WOAH Collaborative Centre Reports Activities 2022

Activities in 2022

This report has been submitted : 21 avril 2023 17:21

Title of WOAH Collaborating Centre	Research on Emerging Avian Diseases
Address of WOAH Collaborating Centre	Southeast Poultry Research Laboratory, U.S. National Poultry Research Center, Agricultural Research Service, U.S. Department of Agriculture, 934 College Station Road, Athens, Georgia 30605 USA
Tel.:	001-706-546-3433
E-mail address:	David.Swayne@usda.gov
Website:	https://www.ars.usda.gov/southeast-area/athens-ga/us-national-poultry-research-center/docs/seprl/
Name Director of Institute (Responsible Official):	David E Swayne
Name (including Title and Position) of Head of the Collaborating Centre (WOAH Contact Point):	David E. Swayne Laboratory Director and Supervisory Veterinary Medical Officer
Name of the writer:	David E Swayne

1. Activities as a centre of research, expertise, standardisation and dissemination of techniques within the remit of the mandate given by WOAH

Avian Diseases	
Title of activity	Scope
	ARS scientists in Athens, Georgia, in collaboration with scientists from the University of Georgia, conducted studies in several housing types using surrogate viruses for avian influenza virus to identify the best sample collection devices and areas from which to collect samples in poultry housing. Cotton gauze pads

Avian influenza, research	that were pre-moistened with transport media recovered the most virus from the most samples compared to the 3 other devices (swabs). The most virus was detected from areas where dust settled near bird level, and sites heavily touched by personnel were the best places for virus detection.

Avian Diseases	
Title of activity	Scope
Avian influenza, research	Highly pathogenic avian influenza viruses (HPAIVs) from the H5Nx Goose/Guangdong/96 lineage continue to cause outbreaks in domestic and wild bird populations around the world. Epidemiological evidence has shown that wild waterfowl play a major role in the spread of these viruses. In our studies, the H5Nx Goose/Guangdong/96 lineage highly pathogenic avian influenza viruses (HPAIVs) have shown that three viral gene segments (PB2, NP, and M) were associated with enhanced virulence of H5N8 HPAIVs in mallards. Phylogenetic analyses established that gene segments related to the more virulent 2016 H5N8 virus have persisted in the contemporary H5Nx HPAIV gene pool until 2020.

Avian Diseases	
Title of activity	Scope
Avian influenza, research	The full genome sequences of 49 H5N2 LPAIVs detected from 1994 to 2019 in Mexico were analysed for genetic changes and reassortments with unidentified avian influenza viruses. Increased infectivity, transmission and adaptation to chickens were observed with a 2011 H5N2 LPAIV in chickens compared to a 1994 virus. The genetic changes that occur as this lineage of H5N2 LPAIVs continues circulating in poultry is concerning not only because of the effect of these changes on vaccination efficacy, but also because of the potential of the viruses to mutate to HPAIV.

Avian Diseases	
Title of activity	Scope
Avian influenza, research	Laughing gulls inoculated with four gull-origin LPAIVs had a predominate respiratory infection. By contrast, mallards inoculated with two mallard-origin LPAIVs became infected and had similar virus amounts in respiratory and fecal samples. The trend toward mostly respiratory shedding in gulls suggest a greater role of direct bird transmission in maintenance, whereas mallards shedding suggests importance of fecal-oral transmission through water contamination.

Avian Diseases	
Title of activity	Scope
	Chickens became infected with H7N9 North American lineage low pathogenic avian influenza, with overt clinical signs of

Avian influenza, research	disease and shedding through both respiratory and fecal routes. Next generation sequencing (NGS) analysis identified numerous mutations in the polymerase genes (i.e., PA, PB1, and PB2) and the hemagglutinin (HA) receptor binding site in viruses recovered from the chickens, indicating possible virus adaptation in the new host. This work demonstrates that the H7N9 viruses could readily jump between avian species, which may have contributed to the evolution of the virus and its spread in the region.

Avian Diseases	
Title of activity	Scope
Newcastle disease, research	The thermal stability of Newcastle disease virus (NDV) was determined in poultry litter. Temperatures at or above 90°F quickly degraded the virus within a week. At lower temperatures (50-70°F) the virus remained infectious for weeks and even months. Thus, heating may be possible to help inactivate NDV in housing systems following an outbreak as part of the decontamination process.

