

Some new range records for Pacific Deer Keds and Western Deer Keds (Hippoboscidae: *Neolipoptena ferrisi* and *Lipoptena depressa*)

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Abstract. Deer keds (Diptera: Hippoboscidae) are biting flies that prefer to feed on deer and other cervids. Two species occur in western North America: *Neolipoptena ferrisi* Bequaert (Pacific Deer Ked) and *Lipoptena depressa* (Say) (Western American Deer Ked). While they were broadly known to occur in the region, recent work has begun to clarify where they occur. However, large gaps still remain where they are suspected to occur but are undocumented. Herein, we document ten new range records, including the first county-level records for North Dakota and Utah.

Deer keds (Diptera: Hippoboscidae: *Lipoptena* and *Neolipoptena*) are ectoparasitic biting flies that preferentially feed on cervids (Mammalia: Cervidae) such as *Odocoileus hemionus* Rafinesque (Mule Deer), *Odocoileus virginianus* Zimmermann (White-tailed Deer), *Cervus canadensis* Erxleben (Elk), and *Alces alces gigas* (Moose) but sometimes bite humans and other animals (Skvarla and Machtinger 2019). Four species occur in North America: *Lipoptena cervi* (Linnaeus) (European Deer Ked), which were introduced from Europe in the late 1800s or early 1900s and are found in the Northeast; *Lipoptena mazamae* Rondani (Neotropical Deer Ked), which are found in the Southeast from Virginia and Florida, west to Texas, and south into Central and South America; *Lipoptena depressa* (Say) (Western American Deer Ked); and *Neolipoptena ferrisi* Bequaert (Pacific Deer Ked) (Fig. 1), which occur throughout western North America, east to North Dakota and Colorado (Skvarla and Machtinger 2019, Skvarla et al. 2020).

Deer keds practice adenotrophic viviparity, where the larvae develop internally in the mother fly. They are larviposited when fully mature and immediately pupate, after which they roll out of the host's pelage and into the soil or leaf litter (Haarløv 1964). Pupae then diapause until they are ready to emerge, which can be months to nearly a year later (Cowan 1943, Haarløv 1964). When adults emerge, they seek hosts quickly because flying keds generally die within 24–48 hours if they do not find a host (M.J. Skvarla, Penn State University, PA, unpubl. data). After landing on a host, deer keds shed their wings and only move to another host during times of close contact (e.g., from deer to deer during mating, feeding by a fawn, bedding in close proximity, and from deer to humans during post-harvest hunting activities). Because of this lifecycle, deer keds have historically been thought to not to transmit pathogens. However, in the last decade, half a dozen typically tick-borne pathogens have been sequenced from various deer ked species, including *Anaplasma phagocytophilum* (Foggie 1949), the causative agent of human granulocytic anaplasmosis, and *Bartonella*

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schoenbuchensis corrig. Dehio et al. 2001, the putative causative agent of ked bite dermatitis (North American studies: Matsumoto et al. 2008, Buss et al. 2016, Foley et al. 2016, Olafson et al. 2022; summary of world studies in Skvarla and Machtinger 2019). While it is still unknown if deer keds can vector these pathogens, their presence in keds has sparked renewed interest in elucidating more about deer ked biology and natural history.

While the general ranges of the four North American species were broadly known previously, the specific locations of occurrences were unclear until Skvarla and Machtinger (2019) mapped every deer ked occurrence in North America based on museum specimens and community science websites, such as BugGuide (Bugguide.net) and iNaturalist (inaturalist.org). Adult deer keds are infrequently encountered off host and so can be uncommon in museum collections if specific efforts are not made to collect them. However, they are often readily found if deer are searched directly, which can be accomplished by checking road killed deer, searching hunter-harvested deer at deer check stations or deer processors or deer killed during state-sponsored culls, or during routine screening by state wildlife veterinarians, game wardens, and other officials who work with deer (Buss et al. 2016, Poh et al. 2020). And while citizen science websites can provide a wealth of presence data points that might otherwise be unavailable, the data can be biased. For example, more records generally come from developed, urban areas compared to rural areas where deer keds are more likely to occur (Skvarla and Fisher 2023).

While previous efforts have provided a foundation for mapping North American deer ked ranges, it was clear there were areas that were not well surveyed and likely gaps in the expected ranges. This was confirmed after extensive efforts to screen deer in Tennessee found

