

Emerging Viral Pathogens in Farmed White-tailed Deer (*Odocoileus virginianus*) in Florida



An-Chi Cheng^{1,2}, Pedro H. de Oliveira Viadanna^{2,3,4}, Laura Roldan^{1,2}, Zoe White^{2,5}, Kristen Wilson^{2,5}, Tracey Logan^{2,4,6}, Emily DeRuyter^{2,4,6},

Kuttchantran Subramaniam^{2,3,4}, John A. Lednicky^{2,4,6}, Joao Bittar¹, Kwangcheol Casey Jeong^{4,7}, Samantha M. Wisely^{2,5}, Juan M. Campos Krauer^{1,2,5}



1. Department of Large Animal Clinical Sciences, College of Veterinary Medicine, University of Florida
3. Department of Infectious Diseases and Immunology, College of Veterinary Medicine, University of Florida
5. Department of Wildlife Ecology and Conservation, College of Agriculture and Life Sciences, University of Florida
7. Department of Animal Sciences, College of Agriculture and Life Sciences, University of Florida

2. Cervidae Health Research Initiative (CHeRI), University of Florida
4. Emerging Pathogens Institute, University of Florida
6. Department of Environmental and Global Health, College of Public Health and Health Professions, University of Florida

Introduction

- White-tailed deer (*Odocoileus virginianus*) farming is an emerging agricultural industry in Florida.
- The University of Florida Cervidae Health Research Initiative (CHeRI) provided free necropsy and diagnostic services and accepted shipped field samples from Florida deer farms to identify the pathogens and causes of death since 2016.
- The high percentage of unknown causes of mortality suggests the potential presence of emerging pathogens that are not included in our current testing protocol for farmed white-tailed deer in Florida.
- This study aims to identify the special heterogeneity, possible origins, and transmission routes for two viruses, bovine viral diarrhea virus (BVDV) and mule deerpox virus (MDPV), the two emerging viral pathogens in farmed white-tailed deer in Florida.

