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Ecto- and endoparasites of brown bears living in an extreme environment, the Gobi Desert, Mongolia

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Abstract: We report the first survey of ecto- and endoparasites of brown bears (*Ursus arctos gobiensis*) in the Gobi Desert, Mongolia. We collected 40 ticks from 1 female (21 yr old, 48 kg) and 2 males (10 yr, 155 kg; 5 yr, 108 kg) captured for research purposes in May 2018. We found *Dermacentor nutalli* ($n = 35$ ticks, 87.5%) on both male bears and *Hyalomma asiaticum* ($n = 5$ ticks, 12.5%) on one male. The female had no ticks. We also collected a fecal sample from each captured bear, and an additional 15 fecal samples in the field. Two (11%) of the 18 fecal samples collected contained eggs of *Strongyloides* spp.; 1 fecal (10-yr-old male) sample had 2 eggs, and 1 fecal sample collected in the field contained 1 egg. This is the first documentation of parasites of wild bears in Mongolia.

Key words: brown bear, Gobi bear, Ixodida, parasites, ticks, *Strongyloides*, *Ursus arctos gobiensis*

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Parasites are integral parts of ecosystems, shape host population dynamics, alter interspecific competition, influence energy flow, and appear to be important drivers of biodiversity (Hudson et al. 2006). Over 170 species of helminths have been documented in Mongolia, mainly in livestock (Mendjargal 1996); the most prevalent helminths in domestic ruminants are *Haemonchus* spp. (Namjil 1967), *Trichostrongylidae* spp., and *Nematodirus* spp. (Sharkhuu 1986). Ectoparasites, such as ticks (Ixodida) and fleas (Siphonaptera), are also commonly found in wildlife in central Asia (Ahmed et al. 2007, Rasulov 2007), and fleas are especially important in the dynamics of the plague–wildlife–human system (Stenseth et al. 2008, Samia et al. 2011). Also ticks cause significant damage to livestock husbandry, and serve as carriers of human and animal diseases in Central Asia (Rasulov 2007). Several species of the Ixodidae family of ticks have been reported in Mongolia (i.e., *Ixodes persulcatus, I. crenulatus, I. lividus, Dermacentor nuttalli, D. silvarum*, *D. marginatus, Hyalomma asiaticum, Haemaphysalis pospelovashtromae, Haemaphysalis concinna,* and *Rhipicephalus pumilio* (Dash 1969, Dash et al. 1988). In wild mammals in Mongolia, nematode eggs (*Nematodirus* spp.) have been found in the feces of wild Bactrian camels (*Camelus bactrianus ferus*) and eggs of *Strongolus* sp., *Oxyuris* sp., and *Anoplacephalidae* sp. have been found in feces of Asiatic wild ass (*Equus hemionus;* Jirnov and Ilinskii 1985). The purpose of our study was to conduct a preliminary investigation of the parasite fauna of the critically endangered population of Gobi brown bears (*Ursus arctos gobiensis*) living at an extremely low density in the Gobi Desert of southwestern Mongolia (Tumendemberel 2020).

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Methods

Study area and study species

The Great Gobi Strictly Protected Area A (GGSPA A) is part of a desert ecosystem in southern Mongolia. It is characterized by harsh environmental conditions and low densities of humans. Our study area was in the Tsagaan Bogd Mountain Range in the GGSPA A (∼42°50′00.41N, ∼98°59′59.62E). The wild large mammal fauna includes the Bactrian camel, Gobi brown bear, snow leopard (*Uncia uncia*), argali sheep (*Ovis ammon*), black-tailed gazelle (*Gazella subgutturosa*), and Asiatic wild ass (Jirnov and Ilinskii 1985, McCarthy 2009). Grazing livestock, mainly located in the surrounding buffer zone of the GGSPA A, includes domestic Bactrian camels, sheep (*Ovis aries*), and goats (*Capra hircus aegagrus*).

