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Wildlife Baiting Is Associated with an Increased Parasite Intensity in Raccoons (*Procyon lotor*) in Mississippi, USA

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ABSTRACT: Gastrointestinal tracts were obtained from 120 raccoons (*Procyon lotor*) on properties in the state of Mississippi, US, with and without wildlife baiting to observe the effects of baiting on parasite prevalence and intensity. Raccoons from baited properties had higher prevalence of *Gnathostoma procyonis* and higher intensities of *Physaloptera rara* and *Macracanthorhynchus ingens*, which can cross species barriers.

Wildlife baiting is an increasingly common practice that may facilitate wildlife pathogen transmission (Murray et al. 2016). Baiting often targets a single game species but usually has high use by nontarget animals. For example, raccoons (*Procyon lotor*) often feed on corn (*Zea mays*) seeds intended as bait for white-tailed deer (*Odocoileus virginianus*) (Bowman et al. 2015). Also, raccoons commonly harbor macroscopic nematodes and acanthocephalans (Kresta et al. 2009). Moreover, it has been experimentally demonstrated that concentrating food sources can affect endoparasite communities in raccoons by increasing prevalence of infection as a result of increased host contact (Wright and Gompper 2005; Monello and Gompper 2011). Here, we observe whether patterns from experimental manipulations are consistent with raccoon populations from baited and nonbaited properties in Mississippi, US.

A fur trapper donated 120 raccoon gastrointestinal tracts (esophagus to rectum) opportunistically trapped between February and March 2016 in seven counties in in the state of Mississippi (Fig. 1). Most were from areas where wildlife baiting was practiced but 18 were from nonbaited properties. Date, county, sex, and age (adult vs. juvenile) were recorded prior to removing the gastrointestinal tract, which was then stored in a –18 C freezer. Of the 120 samples, 92 (77%) were from males and 103 (85.8%) were from adults. After thawing, each gastrointestinal tract was dissected and processed using methods to detect macroscopic gastrointestinal parasites (Page et al. 2005). We acknowledge that focusing on macroscopic parasites could lead to underrepresentation of smaller organisms and underestimation of the total individuals. However, methods were kept consistent and were intended to determine if patterns in parasites were related to wildlife baiting. Presence of corn, gastric perforations, and ulcerative gastric lesions were recorded. Gastrointestinal contents were removed by scraping with a finger, placed into a plastic container, and mixed with tap water. The solution was then filtered through a 600-µm sieve. Parasites were collected with forceps and with the aid of a dissecting scope to discern mucus from helminths. Helminths were fixed in 70% isopropanol. Macroscopic nematodes and acanthocephalans were identified to species level (Miller 1992) in wet mounts by morphologic features.

Corn was present in 68 of the 120 gastrointestinal tracts from baited properties and was not present in gastrointestinal tracts from nonbaited properties. Thus, although we did not have perfect knowledge of each raccoon's access to bait, these data indicated that our knowledge of whether baiting occurred on a property was a good indicator of the probability that a captured raccoon had access to bait. Only *Physaloptera rara* (Museum of Southwestern Biology, Albuquerque, New Mexico, USA; accession no. MSB:Para:30094), *Gnathostoma procyonis* (accession no. MSB:Para:30095), *Macracanthorhynchus ingens* (accession no. MSB:Par:30093), and Cestodia were

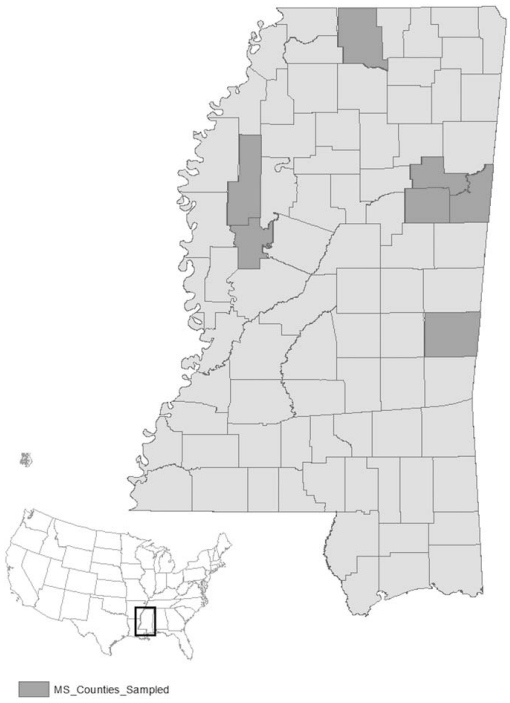

FIGURE 1. Locations in Mississippi, USA, where raccoon (*Procyon lotor*) gastrointestinal tracts were sampled and examined for the presence of parasites.

detected (Table 1). Intensity of Cestodia, the number of parasites found in a specimen, was unmeasurable because of high numbers of proglottids entangled with gastrointestinal mucus and autolysis. *Baylisascaris procyonis* was not detected in any raccoon. Grossly visible gastric lesions (ulcerations or abscesses) were present in 25% of gastrointestinal tracts, and gastric perforations were noted in 1.5% of gastrointestinal tracts at *G. procyonis* gastric attachment sites. Gastric perforations demonstrate a significant health burden in raccoons from parasitism and occurred only in raccoons from baited properties (Babero et al. 1959).