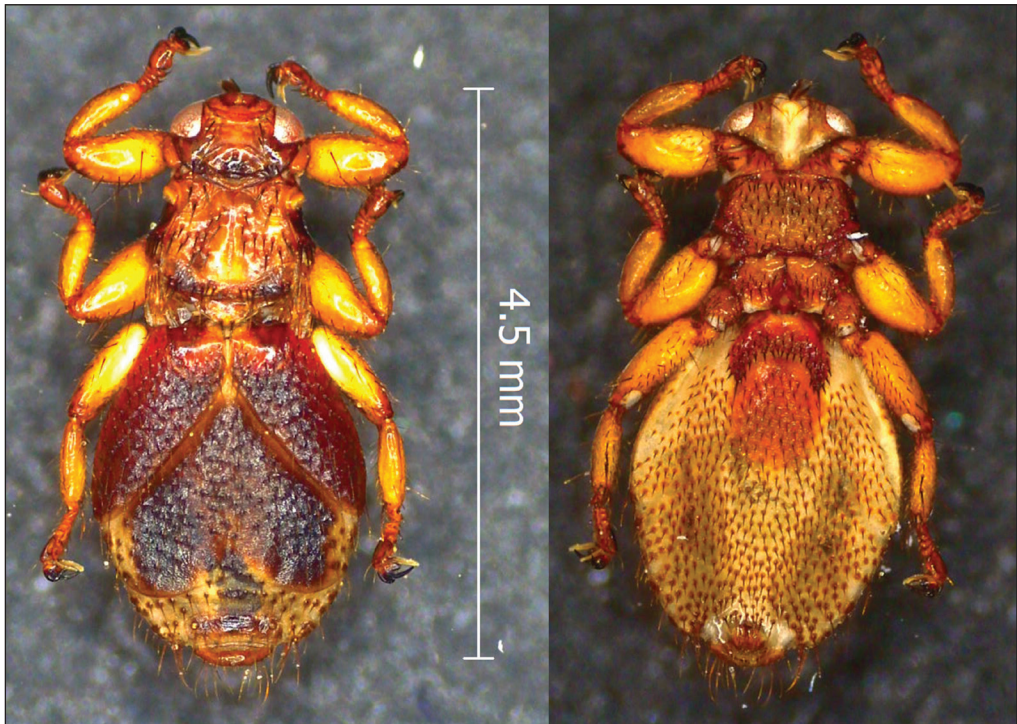


Figure 1. Pacific Deer Ked (*Neolipoptena ferrisi*) collected in Morton County, North Dakota. Photographs by Stephanie Tucker, used with permission.

deer keds in nearly every county that was investigated when only a single county record had been previously reported (Skvarla et al. 2020). Additional new records in eastern North America have included the first reports of European Deer Keds from Canada and Neotropical Deer Keds from Virginia (Hightower et al. 2019, Skvarla et al. 2020). Less work has been done in western North America, including areas that appeared to be under surveyed such as Utah and North Dakota, which only had state-level records without definitive localities.

Herein we report the first county-level records for Pacific Deer Keds from North Dakota and Utah and the first county-level records of Western Deer Keds from Utah (Fig. 2).

The Pacific Deer Keds from North Dakota were collected from Mule Deer and White-tailed Deer when hunters brought their deer to check stations or to the attention of a game warden. They have been accessioned in the collection of the North Dakota Game and Fish Wildlife Health Lab. Maa (1969) stated that Pacific Deer Keds range “eastward to 103° 30’ W in North