Diagnosis, biotechnology and laboratory	
Title of activity	Scope
Avian influenza, research	Updated primers and probe of APHA (UK) test to be more specific to viruses circulating in North America. The chemistry and cycling conditions were also evaluated to allow the reagents commonly used in the U.S. National Animal Health Laboratory Network laboratories to be used. This new test was transferred to the NAPHIS National Veterinary Services Laboratories to allow rapid confirmation of farms for regulatory purposes.

Diagnosis, biotechnology and laboratory	
Title of activity	Scope
Avian disease, research	A simple and cost-effective method was developed to remove the host and bacterial rRNA from clinical samples before next generation sequencing. This host depletion method provided a 100-1000 fold increase in the quantity of pathogen to sequence from the sample which allowed identification of pathogens and in-depth sequence analysis for the determination of subtype, genotype, or pathotype of the virus. This improved technology allows diagnostic laboratories better opportunities to detect pathogens from any species which can directly support the farmer's efforts to control disease.

Diagnosis, biotechnology and laboratory	
Title of activity	Scope
	Next Generation Sequencing (NGS) techniques from clinical specimens can identify pathogens and determine potential virulence and origin of the pathogen. In a study of specimens

Avian disease, research	from Mexico, full genomes of over 20 viruses identified 5 different genotypes of infectious bronchitis coronavirus (IBV) and informed selection of vaccines and targeted vaccination to achieve full protection in flocks.

Epidemiology, surveillance, risk assessment, modelling	
Title of activity	Scope
Avian influenza, research	High infectivity and transmissibility were observed with both the H7N3 North American lineage LPAIVs and HPAIV in turkeys. In contrast, the dose to infect chickens was higher than for turkeys and no transmission was observed. These results corroborate the observed high susceptibility of turkeys to both LPAIV and HPAIV infections in the field.

Epidemiology, surveillance, risk assessment, modelling	
Title of activity	Scope
Avian influenza, research	384 H2N2 low pathogenicity AIVs (LPAIV) were isolated from Live Poultry Markets (LPM) systems of north-eastern USA during 2013–2019. Comparative genetic analysis demonstrated that a wild-bird-origin H2N2 virus may have been first introduced into the LPMs in Pennsylvania and independently evolved since March 2012 followed by spread to LPMs in New York City during late 2012–early 2013. LPMs in New York state played a key role in the maintenance and dissemination of the virus to LBMs in the Northeast US. The frequent detections in the domestic ducks and market environment with viral transmissions between birds and environment possibly led to viral adaptation and circulation in domestic gallinaceous poultry in LBMs, suggesting significant roles of domestic ducks and contaminated LBM environment as reservoirs in maintenance and dissemination of H2N2 LPAIV.

Vaccines	
Title of activity	Scope
Marek's disease, research	From prior studies, Marek's disease virus (MDV) challenge strains in white leghorn chickens for USA vaccine licensing produced at least 80% of the unvaccinated chickens to develop lesions. A series of studies expanded challenge strain evaluation to commercial broiler-type chickens determined several very virulent MDV (vvMDV) isolates were close to the required 80% disease incidence, whereas none of the virulent MDV (vMDV) strains were near 80% and should not be used for broiler vaccine evaluation.

Vaccines	
Title of activity	Scope
	A serotype 2 Marek's disease (MD) vaccine (301B/1) expressing chicken IL-15 was developed and was equal in protective as the

Marek's disease, research	serotype-3 HVT vaccine, the most widely used MD vaccine and favorite vector vaccine platform in the poultry industry. This vaccine opens the door for the development of a novel vaccine vector that can be administered in combination with HVT vector vaccines, allowing protection against multiple poultry viruses.

Vaccines	
Title of activity	**Scope**
Marek's disease, research	A Newcastle disease virus (NDV) recombinant expressing the MDV glycoprotein B (gB) as a dual vaccine was developed. The recombinant virus, rLS/MDV-gB, was slightly attenuated in vivo yet retained similar growth kinetics and stability with comparable in vitro virus titers relative to the parental LaSota virus. The recombinant virus expressed gB DF-1 cells. Vaccinated chickens had significant protection against virulent MDV challenge and complete protection against the velogenic NDV challenge.

