

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



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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 deer pox virus (MDPV), the two emerging viral pathogens in farmed white-tailed deer in Florida.

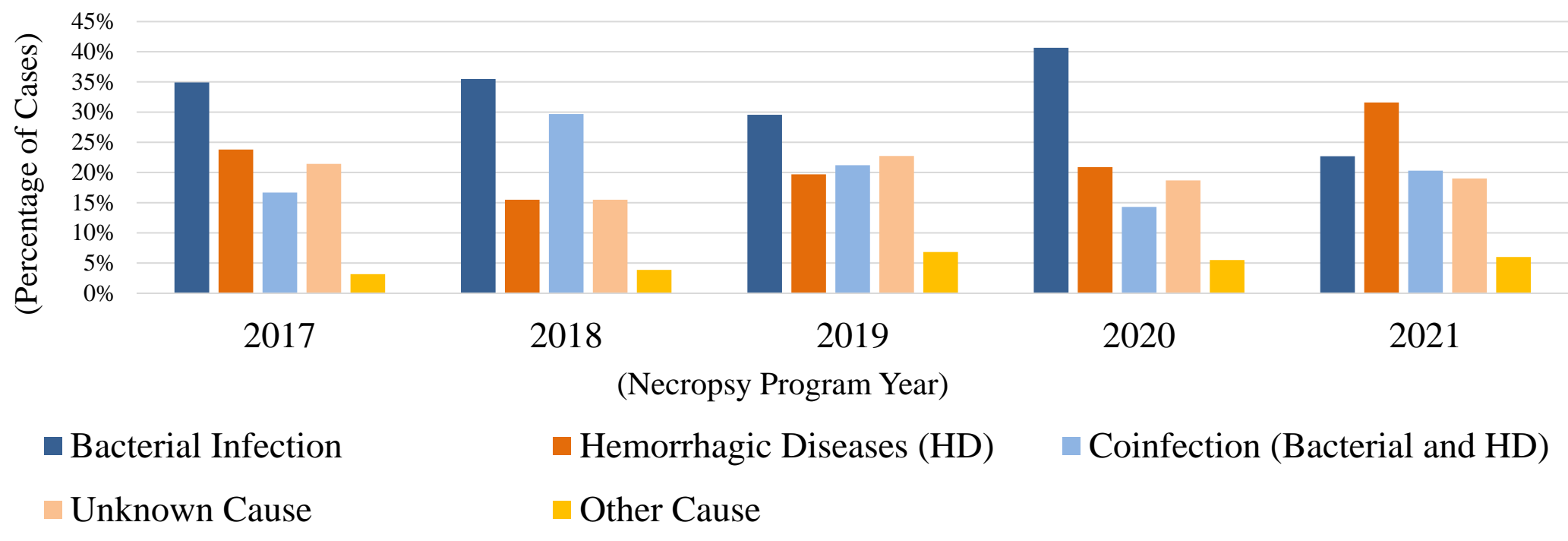


Figure 1. Cause of mortality in farmed white-tailed deer in Florida from 2017 to 2021.

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, and nostrils, hemothorax, hemopericardium, 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, and nostrils, hemothorax, hemopericardium, hemoperitoneum, hemorrhage in lungs 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, hemothorax, 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

Table 2. Differential diagnosis results.

Sample ID	Toxicology	Bacterial culture	EHDV/BTV qPCR	WNV/EEE qPCR	Viral culture
OV853-WB	-	-	Negative	-	-
OV853-KT	-	<i>Escherichia coli</i>	-	-	-
OV853-HT	-	Negative	-	-	-
OV853-ST_cell culture OHH1.k	-	-	-	-	BVDV2a
OV854-WB	-	-	Negative	-	-
OV854-KT	-	<i>Escherichia coli</i>	-	-	-
OV854-HT	-	Negative	-	-	-
OV854-ST_cell culture OHH1.k	-	-	-	-	BVDV2a
OV856-WB	-	-	EHDV	Negative	-
OV856-LT	-	<i>Streptococcus bovis</i>	-	-	-
OV856-KT	-	<i>Streptococcus bovis</i>	-	-	-
OV856-ST_cell culture OHH1.k	-	-	-	-	BVDV2a
OV858-WB	-	-	Negative	-	-
OV858-LT	-	<i>Escherichia coli</i>	-	-	-
OV858-KT	-	<i>Plesiomonas shigelloides</i>	-	-	-
OV858-ST_cell culture OHH1.k	-	-	-	-	BVDV2a

