Veterinary Parasitology: Regional Studies and Reports 17 (2019) 100303

Contents lists available at ScienceDirect

Veterinary Parasitology: Regional Studies and Reports

journal homepage: www.elsevier.com/locate/vprsr

Short communication

The emergence and expansion of sarcoptic mange in American black bears (*Ursus americanus*) in the United States

Kevin D. Niedringhaus[a], Justin D. Brown[b], Mark Ternent[c], Will Childress[d], Jenna R. Gettings[a], Michael J. Yabsley[a,e,*,1]

[a] Southeastern Cooperative Wildlife Disease Study, 589 D.W. Brooks Drive, Wildlife Health Building, College of Veterinary Medicine, University of Georgia, Athens, GA 30602, USA
[b] Department of Veterinary and Biomedical Sciences, 115 Henning Bldg, Pennsylvania State University, University Park, PA 16802, USA
[c] Pennsylvania Game Commission, 2001 Elmerton Ave, Harrisburg, PA 17110, USA
[d] Department of Natural Resources Ecology and Management, 008C Agricultural Hall, Oklahoma State University, Stillwater, OK 74078, USA
[e] Warnell School of Forestry and Natural Resources, 180 E Green Street, University of Georgia, Athens, GA 30602, USA

ARTICLE INFO

Keywords:
Black bear
Sarcoptes scabiei
Sarcoptic mange
Ursus americanus
Wildlife health

ABSTRACT

Mange was historically rare in American black bears (*Ursus americanus*). Since the 1990s, however, sarcoptic mange has become more widespread in black bears with hundreds of reports in 2018 from eight states. This emerging disease has potential implications regarding human and animal health and on future black bear management.

Sarcoptes scabiei is a zoonotic mite that affects hundreds of species globally (Pence and Ueckermann, 2002). The disease is referred to as scabies in people and sarcoptic mange in domestic and wild animals. Mange in animals is often clinically similar to Norwegian or crusted scabies in people and is characterized by severe skin lesions, secondary bacterial and fungal infections, emaciation, and often mortality (Pence and Ueckermann, 2002; Nakagawa et al., 2009; Nimmervoll et al., 2013). Many wildlife populations have endemic sarcoptic mange, but epidemics can cause severe population declines, particularly when mites are introduced into naïve populations or hosts (Henriksen et al., 1993; Martin et al., 2010).

Sarcoptic mange was previously considered to be rare in American black bears (*Ursus americanus*). The disease was observed sporadically in the Midwestern and eastern United States between the 1980s and early 2000s (Schmitt et al., 1987; Fitzgerald et al., 2008). However, more recently, reports of sarcoptic mange in bears have become common and widespread, particularly in the mid-Atlantic states (Peltier et al., 2017; Peltier et al., 2018). The objective of this study was to determine the frequency and distribution of sarcoptic mange in American black bears in the USA.

Between August and October of 2018, we surveyed bear or furbearer biologists or technicians and/or wildlife health personnel from 40 state wildlife agencies with a known resident black bear population to determine if, when, and where suspected (skin disease in an area with confirmed sarcoptic mange) or confirmed cases (skin disease associated with mite identification) of sarcoptic mange in bears have occurred. These reports included those already published in the literature as well as from the clinical case database of the Southeastern Cooperative Wildlife Disease Study (SCWDS). The distribution and frequency of sarcoptic mange reports by decade are in Fig. 1.

In Pennsylvania, the first documented case of sarcoptic mange was in 1991 in Indiana County in an adult male black bear. A year later, three more bears were reported with the disease in Indiana and adjacent Clearfield County. Over the subsequent 27 years, sarcoptic mange was reported in 55 out of 67 counties in Pennsylvania, and the number of cases continues to increase. In 2018, the number of suspected or confirmed cases reported in Pennsylvania was 277, which is a 296% increase from 2008 (70 cases).

