
2. Dhamad AE, Greene E, Sales M, Nguyen P, Beer L, Liyanage R, Dridi S. 2019. 75 kDa glucose- regulated protein (GRP75) is a novel molecular signature for heat stress response in avian species. *Am J Physiol Cell Physiol.* doi: 10.1152/ajpcell.00334.2019.
3. Greene E, Flees J, Dadgar S, Mallmann B, Orlowski S, Dhamad A, Rochell S, Kidd M, Laurendon C, Whitfield H, Brearley C, Rajaram N, Walk C, Dridi S. Quantum Blue Reduces the Severity of Woody Breast Myopathy via Modulation of Oxygen Homeostasis-Related Genes in Broiler Chickens. *Front Physiol.* 2019 Oct 1;10:1251. doi: 10.3389/fphys.2019.01251.
4. Greene, E., Flees, J., Dhamad, A., Alrubaye, A., Hennigan, S., Pleimann, J., Smeltzer, M., Murray, S., Kugel, J., Goodrich, J., Robertson, A., Wideman, R., Rhoads, D. & Dridi, S. 2019. Double- stranded RNA is a novel molecular target in osteomyelitis pathogenesis: A translational avian model for human bacterial chondronecrosis with osteomyelitis. *Amer. J. Pathol.* doi: 10.1016/j.ajpath.2019.06.013. Epub 2019 Aug 2.
5. Greene E, Rajaei-Sharifabadi H, Dridi S. 2019. Feather HSP70: a novel non-invasive molecular marker for monitoring stress induced by heat exposure in broilers. *Poult Sci* 98, 3400-3404.
6. Kadhim, H.K., S.W. Kang and W.J. Kuenzel. 2019. Differential and temporal expression of corticotropin releasing hormone and its receptors in the nucleus of the hippocampal commissure and paraventricular nucleus during the stress response in chickens (*Gallus gallus*). *Brain Res.* 1714:1-7. doi.org/10.1016/j.brainres.2019.02.018.
7. Kadhim, H.K., M. Kidd Jr., S.W. Kang and W.J. Kuenzel. 2019. Differential delayed responses of arginine vasotocin and its receptors in septo-hypothalamic brain structures and anterior pituitary that sustain hypothalamic-pituitary-adrenal (HPA) axis functions during acute stress. *Gen. Comp. Endocrinol.* doi.org/10.1016/j.ygcen.2019.113302.
8. Kang, S.W., K.D. Christensen, D. Aldridge and W.J. Kuenzel. 2019. Effects of light intensity and dual light intensity choice on plasma corticosterone, central serotonergic and dopaminergic activities in birds, *Gallus gallus*. *Gen. Comp. Endocrinol.* doi.org/10.1016/j.ygcen.2019.113289.
9. Khatri, B., S. Kang, S. Shouse, N. Anthony, W. Kuenzel and B.C. Kong. 2019. Copy number variation study in Japanese quail associated with stress related traits using whole genome re-sequencing data. *PLoS ONE* 14(3): e0214543. doi.org/10.1371/journal.pone.0214543.
10. Lassiter K, Kong B, Piekarski-Welsher A, Dridi S, and Bottje WG. 2019. Gene expression essential for myostatin signaling and skeletal muscle development is associated with divergent feed efficiency in pedigree male broilers. *Frontiers in Physiology.* 10:126.

11. Yamashita T, DD Rhoads, J Pummill. 2019. Genome Report: Genome Analyses of a New Mycoplasma Species From the scorpion *Centruroides vittatus*. G3: Genes|Genomes|Genetics 8:993-997 doi.org/10.1534/g3.118.200858.

