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Short Communication

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# Sudden Mortality in Captive White-Tailed Deer With Atypical Infestation of Winter Tick

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## Abstract

In October 2020, three captive male white-tailed deer, *Odocoileus virginianus* [Zimmermann] (artiodactyla: Cervidae), were found dead in central Pennsylvania and a fourth was euthanized due to extreme lethargy. The deer presented with high burdens of *Dermacentor albipictus* (Packard) (Ixoda: Ixodidae) (winter tick). There were no other clinical symptoms and deer were in otherwise good physical condition with no observed alopecia. Winter tick epizootics have been associated with mortalities of moose, *Alces alces* [Linnaeus] (artiodactyla: cervidae), and more recently elk*, Cervus canadensis* [Erxleben] (artiodactyla: cervidae), in Pennsylvania, but have not been reported in white-tailed deer. Mild winters are favorable to winter ticks and deer producers and managers should be aware of possible infestations as a result.

**Key words:** captive deer, deer farming, epizootic, tick control, ticks

Winter ticks, *Dermacentor albipictus* (Packard) (Ixoda: Ixodidae), are one-host ticks with a broad distribution in North America. Elk (*Cervus canadensis* [Erxleben], Artiodactyla:Cervidae), white-tailed deer (*Odocoileus virginianus* [Zimmermann], Artiodactyla: Cervidae), and moose (*Alces alces* [Linnaeus], Artiodactyla: Cervidae) are common hosts for this species. Epizootic infestations of *D. albipictus* can cause severe anemia, extensive epithelial damage, allergic reactions, and loss of winter coats from overgrooming (McLaughlin and Addison 1986, Glines and Samuel 1989). Infestations of *D. albipictus* have been associated with mortality in moose (Jones et al. 2017) and more recently in elk (Calvente et al. 2020), and winter ticks can also transmit pathogens including *Anaplasma marginale* and *Babesia duncani* to cervids (Ewing et al. 1997, Swei et al. 2019).

Farmed white-tailed deer may be exposed to ectoparasites like *D. albipictus* that are frequently found on wild deer (Schulze et al. 1984, Amerasinghe et al. 1992, Kollars et al. 2000, Baer-Lehman et al. 2012). White-tailed deer production is a fast-growing niche industry and Pennsylvania ranks second in United States in the number of commercial deer and elk farms, increasing by 82% since 1990 and representing over $103 million in economic value (Shepstone Managment Company 2007). Negative consequences of tick infestations may cause significant economic burden to deer producers.

While ticks are frequently found on white-tailed deer, this cervid species has been considered a low-quality host for *D. albipictus* (Welch et al. 1991) and severe infestations have not been recorded. Presented here is a case study of the sudden mortality observed in captive white-tailed deer in Pennsylvania with heavy infestations of *D. albipictus* with considerations for future management.

## Chronological Case Description

In November 2020, assistance from Penn State Extension was requested to investigate the sudden death of three white-tailed deer with unusually heavy tick burdens. On 19 September 2020, five apparently healthy, captive 2-yr-old adult male white-tailed deer were transported from a captive herd established in 1999 at a breeding facility in southeastern Pennsylvania to a 164-acre hunting preserve in central Pennsylvania. Four deer were placed in a 40-acre enclosure and one was placed in a nonadjacent 2-acre enclosure. On 16 October 2020, three of the four deer in the 40-acre enclosure were found dead. Upon inspection by the owner, the deer were noted to have heavy tick infestations that were estimated by the owner as being in the '10s of thousands' but were not otherwise quantified. The owner collected several skin patches containing ticks before disposing of the carcasses by burning. The same day the owner noticed the deer in the 2-acre enclosure began acting weak and lethargic. The owner elected to harvest this animal and upon inspection, the owner again noted a heavy tick infestation. Around the same time the last of the four deer in the 40-acre enclosure demonstrated similar signs of lethargy and weakness according to the owner. This deer was moved to a small pen and treated with ivermectin pour-on, ivermectin injection, permethrin, and tulathromycin injectable. The owner observed this deer was infested with several 10s of thousands of ticks. Approximately 4 d after treatment, the owner noted resolution of signs and released the deer back into the 40-acre enclosure. On 30 November 2020, this deer was observed by the authors to be active and in good body condition with no evidence of tick infestation observable from a distance.

Both enclosures that housed these deer had no fence line contact with other captive deer. Enclosures were dominated by northern hardwoods with a notable lack of mid- and understory vegetation and had been without deer since January 2020. The entire property had 8- to 10-ft fencing around the perimeter that separated paddocks and prohibited entry of wild deer, although other wildlife like opossums (*Didelphis virginiana* Dill, Didelphimorphia: Didelphidae), raccoons (*Procyon lotor* [Linneus], Carnivora: Procyonidae), red foxes (*Vulpes vulpes* [Linnaeus], Carnivora: Canidae), and American black bears (*Urus amercanus* Pallas, Carnivora: Ursidae) have been observed on the property. The hunting preserve followed all state requirements for health screening and chronic wasting disease surveillance.

