

## NC1202 Annual Accomplishments Report

**Project/Activity Number:** NC1202

**Project/Activity Title:** Enteric Diseases of Food Animals: Enhanced Prevention, Control and Food Safety

**Period Covered:** 10/01/2019 to 09/30/2020

**Date of Report:** 01/25/2021

**Annual Meeting Dates:** 12/05/2020

**Annual Meeting Participants** (total n=27): Frank Blecha ([blecha@vet.k-state.edu](mailto:blecha@vet.k-state.edu)), Bledar Bisha ([bbisha@uwyo.edu](mailto:bbisha@uwyo.edu)), Roy Curtiss-III ([rcurtiss@ufl.edu](mailto:rcurtiss@ufl.edu)), Yung-Fu Chang ([yc42@cornell.edu](mailto:yc42@cornell.edu)), Connie Gebhart ([gebha001@umn.edu](mailto:gebha001@umn.edu)), Radhey Kaushik ([Radhey.kaushik@sdstate.edu](mailto:Radhey.kaushik@sdstate.edu)), Scott Kenney ([kenney.157@osu.edu](mailto:kenney.157@osu.edu)), Chun-Ming Lin ([CHUNMING.LIN@sdstate.edu](mailto:CHUNMING.LIN@sdstate.edu)), Jun Lin ([jlin6@utk.edu](mailto:jlin6@utk.edu)), Yanhong Liu ([yahliu@ucdavis.edu](mailto:yahliu@ucdavis.edu)), Rodney Moxley ([rmoxley1@unl.edu](mailto:rmoxley1@unl.edu)), T.G. Nagaraja ([tnagaraj@vet.k-state.edu](mailto:tnagaraj@vet.k-state.edu)), Gireesh Rajashekara ([rajashekara.2@osu.edu](mailto:rajashekara.2@osu.edu)), Orhan Sahin ([osahin@iastate.edu](mailto:osahin@iastate.edu)), Linda Saif ([saif.2@osu.edu](mailto:saif.2@osu.edu)), Mo Saif ([saif.1@osu.edu](mailto:saif.1@osu.edu)), Yongming Sang ([ysang@iastate.edu](mailto:ysang@iastate.edu)), Joy Scaria ([joy.scaria@sdstate.edu](mailto:joy.scaria@sdstate.edu)), Devendra Shah ([dshah@wsu.edu](mailto:dshah@wsu.edu)), Xiaolun Sun ([xiaoluns@uark.edu](mailto:xiaoluns@uark.edu)), Anastasia Vlasova ([vlasova.1@osu.edu](mailto:vlasova.1@osu.edu)), QiuHong Wang ([wang.655@osu.edu](mailto:wang.655@osu.edu)), Zhengguo Xiao ([xiao0028@umd.edu](mailto:xiao0028@umd.edu)), Dong-Won Yoo ([dyoo@illinois.edu](mailto:dyoo@illinois.edu)), Glenn Zhang ([glenn.zhang@okstate.edu](mailto:glenn.zhang@okstate.edu)), Qijing Zhang ([Zhang123@iastate.edu](mailto:Zhang123@iastate.edu)), Weiping Zhang ([wpzhang@illinois.edu](mailto:wpzhang@illinois.edu))

**Other members who sent reports but did not attend the meeting due to sickness or other conflicts:**

Philip R. Hardwidge ([hardwidg@vet.k-state.edu](mailto:hardwidg@vet.k-state.edu)), Linda Mansfield ([mansfie4@cvm.msu.edu](mailto:mansfie4@cvm.msu.edu)), Sheela Ramamoorthy ([sheela.ramamoorthy@ndsu.edu](mailto:sheela.ramamoorthy@ndsu.edu))

**New Members:** Chun-Ming Lin ([CHUNMING.LIN@sdstate.edu](mailto:CHUNMING.LIN@sdstate.edu)); Lyte, Joshua - ARS  
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**Brief Summary of Minutes of Annual Meeting from 9:30 am – 5 pm on 12/05/2020:**

- Opening welcome by Dr. QiuHong Wang (Chair)
- Opening remarks - Dr. Frank Blecha, NC1202 Administrative Advisor, Kansas State University: New 5-year proposal will need to be written (due fall 2021)
- Dr. Timothy J. Sullivan, New National Program Leader, NIFA (Animal Health and Aquaculture), USDA gave a presentation on funding and perspectives.
- Self-introduction and current collaboration status with other members
- Business meeting: Discussed budget, student awards, future meeting format, proposal preparation for submission in 2021.
- Voluntary presentations (n=6) of research followed by active discussions (4hrs). Several members expressed that they got good ideas for their own projects from other member's work and suggestions and may seek new collaborations among members.