CA

Publications

1. Walugembe M, Mushi JR, Amuzu-Aweh EN, Chiwanga GH, Msoffe PL, Wang Y, Saelao P, Kelly T, Gallardo RA, Zhou H, Lamont SJ, Muhairwa AP, Dekkers JCM. 2019. Genetic Analyses of Tanzanian Local Chicken Ecotypes Challenged with Newcastle Disease Virus. *Genes (Basel)*. 2019 Jul 17;10(7). pii: E546. doi: 10.3390/genes10070546.
2. Egaña-Labrin, S. R. Hauck, A. Figueroa, S. Stoute, H.L. Shivaprasad, M. Crispo, C. Corsiglia, H. Zhou, C. Kern, B. Crossley, R. Gallardo. 2019. Genotypic Characterization of Emerging Avian Reovirus Molecular Variants in California. *Sci Rep Accepted*.
3. Saelao, P., Y. Wang, G. Chanthavixay, J. Dekkers, R. Gallardo, A. Wolc. T.R. Kelly, S.J. Lamont. Zhou, H. 2019. Genetics and Genomic Regions Affecting Response to Newcastle Disease Virus Infection under Heat Stress in Layer Chickens. *Genes (Basel)*. 2019 Jan 18;10(1). pii: E61. doi: 10.3390/genes10010061.
4. Cadena M, Froenicke L, Britton M, Settles ML, Durbin-Johnson B, Kumimoto E, Gallardo RA, Ferreira A, Chylkova T, Zhou H, Pitesky M. 2019. Transcriptome analysis of *Salmonella* Heidelberg after exposure to cetylpyridinium chloride, acidified calcium hypochlorite, and peroxyacetic acid. *Journal of Food Protection*, Vol. 82, No. 1, 2019, Pages 109–119 doi:10.4315/0362-028X.JFP-18-235
5. Rowland K, Saelao P, Wang Y, Fulton JE, Liebe GN, McCarron AM, Wolc A, Gallardo RA, Kelly T, Zhou H, Dekkers JCM, Lamont SJ. 2018. Association of Candidate Genes with Response to Heat and Newcastle Disease Virus. *Genes (Basel)*. 9(11). pii: E560. doi: 10.3390/genes9110560.
6. Litvak Y., K.K.Z. Mon, H. Nguyen, G. Chanthavixay, M. Liou, E. M. Velazquez, L. Kutter, M. A. Alcantara, M. X. Byndloss, C.R. Tiffany, G. T. Walker, F. Faber, Y. Zhu, D. N. Bronner, A. J. Byndloss, R. M. Tsois, H. Zhou. A. J. Baumler. 2019. Commensal Enterobacteriaceae protect against *Salmonella* colonization by competing for oxygen. *Cell Host & Microbe* 25, 1- 12https://doi.org/10.1016/j.chom.2018.12.003
7. Silva APD, Hauck R, Kern C, Wang Y, Zhou H, Gallardo RA. 2019 Effects of Chicken MHC Haplotype on Resistance to Distantly Related Infectious Bronchitis Viruses. *Avian Dis.* 63(2):310-317. doi: 10.1637/11989-103118-Reg.1.
8. Saelao, P., Y. Wang, G. Chanthavixay, V. Yu, J. Dekkers, R. Gallardo, T.R. Kelly, S.J. Lamont. Zhou, H. 2018. Integrated proteomic and transcriptomic analysis of differential expression of chicken lung tissue in response to NDV infection during heat stress. *Genes* 9, 579; doi:10.3390/genes9120579.

COH

Publications/Presentations:

1. Zhang J, Goto RM, Honaker CF, Siegel PB, Miller MM. 2019. Distribution of haplotypes within selected chicken lines suggests MHC-Y contributes to the genetics underlying heritable high and low antibody responses. Plant and Animal Genome Meeting XXVIII, San Diego CA, January 13-15, 2019.

2. Miller MM, Zhang J, Warden C, Goto RM. 2019. Progress in Revealing MHC-Y Diversity and Function in Chickens. Plant and Animal Genome Meeting XXVIII, San Diego CA, January 13- 15, 2019.
3. Zhang J, Goto RM, Honaker CF, Siegel PB, Miller MM. 2019. Segregation of chicken MHC-Y haplotypes in high and low antibody selected lines provides evidence that MHC-Y contributes to the genetics of immune responses. AAI Meeting, May 9-13, 2019.
4. Goto RM, Gugiu G, Zhang J, Stadtmueller B, Bjorkman PJ, Miller MM. 2019. Polymorphism in chicken MHC-Y class I molecules that bind lipid ligands. AAI Meeting, May 9-13, 2019.
5. Zhang J, Goto, RM, Miller, MM. A simple means for chicken MHC-Y genotyping using short tandem repeat sequences. Manuscript submitted December 18, 2019.

