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PARASITE SPECIES ASSOCIATED WITH WILD PLATEAU PIKA (*OCHOTONA CURZONIAE*) IN SOUTHEASTERN QINGHAI PROVINCE, CHINA

Chengmin Wang,[1] Hongxuan He,[1,4] Ming Li,[1] Fumin Lei,[1] J. Jeffrey Root,[2] Yanyun Wu,[1] and Jianhua Qin[3]

[1] National Research Center for Wildlife Borne Diseases, Key Laboratory of Animal Ecology and Conservation Biology, Institute of Zoology, Chinese Academy of Sciences, Beijing, China
[2] United States Department of Agriculture, Wildlife Services, National Wildlife Research Center, Fort Collins, Colorado 80521, USA
[3] Department of Animal Science and Technology, Hebei Agricultural University, BaodingHebei, China
[4] Corresponding author (email: hehx@ioz.ac.cn)

ABSTRACT: A survey was conducted to determine the prevalence and seasonal abundance of egg, larval, and adult stages of helminths; oocyts of protozoans; and ectoparasites of plateau pikas (*Ochotona curzoniae*) in seven areas of southeastern Qinghai Province, China, during August 2006 and May 2007. Fecal samples collected from 430 plateau pikas were examined by the modified McMaster technique, which revealed that 83% of the samples contained eggs from two or more helminth species. Mean fecal egg counts were generally moderate and showed the same trend irrespective of the age or sex of the pikas. The prevalence and counts of cestode eggs showed strong seasonal relationships that corresponded with the rainfall pattern in the study area during the study period. Of the 430 plateau pika examined at necropsy, 89% contained adult nematode or cestode species, but none of these contained adult trematode species or protozoans. Overall, six genera of adult nematodes including *Oesophagostomum* sp., *Cephaluris coloradensis*, *Eugenuris schumakowiescsi*, *Haemonchus* sp., *Trichuris* sp., and *Chbertiinae* sp.; three genera of adult cestodes including *Schizorchis sp.*, *Ochotonae sp.*, *and Hymenolepis nana*; three ectoparasite species including *Hypoderma curzonial*, *Pulex* sp., and *Ixodes ovatus*; and one proscolex stage of a cestode, *Echinococcus multilocularis* or *Echinococcus shiquicus*, were encountered during the study. Other genera examined occurred in low numbers, which did not allow any meaningful comparisons. Overall, results suggest that four parasite species, *Hypoderma curzonial*, *Pulex* sp., *Ixodes ovatus* Neumann, and *Cephaluris coloradensis*, may be regulating factors in controlling future numbers of plateau pika in this study area. These data provide evidence of a natural biologic control mechanism of plateau pika on grassland habitats, and may be of use for identifying the mechanism of transmission of parasites between plateau pika, livestock, and humans.

Key words: Ectoparasite, endoparasite, helminth, *Ochotona curzoniae*, plateau pika.

INTRODUCTION

Plateau pikas (*Ochotona curzoniae*) are found in the Alpine meadows and steppes of the Tibetan Plateau in the Chang Tang region of the People's Republic of China (Schaller, 1998). They are small, lack a conspicuous tail, and have characteristic black lips and thick fur, which is brown to reddish-tan on the dorsal side and light gray on the ventral side. In their endemic habitat, they are predated upon by Common Kestrels (*Falco tinnunculus*), Black Kites (*Milvus lineatus*), Upland Buzzards (*Buteo hemilasius*), and weasels and polecats (*Mustela* spp.). Recently, plateau pikas have been attributed to multiple wildlife damage issues, such as soil erosion caused by burrowing and competing with livestock for available vegetation (Pech et al., 2007). However, their excrement may be a beneficial fertilizer for plants that livestock consume (Schaller, 1998). Plateau pikas are not currently threatened, but zinc phosphate poisoning by pastoralists and habitat alterations could threaten populations of this species (Schaller, 1998). Although likely unintended, poison control efforts are thought to affect some avian species adversely (e.g., Snowfinch [*Montifringilla* sp.], Small Snowfinch [*Pyrgilauda* sp.], and Hume's Groundpecker [*Pseudopodoces humilis*]), as these birds are known to nest in plateau pika burrows and are harmed by the poison (Schaller, 1998; Lai and Smith, 2003).