Based on photographs and owner description, the four deceased deer all presented with heavy tick infestations covering primarily the shoulders, chest, neck, and head (Fig. 1). At the time of transport, approximately 4 wk prior to the first deaths, all five deer had been tranquilized and were observed by the owner to be in good body condition with no evidence of alopecia or tick infestations. The owner, having prior experience with cases of epizootic hemorrhagic disease (EHD), did not note any signs consistent with EHD or other diseases he had knowledge of prior to death or harvest. Outside of deer at the breeding facility, there was no known contact between affected deer and wild deer, although the 40-acre enclosure was adjacent to Pennsylvania State Game Lands and forested private property, allowing the possibility of fence line contact with wild deer. The owner reports no evidence of tick infestations on other deer at the breeding facility or in other enclosures on the preserve. On 30 November 2020, deer at the preserve were observed by the authors to be in good body condition with no evidence of tick infestation observable from a distance.

A subset of ~100 ticks on the skin patches collected from the deceased deer were sent to the Veterinary Entomology Laboratory (Pennsylvania State University, University Park, PA) for identification. Tick samples included males, engorged and unengorged females, and larvae that were morphologically identified to *D. albipictus* (Keirans and Litwak 1989; Fig. 2). Samples ($n$ = 22 ticks) were sent in ethanol to the USDA-ARS Knipling-Bushland U.S. Nymphs were not found in the sample but could have been present on the deer. Livestock Insects Research Laboratory (Kerrville, TX) for molecular confirmation. Ticks were rinsed in 1% sodium hypochlorite and three changes of ultrapure water prior to DNA isolation using the DNEasy Blood and Tissue Kit (Qiagen, Germantown, MD). A region of the tick 16S rRNA (rDNA) gene was amplified using primers 16S +1 and 16S −1 (Black and Piesman 1994). The rDNA sequence from three female and four male ticks confirmed their identity as *D. albipictus* (99.8% identity to GenBank AY676458). No other ticks were identified from the sampled areas. These 22 tick samples were also screened for presence of rickettsial bacteria or piroplasm DNA, as in Olafson et al. (2020). All were negative for *Rickettsia* spp. and *Anaplasma/Ehrlichia* spp. and for *Theileria/Babesia* spp. DNA.

## Discussion and Conclusions

*Dermacentor albipictus* are frequently found on wild white-tailed deer in Pennsylvania (Baer-Lehman et al. 2012) and other states (Schulze et al. 1984, Amerasinghe et al. 1992, Kollars et al. 2000), but infestations to the extent observed in the current case on wild or captive white-tailed deer have not been reported to our knowledge.

The presentation of tick infestation on captive white-tailed deer was not consistent with mortalities of moose (Jones et al. 2017) or elk (Calvente et al. 2020) where severe alopecia has been observed. Modeling of expected blood loss from winter tick infestations in moose calves (150 kg) suggest that a moderate tick burden of 30,000 ticks could result in blood loss between 7,600 and 13,000 ml over 8 wk (Musante et al. 2007). Assuming a 75-kg deer has a blood volume of 6,000 ml (8% bodyweight), a heavy burden of winter

**Fig. 1.** Infestation of winter tick, *Dermacentor albipictus*, on a deceased captive white-tailed deer in central Pennsylvania.

**Fig. 2.** Male *Dermacentor albipictus* (left) and male and larval *D. albipictus* (right) on deceased captive white-tailed deer in central Pennsylvania.

ticks could consume as much as twice the animal's blood volume in 8 wk. This makes a fatal anemia due to heavy winter tick burdens a plausible explanation for the sudden deaths observed here. Additionally, previous studies have reported white-tailed deer mortalities caused from tissue damage from lone star tick infestations (Bolte et al. 1970). The similar presentation among all affected deer, the owner description of weakness and lethargy which are signs consistent with anemia, and the resolution of clinical signs in the deer treated with acaricides suggest the heavy tick burdens were likely a contributing factor in the death of these deer. However, direct mortality associated with tick infestation cannot be confirmed because the prompt disposal of the carcasses prevented further diagnostic testing to rule out other causes of sudden death such as infectious disease, toxicity, or other unidentified condition.