DE

REFEREED PUBLICATIONS

1. Papah, M.B. and Abasht, B., 2019. Dysregulation of lipid metabolism and appearance of slow myofiber-specific isoforms accompany the development of Wooden Breast myopathy in modern broiler chickens. *Scientific reports*, 9(1), pp.1-12.
2. Lake, J.A., Papah, M.B. and Abasht, B., 2019. Increased Expression of Lipid Metabolism Genes in Early Stages of Wooden Breast Links Myopathy of Broilers to Metabolic Syndrome in Humans. *Genes*, 10(10), p.746.
3. Abasht, B., Zhou, N., Lee, W.R., Zhuo, Z.&Peripolli, E.2019.The metabolic characteristics of susceptibility to wooden breast disease in chickens with high feed efficiency. *Poultry Science* doi:10.3382/ps/pez183
4. Brothers, B.K., Zhuo, Z., Papah, M. and Abasht, B., 2019. RNA-seq analysis reveals spatial and sex differences in pectoralis major muscle of broiler chickens contributing to difference in susceptibility to wooden breast disease. *Frontiers in Physiology*, 10, p.764.
5. Zhuo, Z., Lamont, S.J. and Abasht, B., 2019. RNA-Seq Analyses Identify Additivity as the Predominant Gene Expression Pattern in F1 Chicken Embryonic Brain and Liver. *Genes*, 10(1), p. 27.
6. Adentunji, M., Lamont, S.J., Abasht, B.A., and Schmidt, C.J. 2019. Variant analysis pipeline for accurate detection of genomic variants from transcriptome sequencing data. *PLOS ONE* 14(9): transcriptome sequencing data. *PLOS ONE* 14(9): e0216838. doi.org/10.1371/journal.pone.0216838
1. Reed KM, Mendoza, KM and Abrahante JE. Circular RNA expression in turkey skeletal muscle and response to thermal challenge. ISAG, Lleida Spain, 2019.

GA

Publications:

1. Vilar da Silva, J.H., F. Gonzalez-Ceron, E. W. Howerth, R. Rekaya and S. E. Aggrey, 2019. Inhibition of the transsulfuration pathway affects growth and feather follicle development in meat-type birds. *Animal Biotechnology* 30: 175-179.
2. Vilar da Silva, J.H., F. Gonzalez-Ceron, E. W. Howerth, R. Rekaya and S. E. Aggrey, 2019. Alteration of Dietary Cysteine Affects Activities of Genes of the Transsulfuration and Glutathione pathways, and Development of Skin tissues and Feather Follicles in Chickens. *Animal Biotechnol.* 2019 Apr 5:1-6. doi: 10.1080/10495398.2019.1577253

3. Ellestad LE, Cogburn LA, Simon J, Le Bihan-Duval E, Aggrey SE, Byerly MS, Duclos MJ, Porter TE. 2019. Transcriptional profiling and pathway analysis reveal differences in pituitary gland function, morphology, and vascularization in chickens genetically selected for high or low body weight. *BMC Genomics*. 2019 Apr 25;20(1):316. doi: 10.1186/s12864-019-5670-9
4. Chang L.Y., Toghiani S, S.E. Aggrey, Rekaya R, 2019. Increasing accuracy of genomic selection in presence of high density marker panels through the prioritization of relevant polymorphisms. *BMC Genet*. 2019 Feb 22;20(1):21. doi: 10.1186/s12863-019-0720-5.
5. Habashy, W.S., M. C. Milfort, R. Rekaya and S. E. Aggrey, 2019. Cellular antioxidant enzyme activity and biomarkers for oxidative stress are affected by heat stress. *Int. Journal of Biometeorology* 63: 1569-1584. doi: 10.1007/s00484-019-01769-z.
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7. Chang, L.-Y., S. Toghiani, E. H. Hay, S. E. Aggrey, and R. Rekaya, 2019. A weighted genomic relationship matrix based on *Fst* prioritized SNPs for genome selection. *Genes*. 10(11). pii: E922. doi:10.3390/genes10110922.
8. Aggrey, S.E., M. C. Milfort, A. L. Fuller, Y. Jiamin and R. Rekaya, 2019. Effect of host genotype and *Eimeria acervulina* infection on the metabolome of meat-type chickens. *PLoS One*. 14(10):e0223417. doi: 10.1371/journal.pone.0223417
9. Glenn, T.C, R.A Nilsen, T.J. Kieran, J.W. Finger, T.W. Pierson, K.E. Bentley, S.L. Hoffberg, S. Louha, F.J. Garcia-De Leoen, M.A.D.R. Portilla, K.D. Reed, J.L. Anderson, J.K. Meece, S.E. Aggrey, R. Rekaya, M. Alabady, M. Belanger, K. Winker and B.C. Faircloth, 2019. Adapterama I: Universal stubs and primers for thousands of dual-indexed Illumina libraries 1 (iTru & iNext). *Peer J*. e7755. doi: 10.7717/peerj.7755.
10. Sumreddee, P., S. Toghiani, E. H. Hamidi, A. Roberts, S. E. Aggrey, and R. Rekaya, 2019. Inbreeding depression in line 1 Hereford cattle population using pedigree genomic information. *J. Animal Sci*. 97: 1-8.