More recently, states surrounding Pennsylvania reported sarcoptic mange in bears. In New York, the disease was first confirmed in 2011 in

* Corresponding author at: Southeastern Cooperative Wildlife Disease Study, 589 D.W. Brooks Drive, Wildlife Health Building, College of Veterinary Medicine, University of Georgia, Athens, GA 30602, USA.
E-mail addresses: kevindn@uga.edu (K.D. Niedringhaus), jdb56@psu.edu (J.D. Brown), mternent@pa.gov (M. Ternent), wchildr@ostatemail.okstate.edu (W. Childress), Jenna.Gettings@uga.edu (J.R. Gettings), myabsley@uga.edu (M.J. Yabsley).
[1] [spice] Please check this,Present Address: Southeastern Cooperative Wildlife Disease Study, 589 D.W. Brooks Drive, Wildlife Health Building, College of Veterinary Medicine, University of Georgia, Athens GA 30602, USA

https://doi.org/10.1016/j.vprsr.2019.100303
Received 2 March 2019; Received in revised form 30 April 2019; Accepted 8 May 2019
Available online 10 May 2019
2405-9390/ Published by Elsevier B.V.

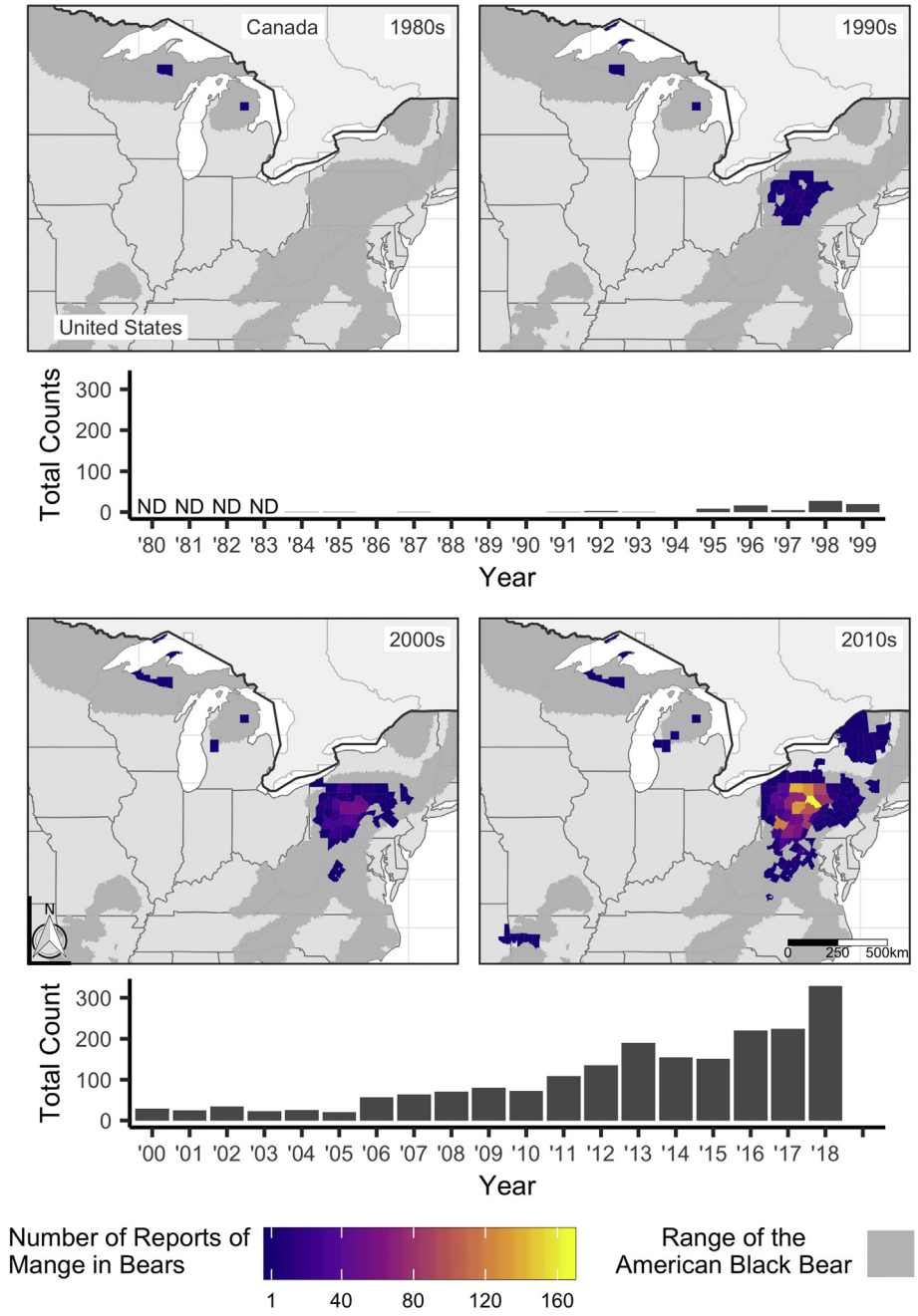

Fig. 1. The spatial and temporal distribution of cumulative reported or confirmed cases of sarcoptic mange in black bears from 1980 to 2018 in the United States as obtained from a survey of the state agencies. ND = no data.