^aWB: whole blood, KT: kidney tissue, HT: liver tissue, ST: spleen tissue, OHH1.k: Columbia black tail deer kidney cell, EHDV: Epizootic hemorrhagic disease virus, BTV: Bluetongue virus, WNV: West Nile virus, EEE: Eastern equine encephalitis virus, BVDV: Bovine Viral Diarrhea Virus

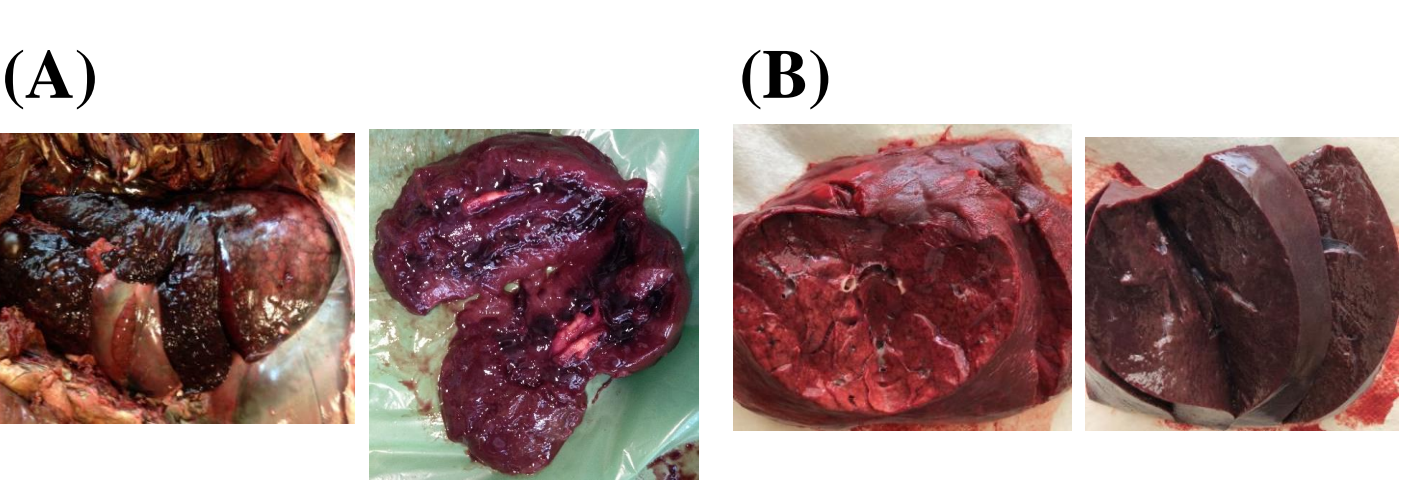


Figure 1. Hemorrhaging organs from the BVDV-infected white-tailed deer. (A) OV856 lungs and kidney, and (B) OV858 lungs and liver.

