Host Specificity of *Oxyspirura petrowi* in Wild Turkey

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Abstract - The Rolling Plains ecoregion of Texas hosts the highest known prevalence and intensity of the eyeworm *Oxyspirura petrowi* among *Colinus virginianus* (Northern Bobwhite) in the US. *Meleagris gallopavo* (Wild Turkey) and the Northern Bobwhite have a similar diet (i.e., facultative insectivore), overlapping ranges, and phylogenetic relatedness (i.e., Galliformes); thus, we expected Wild Turkeys sympatric with an infected population of wild Northern Bobwhites to also host eyeworms. In 2014, we dissected 104 Wild Turkey and 50 Northern Bobwhite heads from a 27,530-ha area in Roberts County, TX. Only 1 turkey (female) was infected with a single eyeworm. Prevalence, mean abundance (± SE), and mean intensity (± SE) among Northern Bobwhites on the same area was 58%, 7.6 ± 1.8, and 13.1 ± 2.7, respectively. Eyeworm prevalence between Northern Bobwhite males (n = 25, 64%) and females (n = 25, 52%) was not statistically different (P = 0.57). Mean abundance (± SE) was similar between males (8.8 ± 2.6) and females (6.4 ± 2.5; P = 0.53), and mean intensity between males (13.7 ± 3.5) and females (12.4 ± 4.3) did not differ (P = 0.71). Wild Turkeys do not appear to be suitable hosts for *O. petrowi.*

Introduction

Host specificity is defined as the number of host species that are used by a parasite population (Poulin et al. 2011). High host specificity is demonstrated in parasites utilizing a single or few host(s) to complete a life cycle, whereas low host-specificity is described as a parasite infecting multiple definitive hosts. Collectively, host diversity and parasite specificity dictate whether a parasite can persist when a host becomes locally extirpated or scarce, and whether a parasite has the potential to colonize new areas (Lafferty 2012, Poulin et al. 2011). Therefore, understanding the susceptibility of various host species to a parasite offers insight into the life cycles and extinction risks of parasites themselves (Strona 2015).

Colinus virginianus L. (Northern Bobwhite, hereafter, Bobwhite) and *Meleagris gallopavo* L. (Wild Turkey) are among the most pursued game birds in Texas and occur sympatrically across most of their range. Recent studies in the Rolling Plains ecoregion of Texas have considered the role of disease in population regulation of Bobwhite, with heightened interest on the eyeworm *Oxyspirura petrowi* (Cobbold) (Brym et al. 2018; Dunham et al. 2014, 2016a, 2016b). The highest known prevalence and intensity of eyeworms among Bobwhites in the US occurs in the Rolling Plains ecoregion of northwest Texas and western Oklahoma (Kubečka et al. 2017). Wild Turkeys and Bobwhites have similar diets (i.e., facultative insectivores), overlapping ranges, and phylogenetic relatedness (i.e., Galliformes); thus, we expected Wild Turkeys sympatric with an infected population of Bobwhites would also host eyeworms.

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Field-site Description

This study was conducted on a 27,530-ha area in Roberts County, TX (35°56'1"N, 100°52'33"W) where Bobwhites and Wild Turkeys inhabit similar vegetation communities (Guthery et al. 2005). Annual precipitation averages 590 mm and the area is characterized by a native plant community of *Andropogon hallii* Hack. (Sand Bluestem), *Schizachyrium scoparium* Michx. (Little Bluestem), *Panicum virgatum* L. (Switchgrass), *Artemsia filifolia* Torr. (Sand Sagebrush), *Prunus angustifolia* Marsh. (Sand Plum), and *Rhus trilobata* Nutt. (Skunkbush Sumac) (NRCS 2017, US Climate Data 2017).

Methods

We solicited hunter-donated Bobwhites (n = 50) during October 2014–February 2015. We opportunistically solicited Wild Turkey heads (n = 104) from hunters and researchers conducting a study of Wild Turkey diets in the area during April–July 2014. Researchers flash-froze Wild Turkey heads immediately upon harvest using ethyl alcohol and dry ice to mitigate the possibility of eyeworms migrating from the orbital cavity. For convenience of quail hunters and lack of research personnel on site during hunts, hunter-harvested Bobwhite samples were not flash frozen but conventionally frozen. We stored all heads frozen in individual, labeled, plastic bags until dissection.