Herkimer County, and now the disease occurs in 17 counties. West Virginia and Virginia also confirmed mange in bears near the Pennsylvania border in 2003 and 2012, respectively. Despite a high bear population, sarcoptic mange has not yet been confirmed in New Jersey or northeastern Pennsylvania, including the Poconos, to the best of our knowledge. Arkansas and Oklahoma confirmed their first cases of sarcoptic mange in black bears in 2018.

Sarcoptic mange has not been formally reported or confirmed in bears in Tennessee, Kentucky, or any other state due east of Arkansas, south of Virginia, or west of Oklahoma. This large gap between the mid-Atlantic area, the Great Lakes region, and Arkansas/Oklahoma suggests that these are novel foci. In a previous genetic study, samples from the northeastern USA suggested that multiple strains of mites are circulating in black bears based on *cox1* sequences; additional genetic analyses from mites in these new regions or with other genetic markers/techniques may provide additional insights into disease expansion (Peltier et al., 2017).

The cause for the emergence and expansion of sarcoptic mange in black bears is unknown. The American black bear range overlaps with many other mammalian hosts that are commonly affected by sarcoptic mange, including red fox (*Vulpes vulpes*) and coyotes (*Canis latrans*); while the host-switch and emergence of this disease in bears is likely due from spillover from a canid or other wildlife host, it is presumed that inter-bear transmission is occurring in highly-impacted areas (Astorga et al., 2018). It is unknown if infestation consistently causes clinical disease or if some bears are predisposed to overt mange as has been suggested with notoedric mange in wild felids associated with exposure to anticoagulant rodenticides (Riley et al., 2010). Additionally, it is unclear if potentially bear-adapted mites are found across the eastern USA (either subclinically or clinically but have not

been found/reported) or are only found in areas with reported clinical disease.

The relatively slow rate of mange expansion in this host in the northeastern USA may be a result of the generally solitary nature of bears, which is different than many other social species commonly affected with mange such as wolves (*Canis lupus*) and coyotes (Almberg et al., 2015). Mites are likely transmitted through direct and indirect contact with other infected bears, and we do not currently know how the mite is maintained in bear populations compared to canids. The radiating pattern of disease expansion suggests that mites themselves or an unidentified co-infection or risk factor is spreading, but additional studies are needed. Many state wildlife agencies have also reported increasing bear populations since the 1980s, including Pennsylvania, Michigan, and Arkansas, among others (Hristienko and McDonald Jr, 2007). The increasing bear populations in these states suggests a potential role of bear density in disease emergence or pathogen transmission; however, it is unclear why there are fewer cases in Michigan, Arkansas, and other states with increasing bear populations compared to Pennsylvania. The apparent increase in mange may be a true increase in prevalence, a constant prevalence in an increasing host population, or both.

There are several implications for the emergence of this new disease system. As the disease continues to spread across the eastern United States, additional bear populations may be at risk. If bears with outward mange become more common, it may have additional implications for wildlife management agencies including changes in hunters' or tourists' attitudes towards bears.

Bears are another host species, along with other domestic and wild animals, that can be infected with mange. Domestic animal owners, including farmers and pet owners, and humans, including hunters and wildlife management personnel, should take precautionary measures to limit contact with animals with mange or their environments.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vprsr.2019.100303.

Declaration of conflicting interests

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property. We understand that the Corresponding Author is the sole contact for the Editorial process (including Editorial Manager and direct communications with the office). He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs. We confirm that we have provided a current, correct email address which is accessible by the Corresponding Author and which has been configured to accept email from myabsley@uga.edu.

Ethical statement

No animals were specifically harmed for the purpose of this study but were used opportunistically and abided by all of the authors' respective institutional IACUCs.

Acknowledgments

The authors thank the state wildlife agencies for providing data for this manuscript. JRG was supported by the Companion Animal Parasite Council (www.capcvet.org). Additional support was provided by the nineteen state wildlife agencies that support SCWDS as well as the Federal Aid to Wildlife Restoration Act (50 Stat. 917).

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