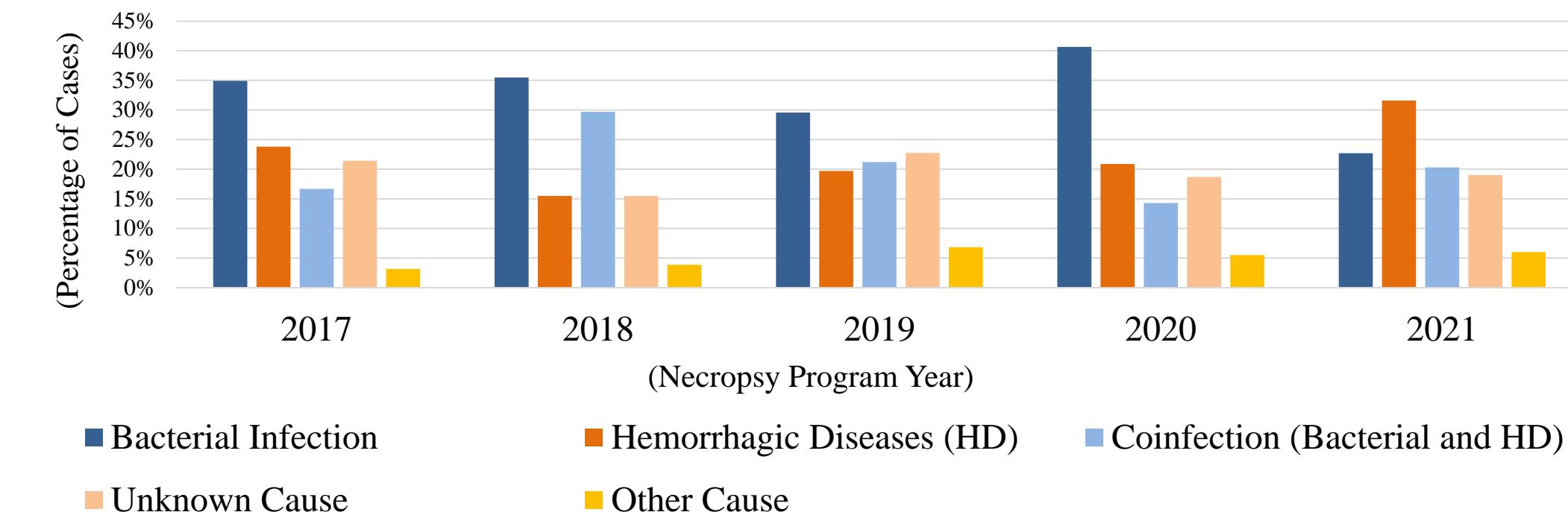


Figure 1. Cause of mortality in farmed white-tailed deer in Florida from 2017 to 2021.

Bovine Viral Diarrhea Virus (BVDV)

Materials and Methods

- Fresh whole blood and organ tissue collected during necropsy
- Virus isolation
- Miseq whole genome sequencing
- Comparison of BVDV whole genome and amino acid sequences from this study and NCBI database

Table 1. BVDV animal information and gross presentation.

Animal ID	Age (year)	Sex	Farm ID	County	Symptoms	Gross necropsy	Necropsy date
OV853	1.5	Female	Farm A	Martin	No symptom before found dead	Excellent body condition, bloody discharge from vagina, anus, mouth, nostrils, hemothorax, hemoperitoneum, hemorrhage in lungs and liver, petechial hemorrhage in myocardium and bowel, kidneys without consistency	Sep-10-2018
OV854	1.5	Female	Farm A	Martin	No symptom before found dead	Bloody discharge from vagina, anus, mouth, nostrils, hemothorax, hemoperitoneum, hemobdomen, hemorrhage in lungs, heart, and liver, petechial hemorrhage in bowel, mushy kidneys, friable spleen	Sep-10-2018
OV856	4	Male	Farm B	Lafayette	No symptom before found dead	Great body condition, bloody discharge from nostrils and mouth, swollen ankles on all legs, hemorrhage in lungs, hemorrhage, slightly inflamed intestines, kidneys and spleen without consistency	Sep-14-2018
OV858	2	Female	Farm A	Martin	No symptom before found dead	Excellent body condition, bloody discharge from nostrils and anus, hemothorax and hemoabdomen	Sep-12-2018

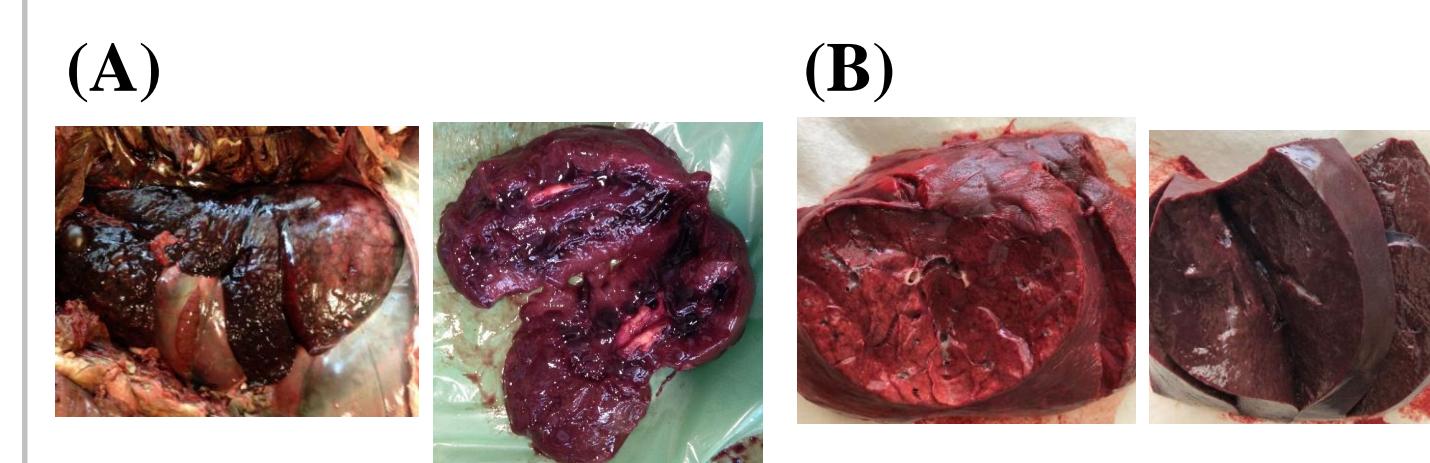


Figure 1. Hemorrhaging organs from the BVDV-infected white-tailed deer. (A) OV856 lungs and kidney, and (B) OV858 lungs and liver.