Vaccines	
Title of activity	**Scope**
Newcastle disease, research	A recombinant Newcastle disease virus was developed that expressed, a biological protein and key regulator in humoral and adaptive immunity, IL-4. The recombinant virus replicated efficiently in chickens and the production of IL-4 was successfully demonstrated in multiple tissues. IL-4 is known to enhance humoral immunity and recombinant Newcastle disease virus co-expressing IL-4 has a potential to be developed as a vaccine to enhance protection against virulent Newcastle disease virus infection.

Vaccines	
Title of activity	**Scope**
Newcastle disease, research	Current NDV vaccines cannot be used in ovo because they cause chicks to not hatch or be sick after hatch. To improve the in ovo vaccination, a new NDV vaccine was developed that was more attenuated and can be used safely to immunize embryonating chicken eggs while providing good protection from virulent NDV challenge. This vaccine shows the possibility of use as a live vaccine given in ovo which can potentially improve our ability to protect poultry from this disease.

Vaccines	
Title of activity	**Scope**
	A collaborative study showed that the negative surface charge of the viral attachment glycoprotein on Newcastle disease virus was a critical determinant of thermal stability, preventing temperature-induced aggregation of glycoprotein and subsequent detachment from the virion surface. This virus

Newcastle disease, research	could bind to and infect cells efficiently after heat treatment. Genetically engineered live and inactivated NDV vaccines with the increased negative surface charge of the attachment glycoprotein maintained their protective efficacy against the virulent NDV challenge after storage at 37C for at least 10 and 60 days, respectively. Based on these data, we proposed a novel surface-charge-mediated mechanism for viral thermal stability, which could be used to design thermal stable enveloped virus vaccines rationally.

2. Proposal or development of any procedure that will facilitate harmonisation of international regulations applicable to the main fucus area for which you were designated

Proposal title	Scope/Content	Applicable area

4. Did your Collaborating Centre maintain a network with other WOAH Collaborating Centres (CC), Reference Laboratories (RL), or organisations designated for the same specialty, to coordinate scientific and technical studies?

Yes

Name of OIE CC/RL/other organisation(s)	Location	Region of networking Centre	Purpose
Roslin Institute at the University of Edinburgh	United Kingdom	Europe	Evolution of Avian Influenza Virus
Sokoine University of Agriculture	Tanzania	Africa	Diagnostic testing of chicken samples from live bird markets from Tanzania
Kenya Agricultural and Livestock Research Organization	Kenya	Africa	Collaboration on active surveillance in chickens and passive surveillance in chickens, pigeons and wild species of birds to determine avian influenza viral distribution, and identification of ecological correlates in Kenya, and to develop a training program on genomic characterization, sequencing, and bioinformatics.

University of Georgia (USA)	USA	Americas	Development of Modified Live vaccines for protection of poultry against high and low pathogenic avian influenza virus
Avian influenza laboratory, Avian Diseases Division; WOAH Reference Labs for Highly pathogenic avian influenza and low pathogenic avian influenza (poultry)	Dominican Republic and USA	Americas	Modelling of H5N2 low pathogenic avian influenza virus epidemiology
WOAH Reference Laboratories for Avian Influenza	Canada, France, Italy, Canada and USA	Americas Europe	Multilateral sharing of experimental and diagnostic data on 2.3.4.4b HPAI to improve diagnosis and reduce duplication of research studies

5. Did your Collaborating Centre maintain a network with other WOAH Collaborating Centres, Reference laboratories, or organisations in other disciplines, to coordinate scientific and technical studies?

No

6. Did your Collaborating Centre place expert consultants at the disposal of WOAH?

Yes

NAME OF EXPERT	KIND OF CONSULTANCY	SUBJECT
David E Swayne	Scientific	OFFLU network expertise on Avian influenza
David L Suarez	Scientific	OFFLU network expertise on Avian influenza
Erica Spackman	Scientific	OFFLU Technical Activities - Vaccine Composition in antigenic characterization and Wildlife Technical Activities

7. Did your Collaborating Centre provide advice/services to requests from Members in your main focus area?

No

8. Did your Collaborating Centre provide scientific and technical training, within the remit of the mandate given by WOAH, to personnel from WOAH Members?