IA

Journal Articles and Book Chapters

1. Adentunji, M., Lamont, S.J., Abasht, B.A., and Schmidt, C. J. 2019. Variant analysis pipeline for accurate detection of genomic variants from transcriptome sequencing data. *PLOS ONE* 14(9): e0216838. doi.org/10.1371/journal.pone.0216838
2. Monson, M.S., Van Goor, A.G., Persia, M.E., Rothschild, M. F., Schmidt, C.J., Lamont, S.J. 2019. Genetic lines respond uniquely within the chicken thymic transcriptome to acute heat stress and low dose lipopolysaccharide. *Scientific Reports* 9:13649 doi.org/10.1038/s41598-019-50051-0
3. Barrett, N.W., Schmidt, C.J., Lamont, S.J., Ashwell, C.M., Persia, M.E. 2019. Effects of acute and chronic heat stress on the performance, egg quality, body temperature and blood gas parameters of laying hens. *Poultry Science*. <http://dx.doi.org/10.3382/ps/pez541>
4. Walugembe, M. Mushi, J., Amuzu-Aweh, E., Chiwanga, G., Msoffe, P., Wang, Y., Saelao, P., Kelly, T., Gallardo, R., Zhou, H., Lamont, S., Muhairwa, A., Dekkers. J.

2019. Genetic analyses of Tanzania local chicken ecotypes challenged with Newcastle disease virus. *Genes* 10, 546; doi:10.3390/genes10070546
5. Schilling, M., Memari, S., Cavanaugh, M., Katani, R., Deist, M.S., Radzio-Basu, J., Lamont, S.J., Buza, J.J., and Kapur, V. 2019. Conserved, breed-dependent, and subline-dependent innate immune responses of Fayoumi and Leghorn chicken embryos to NDV infection. *Scientific Reports* 9:7209 doi.org/10.1038/s41598-019-43483-1
 6. Rowland, K., Ashwell, C.M., Persia, M.P., Rothschild, M.F., Schmidt, C., Lamont, S.J. 2019. Genetic analysis of production, physiologic, and egg quality traits in heat-challenged commercial white egg-laying hens using 600k SNP array data. *Genetics Selection Evolution* 51:31 doi.org/10.1186/s12711-019-0474-6
 7. Elbeltagy, A.R., Bertolini, F., Fleming, D.S., Van Goor, A., Ashwell, C.M., Schmidt, C.J., Kugonza, D., Lamont, S.J., Rothschild, M.F. 2019. Natural selection footprints among African chicken breeds and village ecotypes. *Front. Genet.* 10:376. doi: 10.3389/fgene.2019.00376
 8. Rowland, K., Persia, M., Rothschild, M., Schmidt, C., Lamont, S. 2019. Blood gas and chemistry components are moderately heritable in commercial white egg-laying hens under acute or chronic heat exposure. *Poultry Science* 0:1–5 <http://dx.doi.org/10.3382/ps/pez204>
 9. Saelao, P., Wang, Y., Chanthavixay, G., Gallardo, R.A., Wolc, A., Dekkers, J.C.M., Lamont, S.J., and Zhou, H. 2019. Genetics and genomic regions affecting response to Newcastle disease virus infection under heat stress in layer chickens. *Genes* 10(1), 61; <https://doi.org/10.3390/genes10010061>
 10. Walugembe, M., Bertolini, F., Dematawewa, C.M.B., Reis, M.P., Elbeltagy, A.R., Schmidt, C.J., Lamont, S.J., and Rothschild, M.F. 2019. Detection of selection signatures among Brazilian, Sri Lankan, and Egyptian chicken populations under different environmental conditions. *Front. Genet.* doi: 10.3389/fgene.2018.00737
 11. Zhuo, Z., Lamont, S., Abasht, B. 2019. RNA-Seq analyses identify additivity as the predominant gene expression pattern in F1 chicken embryonic brain and liver. *Genes* 10, 27; doi:10.3390/genes10010027
 12. Drobik-Czwarno, W., Wolc, A., Kucharska, K., Martyniuk, E., Genetic basis of resistance to highly pathogenic avian influenza in chicken. Review article in Polish. *Scientific Annals of Polish Society of Animal Production.*
 13. Wolc, A., Arango, J., Settar, P., Fulton, J.E., O'Sullivan, N.P. and Dekkers, J.C., 2019. Genetics of male reproductive performance in White Leghorns. *Poultry Sci.* 98: 2729-2733.
 14. Weng, Z., Wolc, A., Su, H., Fernando, R.L., Dekkers, J.C., Arango, J., Settar, P., Fulton, J.E., O'Sullivan, N.P. and Garrick, D.J., 2019. Identification of recombination hotspots and quantitative trait loci for recombination rate in layer chickens. *J. Anim. Sci. Tech.* 10(1), p.20.