Result

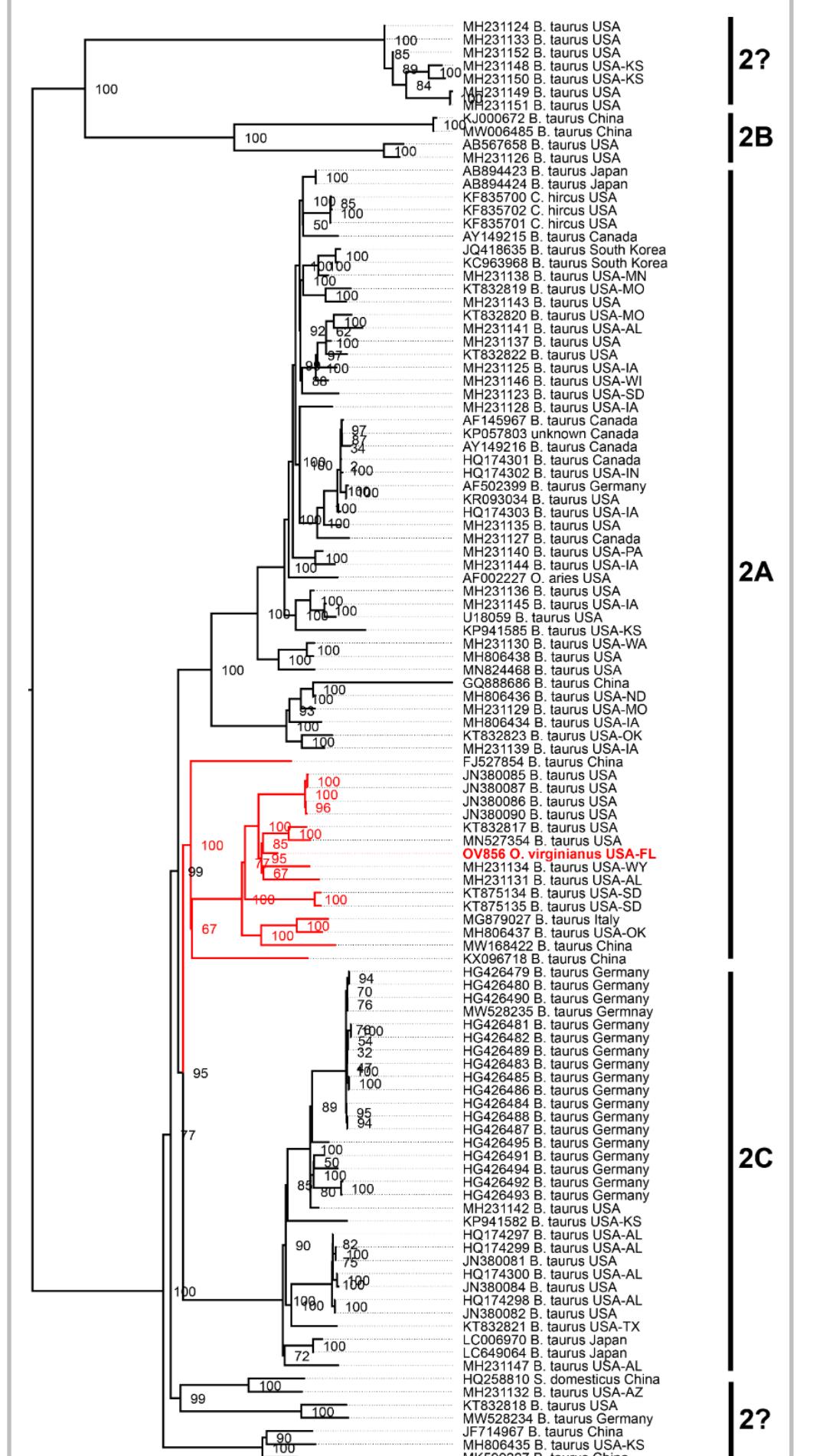


Figure 2. Amino acid identity comparison of BVDV2 Npro (nonstructural proteins) sequence in this study and BVDV2 sequences from NCBI database.