In addition to the wildlife damage issues caused by this species, it is also a host (intermediate or final) for parasite species such as warble flies, fleas, cestodes, and others (e.g., *Hypoderma* sp., *Echinococcus sp.*, etc.). Because plateau pikas are often found within close proximity of pastoralists of the Tibetan Plateau, this association may have important transmission implications for select parasite species among humans and livestock. Further, some of these parasites may be vectors of bacteria, viruses, or other pathogenic agents. It is widely recognized that parasites play an important role in population and community regulation, as well as in conservation biology (Dobson and Hudson, 1986; Dobson, 1988; Scott, 1988; Minchella and Scott, 1991; Renaud et al., 1996; Morand and Arias-Gonzalez, 1997). For these reasons, the objective of this study was to identify and describe the range of parasites of plateau pikas so that risks to humans and livestock can begin to be assessed.

MATERIALS AND METHODS

Study sites

The study was conducted between August 2006 and May 2007 at seven study sites (Bird Island 36°57′N, 99°49′E, Gangca County 37°16′N, 100°05′E, Norling Lake 34°45′N, 97°31′E, Gyling Lake 34°48′N, 97°02′E, Madot County 34°50′N, 98°50′E, Yushu City 28°35′N, 90°35′E, and Huangyuan County 36°41′N, 101°16′E) located primarily in the southeastern region of Qinghai Province, People's Republic of China. This general area, with a mean annual rainfall of 50 mm, typically has a short rainy season from May to September followed by a prolonged dry season for the rest of the year. Qinghai is a large but thinly populated province dominated by a plateau greater than 2,000 m in elevation. Grasslands cover 96% of the land area and animals outnumber people by five to one.

Fecal examination

Fecal samples were collected directly from the rectum of plateau pikas. Fecal egg and/or oocyst counts were determined by the modified McMaster technique using a saturated solution of sodium chloride as the floating medium (MOA, 1977). In all tests, 3 g of feces were mixed in 42 ml of saturated solution of sodium chloride. The number of ova or oocysts per gram of feces was obtained by multiplying the total number of ova or oocysts counted in the two squares of counting chambers of the McMaster slide by a dilution factor of 50 (MOA, 1977). Ova or oocysts present were identified using standard parasitologic criteria (MOA, 1977; Soulsby, 1982; Hansen and Perry, 1990).

Ectoparasite examination and necropsy

To collect ectoparasites, plateau pikas were placed into a plastic bag with ether as an anesthetic and parasites were collected, identified, and counted (Wang et al., 2003). Anesthetized pikas were euthanized via exsanguination and a blood sample was collected from this process. Following necropsy, multiple organs, including organs of the gastrointestinal tract, liver, lung, kidney, brain, and muscle were collected and examined. Sections of the gastrointestinal tracts were separated by ligature and the entire tracts were placed in plastic containers and transported to the laboratory (Wildlife Borne Diseases Research Laboratory, the Institute of Zoology, Chinese Academy of Sciences, Beijing, China). The contents of individual sections of the tracts were washed with phosphate-buffered saline. The section was cut longitudinally and the mucosa was carefully examined, scraped, and washed to remove any adhering worms. The washings from the esophagus, ventriculus, and small and large intestines were thoroughly examined for worms. The worms present in the various sections were identified and counted (MOA, 1977; Soulsby, 1982; Hansen and Perry, 1990).

Meteorological data and statistical analysis

The mean monthly precipitation for the study areas was obtained from the Meteorological Center of China (http://cdc.cma.gov.cn/). Results were summarized as percentages and means±SD.

RESULTS

Overall, 430 plateau pikas were collected from seven study sites (Fig. 1), although sample sizes varied among study sites (Table 1). A diversity of helminths and ectoparasites were detected, including six species of nematodes, two species of adult cestodes, and one *Echinococcus* sp.