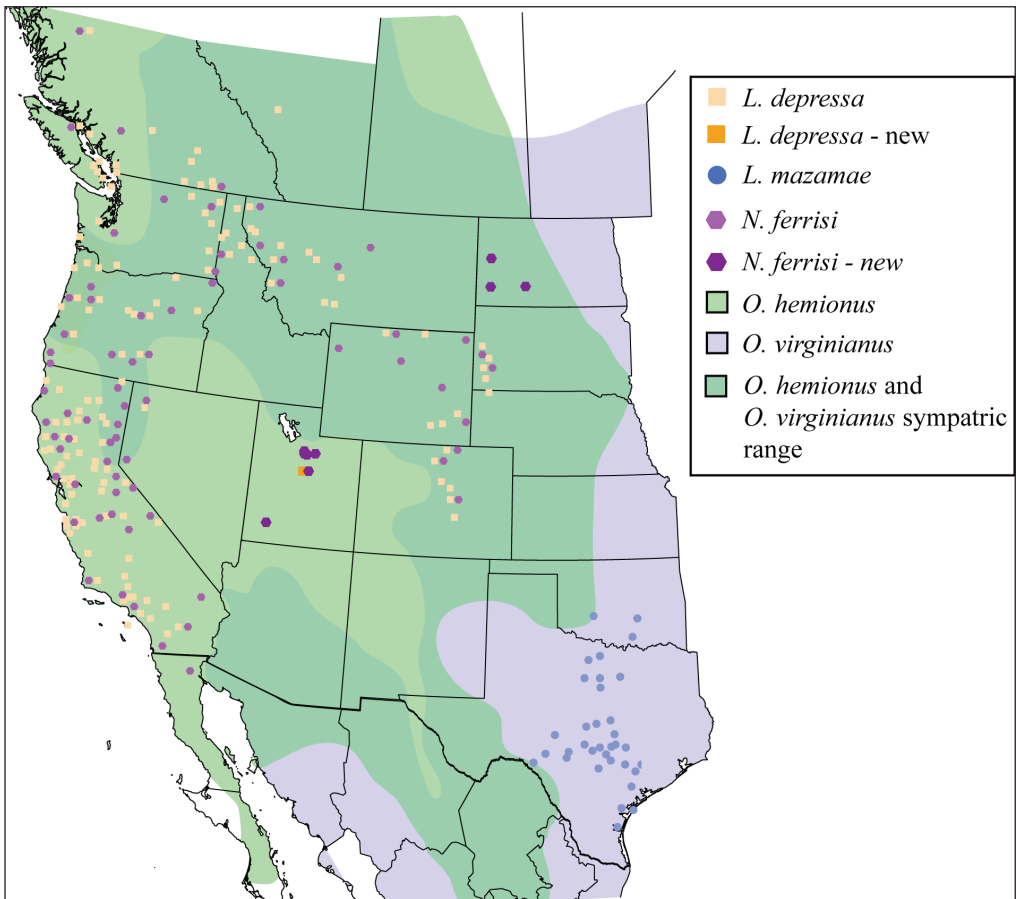


Figure 2. Range map of deer keds in western North America, modified from Skvarla and Machtiger (2019). Symbols for new range records presented herein are larger and darker than previously published records. One collection of Western Deer Keds and Pacific Deer Keds in Utah was made from the same Mule Deer; the symbol for the Western Deer Ked record has been shifted slightly westward so it is not obscured by the Pacific Deer Ked symbol. Mule Deer and White-tailed Deer ranges are after Berry et al. (2019).

Dakota,” which is the same longitude as the western-most specimens reported here. However, the author did not provide a latitude and Skvarla and Machtinger (2019) could not find the specimens he based his statement on, so the statement was considered a state-level record. The second North Dakota specimen reported here represents a new eastern-most record for this species.

The Pacific Deer Keds from Utah collected by EJK and CCC were collected from two Mule Deer that were submitted for necropsy to the Utah Veterinary Diagnostic Lab, Spanish Fork. EJK performed the necropsies and noticed a large number of external parasites on both deer, which she collected. CCC confirmed that the parasites were deer keds and submitted them for identification to MJS, who confirmed the species identification. They have been accessioned into the Frost Entomological Collection at Pennsylvania State University. The Pacific Deer Keds from Utah collected by R.C. Mower from mosquito CO₂ traps are housed in the Utah County Health Department, Mosquito Abatement Division’s insect reference collection, while the Pacific Deer Ked and Western Deer Ked specimens he collected from a Mule Deer from his cabin are housed in his personal collection with a series deposited in the Brigham Young University insect collection housed at the Bean Life Science Museum. The Pacific Deer Keds collected from CO₂ traps by MLF have also been accessioned into the Brigham Young University insect collection.

These specimens help fill in some of the range gaps for western deer ked species. However, there are still broad areas where deer occur in the West from which Pacific and Western Deer Keds have not been reported (Fig. 2), so there remains a need to conduct systematic surveys of deer in western states or use other techniques (e.g., ecological niche modeling) to further refine the geographic ranges of deer keds.

Specimens examined

Latitude and longitude coordinates have been transcribed verbatim from specimen labels. *Lipoptena ferrisi*: **Utah**: Sanpete County, Oakcreek, 2.5 mi N of Fairview, 27,000 N. Mower Ln, dry farm E of Mower cabin, 39°39.32’ N, 111°25.06’ W, el: 6561’, ex. Mule Deer, 28 Aug 2012, col. R.C. Mower.

Neolipoptena depressa: **North Dakota**, Slope County, Section 8, Township 136 N., Range 102 W., 46° 36’ N, 103° 30’ W, ex. hunter harvested adult male Mule Deer, 13 November 1998, col. W. Jensen • Morton County, along Heart River, ex. yearling male White-tailed Deer, 2019 [day and month unknown], col. J. Violet • McKenzie County, Township 145 N., Range 101 W., 47° 22’ N, 103° 35’ W, ex. adult female White-tailed Deer, 14 November 2023, col. W. Jensen • **Utah**, Iron County, Kanarrville, ex Mule Deer, 17 August 2023, col. J. Kelly and C. Christensen • Sanpete County, Oakcreek, 2.5 mi N of Fairview, 27,000 N. Mower Ln, dry farm E of Mower cabin, 39°39.32’ N, 111°25.06’ W, el: 6561’, ex. Mule Deer, 28 Aug 2012, col. R.C. Mower • Utah County, Ironton, 40.19575 N, 111.62111 W, ex. mosquito CO₂ trap, 22 August 2016, col. M.L. Fisher • Utah County, Lehi, Loch Lomond subdivision, 40°21.40’N, 111°51.54’W, ex. mosquito CO₂ trap, 16 June 2014, col. R.C. Mower • Utah County, Orem, State Road Shop, 40.27430 N, 111.73956 W, ex. mosquito CO₂ trap, 8 July 2016, col. M.L. Fisher • Wasatch County, Strawberry Reservoir, ex. Mule Deer, 28 August 2023, col. C. Christensen.

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