Conclusion

- This is the first case of BVDV in farmed white-tailed deer in the US and the first case of BVDV2a in white-tailed deer.
- Virus isolation might be a better testing method for BVDV in white-tailed deer, especially for different infection stages.
- There are only sporadic cases of BVDV in Florida farmed white-tailed deer, but future surveillance is still important.
- The possible origin of BVDV in Florida white-tailed deer might be cattle based on the genome sequence, and it has a chance of spillback.

Acknowledgments

This study was funded by the University of Florida, Cervidae Health Research Initiative, with funds provided by the State of Florida legislature. We thank the deer farms for the deer samples and all necropsy technicians for sample collection.

Mule Deerpox Virus (MDPV)

Materials and Methods

- Out of 752 white-tailed deer collected throughout the state of Florida from 2017 to 2023, 145 animals (33.79%, 95% CI: 26.6%-42.18%) presented with gross skin lesions
- Skin lesion, scab, organ tissues collected during necropsy
- 367 samples collected from 145 animals with skin lesions
- cPCR targeting low GC pox viruses
- A21 gene and whole genome sequencing

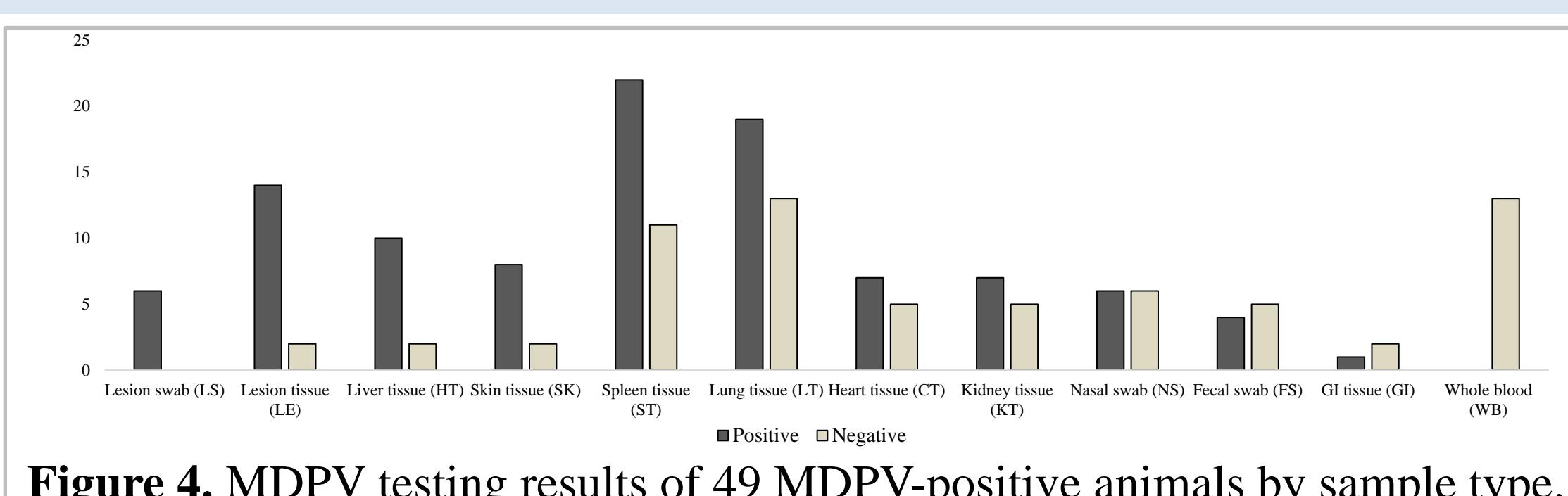


Figure 4. MDPV testing results of 49 MDPV-positive animals by sample type.