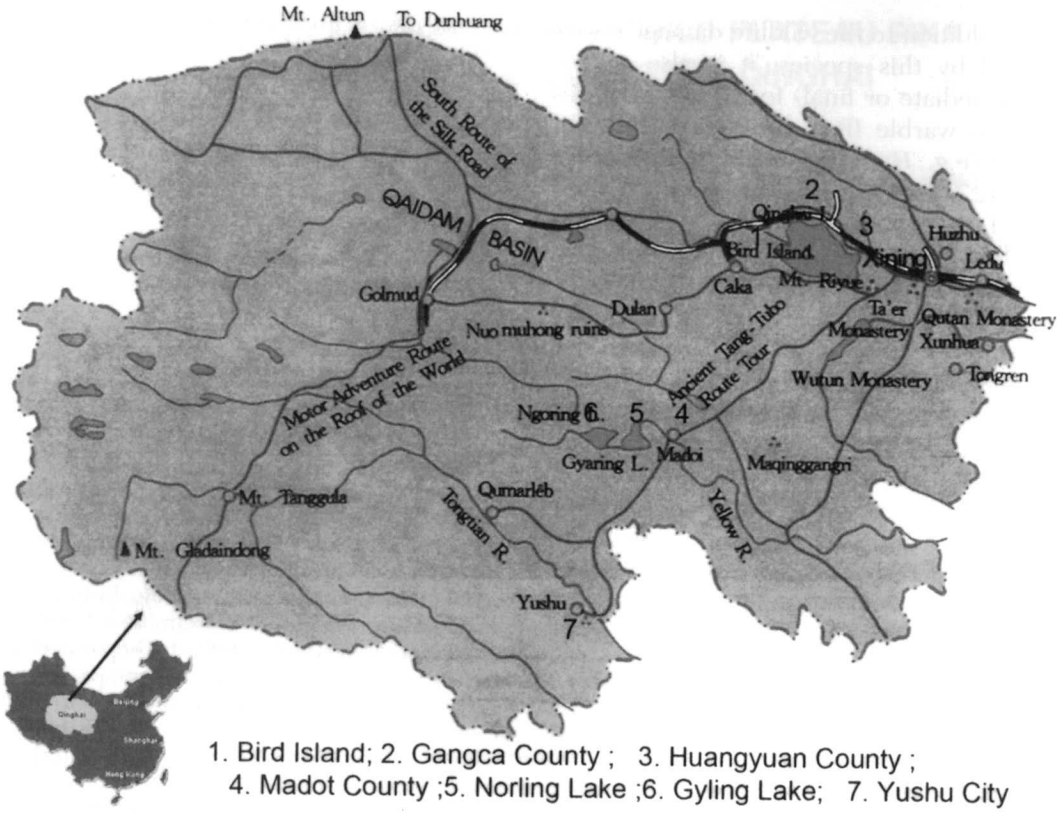

FIGURE 1. Study sites for plateau pika collections in Qinghai Province, China, 2006–07.

(e.g., either *Echinococcus multilocularis* or *Echinococcus shiquicus*; a definitive identification could not be made on larvae) were found in the gastrointestinal tract, liver, lung, spleen, and/or kidney of the 430 plateau pikas (Table 2). To the best of our knowledge, these are the first records of the cestodes *Schizorchis ochotonae* and *Echinococcus* sp. (see above) in southeastern Qinghai Province.

In addition, three species of ectoparasites—*Hypoderma curzonial*, *Pulex* sp., and

TABLE 1. The number of plateau pika (*Ochotona curzoniae*) captured and infected with parasites and infection rates in seven study areas in Qinghai Province, China, 2006–07.

Time period	Study site						
	Huang-yuan	Gangca	Bird Island	Madot	Gyling Lake	Norling Lake	Yushu
August 2006							
No. captured	33	32	32	31	31	29	30
No. infected[a]	27	28	25	27	23	21	26
Infection rate (%)	81.8	87.5	78.1	87.1	74.2	72.4	86.7
May 2007							
No. captured	33	31	30	30	29	28	31
No. infected[a]	25	29	26	28	22	21	29
Infection rate (%)	75.8	93.6	86.7	93.3	75.9	75	93.6

[a] Infected number refers to the number pikas with at least one parasite species noted.

TABLE 2. Mean counts of gastrointestinal helminth eggs (primarily nematode) in plateau pikas examined in seven areas of Qinghai Province, China.

	Study sites						
Egg counts per gram of feces	Huang-yuan	Gangca	Bird Island	Madot	Gyling Lake	Norling Lake	Yushu
Chbertiinae sp.	220±88[a]	203±54	190±56	120±34	82±45	65±32	130±65
	240±63	185±69	230±89	143±76	78±34	68±23	145±43
Trichuris sp.	180±58	183±64	200±66	110±44	56±25	55±22	80±35
	169±73	195±59	190±69	123±46	67±24	58±24	95±33
Haemonchus sp.	185±48	173±54	203±62	122±43	66±35	58±21	83±36
	165±63	185±55	198±63	125±36	69±34	64±34	97±34
Eugenuris schumakowiescsi	485±98	437±55	413±102	332±53	176±53	185±53	288±66
	465±83	458±57	489±93	329±66	163±43	168±54	279±84
Cephaluris coloradensis	365±89	373±75	313±99	303±83	126±55	175±37	230±76
	375±87	385±87	389±83	307±69	138±45	137±45	225±81
Oesophagostomum sp.	155±68	153±66	123±67	120±65	56±25	55±37	103±55
	165±65	158±78	169±68	117±49	68±35	77±25	105±65

[a] In each cell, the top numbers refer to 2006 samples and the bottom numbers refer to 2007 samples

Ixodesovatus neumann—were found on the body surfaces of these animals. No parasitic protozoans were found in blood or tissues of these mammals using smear dye staining. Helminth eggs, primarily nematode, were present in a large number (83% of animals) of fecal samples (Table 2). The nematode eggs recovered from plateau pikas were primarily from *Eugenuris schumakowiescsi* and *Cephaluris coloradensis*.