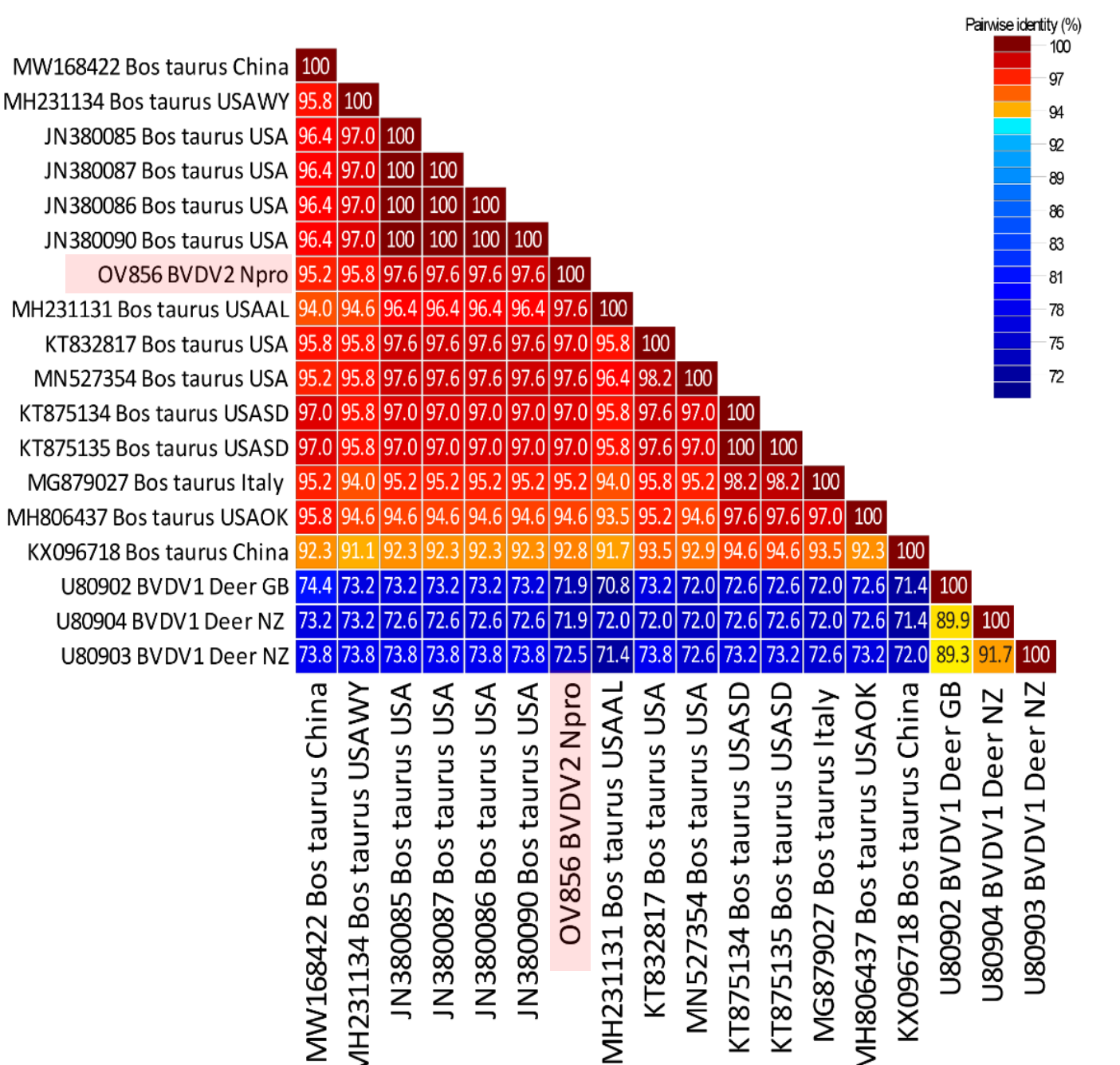


Figure 2. Amino acid identity comparison of BVDV2a Npro (nonstructural proteins) sequence in this study and BVDV2 sequences from NCBI database.