**Accomplishment Summaries (focus on novel discoveries and collaboration efforts):**

1. *Escherichia albertii* is an emerging and the newest member of the attaching-effacing (A/E) family of bacterial pathogens. To date, the prevalence and major animal reservoirs of this pathogen are still largely unknown. We performed large scale survey in US wildlife and poultry and observed that raccoons and broilers are important reservoirs for *E. albertii*.
2. We first reported the *E. coli* O157:H7 causing A/E-like lesions in the urinary bladder epithelium in the gnotobiotic piglet model and showed the evidence of the utility of the gnotobiotic piglet as a model for studies of the pathogenesis of enterohemorrhagic *E. coli* in urinary tract infections.
3. We identified the first intra-bacterial activity for a type III secretion system effector protein.

4. We developed and validated multiplex PCR assays that can identify 137 serogroups of Shiga toxin-producing *E. coli*.
5. Evaluation of swine enteroids as *in vitro* models for *Lawsonia intracellularis* and rotavirus infections.
6. Developed a novel diagnostic platform, next-generation sequencing (NGS) coupled with *in situ* hybridization (ISH), to investigate swine emerging pathogens and new variants of endemic viruses.
7. We discovered new mechanisms of antimicrobial resistance (AMR). Polymyxins (e.g., colistin) are the drugs of last resort to treat multidrug-resistant infections in humans. We found two new targets that are essential for the PmrAB-mediated polymyxin resistance in *E. coli*.
8. We found that European starlings could be involved in the interstate dissemination of priority AMR bacteria.
9. We used transplanted human microbiota mouse models to study horizontal gene transfer of antimicrobial resistance in gut microbial communities.
10. We are screening for promising candidates to partially replace antibiotics in feed. We identified two novel narrow spectrum *Campylobacter* specific small molecule growth inhibitors, tested several probiotic strains and algae-derived beta-glucan on disease resistance and growth performance of weaned pigs. Both probiotics and beta-glucan have positive impacts on reducing diarrhea score and enhancing growth performance of weaned pigs.
11. We developed a fimbria-toxoid candidate vaccine for post-weaning enterotoxigenic *E. coli* (ETEC) in swine.
12. We evaluated the use of high throughput detection and characterization of enterococci from wildlife by matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF MS) following culture-based isolation, with pipelines proving reliable for the purpose of environmental surveillance protocols.
13. Rotaviruses (RVs) are a leading cause of acute viral gastroenteritis in young children and livestock worldwide. Growing evidence suggests that host cellular glycans, such as histo-blood group antigens (HBGAs) and sialic acids (SA), are recognized by the RV surface protein VP4 and some strains of beneficial (probiotic bacteria). We demonstrated that different human and porcine RV strains interact with host glycans in distinct and even contrasting manners which affects their replication efficacy. Moreover, some commensal/probiotic bacteria can interact with the host glycans, blocking attachment of some RVs, and directly bind various RVs.
14. We studied the nsp1 and nsp14 of porcine epidemic diarrhea virus (PEDV) in viral pathogenesis using our infectious clone platform. We found that the nsp14 exoribonuclease activity is essential for PEDV replication and the inactivation of this enzyme caused high genetic instability or no replication. We confirmed that PEDV nsp1 is an interferon antagonist and a determinant of virulence in pigs.
15. Piglets born to gilts are at higher risk of developing severe disease and dying due to PEDV infection. We identified vitamin A as a feasible strategy to improve PEDV-specific immune responses in mothers and protection of their piglets.
16. We developed a luminescent immunoprecipitation assay (LIPS) for serological detection of porcine deltacoronavirus (PDCoV) infection in pigs with > 95% specificity. Also, we established a LIPS assay specific for SARS-CoV-2 and screened serum samples from various species in Ohio.
17. We reported the structure-guided optimization of a series of inhibitors of the coronavirus 3C-like protease.
18. We have published results demonstrating that PDCoV can cross species barriers to infect chickens and turkeys.

**Impacts:** Enteric pathogens of food animals not only cause diseases in animals but some are also zoonotic pathogens and often cause sporadic cases and outbreaks of gastroenteritis in humans. The collaborative efforts of NC1202 multistate group focus on both applied and basic research, including the identification and characterization of emerging enteric pathogens, surveillance of the mutants of existing pathogens, development of improved diagnostic assays and prevention methods (e.g., vaccines and antibiotic

alternatives) to control and prevent enteric infections of food animals and humans under the One Health concept. New knowledge is distributed among producers and shareholders.