Yes

a) Technical visit :

b) Seminars :

c) Hands-on training courses:

d) Internships (>1 month) : 8

TYPE OF TECHNICAL TRAINING PROVIDED (A, B, C OR D)	CONTENT	COUNTRY OF ORIGIN OF THE EXPERT(S) PROVIDED WITH TRAINING	NO. PARTICIPANTS FROM THE CORRESPONDING COUNTRY
D	Learn the molecular biology techniques and get training in reverse genetics technology, conduct research on enteric viral diseases of poultry and develop an enterotropic Newcastle disease virus (NDV) vaccine strain- based live recombinant vaccine against an enteric viral disease and NDV	Egypt	1
D	Diagnosis, epidemiology, control (including vaccines) and pathobiology of Newcastle Disease, Avian Influenza and Marek's Disease	South Korea	4
D	Diagnosis, epidemiology, control (including vaccines) and pathobiology of Newcastle Disease and Avian Influenza	Kenya	1
D	Diagnosis, epidemiology, control (including vaccines) and pathobiology of Marek's Disease	Nigeria	1
D	Diagnosis, epidemiology, control (including vaccines) and pathobiology of Avian Influenza	Philippines	1

9. Did your Collaborating Centre organise or participate in the organisation of scientific meetings related to your main focus area on behalf of WOAH?

Yes

NATIONAL/INTERNATIONAL	TITLE OF EVENT	CO-ORGANISER	DATE (MM/YY)	LOCATION	NO. PARTICIPANTS
	IABS Meeting on High Pathogenicity Avian Influenza Vaccination	International Alliance			

International	Strategies to prevent and control HPAI: Removing unnecessary barriers for usage	for Biological Standardization	2022-10-25	Paris	139

10. Publication and dissemination of any information within the remit of the mandate given by WOAH that may be useful to Members of WOAH

a) Articles published in peer-reviewed journals:

1. Brown C, Zhang J, Pantin-Jackwood M, Dimitrov K, Ferreira HL, Suarez D. In situ cytokine gene expression in early stage of virulent Newcastle disease in chickens. Vet Pathol. 2022 Jan;59(1):75-81. doi: 10.1177/03009858211045945.

2. Chung, D.H., Torchetti, M.K., Killian, M.L., Swayne, D.E., Lee, D.H. Transmission dynamics of low pathogenicity avian influenza (H2N2) viruses in live bird markets of the Northeast United States of America, 2014-2019. Virus Evolution 8(1):veac009, 2022. doi: 10.1093/ve/veac009.

3. Clark, A, Eid, S., Hassan, M.K., Carter, K., Swayne, D.E. Reducing zoonotic avian influenza transmission at household poultry slaughter using a behaviour change tool for limited literacy audiences. Zoonoses and Public Health 69(8):956-965, 2022. doi: 10.1111/zph.12993. Epub 2022 Sep 6

4. Conrad SJ, Oluwayinka EB, Heidari M, Mays JK, Dunn JR. Deletion of the Viral Thymidine Kinase in a Meq-Deleted Recombinant Marek's Disease Virus Reduces Lymphoid Atrophy but Is Less Protective. Microorganisms. 10:7; 2022.

5. Criado, M.F., Leyson, C., Youk, S., DeBlois, S., Olivier, T., Killian, M.L., Torchetti, M.L., Parris, D.J. Spackman, E., Kapczynski, D.R., Suarez, D.L., Swayne, D.E., Pantin-Jackwood, M.J. The pathobiology of H7N3 low and high pathogenicity avian influenza viruses from the United States outbreak in 2020 differs between turkeys and chickens. Viruses 2021, 13, 1851, 2021. doi 10.3390/v13091851.

6. Dar, M.A., Ahmad, S.M., Bhat, B.A., Dar, T.A., Ul Haq, Z., Wani, B.A., Shabir, N., Kashoo, Z.A., Ganai, N.A., Heidari, M., Shah, R.A. 2022. Comparative RNA-Seq analysis reveals insights in Salmonella disease resistance of chicken; and database development as resource for gene expression in poultry. Genomics. 113 / 1-12. https://doi.org/10.1016/j.ygeno.2022.110475.