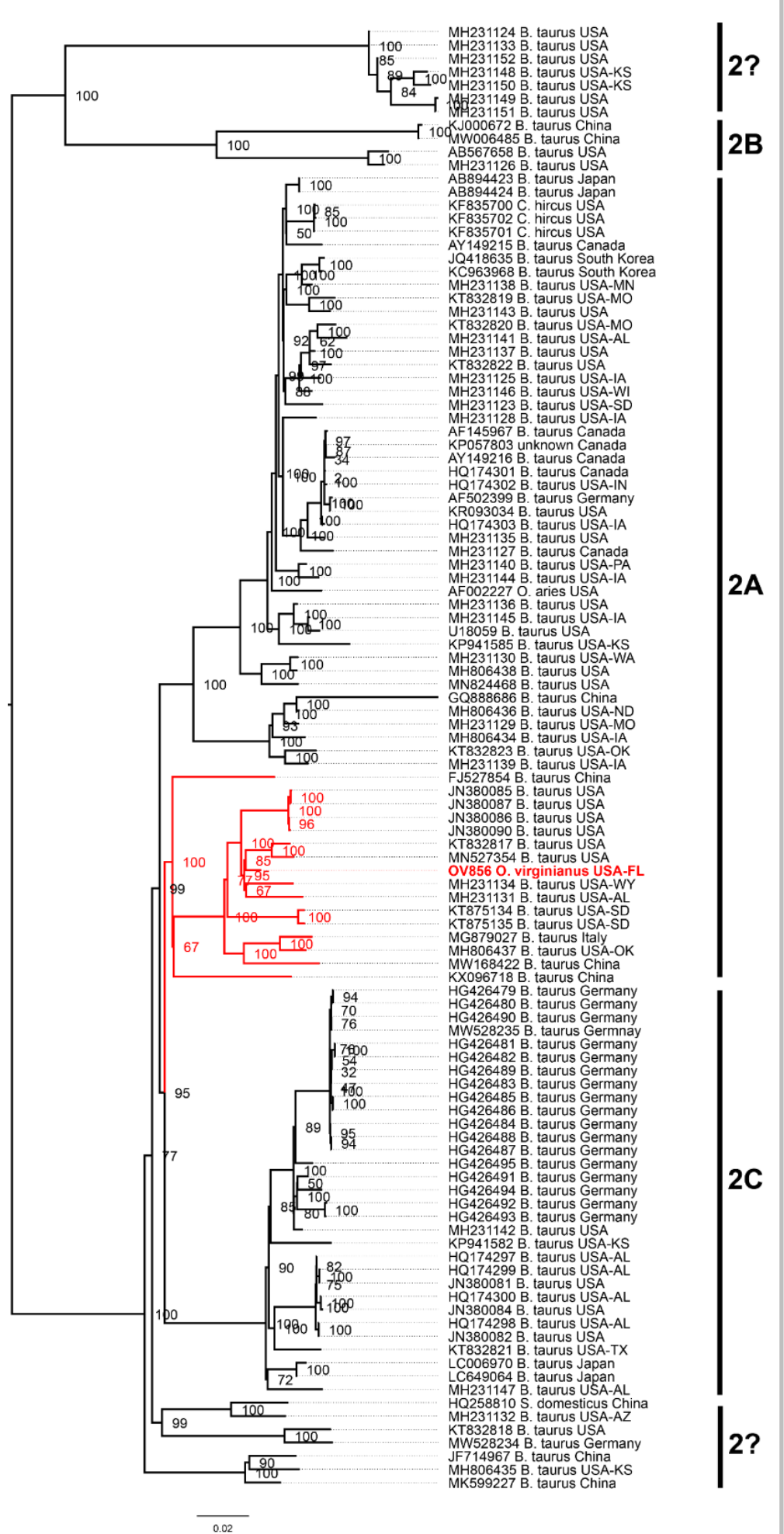


Figure 3. Phylogenetic tree of BVDV2 whole genome sequences from Florida farmed white-tailed deer compared to BVDV2 sequences from the NCBI database, constructed using the maximum likelihood method with 1000 non-parametric bootstrap replications.

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

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Mule Deer pox 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