#### **Publications of Collaborations:**

1. **Moxley RA**, Bargar TW, Kachman SD, Baker DR, **Francis DH**. 2020. Intimate attachment of *Escherichia coli* O157:H7 to urinary bladder epithelium in the gnotobiotic piglet model. *Microorganisms* 8:263.
2. Lu T, **Moxley RA**, **Zhang W**. 2020. Application of a novel epitope and structure vaccinology-assisted fimbria-toxin multiepitope fusion antigen of enterotoxigenic *Escherichia coli* for multivalent vaccine development against porcine post-weaning diarrhea. *Appl Environ Microbiol AEM.00274-20* (Epub 3-6-2020).
3. Wu Y, Ho W, Huang Y, Jin D-Y, Li S, Liu S-L, Liu X, Qiu J, **Sang Y**, **Wang Q**, Yuen K-Y, Zheng Z-M (2020) SARS-CoV-2 is an appropriate name for the new coronavirus. *The Lancet*, 2020 Mar 21;395(10228):949-950.
4. Boley PA, Alhamo MA, Lossie G, Yadav KK, Vasquez-Lee M, **Saif LJ**, **Kenney SP**. 2020. Porcine Deltacoronavirus Infection and Transmission in Poultry, United States(1). *Emerg Infect Dis* **26**:255-265.
5. **Kenney SP**, **Wang Q**, **Vlasova A**, Jung K, **Saif L**. 2020. Naturally Occurring Animal Coronaviruses as Models for Studying Highly Pathogenic Human Coronaviral Disease. *Vet Pathol* doi:10.1177/0300985820980842.

#### **Fund Leveraging via collaborative grants between stations and members.**

1. Dr. Jun Lin at The University of Tennessee has an active collaboration with Dr. Glenn Zhang at Oklahoma State University for the ongoing NIFA Food Safety Challenge Grant (NIFA 2018-68003-27462). Novel non-antibiotic approaches for mitigation of antimicrobial resistance in poultry.
2. Dr. Sang at The University of Tennessee has an active collaboration with Drs. Wenjun Ma and Frank Blecha at Kansas State University for the ongoing NIFA Animal Health and Disease Grant (NIFA 2018-67016-28313). Antiviral potency and functional novelty of porcine interferon-omega subtype.
3. Dr. Sang at The University of Tennessee collaborates with Dr. Laura Miller (USDA ARS, Ames) and Dr. Bernd Lepenies (Univ. Hanover, Germany) for NIFA USDA 2020-67016-31347. Title: Validation of a live-virus vaccine candidate for efficient attenuation and better protection.
4. Dr. R.A. Moxley at the University of Nebraska-Lincoln has an active collaboration with Drs. W. Zhang (UIUC), and N. Cernicchiaro (Kansas State University). USDA NIFA 2017-67015-26632. Title: A Broadly Protective Vaccine against Post-Weaning Diarrhea (PWD).
5. Drs. Roy Curtiss III (University of Florida) and Gireesh Rajashekara (The Ohio State University) collaborate on NIFA USDA Award #: 2017-67017-26179. Title: A Food Safety Vaccine to Control *Salmonella* Enteritidis and Reduce *Campylobacter* in Poultry.
6. Drs. R.A. Moxley and J.D. Loy (University of Nebraska-Lincoln) collaborate on a project entitled "Genetic Analysis and Rapid Detection of Multidrug-Resistant *Salmonella enterica* Isolates from Cattle". Nebraska Beef Council and National Cattlemen's Beef Association. 10/1/2020-9/30/2021.
7. Drs. Kenney, Saif and Wang (The Ohio State University) collaborate on NIFA, USDA 2020-67015-31618. Title: Functional genomics approach in livestock to delineate host factors critical for emerging virus replication.
8. Drs. Saif, Vlasova, and Wang (The Ohio State University) collaborate on NIH-USDA Dual Purpose with Dual Benefit (NICHD R01HD095881): Research in Biomedicine and Agriculture. Title: The impact of vitamin A on the gut-mammary gland-secretory IgA axis during enteric viral infections.
9. Drs. Kenney and Wang (The Ohio State University) collaborate on OSU Seeds grant entitled "Interspecies transmission mechanisms of deltacoronavirus from birds to pigs".