MI

Publications for 2019

1. Barnes NE, Strasburg GM, Velleman SG, and Reed KM. 2019. Thermal challenge alters the transcriptional profile of the breast muscle in turkey poults. *Poultry Science* 98: 74-91 doi: 10.3382/ps/pey401.

2. Reed KM, Velleman SG, and Strasburg GM. 2019. Effects of thermal stress and genetic selection on turkey muscle gene expression. Proceedings of the 10th International Meeting of the Working Group 10 (Turkey).
3. Malila Y, Thanatsang K, Arayamethakorn S, Uengwetwanit T, Srimarut Y, Petracci M, Strasburg GM, Rungrassamee W, Visessanguan W. 2019. Absolute expressions of hypoxia-inducible factor-1 alpha (HIF1A) transcript and the associated genes in chicken skeletal muscle with white striping and wooden breast myopathies. PLoS One. Aug. 8;14(8):e0220904. doi: 10.1371/journal.pone.0220904. eCollection 2019

MN

Publications and presentations for 2019

1. Ward TL, Weber BP, Mendoza KM, Danzeisen JI, Llop K, Lang K, Clayton JB, Grace E, Brannon J, Radovic I, Beauclaire M, Heisel TJ, Knights D, Cardona C, Kogut M, Johnson C, Noll SL, Arsenault R, Reed KM, and Johnson T. 2019. Antibiotics and host-tailored probiotics similarly modulate effects on the developing microbiome, mycobiome, and host transcriptome. MBio, DOI: 10.1128/mBio.02171-19.
2. Reed KM, Mendoza KM, and Coulombe RA. 2019. Altered gene response to aflatoxin B1 the spleens of susceptible and resistant turkeys. Toxins (Basel) 11(5), 242; doi.org/10.3390/toxins11050242
3. Reed KM, Mendoza KM, and Coulombe RA Jr. 2019. Differential transcriptome responses to aflatoxin B1 in the cecal tonsil of susceptible and resistant turkeys. Toxins (Basel) 11(1); 55. doi:10.3390/toxins11010055.
4. Barnes NE, Strasburg GM, Velleman SG, and Reed KM. 2019. Thermal challenge alters the transcriptional profile of the breast muscle in turkey poults. Poultry Science, 98:74-91. doi: 10.3382/ps/pey401.
5. Reed KM and Coulombe RA Jr. 2019. Systemic response to aflatoxin B1 in gene expression of susceptible and resistant turkeys. Proceedings of the 10th International Meeting of the Working Group 10 (Turkey).
6. Reed KM, Velleman SG, and Strasburg GM. 2019. Effects of thermal stress and genetic selection on turkey muscle gene expression. Proceedings of the 10th International Meeting of the Working Group 10 (Turkey).