7. Deng, Q., Li, Q., Li, M., Zhang, S., Wang, P., Fu, F., Zhu, W., Wei, T., Mo, M., Huang, T., Zhang, H., Wei, P. 2022. The Emergence, Diversification, and Transmission of Subgroup J Avian Leukosis Virus Reveals that the Live Chicken Trade Plays a Critical Role in the Adaption and Endemicity of Viruses to the Yellow-Chickens. Journal of Virology. https://doi.org/10.1128/jvi.00717-22.

8. Dong, K., Heidari, M., Mays, J.K., Chang, S., Xie, Q., Zhang, L., Ai, Y., Zhang, H. 2022. LncRNA signature of avian lymphoid leukosis-like lymphomas differed from normal controls. PLoS ONE. https://doi.org/10.1016/j.micpath.2022.105688.

9. Eldemery F, Ou C, Kim T, Spatz S, Dunn J, Silva R, Yu Q. Evaluation of Newcastle disease virus LaSota strain attenuated by codon pair deoptimization of the HN and F genes for in ovo vaccination. Veterinary Microbiology.109625; 2022 2022/12/06/.

10. Ford AK, Watanabe TTN, Fenton H, Dunn JR, Shivaprasad HL, Williams SM, Wakamatsu N. Pathology in Practice. J. Am. Vet. Med. Assoc. 259:1-4; 2022 May 11.

11. Gerber, P.F., Spatz, S.J., Alfieri, S., Walkden-Brown, S.W. 2022. Circulation and molecular characterization of hemorrhagic enteritis virus (HEV) in commercial turkey and meat chicken flocks in Australia. Avian Diseases. https://doi.org/10.1637/21- 00095.

12. Guan, D., Halsted, M.M., Islas-Trejo, A.D., Goszczynski, D.E., Cheng, H.H., Ross, P., Zhou, H. 2022. Prediction of full-length transcripts in 19 chicken tissues by Oxford Nanopore long-read sequencing. Frontiers in Genetics. https://doi.org/10.3389/fgene.2022.997460

13. Heidari, M., Zhang, H., Sunkara, L. 2022. MDV-induced differential microRNA expression in the primary lymphoid organ of thymus. Microbial Pathogenesis. https://doi.org/10.1016/j.micpath.2022.105688.

14. Kapczynski, D.R., Sweeney, R.P., Spackman, E., Pantin Jackwood, M.J., Suarez, D.L. 2022. Development of an in vitro model for animal species susceptibility to SARS-CoV-2 replication based on expression of ACE2 and TMPRSS2 in avian cells. Virology. 569:1-12. https://doi.org/10.1016/j.virol.2022.01.014.

15. Kariithi, H., Christy, N., Decanini, E.L., Lemiere, S., Volkening, J.D., Afonso, C.L., Suarez, D.L. 2022. Detection and genome sequence analysis of avian metapneumovirus subtype A viruses circulating in commercial chicken flocks in Mexico. Veterinary Sciences. 9(10):579. https://doi.org/10.3390/vetsci9100579.

16. Kariithi, H.M., Volkening, J.D., Leyson, C.M., Alfonso, C.L., Christy, N., Lucio, E.D., Lemiere, S., Suarez, D.L. 2022. Genome sequence variations of infectious bronchitis virus serotypes from commercial chickens in Mexico. Frontiers in Veterinary Science. 9:931272. https://doi.org/10.3389/fvets.2022.931272.

17. Kim, T.N., Hearn, C.J. 2022. Vaccinal Efficacy of recombinant Marek's disease vaccine 301B/1 expressing chicken interleukin-15. Avian Diseases. https://doi.org/10.1637/21-00089.