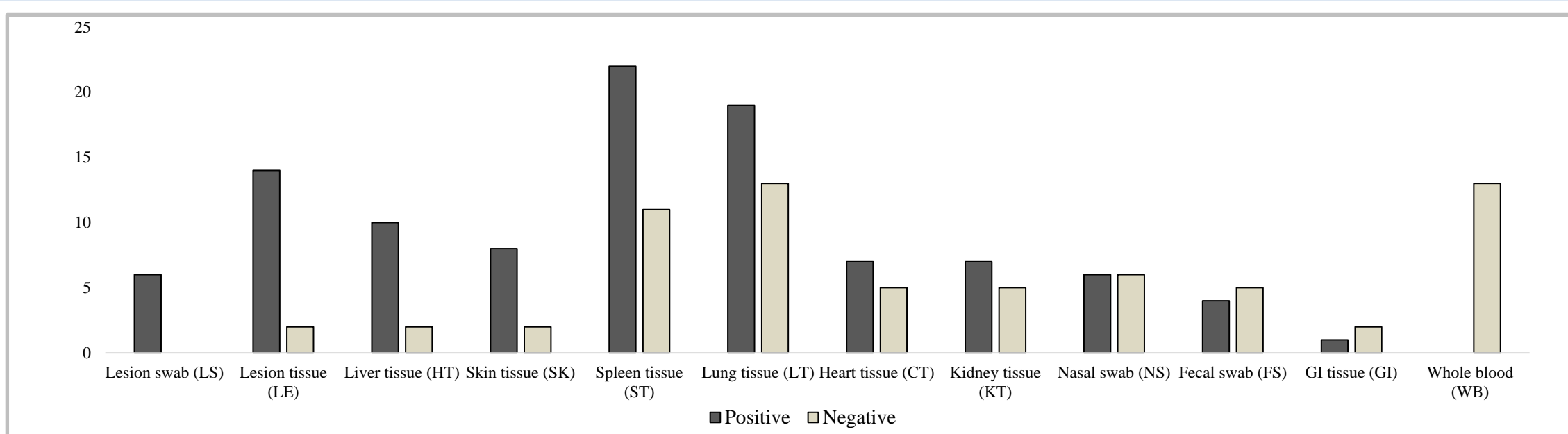


Figure 4. MDPV testing results of 49 MDPV-positive animals by sample type.

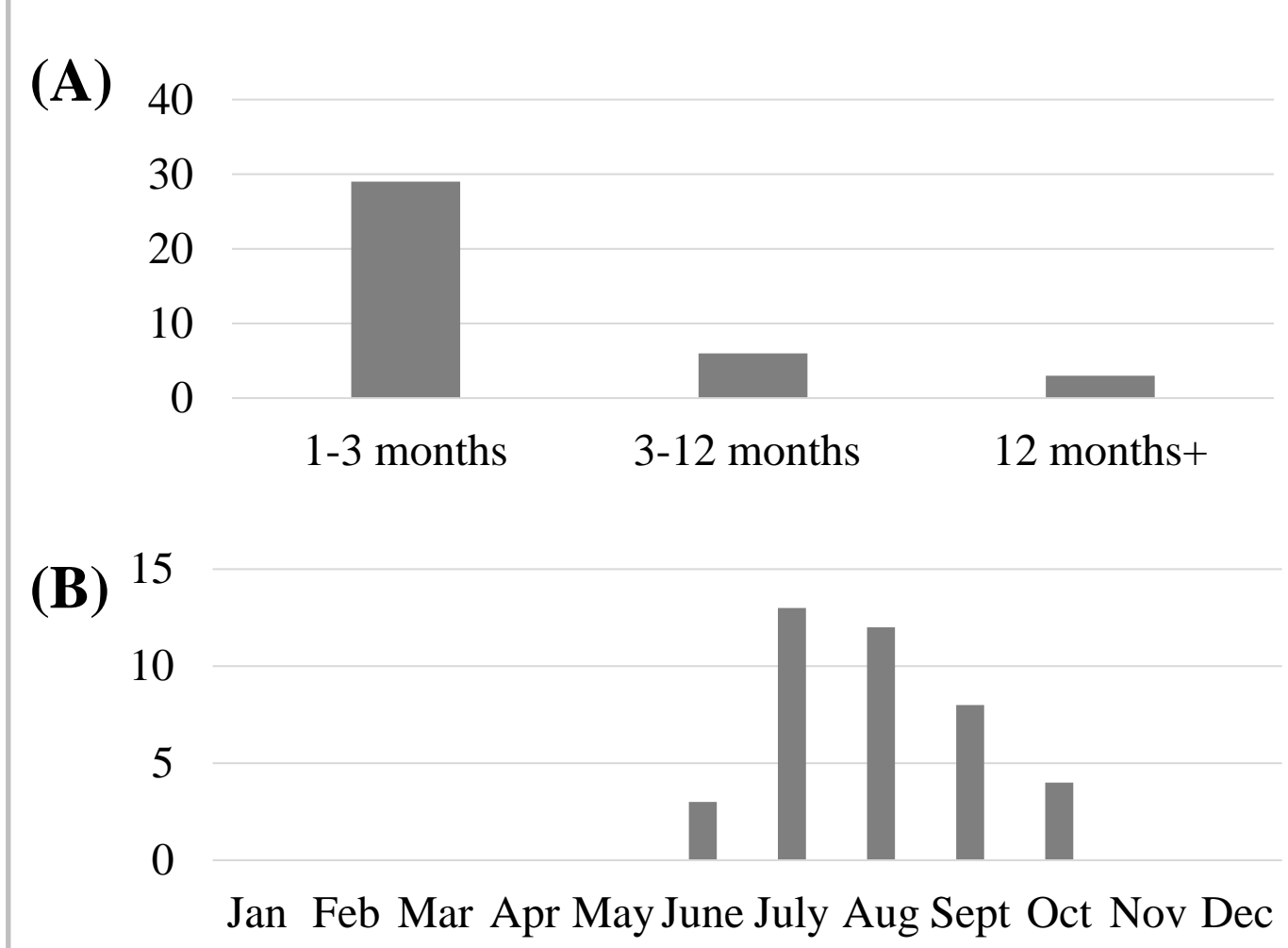


Figure 5. MDPV case number by (A) age and (B) month.