NY

Publications

1. Stephens, C.S. and P.A. Johnson. Reproductive Physiology of Poultry in Animal Agriculture: Sustainability, challenges and Innovations. Ed. by F.W. Bazer, G.C. Lamb and G. Wu. Academic Press, London. 2020.

RVC

Publications and presentations for 2019

1. L. Freem, KM Summers , A Gheyas, A. Psifidi, Kay Boulton, A. McCallum, J O'Dell, SJ Bush and D Hume. (2019) "Analysis of the progeny of sibling matings reveals regulatory

- variation impacting the transcriptome of immune cells in commercial chickens”, *Frontiers in Genetics* DOI: 10.3389/fgene.2019.01032.
2. AT. Hinsu, RJ. Pandit, SH. Patel, A. Psifidi, FM. Tomley, SK. Das, DP. Blake, CG. Joshi. 2019. Genome reconstruction of a novel carbohydrate digesting bacterium from the chicken caecal microflora. *Meta Gene* 20 (2019) 100543
 3. Psifidi A. 2019. "Dissecting the genomic architecture of host resistance to *Campylobacter* colonisation in chickens". Newton Agham Workshop 2019 on Vaccines and Diagnostics, Manila, Philippines https://www.slideshare.net/zerep_cire/2019-newton-aghama-researcher-links-workshop-vaccines-and-diagnostics-conference-proceedings
 4. Psifidi A., L. Rothwell, D. Robledo, A. Bremner, A. Kranis, G. Banos, R. Bailey, M.S. Fife, P.M. Hocking, K. Watson, P. Kaiser, S. Avendano, M. Stevens. 2019. “Genomic and Transcriptomic Characterisation of *Campylobacter* Resistance in Broilers”, Host Pathogen Workshop, Plant & Animal Genome XXVII (PAG) conference, San Diego, California, USA
 5. A. Psifidi, M. Crotta, A. Hinsu, RJ. Pandit, B. Fosso, PG. Koringa, G Limon, G. Banos, J Guitian, DN. Rank, FM. Tomley, D. Hume, CG. Joshi, and DP. Blake. 2019. “Microbiota of the chicken gut: genomic and metagenomic characterisation” Plant & Animal Genome XXVII (PAG) conference, 2019, San Diego, California, USA
 6. Psifidi A. 2019. Genomic, transcriptomic and 16S sequencing characterisation of host resistance to *Campylobacter* colonisation in chickens. Invited speaker from EFSA in the Intervention Measures Across the Poultry Production Chain Workshop the CHRO conference, 2019, Belfast, UK

TN

1. Mihelic R, Winter H, Powers J, Das S, Lamour K, Campagna S, Voy BH. Developmental regulation of the fatty acid elongase and desaturase pathways in broiler chicks. In review, *British Poultry Science*, 2019
2. Mihelic, R*, Urban ER, Gill T, Smith MO, and Voy BH. 2019. Increasing Charcoal Efficiency for Brooding Broiler Chickens in Rural Rwanda. *African Journal of Poultry Farming*, in press (corresponding author).
3. Mihelic R, Piaquadio K, Voy BH. Developmental regulation of elongase enzyme expression in broiler chick adipose tissue. *Poult. Sci.* 95(E-Suppl. 1).
4. Mihelic R, Urban E, Voy BH, Gill T. Improving brooding efficiency for small holder broiler farms in rural Rwanda. Atlanta, GA. International Poultry Scientific Forum, Atlanta, GA, 2019.
5. Mihelic, R. Broiler chicken development: from genetic regulation to rural Rwandan production (Master’s thesis); 2019.