18. Krieter, A., Xu, H., Akbar, H., Kim, T.N., Jarosiniski, K.W. 2022. The Conserved Herpesvirus Protein Kinase (CHPK) of Gallid alphaherpesvirus 3 strain 301B is required for horizontal transmission in chickens. Viruses. https://doi.org/10.3390/v14030586.
19. Liao, L., Chen, W., Zhang, X., Zhang, H., Li, A., Yan, Y., Zhang, X., Li, H., Lin, W., Ma, J., Xie, Q. 2022. Semen Exosomes Mediate Vertical Transmission of Subgroup J Avian Leukosis Virus. Journal of Virology. https://doi.org/10.1016/j.virs.2022.01.026.
20. Leyson CM, Criado MF, Youk S, Pantin-Jackwood MJ. Low Pathogenicity H7N3 Avian Influenza Viruses Have Higher Within-Host Genetic Diversity Than a Closely Related High Pathogenicity H7N3 Virus in Infected Turkeys and Chickens. Viruses. 2022 Mar 8;14(3):554. doi: 10.3390/v14030554. PMID: 35336961; PMCID: PMC8951284.
21. Mo, J., Stephens, C.B., Spackman, E. The Thermal Stability of Newcastle Disease Virus in Poultry Litter. Avian Diseases, 66(2), 131–134. 2022 https://doi.org/10.1637/aviandiseases-D-21-00113
22. Mo, J., Stephens, C.B., Jordan, B., Ritz, C., Swayne, D.E., Spackman, E. Optimizing sample collection methods for maximum detection of respiratory viruses in poultry housing environments. Transboundary and Emerging Diseases 69:e2111-e2121, 2022. http://doi.org/10.1111/tbed.14547.
23. Mohanty, S.K., Donnelly, B., Temple, H., Mowery, S., Poling, H.M., Meller, J., Malik, A., Mcneal, M., Tiao, G. 2022. Rhesus rotavirus receptor-binding site affects high mobility group box 1 release, altering the pathogenesis of experimental biliary atresia. Hepatology Communications. https://doi.org/10.1002/hep4.2024.
24. Parris, J.D., Kariithi, H., Suarez, D.L. 2022. Non-target RNA depletion strategy to improve sensitivity of next-generation sequencing for the detection of RNA viruses in poultry. Journal of Veterinary Diagnostic Investigation. 34(4), 638-645. https://doi.org/10.1177/10406387221102430.
25. Sani NA, Ugochukwu ICI, Abalaka SE, Saleh A, Idoko IS, Oladele SB, Abdu PA, Njoku COI, Dunn JR. Immunohistochemical and molecular detection of avian neoplastic disease viruses in layer chickens from poultry farms in Northwestern and Northcentral Nigeria. Comparative Clinical Pathology. 2022 2022/06/28.
26. Santos, W.H., Spatz, S.J., Ecco, R., Wenceslau, R., Hergot, I.G., De Rocha, C.M., Ferreira, H.L., Resende, M., Martins, N.R., De Oliveira, L.B., Leão, P.A. 2022. A five year surveillance study of vaccination schedules using viral-vectored vaccines against infectious laryngotracheitis in a quarantine high-density layer region. Avian Diseases. https://doi.org/10.1590/1678-5150-PVB-7037.