Captive deer may experience a decrease in biological fitness leading to an increased susceptibility to parasitism over their wild counterparts. While differences in genetic diversity have not been observed after short-term domestication of white-tailed deer (Hernández-Mendoza et al. 2014), it is possible that longer periods of domestication may lead to reduced biological fitness from a reduction in genetic diversity. Deer may also experience losses in programmed grooming behaviors like grooming due to captive production. White-tailed deer grooming is suggested to be primarily stimulus-based, which may account for higher observed tick burden on bucks in the fall during the rut (Heine et al. 2017); however, programmed grooming also occurs. Programmed grooming in moose and elk can remove ticks before they attach, which may reduce tick burdens and risk of disease (Welch et al. 1991, Mooring and Samuel 1998a, b). Behaviors can be distinctly modified after captive rearing (McPhee 2004). It is possible that these deer, which came from a captive herd established over 20 yr prior, were incapable of removing high numbers of ticks due to a decrease in grooming behavior.

Interestingly, adult *D. albipictus* was the dominant life stage from the subsample. *Dermacentor albipictus* is a one-host tick that parasitizes a host as a larva and remains on that host throughout each life stage. However, ticks were not observed on deer during handling prior to release into the site paddocks. Previous studies have found larval ticks common in the early fall and nymphs becoming prevalent from November to January on moose host (Addison and Mclaughlin 1988). Adults are most frequently found from January to April. Therefore, presentation of adult *D. albipictus* in October was atypical. The source of the ticks found on the affected deer is unknown, as adult ticks are not known to host seek. It is possible that ticks were present in the enclosures prior to release, perhaps originating from movement off a mortality of a different species, but ticks were found on deer in two separate paddocks, so this seems unlikely.

The northern range expansion of *D. albipictus* has been suggested to be associated with climate change (Chenery et al. 2020). In addition, winter tick abundance can be influenced by mild seasons and low snowfall (Garner and Wilton 1993). The anomalies in tick burdens and life stage may be related to mild winters experienced in the region in 2019 and 2020. The current and predicted frequency of shorter winters due to climate change (Wake et al. 2014) will be favorable to *D. albipictus* and are a concern for cervid management throughout the range of this tick.

Ectoparasites are a concern for wild and captive white-tailed deer. While these white-tailed deer mortalities were isolated cases, the heavy *D. albipictus* infestation and the recent elk mortality associated with *D. albipictus* in Pennsylvania underscore the need for deer producers and preserve managers to be vigilant in scouting for ectoparasites during the production cycle and when considering translocation. Increased surveillance for ticks may also intercept other tick species that can have negative health consequences to cervids, such as the invasive Asian longhorned tick (*Haemaphysalis longicornis* Neumann [Ixodida: Ixodidae]). Assessments of tick burdens on harvested wild deer by game managers may help to better understand fluctuations of *D. albipictus* and other species of concern.

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## References Cited

**Addison, E. M., and R. F. McLaughlin. 1988**. Growth and development of winter tick, *Dermacentor albipictus*, on moose, *Alces alces*. J. Parasitol. 74: 670–678.

**Amerasinghe, F. P., N. L. Breisch, A. F. Azad, W. F. Gimpel, M. Greco, K. Neidhardt, B. Pagac, J. Piesman, J. Sandt, and T. W. Scott. 1992**. Distribution, density, and Lyme disease spirochete infection in *Ixodes dammini* (Acari: Ixodidae) on white-tailed deer in Maryland. J. Med. Entomol. 29: 54–61.

**Baer-Lehman, M. L., T. Light, N. W. Fuller, K. D. Barry-Landis, C. M. Kindlin, and R. L. Stewart, Jr. 2012**. Evidence for competition between *Ixodes scapularis* and *Dermacentor albipictus* feeding concurrently on white-tailed deer. Exp. Appl. Acarol. 58: 301–314.

**Black, W. C. IV, and J. Piesman. 1994**. Phylogeny of hard- and soft-tick taxa (Acari: Ixodida) based on mitochondrial 16S rDNA sequences. Proc. Natl. Acad. Sci. U. S. A. 91: 10034–10038.

**Bolte, J. R., J. A. Hair, and J. Fletcher. 1970**. White-tailed deer mortality following tissue destruction induced by lone star ticks. J. Wildl. Manage. 34: 546–552.

**Calvente, E., N. Chinnici, J. Brown, J. E. Banfield, J. W. Brooks, and M. J. Yabsley. 2020**. Winter tick (*Dermacentor albipictus*)–associated dermatitis in a wild elk (*Cervus canadensis*) in Pennsylvania, USA. J. Wildl. Dis. 56: 247–250.

**Chenery, E. S., N. J. Harms, N. E. Mandrak, and P. K. Molnár. 2020**. First records of *Dermacentor albipictus* larvae collected by flagging in Yukon, Canada. Parasites Vectors. 13: 1–7.

**Ewing, S. A., R. J. Panciera, K. M. Kocan, N. L. Ge, R. D. Welsh, R. W. Olson, R. W. Barker, and L. E. Rice. 1997**. A winter outbreak of anaplasmosis in a nonendemic area of Oklahoma: a possible role for *Dermacentor albipictus*. J. Vet. Diagn. Invest. 9: 206–208.