Result

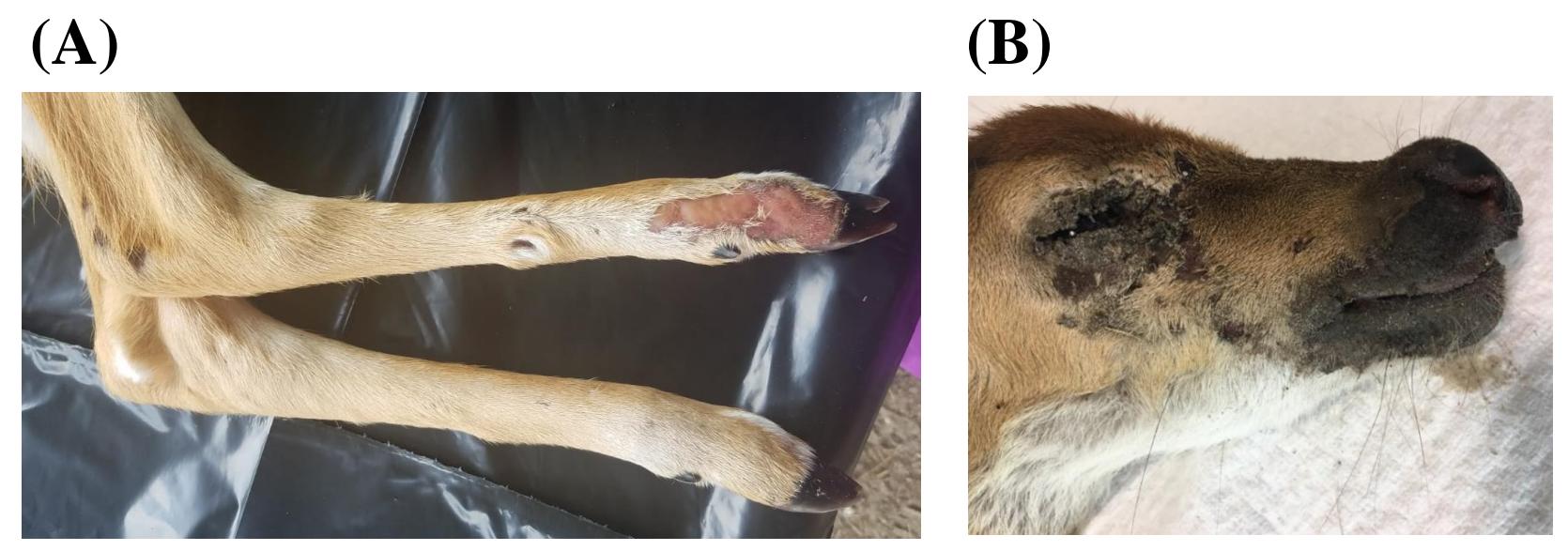
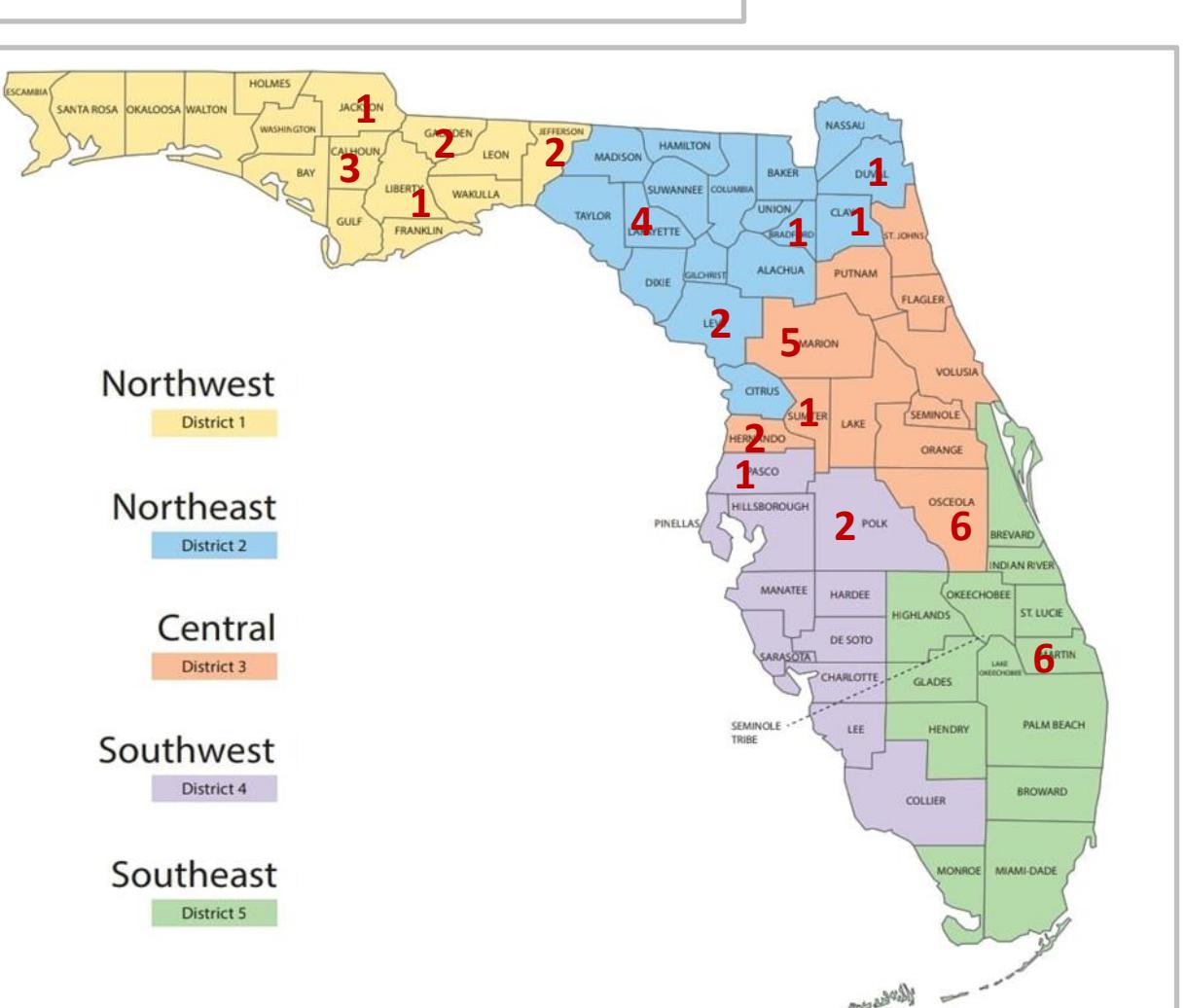