27. Shang, Y., Li, L., Zhang, T., Luo, Q., Yu, Q., Zeng, Z., Li, L., Jia, M., Tang, G., Fan, S. 2022. Quantitative regulation of the thermal stability of enveloped virus vaccines by surface charge engineering to prevent the self-aggregation of attachment glycoproteins. PLoS Pathogens. https://doi.org/10.1371/journal.ppat.1010564.
28. Steep A, Hildebrandt E, Xu H, Hearn C, Frishman D, Niikura M, Dunn JR, Kim T, Conrad SJ, Muir WM, et al. Identification and Validation of Ikaros (IKZF1) as a Cancer Driver Gene for Marek's Disease Virus-Induced Lymphomas. Microorganisms. 10: 2022 Feb 9.
29. Stephan, T., Burgess, S.M., Cheng, H.H., Danko, C., Gill, C.A., Jarvis, E.D., Koepfli, K., Koltes, J.E., Lyons, E., Ronald, P., Ryder, O.A., Schriml, L.M., Soltis, P., Vandewoude, S., Zhou, H., Ostrander, E.A., Karlsson, E.K. 2022. Darwinian genomics and diversity in the tree of life. Proceedings of the National Academy of Sciences(PNAS). 119:4. https://doi.org/10.1073/pnas.2115644119.
30. Xing, N., Hofler, T., Hearn, C.J., Nascimento, M., Camps Paradell, G., Mcmahon, D.P., Kunec, D., Cheng, H.H., Trimpert, J., Osterrieder, N. 2022. Fast forwarding evolution – accelerated adaptation in a proofreading deficient hypermutator herpesvirus. Virus Evolution. https://doi.org/10.1093/ve/veac099.
31. Xu, H., Kriter, A.L., Ponnuraj, N., Tien, Y., Kim, T.N., Jarosinski, K.W. 2022. Coinfection in the host can result in functional complementation between live vaccines and virulent virus. Virulence. https://doi.org/10.1080/21505594.2022.2082645.
32. Yan, Y., Chen, S., Liao, S., Gao, S., Pang, Y., Zhang, X., Zhang, H., Xie, Q. 2022. ALV-miRNA-p19-01 Promotes Viral Replication via Targeting Dual Specificity Phosphatase 6. Viruses. https://doi.org/10.3390/v14040805.
33. Youk S, Leyson CM, Parris DJ, Kariithi HM, Suarez DL, Pantin-Jackwood MJ. Phylogenetic analysis, molecular changes, and adaptation to chickens of Mexican lineage H5N2 low-pathogenic avian influenza viruses from 1994 to 2019. Transbound Emerg Dis. 2022 Feb 11. doi: 10.1111/tbed.14476. PMID: 35150205.
34. Youk S, Leyson C, Killian ML, Torchetti MK, Lee D-H, Suarez DL, and Pantin-Jackwood MJ. Evolution of the North American lineage H7 avian influenza viruses in association with the virus introduction to poultry. Journal of Virology 2022 Jul 27;96(14):e0027822. doi: 10.1128/jvi.00278-22. PMID: 35862690
35. Zhang, X., Zhao, Q., Yao, Z., Chen, L., He, Y., Xie, Z., Zhang, H., Lin, W., Chen, F., Xie, Q. 2022. Transcriptome-wide dynamics of m6A methylation in tumor livers induced by ALV-J infection in chickens. Journal of Immunology. https://doi.org/10.3389/fimmu.2022.868892.