**Garner, D., and M. Wilton. 1993**. The potential role of winter tick (*Dermacentor albipictus*) in the dynamics of a south central Ontario moose population. Alces. 29: 169–173.

**Glines, M. V., and W. M. Samuel. 1989**. Effect of *Dermacentor albipictus* (Acari: Ixodidae) on blood composition, weight gain and hair coat of moose, *Alces alces*. Exp. Appl. Acarol. 6: 197–213.

**Heine, K. B., P. J. DeVries, and C. M. Penz. 2017**. Parasitism and grooming behavior of a natural white-tailed deer population in Alabama. Ethol. Ecol. Evol. 29: 292–303.

**Hernández-Mendoza, P. M., G. M. Parra-Bracamonte, X. F. De La Rosa-Reyna, O. Chassin-Noria, and A. M. Sifuentes-Rincón. 2014**. Genetic shifts in the transition from wild to farmed white-tailed deer (*Odocoileus virginianus*) population. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 10: 3–8.

**Jones, H., P. J. Pekins, L. E. Kantar, and D. Ellingwood. 2017**. Fecundity and summer calf survival of moose during 3 successive years of winter tick epizootics. Alces. 53: 85–98.

**Keirans, J. E., and T. R. Litwak. 1989**. Pictorial key to the adults of hard ticks, family Ixodidae (Ixodida: Ixodoidea), east of the Mississippi River. J. Med. Entomol. 26: 435–448.

**Kollars, T. M., J. H. Oliver, E. J. Masters, P. G. Kollars, and L. A. Durden. 2000**. Host utilization and seasonal occurrence of *Dermacentor* species (Acari: Ixodidae) in Missouri, USA. Exp. Appl. Acarol. 24: 631–643.

**McLaughlin, R. F., and E. M. Addison. 1986**. Tick (*Dermacentor albipictus*)-induced hair-loss in captive moose (*Alces alces*). J. Wildl. Dis. 22: 502–510.

**McPhee, M. E. 2004**. Generations in captivity increases behavioral variance: considerations for captive breeding and reintroduction programs. Biol. Conserv. 115: 71–77.

**Mooring, M. S., and W. M. Samuel. 1998a**. The biological basis of grooming in moose: programmed versus stimulus-driven grooming. Anim. Behav. 56: 1561–1570.

**Mooring, M. S., and W. M. Samuel. 1998b**. Tick-removal grooming by elk (*Cervus elaphus*): testing the principles of the programmed-grooming hypothesis. Can. J. Zool. 76: 740–750.

**Musante, A., P. Pekins, and D. Scarpitti. 2007**. Metabolic impacts of winter tick infestations on calf moose. Alces. 43: 101–110.

**Olafson, P. U., B. G. Buckmeier, M. A. May, and D. B. Thomas. 2020**. Molecular screening for rickettsial bacteria and piroplasms in ixodid ticks surveyed from white-tailed deer (*Odocoileus virginianus*) and nilgai antelope (Boselaphus tragocamelus) in southern Texas. Int. J. Parasitol. Parasites Wildl. 13: 252–260.

**Schulze, T. L., M. F. Lakat, G. S. Bowen, W. E. Parkin, and J. K. Shisler. 1984**. *Ixodes dammini* (Acari: Ixodidae) and other ixodid ticks collected from white-tailed deer in New Jersey, USA. I. Geographical distribution and its relation to selected environmental and physical factors. J. Med. Entomol. 21: 741–749.

**Shepstone Management Company. 2007**. The Economic Impact of Pennsylvania's Deer Farms. Honesdale, PA. http://www.shepstone.net/PaDeer.pdf

**Swei, A., K. E. O'Connor, L. I. Couper, J. Thekkiniath, P. A. Conrad, K. A. Padgett, J. Burns, M. H. Yoshimizu, B. Gonzales, B. Munk, et al. 2019**. Evidence for transmission of the zoonotic apicomplexan parasite *Babesia duncani* by the tick *Dermacentor albipictus*. Int. J. Parasitol. 49: 95–103.

**Wake, C., E. Burakowski, P. Wilkinson, K. Hayhoe, A. Stoner, C. Keeley, and J. LaBranche. 2014**. Climate change in southern New Hampshire: past, present, and future. Sustainability Institute. 77. https://scholars.unh.edu/cgi/viewcontent.cgi?article=1002&context=sustainability

**Welch, D. A., W. M. Samuel, and C. J. Wilke. 1991**. Suitability of moose, elk, mule deer, and white-tailed deer as hosts for winter ticks (*Dermacentor albipictus*). Can. J. Zool. 69: 2300–2305.