DISCUSSION

The results of the fecal examination revealed that 83% of pikas, collected from various regions of Qinghai Province, maintained helminths. *Hypoderma curzonial*, *Pulex* sp. and *C. coloradensis* were the most abundant (Table 3). This observation is consistent with previous reports from other geographic regions of Qinghai (Wang et al., 2003) and Sichuan provinces (Ding et al., 1999).

Overall, intensity of infection with nematodes at Gyling Lake and Norling Lake were generally lower than the other regions surveyed, possibly because of the higher elevation (above 4,000 m) and lower rainfall of these sites (data not shown). However, the infection intensity at Madot (also above 4,000 m) may represent an exception to this observation.

The low prevalence of the *Echinococcus* sp. (e.g., either *E. multilocularis* or *E. shiquicus*; see above) at select study sites was likely associated with both the distribution of host species and environmental conditions (Table 3 and Table 4). These site-specific prevalence rates suggested that there might be some carnivores, such as foxes, at all study sites with the exceptions of Gyling Lake and Norling Lake, as the life cycle of *E. multilocularis* and/or *E. shiquicus* usually involves foxes (*Vulpes vulpes* in temperate regions, *Alopex lagopus* in arctic and subarctic regions and Tibetan fox [*Vulpes ferrilata*]) as definitive hosts (Schantz et al., 1995; Xiao et al., 2005). *Hymenolepis nana* showed a prevalence pattern similar to that mentioned above for *Echinococcus* sp. Of interest, *H. nana* can infect humans when eggs are ingested from contaminated food, water, or infected food handlers. Further, the eggs of this cestode can develop in grain beetles, which can contaminate grain intended for human consumption. Several peridomestic and domestic mammals can also become infected by ingesting this parasite, which represents another indirect potential risk for humans.

The high-elevation zone surveyed in this study records more rainfall than

TABLE 3. Number of parasites detected from plateau pikas at seven study sites during 2006 and 2007, Qinghai Province, China.

Species	Year	Study site						
		Huang-yuan	Gangca	Bird Island	Madot	Gyling Lake	Norling Lake	Yushu
Hypoderma curzonial	2006	31	31	28	28	31	28	28
	2007	32	28	28	27	28	28	29
Pulex sp.	2006	30	27	26	28	29	26	27
	2007	28	28	28	26	27	27	29
Ixodes ovatus	2006	27	28	28	26	2	1	28
	2007	28	29	26	25	3	3	26
Chbertiinae sp.	2006	8	7	6	5	6	5	7
	2007	9	7	7	7	5	5	8
Trichuris sp.	2006	5	6	5	4	5	5	7
	2007	6	4	4	5	4	5	5
Haemonchus sp.	2006	13	14	12	15	13	13	14
	2007	15	15	13	14	12	11	13
Eugenuris schumakowiescsi	2006	22	23	22	20	23	24	26
	2007	21	20	20	18	22	23	25
Cephaluris coloradensis	2006	30	29	28	29	28	27	26
	2007	29	28	27	28	28	28	27
Oesophagostomum sp.	2006	9	7	6	8	5	5	8
	2007	9	8	6	7	5	6	7
Schizorchis ochotonae	2006	3	4	3	2	2	3	2
	2007	4	3	2	2	4	4	3
Hymenolepis nana	2006	3	4	4	4	1	1	5
	2007	4	3	2	4	0	2	4
Echinococcus multilocularis	2006	4	5	3	4	1	0	3
or *Echinococcus shiquicus*	2007	4	4	3	3	0	1	2

TABLE 4. Prevalence of different parasite species associated with plateau pika in Qinghai Province in 2006 and 2007.