b) International conferences:
1. Pantin-Jackwood, M. Overview of the 2022 H5N1 highly pathogenic avian influenza. Virtual Webinar. Colombian Association of Veterinarian and Zootechnician Specialists in Poultry – AMEVEA, December 1, 2022
2. Spackman, E. Vaccines available and systems for usage in the field (Virtual). Workshop on Vaccination Strategies to Prevent and Control HPAI: Removing Unnecessary Barriers for Usage, International Alliance for Biologics Standardization, World Organization for

Animal Health, Paris, France, 25-26 October 2022
3. Swayne, D.E. Role of Agriculture in Control of Avian Influenza in a One Health Concept, Virtual Webinar on Avian influenza, Steinhardt Museum of Natural History Tel Aviv University, 11 January 2022
4. Swayne, D.E. Best practices for efficient implementation and post epidemic resilience of biosecurity measurements in poultry farms management, Biosecurity and Biosafety webinar, OIE Sub-Regional Representation in Abu Dhabi, 1 February 2022.
5. Swayne, D.E., Short Introduction on Changing Epidemiology of High Pathogenicity Avian Influenza in Poultry and Wild Aquatic Birds, Virtual Webinar on Managing large-scale highly pathogenic avian influenza (HPAI) outbreaks in wild birds, Food and Agriculture Organization of the United Nations, Rome, Italy, 10 February 2022.
6. Swayne, D.E., Short Introduction on Changing Epidemiology of High Pathogenicity Avian Influenza in Poultry and Wild Aquatic Birds, Virtual Webinar on Managing large-scale highly pathogenic avian influenza (HPAI) outbreaks in wild birds, Food and Agriculture Organization of the United Nations, Rome, Italy, 10 February 2022.
7. Swayne, D.E., Intercontinental Outbreak of H5Nx clade 2344b High Pathogenicity Avian Influenza and Impact on the Americas, Virtual XLVI Annual Congress of Asociación Nacional De Especialistas En Ciencias Avícolas De México (ANECA) (ie Mexican Poultry Health Association) on 31 March 2022.
8. Swayne, D.E., Intercontinental Outbreak of H5Nx clade 2344b High Pathogenicity Avian Influenza and Impact on the Americas, Virtual Committee Meeting of Tri-State Poultry Veterinarians (Ohio, Indiana and Michigan), 8 April 2022
9. Swayne, D.E., Global Situation of Highly Pathogenic Avian Influenza and Vaccination as a Control Tool., World Veterinary Poultry Association (Virtual), Marrakesh, Morocco, 23-25 June 2022
10. Swayne, D.E., High Pathogenicity Avian Influenza in a One Health Framework," World's Poultry Congress (Virtual), Paris, France, 7-11 August 2022
11. Swayne, D.E., The U.S. Experience in Avian Influenza Control: Lessons Learned for Latin America Preparedness, Latin American Poultry Congress (OVUM 2022)(Virtual), San Pedro Sula, Honduras, 6-9 September 2022.
12. Swayne, D.E., USA H5N1 2.3.4.4b HPAI Outbreak: Features and Basic Epidemiology, 28th Annual meeting of the National Reference Laboratories for Avian Influenza and Newcastle Disease (Virtual), Verona, Italy, 20-21 September 2022
13. Swayne, D.E., Epidemiology and Control of High Pathogenicity Avian Influenza in the Americas, IDEXX Poultry Academy Webinar, 30 September 2022
14. Swayne, D.E., National and Global Lessons Learned from 2.3.4.4 HPAI Outbreaks of 2014-15 and 2022, Western Association of Poultry Veterinarians (Canadian)(Virtual), Banff, Alberta, Canada, 5 October 2022
15. Swayne, D.E., Vaccine Usage to Control High Pathogenicity Avian Influenza and Barriers to More Effective Usage: Setting the Scene, Workshop on Vaccination Strategies to Prevent and Control HPAI: Removing Unnecessary Barriers for Usage, International Alliance for Biologics Standardization, World Organization for Animal Health, Paris, France, 25-26 October 2022
16. Swayne, D.E., Global Avian Influenza and Impact on the Americas, XX National Poultry Congress, National Federation of Poultry Farmers of Colombia (Fenavi), Plaza Mayor, Medellín, Colombia, 2-4 November 2022
17. Swayne, D.E., The Situation of High Pathogenicity Avian Influenza in the World and Its Effects on Global Trade, 13th Symposium on Poultry Production (Virtual), World Veterinary Poultry Association – Turkish Branch, Ankara, Turkiye, November 30-December 1, 2022

c) National conferences:
1. Criado, M.F. "Evaluation of Licensed and In-house Vaccines Against Recent H5 Low Pathogenicity Avian Influenza viruses", 2022 American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
2. Dunn JR, Mays J, Hearn C, Hartman A. Comparison of Marek's disease virus challenge strains in commercial broiler-type chickens. American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
3. Ghorbani A, Ngunjiri JM, Abundo M, Lee CW. Development of a high interferon inducing live attenuated influenza vaccine for in ovo vaccination of chickens. American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
4. Leyson, C. Temperature and pH stability of low and high pathogenicity avian influenza viruses. 2022 American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
5. Mo, J. The Thermal Stability of Newcastle Disease Virus in Poultry Litter, 2022 American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
6. Pantin-Jackwood M. Comparison of the pathogenicity in chickens and turkeys of a 2022 United States wild bird H5N1 highly pathogenic avian influenza clade 2.4.4.4b virus, and two previous clade 2.3.4.4 H5N8 HPAI viruses. 2022 American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
7. Pantin-Jackwood, M. Overview of the 2022 highly pathogenic avian influenza outbreak. 2022 National Meeting on Poultry Health, Processing and Live Production, October 3-5, 2022, Ocean City Maryland.

8. Spackman, E. HPAIV stability in outbreak waste and environmental testing strategies, 2022 American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
9. Swayne, D.E., Global Evolution and Intercontinental Spread of H5Nx clade 2344b High Pathogenicity Avian Influenza Viruses since 2020, 2022 American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022
10. Youk, S Stepwise adaptation of the hemagglutinin protein of H5N2 highly pathogenic avian influenza virus in chickens. 2022 American Association of Avian Pathologist Annual Meeting, Philadelphia, Pennsylvania, 29 July - 2 August 2022

d) Other (Provide website address or link to appropriate information):

11. What have you done in the past year to advance your area of focus, e.g. updated technology?
Q Yu, SJ Spatz, JR Dunn - US Patent App. 17/682,358, 2022. Recombinant vaccine against Marek's disease and Newcastle disease.

12. Additional comments regarding your report: