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Chorioptic Mange in an American Black Bear (*Ursus americanus*) from Massachusetts, USA

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ABSTRACT: American black bears (*Ursus americanus*) are increasingly reported to develop mange. This report describes a case of mange associated with a *Chorioptes* species, which has not previously been reported, to our knowledge, in free-ranging black bears. Basic clinical findings as well as methods of identification for this mite are provided.

American black bears (*Ursus americanus*) are a common megafauna that inhabit a variety of landscapes across North America and are reportedly experiencing expanding and increasing populations in many areas (Scheick and McCown 2014). This population growth has resulted in increased potential for transmission of pathogens among bears, humans, and domestic animals. American black bears have been documented to develop disease from multiple mite species. Notably, *Sarcoptes scabiei*, the causative agent of sarcoptic mange, has become an important pathogen of black bears in the eastern US (Niedringhaus et al. 2019).

Chorioptes spp. can cause a disease characterized by pruritus and hyperkeratosis of varying severity (Lusat et al. 2011). They are important pathogens of livestock, including goats (*Capra aegagrus hircus*), sheep (*Ovis aries*), and cattle (*Bos taurus*), because they can result in reduced productivity (Mullen and O'Connor 2019). Chorioptic mange has been reported in multiple ungulate species, as well as rabbits (Leporidae), horses (*Equus caballus*), and badgers (Mustelidae; Bochkov 2010; Mullen and O'Connor 2019). In North America, the *Chorioptes* species most commonly reported to cause disease is *Chorioptes bovis*, but recently, advances in molecular technology have revealed the widespread distribution of *Chorioptes texanus* (Essig et al. 1999). One species, *Chorioptes panda*, has been described from a Giant panda (*Ailuropoda melanoleuca*) and was possibly identified from a captive American black bear in the London Zoo; these represent the only members of the Ursidae family reported to harbor *Chorioptes* (Bochkov 2010; Bochkov et al. 2014). Chorioptic mange has not previously been reported, to our knowledge, in any free-ranging North American carnivore.

A yearling male American black bear was admitted to the Wildlife Clinic at the Cummings School of Veterinary Medicine (CSVM) at Tufts University (Medford, Massachusetts, USA) in March 2019 after being observed in a residential backyard for 1 wk. On physical examination, the bear was emaciated (6.3 kg) and dehydrated. Patchy hair loss and crusting were noted over the entire body, most pronounced on the muzzle, ears, and hind legs (Fig. 1A, B). An initial skin scrape did not reveal any pathogens. Nonetheless, topical selamectin (60 mg, Revolution©, Zoetis, Inc, Kalamazoo, Michigan, USA) was applied. A complete blood cell count revealed a slightly elevated white blood cell count (13.72×10^3/μL, reference range $4.0–12.0\times10^3$/μL) and moderate anemia (hematocrit 28%, reference range 35–40%). A serum chemistry profile revealed no abnormalities.

The following day, a single mite was detected in crusts from the bear after it was

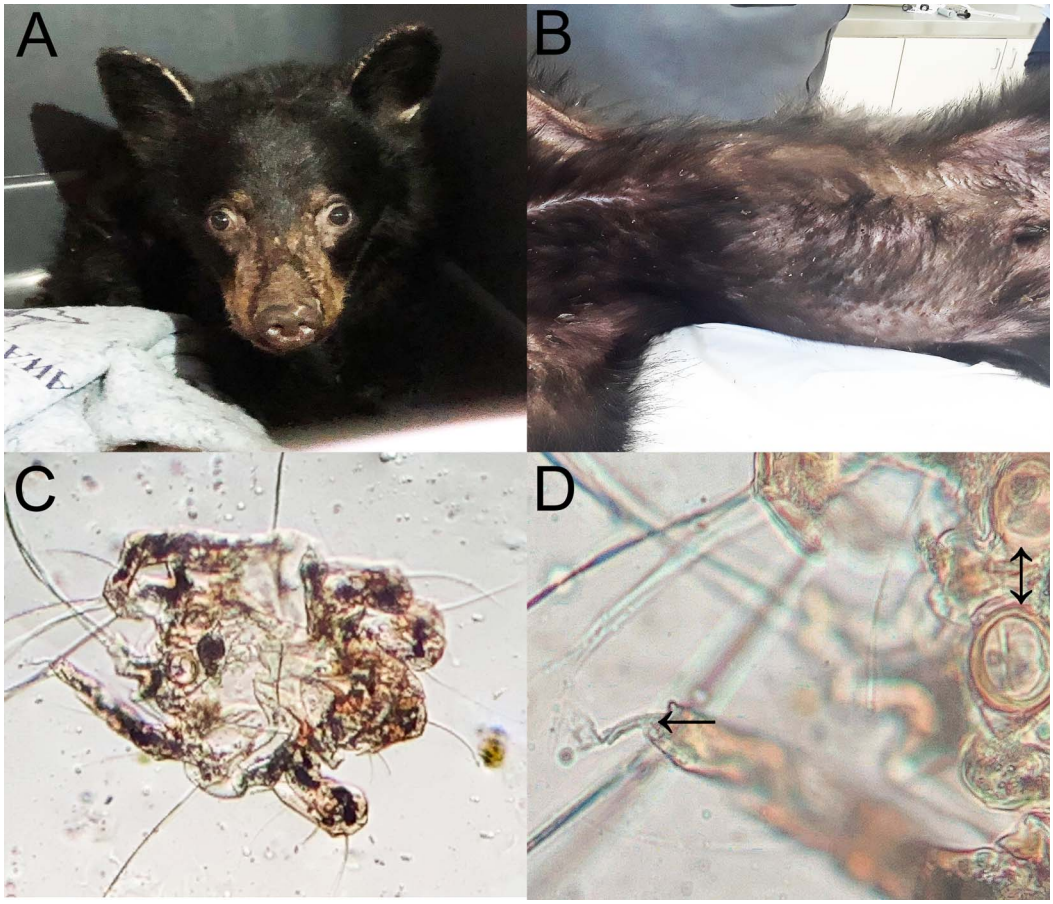

FIGURE 1. Yearling American black bear (*Ursus americanus*) found free-living in Massachusetts, USA, in March 2019, showing patchy alopecia on the muzzle (A) and ventrum (B). (C) The mites were psoroptiform shape with a round idiosoma and long legs. (D) The mites had paired copulatory suckers (double-headed arrow), and the pedicels were short and unsegmented (arrow).

removed from its enclosure. Initial examination of the crust material was performed at CSVM, and additional crust material was submitted to the Southeastern Cooperative Wildlife Disease Study (SCWDS; Athens, Georgia, USA) for further analysis.

At 2 wk after admission, the bear was treated with a single oral dose of 250 mg fluralaner (Bravecto©, Merck Animal Health, Madison, New Jersey, USA). The bear had a good appetite and steadily increased in weight. Over the next 2 wk, the lesions continued to improve, and new hair growth was observed. By 50 d after admission, all lesions were fully resolved, and the bear weighed 17.4 kg. The bear was subsequently released with the assistance of the Massachusetts Division of Fisheries and Wildlife (Westborough, Massachusetts, USA).

At SCWDS, the crust material was examined via light microscopy and revealed the presence of two additional mites. These were both male and had a psoroptiform shape, with long legs, with the exception of the fourth pair, which was rudimentary. The anus was terminal, and there were suckers on short, unsegmented stalks on legs one through four. The posterior idiosoma had two symmetric copulatory suckers (Fig. 1B, C). These features were consistent with *Chorioptes* spp. (Greiner 2012; Bowman 2014).

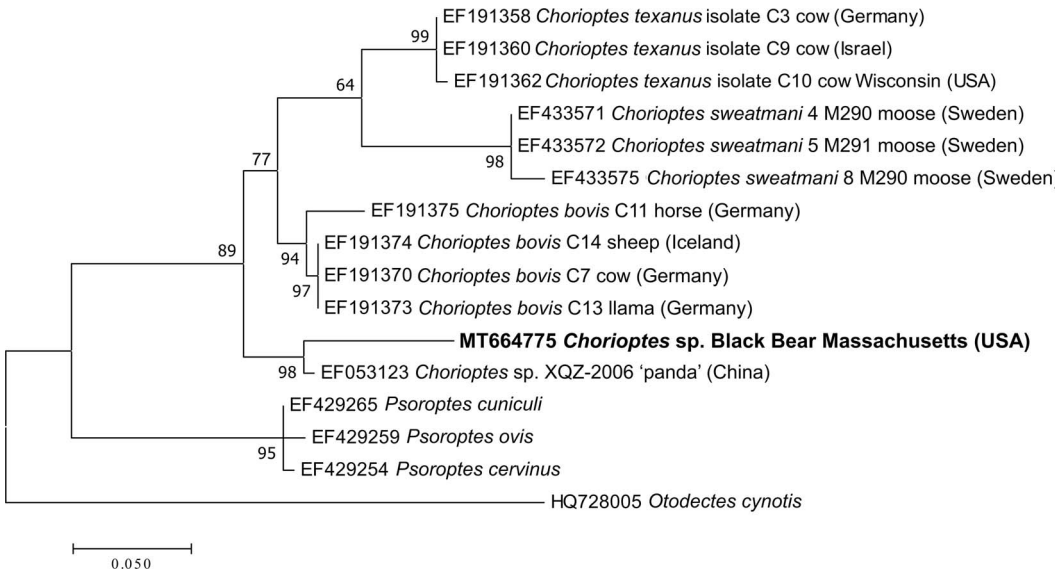

FIGURE 2. Phylogenetic analysis of the *Chorioptes* sp. internal transcribed spacer-2 sequence from a free-living yearling American black bear (*Ursus americanus*) found in Massachusetts, USA, in March 2019 (bolded), with other *Chorioptes* spp. and related mite species. The evolutionary history was inferred by using the maximum-likelihood method based on the Tamura 3–parameter model (Tamura 1992). The tree with the highest log-likelihood (–896.06) is shown. The percentage of trees in which the associated taxa clustered together is shown next to the branches. A discrete γ-distribution was used to model evolutionary-rate differences among sites (five categories [+G, parameter=0.6737]). The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. Evolutionary analyses were conducted in MEGA 7 software (Kumar et al. 2016).

At CSVM, DNA was extracted from a sample of crust material from the bear in a QIAcube instrument using the QIAmp PowerFecal DNA kit (Qiagen, Germantown, Maryland, USA), according to the manufacturer's protocol. The DNA was eluted to 50 µL of elution buffer stored at –20 C. Mite DNA was amplified with primers RIB-18 and RIB-3, which amplify the internal transcribed spacer-2 region, using 40 cycles with denaturation at 94 C for 45 s, annealing at 60 C for 45 s, and extension at 72 C for 40 s (Zahler et al. 1999). The amplified fragments were electrophoresed, stained with GelRed© (Biotium, Fremont, California, USA), and visualized on an ultraviolet transilluminator. Amplicons were Sanger sequenced in both directions. The sequenced sample was 92.2% identical to a *Chorioptes* sp. from a 'panda' (GenBank accession no. EF053123). This DNA extraction and PCR procedure was also performed at SCWDS using identical methods, and an identical sequence was obtained. Phylogenetic analysis showed that this sequence grouped with a *Chorioptes* sp. collected from a Giant panda (Fig. 2).

The presence of mites in exfoliated crusts, in conjunction with resolution after acaricide treatment, suggests the mites caused the bear's lesions. The potential novelty of this species could not be determined from morphologic features because of the few specimens obtained, as well as the absence of female mites. However, the internal transcribed spacer-2 sequence, which is a commonly used target to identify and phylogenetically compare parasitic mites, was unique. It is particularly interesting that our phylogenetic tree produced two seemingly distinct *Chorioptes* species from free-ranging ursids in Asia and in North America, which are phylogenetically separated from the *Chorioptes* spp. of artiodactylids (*C. texanus*, *C. bovis*, and *Chorioptes sweatmani*). These findings are consistent with those of Bochkov et al. (2014), which show a basal group of ursid

Chorioptes (the presumed *C. panda* and the species in this report) with hypothesized transmission and evolutionary speciation to herbivorous hosts, possibly from predation.

This report is the first, to our knowledge, to suggest that a *Chorioptes* sp. can cause skin lesions consistent with mange in a free-ranging American black bear. Because mange is an increasingly important disease in black bears, this case emphasizes the importance of performing appropriate skin scrapes and mite identification in animals with hyperkeratotic skin lesions, because of the clinical similarities of sarcoptic, ursicoptic, chorioptic, and to a lesser extent, demodectic mange. Confirming the disease, as well as the causative agent, in these cases is important because these mite species have different health implications for humans and bears, as well as for other wild and domestic animals.

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