Using logistic and linear regression, we modeled the effect of baiting on the occurrence (binary response) and intensity (continuous response) of each parasite in JMP® (version 13, SAS Institute Inc., Cary, North Carolina, USA). Occurrence of *G. procyonis* was greater in raccoons from baited properties ($P<0.001$, $r^2=0.931$). Cestode occurrence tended to be associated with the presence of corn in the gastrointestinal tract ($P=0.067$, $r^2=0.771$). The presence of corn in the gastrointestinal tract was associated with an increased parasite intensity for *M. ingens* ($P<0.001$, $r^2=0.952$) and *P. rara* ($P<0.001$, $r^2=0.891$), but *G. procyonis* ($P=0.372$, $r^2=0.573$) was unaffected.

Consistent with the experimental data presented by Wright and Gompper (2005) and Monello and Gompper (2011), our data indicate that current baiting practices in wild populations of raccoons in Mississippi may be associated with increased parasite prevalence and intensities. Thus, wildlife baiting could potentially lead to wildlife health concerns not only for raccoons, but other wildlife species and humans. Baiting may facilitate the spillover of *P. rara*, *G. procyonis*, and *M. ingens* to other species. For example, *Physaloptera* spp. can also infect domestic dogs (*Canis lupus familiaris*), cats (*Felis catus*), coyotes (*Canis latrans*), and some lizards (Petri and Ameel 1950; Goldberg and Bursey 1989). Similarly, *M. ingens* can infect rats, swine, humans, and

TABLE 1. Percentage prevalence, intensity (the number of parasites found in a specimen), and intensity SD for each parasite found in raccoon (*Procyon lotor*) gastrointestinal tracts collected in the state of Mississippi, USA. Intensity and intensity SD of Cestodia could not be calculated because of high numbers of proglottids entangled with gastrointestinal mucus and autolysis.[a]

Parasites	Prevalence	Mean intensity	Intensity (SD)
Gnathostoma procyonis	46.7	1.08	1.1 (2.2)
Physaloptera rara	39.2	1.3	3.9
Macracanthorhynchus ingens	45.0	2.2	2.2
Cestodia	27.5	—	—

[a] — = not applicable.

many carnivore species (Dingley and Beaver 1985; Pearce et al. 2001). *Gnathostoma procyonis* can infect most vertebrate animals, including humans (Lockhart 2007). Concentrating animal and human use at feeders is likely to increase contact rates across species and result in exposure to these parasites. Thus, continuation of wildlife baiting may be a wildlife and human health concern (Milner et al. 2014).

LITERATURE CITED

Babero BB, Shepperson JR, Sicay TC. 1959. Additional records of Gnathostomes in North American hosts. *Rev Biol Trop* 7:63–66.

Bowman B, Belant JL, Beyer DE Jr, Martel D. 2015. Characterizing nontarget species use at bait sites for white-tailed deer. *Hum Wildl Interact* 9:11.

Dingley D, Beaver PC. 1985. *Macracanthorhynchus ingens* from a child in Texas. *Am J Trop Med Hyg* 34:918–920.

Goldberg SR, Bursey CR. 1989. *Physaloptera retusa* (Nematoda, Physalopteridae) in naturally infected sagebrush lizards, *Sceloporus graciosus* (Iguanidae). *J Wildl Dis* 25:425–429.

Kresta AE, Henke SE, Pence DB. 2009. Gastrointestinal helminths in raccoons in Texas. *J Wildl Dis* 45:1–13.

Lockhart JM. 2007. *Gnathostoma procyonis* from south Georgia and north Florida raccoons. *J Parasitol* 93: 1533–1536.

Miller GC. 1992. A key to some common helminths of the raccoon, *Procyon lotor*, in the southeastern United States. *J Elisha Mitchell Sci Soc* 1:111–116.

Milner J, Van Beest F, Schmidt K, Brook R, Storaas T. 2014. To feed or not to feed? Evidence of the intended and unintended effects of feeding wild ungulates. *J Wildl Manag* 78:1322–1334.

Monello RJ, Gompper ME. 2011. Effects of resource availability and social aggregation on the species richness of raccoon endoparasite infracommunities. *Oikos* 120:1427–1433.

Murray MH, Becker DJ, Hall RJ, Hernandez SM. 2016. Wildlife health and supplemental feeding: A review and management recommendations. *Biol Conserv* 204:163–174

Page LK, Gehrt SD, Titcombe KK, Robinson NP. 2005. Measuring prevalence of raccoon roundworm (*Baylisascaris procyonis*): A comparison of common techniques. *Wildl Soc Bull* 33:1406–1412.

Pearce JR, Hendrix CM, Allison N, Butler JM. 2001. *Macracanthorhynchus ingens* infection in a dog. *J Am Vet Med Assoc* 219:194–196.

Petri LH, Ameel DJ. 1950. Studies on the life cycle of *Physaloptera rara* Hall and Wigdor, 1918, and *Physaloptera praeputialis* Linstow, 1889. *J Parasitol* 36 (Sect. 2 Suppl):40.

Wright AN, Gompper ME. 2005. Altered parasite assemblages in raccoons in response to manipulated resource availability. *Oecologia* 144:148–156.

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