TX - Athrey

Publications

1. Hubert SM§, Al-Ajeeli M, Bailey CA, and Athrey G‡. The role of housing environment and dietary protein source on the gut microbiota of chicken. (2019). *Animals* 9:1085. <https://doi.org/10.3390/ani9121085>.
2. Shivanagoudra SR, Perera WH, Perez JL, Athrey G, Sun Yuxiang, Jayaprakasha GK, Patil BS. In vitro and in silico elucidation of antidiabetic and anti-inflammatory activities of bioactive compounds from *Momordica charantia* L. . (2019). *Bioorganic & Medicinal Chemistry*. 27:3097-3109. <https://doi.org/10.1016/j.bioorg.2019.02.040>.
3. Klerks PL, Athrey G, Leberg PL. Response to selection for increased heat tolerance in a small fish species, with response decreased by a population bottleneck. (2019). *Frontiers in Ecology and Evolution*. 7 (270): 1-10. <https://doi.org/10.3389/fevo.2019.00270>.
4. ShivanagoudraSR,PereraWH,PerezJL,AthreyG,SunYuxiang,JayaprakashaGK,PatilBS.Cucurbitane- type compounds from *Momordica charantia*: Isolation, in vitro antidiabetic, anti-inflammatory activities and in silico modeling approaches. (2019). *Bioorganic Chemistry*. 87:31-42. <https://doi.org/10.1016/j.bioorg.2019.02.040>.
5. Hieke ASC, Hubert SM, Athrey G. Circadian Disruption and Divergent Microbiota Acquisition Under Extended Photoperiod Regimens in Chicken. (2019) *PeerJ*. 7.e6592 <https://peerj.com/articles/6592/>.

TX- Walzem

Publications and presentations for 2019

1. Rosemary Walzem “Avian Genetic Rescue” presented on June 16, 2019 Team Call for Revive& Restore. Davis, California.
2. Rosemary Walzem, “Catalyst for Common Use.” W891 Poultry Genetic Resources: Plant and Animal Genome Conference January 12. 2020, San Diego, California.

VA

Refereed Journal Articles

1. Zhang, H and Wong, E. A. 2019. Expression of avian β -defensin mRNA in the chicken yolk sac. *Develop. Comp. Immunol.* 95:89-95. doi:10.1016/j.dci.2019.02.006
2. Reynolds, K. R. and Wong, E. A. Changes with age in density of goblet cells in the small intestine of broiler chicks. *Poult. Sci.* (in press).
3. Adikari A. M. J. B., Xu, J., and Smith, E. J. 2019. Association of polymorphisms in the Cryptochrome-1 gene (*turCry1*) with growth and reproductive traits in turkeys, *Meleagris gallopavo*. *Sri Lankan Journal of Agriculture and Ecosystems*. ISSN: 2673-1401. Volume: 1, Issue: 1, (August, 2019), pp 23-40 www.rjt.ac.lk/agri/sljae

WI

Refereed Journal Articles

1. Fernandes, A. F. A., Dorea, J. R. R., Fitzgerald, R., Herring, W. and Rosa, G. J. M. A novel automated system to acquire biometric and morphological measurements, and

- predict body weight of pigs via 3D computer vision. *Journal of Animal Science* 97: 496-508, 2019.
2. Passafaro, T.L., Van de Stroet, D., Bello, N. M., Williams, N. H. and Rosa, G. J. M. Generalized additive mixed model on the analysis of total transport losses of market-weight pigs. *Journal of Animal Science* 97: 2025-2034, 2019.
 3. Aiken, V. C. F., Dórea, J. R. R., Acedo, J. S., Sousa, F. G., Dias, F. G. and Rosa, G. J. M. Record linkage for farm-level data analytics: Comparison of deterministic, stochastic and machine learning methods. *Computers and Electronics in Agriculture* 163: 104857, 2019.
 4. Fernandes, A. F. A., Alvarenga, E. R., Alves, G. F. O., Manduca, L. G., Toral, F. L. B., Valente, B. D., Silva, M. A., Rosa, G. J. M. and Turra, E. M. Genotype by environment interaction across time for Nile tilapia, from juvenile to finishing stages, reared in different production systems. *Aquaculture* 513: 734429, 2019.
 5. Koltjes, J. E., Cole, J. B., Clemmens, R., Dilger, R. N., Kramer, L. M., Lunney, J. K., McCue, M. E., McKay, S. D., Mateescu, R. G., Murdoch, B. M., Reuter, R., Rexroad, C.E., Rosa, G. J. M., Serão, N. V. L., White, S. N., Woodward-Greene, M. J., Worku, M., Zhang, H. and Reecy, J. M. A Vision for development and utilization of high-throughput phenotyping and big data analytics in livestock. *Frontiers in Genetics* 10: 1197, 2019.
 6. Chitakasempornkul, K., Meneget, M. B., Rosa, G. J. M., Lopes, F. B., Jager, A., Gonçalves, M. A. D., Dritz, S. S., Tokach, M. D., Goodband, R. D. and Bello, N. M. Investigating causal biological relationships between reproductive performance traits in high-performing gilts and sows. *Journal of Animal Science* 97: 2385-2401, 2019.
 7. Goto, T., Fernandes, A. F. A., Tsudzuki, M. and Rosa, G. J. M. Causal phenotypic networks for egg traits in an F2 chicken population. *Molecular Genetics and Genomics* 294: 1455- 1462, 2019.
 8. Abdalla, E. A., Lopes, F. B., Byrem, T. M., Weigel, K. A. and Rosa, G. J. M. Genomic prediction of bovine leukosis incidence in a US Holstein population. *Livestock Science* 225: 73–77, 2019.
 9. Bresolin, T., Rosa, G. J. M., Valente, B. D., Espigolan, R., Gordo, D. G. M., Braz, C. U., Fernandes, G. A., Magalhães, A. F. B., Garcia, D. A., Frezarim, G. B., Leão, G. F. C., Carneiro, R., Baldi, F., Oliveira H. N. and Albuquerque, L. G. Effect of quality control, density and allele frequency of markers on the accuracy of genomic prediction for complex traits in Nelore cattle. *Animal Production Science* 59(1): 48-54, 2019.