The Gobi bear is critically endangered (Shiirevdamba 2013) with a population size of ∼30 individuals (Tumendemberel 2020). It exhibits primarily vegetarian food habits; most of its diet consists of berries of the nitre bush (*Nitraria* sp.), wolfberries (*Lycium* sp.), ephedra (*Ephedra* sp.), wild rhubarb (*Rheum* sp.), licorice (*Glycyrrhiza glabra*), and other plants (Jirnov and Ilinskii 1985, Mijiddorj 2013). Only about 8% of the diet is animal protein (Mijiddorj 2013). As a conservation measure, an extensive supplemental feeding program has been in place in the study area since 1985, and pellets containing wheat (*Triticum aestivum*), corn (*Zea mays*), carrots (*Daucus carota sativus*), and turnips (*Brassica rapa*) are provided in spring and autumn at feeders located near selected waterholes throughout the GGSPA A (Mijiddorj 2006).

Collection of parasites

We opportunistically collected ectoparasite samples from Gobi bears trapped for research purposes near water holes in May 2018. We captured bears in box traps at artificial feeders located near oases complexes during spring and autumn (Tumendemberel et al. 2015, Tumendemberel 2020). We baited traps with artificial feed and visually controlled them every morning. We immobilized captured bears with Telazol® (tiletamine–zolazepam) administered with a jab stick. We estimated ages of captured bears based on tooth cementum layers (Matson et al. 1993). We obtained the capture permit by Joint Order of The Minister of Environment and The President of The Academy of Sciences of Mongolia, "Procedures for capturing and marking animals for scientific purposes 120/51 permit no. 06/2642."

We thoroughly searched the entire body of captured bears for ectoparasites visible to the naked eye (especially ticks, fleas, lice), and removed them with forceps to be stored in 2-mL tubes. We did not collect ticks that were attached in the eyelids of captured bears so as to avoid potential injuries or infections caused by the collection process. We identified the species of ticks using the standard "Tick identification key" for Mongolia (Pavlovskii 1955).

To document the eggs of endoparasites, we collected one fecal sample from each captured bear with a swab. In addition, we collected 15 fresh fecal samples around 4 water wells in the study area. We selected scats that included primarily natural foods and not the pellets provided to the bears at feeding sites, because the main purpose of scat collection was to investigate the natural diet of Gobi bears. We selected ∼3 mg of moist material from the center of each scat and stored it in 70% alcohol (2 mg) in a sampling tube. Samples were stored in alcohol because our study camp had no electricity to store samples in a freezer. We extracted parasite eggs from scat samples with the Wisconsin Sugar Flotation Method (Bagley 1997). We measured 3 g of each feces into a plastic cup, mixed in 10 mL of Sheather solution (Jorgensen Laboratories, Loveland, Colorado, USA), filtered the samples through a fine strainer, and then centrifuged them at 1,000 revolutions/minute for 7 minutes. Then we filled the tubes with Sheather solution until a meniscus formed and covered the tube with a coverslip on the meniscus for 5 minutes. We then placed the cover slips in a Bresser LCD MICRO 5MP microscope (Bresser Corporation, Rhede, North Rhine-Westphalia, Germany; 40×) and identified and counted the parasite eggs (Pittman et al. 2010).

Results

We captured 3 bears in our study area in 2018, 1 female (21 yr old, 48 kg) and 2 males (10 yr old, 155 kg; 5 yr old, 108 kg) and examined each bear for ectoparasites. We found ectoparasites on both of the captured male bears, but not the female. All parasites were ticks belonging to the species *Dermacentor nutalli* ($n = 35$, 87.5%) and *H. asiaticum* ($n = 5$, 12.5%). One male (5 yr old) had 19 ticks, all of which were *D. nutalli*. The other male (10 yr old) had 2 species of ticks, 16 *D. nutalli* and 5 *H. asiaticum*. Two (11%) of 18 fecal samples collected included *Strongyloides* spp.; 1 fecal (10-yr-old male) sample had 2 eggs, and 1 fecal sample collected in the field contained 1 egg. This is the first documentation of parasites of wild bears in Mongolia (Fig. 1).