	Location[b]													
	HC		GA		BI		MC		GL		NL		YC	
Parasite[a]	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Hc	100	99	99	100	98	98	93	99	98	100	96	100	98	99
Ps	90	90	89	91	89.5	89	88	88	91	87.5	87.5	89	88	86
In	89	89	88	88	89	89	87	87.5	89	88	89.5	89	89	88
Cs	28	27	27	26	29	28	28.5	27	29	28	28	26	27.5	27
Ts	18	19	19	17	17.5	18	18	17	18	17.5	18	18	19	19
Hs	43	42	44	44	43	41	42	45	45	43	42	44	41.5	42
Es	78	76	78	77	77	75	79	76	76	77.5	79	79	77.5	75
Cc	99	99	98	100	100	98	99	97	98	98	99	99	99	98
Os	22	21	21.5	22	23	20	22	21	21	20.5	22	22	21	19
So	9	9	8	8	9	8	8	10	9	9	9	10	9	8
Hn	12	12	12	13	11.5	11	10	11	12	12	13	13	12	11
Em	10	11	9	9	10	8	10	9	7	12	12	10	11	9

[a] Hc = *Hypoderma curzonial*; Ps = *Pulex* sp.; In = *Ixodes ovatus*; Cs = *Chbertiinae* sp.; Ts = *Trichuris* sp.; Hs = *Haemonchus* sp.; Es = *Eugenuris schumakowiescsi*; Cc = *Cephaluris coloradensis*; Os = *Oesophagostomum* sp.; So = *Schizochis ochotonae*; Hn = *Hymenolepis nana*; Em = *Echinococcus multilocularis*.

[b] HC=Huangyuan County; GA= Gangca County; BI=Bird Island; MC=Madot County; GL=Gyling Lake; NL=Norling Lake; YC=Yushu City.

northwestern Qinghai Province where other surveys have been conducted (Yu et al., 1997). This may explain the higher prevalence and presence of some of the nematode species encountered during this project as compared to the northwestern portion of this province.

Ectoparasites, such as *Hypoderma curzonial*, *Pulex* sp., and *I. neumann*, yielded high numbers of individuals at most study sites, possibly because many migratory animals (e.g., livestock, which are often grazed at higher elevations in the summer and lower elevations in the winter) are present on the Tibetan Plateau, and these animals could transport ectoparasites to many locations that pastoralists utilize.

Certain parasitic infections can be carried over from one season to another within a host when conditions are favorable. This may explain the continued presence of the helminths in these animals, irrespective of seasons when environmental conditions preclude the development and survival of periphrastic stages. For example, localized contamination of watering and feeding areas may predispose certain mammals (e.g., blue sheep [*Pseudois nayaur*], wild yak [*Bos mutus*], fox [*Vulpes* sp.], wolf [*Canis lupis*], etc.) to infection by nematodes such as *Cephaluris* spp. These areas, therefore, may be key areas of transmission. In addition, swampy areas near livestock water troughs may provide a favorable environment for preparasitic worm development and larva survival.

Okamoto et al. (1988) indicated that captive Afghan pika (*Ochotona rufescens*) were highly susceptible to experimental infections with invasive larvae of roundworms (i.e., *Nematodirus* sp.) obtained from the gastrointestinal tract of a ruminant. Both *O. curzoniae* and *O. rufescens* are commonly found in plateau grasslands with ruminants and other livestock. However, parasites previously found in the gastrointestinal tract of ruminants (Okamoto et al., 1988) were not found in plateau pikas during this investigation. This observation could be related to annual helminthicide administration to yak and sheep during the spring and autumn.

At present, the number of species documented to parasitize plateau pika is greater than 40, including one trematode (Grundmann and Lombardi, 1976), six cestodes, 30 nematodes, and three arthropods (Hansen, 1948; Olsen, 1948; Rausch, 1963; Seesee, 1973). This study brings the addition of *Oesophagostomum* sp., *Haemonchus* sp., *Trichuris* sp., *Chbertiinae* sp., and *Pulex* sp. to this list. Overall, some of the parasites discovered in this study are consistent with those previously found in/on *Ochotona daurica* from northwestern China (i.e. *Ixodes* sp., *Cephaluris* sp., etc.; Liu et al., 2002) and *Ochotona princeps* from North America (i.e., *Dermatoxys* sp., *Murielus harpespiculus*, *Labiostomum* sp., *Cephaluris coloradensis*, and *Schizorchis ochotonae* (Hansen, 1948; Olsen, 1948; Leiby, 1961; Rausch, 1963; Seesee, 1973; Grundmann and Lombardi, 1976).

In summary, the results of this study indicated that plateau pikas in seven regions of southeastern Qinghai Province suffer from different degrees of parasite burdens. The close, often peridomestic, associations of this species with pastoralists and their livestock may contribute to human and ruminant parasitic infections. Undoubtedly, this is an area of research that warrants further attention.

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