WI-SUNDE

Manuscripts published in 2019

1. Taylor RM, Bourget VG, Sunde RA 2019 High dietary inorganic selenium has minimal effects on turkeys and selenium status biomarkers. *Poult. Sci.* 98: 855-865. PMID: 30239950

Abstracts published in 2019

1. Sunde RA, Taylor RM 2019 The Turkey Selenoproteome: genes and regulation of transcript expression by selenium deficiency and high Se status. *Plant Anim Genom.* 27: W881. (abs.)
2. Taylor RM, Sunde RA 2019 Transcriptomic analysis of selenium-deficient and high-selenium turkey liver. *Plant Anim Genom.* PE0428. (abs.)

3. Taylor RM, Sunde RA 2019 Full transcriptome expression in liver of selenium-deficient and high-selenium turkeys (*Meleagris gallopavo*) determined by RNA-seq. ASN P24-025-19: (abs.)
4. Taylor RM, Sunde RA 2019 Selenium requirement of turkeys based on tissue selenium concentration and selenoprotein activity and transcript expression. *J Anim Sci.* 97: 177-178. (abs.)
5. Sunde RA. Impact of high dietary selenium on the selenoprotein transcriptome, selenoproteome, and selenometabolites in multiple species. In: *Selenium Research for Environment and Human Health: Perspectives, Technologies and Advancements* (Banelos G., Lin Z. Q., Liang D. & Yin X. B., eds.), pp. 159-160. Taylor and Francis, London

1. Alec Steep, Genetics Program – Genomic Investigations of Marek’s Disease Lymphomas
Cari Hearn, Comparative Medicine and Integrative Biology - Role of the Chicken T Cell
2. Tae-hyun Kim, Elucidating the Functional Role of Interferon Regulatory Factor 7 in the
Host Antiviral Pathway Against Avian Influenza Virus in Chickens., September 2019
3. Gustavo H. Schneiders, 2019. Unraveling the pathogenesis and molecular development of
Eimeria species under heat stress and thermoneutral conditions. PhD Dissertation.
Department of Poultry Science, University of Georgia, Athens, GA
4. Liu, K. Delayed access to feed affects broiler small intestinal morphology and intestinal
cell ontogeny. MS thesis, Virginia Tech, 2019.
5. Morphological and Molecular Characterization of Wooden Breast Myopathy in
Commercial Broiler Chickens. Michael Babak, Sept 10, 2019
6. Reynolds, K. Effects of high incubation temperature on the developing small intestine and
yolk sac of broiler chicks with insight into goblet cell development in the small intestine
early posthatch. MS thesis, Virginia Tech, 2019.
7. Shawna M. Hubert, Summer 2019. Functional and genomic drivers of wooden breast in
commercial broilers. Texas A&M University, College Station, Texas. 2019
8. Supawadee Umthong, Microbiology and Molecular Genetics – Identifying the Underlying
Mechanisms of Marek’s Disease Vaccine Synergy
9. Karen Tracy, The systemic immune response to Newcastle disease virus infection in
chickens., December 2019