Figure 7. Deerpox infected white-tailed deer with the symptom of skin lesions on (A) hooves and (B) face.

Table 3. Number of positive animals to season, age, sex, area, EHDV/BTV co-infection, and bacterial pathogen infection.

Factors	No. of positive	P value
Season	0	<0.0001***
Spring	0	
Summer	36	
Fall	13	
Winter	0	
Age		<0.0001***
1-3 months	37	
4-12 months	8	
13+ months	3	
Sex		0.1489
Male	29	
Female	19	
Area		0.0254*
Northwest	9	
Northeast	15	
Central	15	
Southwest	3	
Southeast	7	
EHDV/BTV infection		0.5371
Positive	19	
Negative	23	
Bacterial pathogen infection		0.0002***
Positive	29	
Negative	7	

Table 6. Case numbers of MDPV in farmed white-tailed deer in Florida counties.



Conclusion

- MDPV can be detected not only in lesion tissues and swabs from white-tailed deer but also in organ tissue samples such as the liver and spleen, indicating systemic circulation of the virus throughout the animal's body.
- Fawns under three months old are prone to MDPV-relative mortality, likely due to their weaker immune systems and lack of MDPV antibodies.
- MDPV can be found in many areas in Florida, and animal transportation might be one of the transmission routes.
- The increased incidence of MDPV cases in the summer may be attributed to the presence of potential insect vectors.



For more information about my research projects, please scan the QR code.