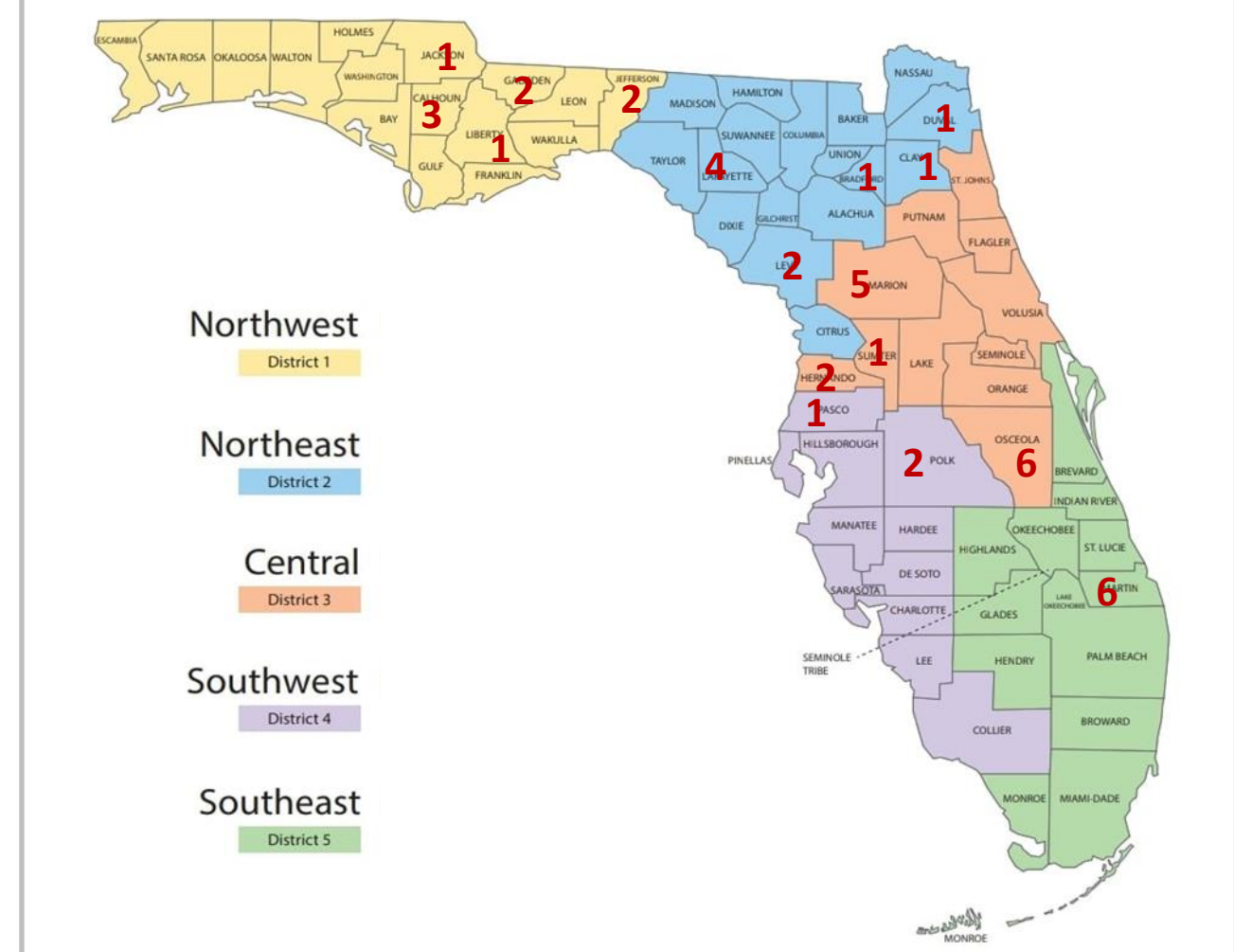


Figure 6. Case numbers of MDPV in farmed white-tailed deer in Florida counties.

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-related 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.

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