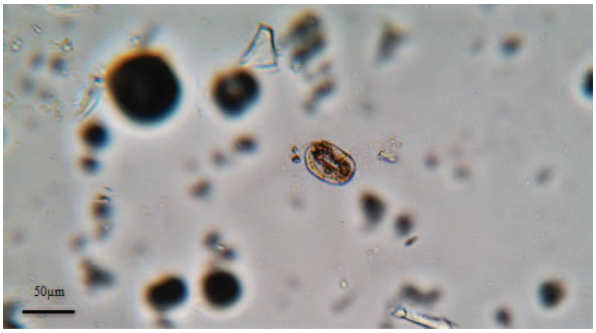

Fig. 1. A *Strongyloid* spp. egg (digitally enlarged picture taken with 40× magnification) found in the fecal sample of a 10-year-old male brown bear (*Ursus arctos gobiensis*) from the Greater Gobi Specially Protected Area A, Mongolia, May 2018.

Discussion

We found endo- and ectoparasites in bears living in the Gobi Desert ecosystem in Mongolia. Ticks of the species *H. asiaticum* and *D. nutalli* were the only ectoparasites found; both species are common in the Gobi Desert ecosystem, and both are generally a source for tick-borne diseases in different parts of the world, such as anaplasmosis, rickettisosis, tick-born encephalitis, Crimean–Congo haemorrhagic fever, and Lyme borreliosis (Černý et al. 2019). In Mongolia, 3 species of *Ixodes*, 2 species of *Haemaphysalis,* 3 species of *Dermacentor,* 2 species of *Hyalomma,* and 1 species of *Rhipicephalus* have been reported (Dash 1969, Dash et al. 1988).

Ticks are commonly found in wild Ursids; for example, the species *Ixodes dammini* and *D. variabilis* have been found on American black bears (*U. americanus*) in Wisconsin, USA (Kazmierczak et al. 1988). In other areas of the United States, ticks (e.g., *Ixodes scapularis, Amblyomma americanum, A. maculatum, D. variabilis, Rickettsia parkeri*) and tick-borne pathogens (e.g., *Anaplasma phagocytophilum, Toxoplasma gondii, Borrelia burgdorferi, Trichinella spiralis, Francisella tularensis, Yersinia pestis*) have been found on or in American black bears (Stephenson et al. 2015, Zolnik et al. 2015, Skinner et al. 2017). Although ticks and tick-borne pathogens are commonly found in Ursids across the world (e.g., Víchová et al. 2010, Paillard et al. 2015, Skinner et al. 2017), to our knowledge no evidence exists that this has a negative effect on bear populations.

We found eggs of *Strongyloides* spp. in the feces of Gobi brown bears. However, we were not able to cultivate larvae and determine the species because of the lack of direct fixing of fecal samples in ethanol. Only 11% of the fecal samples contained *Strongyloides* spp. eggs, so we are unable to determine the prevalence of *Strongyloides* spp. in the Gobi bear population because of the small sample size, as well as the fact that 15 of the 18 fecal samples collected could not be assigned to specific individuals. Infections caused by Strongylidae are common in the gastrointestinal system and feces of ruminants, especially domestic livestock, in Mongolia (Mendjargal 1996), and can cause diarrhea, anemia, poor body condition, loss of reproductive abilities, and even result in the death of the host (Stephen and Gareth 2003). Domestic livestock, especially camels, are common in the buffer zones of the GGSPA A and use the same water sources as other wildlife. Water and vegetation contaminated with feces thus may serve as a source for infection of wildlife with parasites, including the highly omnivorous Gobi bear (i.e., 92% of the diet is vegetation; Mijiddorj 2006).

Future studies should evaluate the potential risk of parasites and diseases for the long-term persistence of this highly endangered and isolated population. This is especially important because of increasing encroachment of humans and their livestock on this ecosystem, especially the extremely scarce water sources that are crucial for the long-term survival of wildlife in the Gobi Desert ecosystem. Although most bears do not die from diseases or parasitic infections (Swenson et al. 2020), these may be more important in very small populations living in extreme environments, such as the Gobi Desert.

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