For both host species, we examined under the eyelids and nictitating membranes before removing the eyes and examining the nasal-lacrimal sinuses, Harderian glands, and lacrimal ducts (Bruno et al. 2015, Dunham et al. 2014). Although eyeworms are apparent to the naked eye, we used a stereo zoom microscope (7X–45X) and a 3-diopter (1.75X) magnifying lens with LED illumination to assure detection. We compared host prevalence by sex using Fisher's exact test (PROC FREQ) and mean abundance and mean intensity with a Kruskal–Wallis test (PROC NPAR1WAY) in SAS Studio (SAS Institute Inc., Cary, NC).

Parasitological terms presented herein adhere to definitions suggested by Bush et al. (1997), where "prevalence" describes percent of infected individuals in a sample; "mean abundance" describes average number of eyeworms among all samples (i.e., infected and non-infected), and "mean intensity" describes the average number of eyeworms within the subset of infected individuals. Descriptive statistics herein are presented as the mean ± 1 standard error (SE).

Results

Twenty-nine of the 50 Bobwhites (58%) hosted eyeworms, with a mean abundance of 7.6 ± 1.8 and mean intensity of 13.1 ± 2.7. Prevalence was similar between male (n = 25, 64%) and female (n = 25, 52%) Bobwhites (P = 0.57). Mean abundance was similar between males (8.8 ± 2.6) and females (6.4 ± 2.5; P = 0.53); mean intensity between males (13.7 ± 3.5) and females (12.4 ± 4.3) did not differ (P = 0.71). Only 1 of the 104 Wild Turkeys (female) hosted a single eyeworm.

Discussion

We examined 104 Wild Turkeys (*n* = 63 females, 41 males) and 50 Bobwhites (*n* = 25 females, 25 males) for eyeworms during 2014–2015. Age composition of our Bobwhite sample was 32 juveniles, 3 adults, and 15 birds of unknown age. We did not obtain specific ages for female Wild Turkeys, but all were after-hatch-year (AHY) individuals. Male age composition included 15 juveniles (i.e., 1-y old), 18 adults (>1-y old), and 8 of unknown age. We were unable to evaluate the effect of host age on eyeworm prevalence or abundance for either species, though eyeworm prevalence and abundance in Bobwhites tends to be greater in adults than juveniles (Bruno et al. 2018, Dunham et al. 2016a). Thus, given the large proportion of juveniles in the sample, our estimate for mean abundance and intensity for Bobwhites is likely a conservative one. No evidence currently exists for developed resistance to eyeworm with host age. Rather, time-related accumulation seems to occur from prolonged exposure to infective stages of eyeworm (Bruno et al. 2018, Dunham et al. 2016a, Villareal et al. 2016).

Our Wild Turkey sample appears to be the first conclusive report of eyeworm in *Meleagris gallopavo* ssp. *intermedia* Sennett (Rio Grande Wild Turkey). We deposited the eyeworm voucher specimen from the Wild Turkey in the Sam Houston State University Parasite Museum (SHSUP), Sam Houston State University, Huntsville, TX (SHSUP 001599). Though eyeworms are not commonly reported to infect Wild Turkeys, Addison and Prestwood (1978) documented prevalence of *Oxyspirura turcottei* Addison in 8% of *M. g. silvestris* (Viellot) (Eastern Wild Turkey) collected in West Virginia. Infections of *O. petrowi* are reported in a wide range of galliforms, except for Wild Turkeys, in the Great Plains. For example, Robel et al. (2003) documented 95% prevalence among *Tympanuchus pallidicinctus* (Ridgway) (Lesser Prairie Chicken) in western Kansas. Likewise, *Phasianus colchicus* (L.) (Ring-necked Pheasant) and *Callipepla squamata* (Vigors) (Scaled Quail) are also susceptible hosts with prevalence of 39% and 72%, respectively (Bedford 2015, Dunham et al. 2017, McClure 1949). Pence (1972) recovered eyeworms from 21 species of birds from across multiple taxonomic orders. In regards to host specificity, Pence (1972:27) stated, "*O. petrowi* exhibits little host specificity and is encountered primarily in birds found in open fields, submarginal grasslands, and marsh lands. Its presence in a number of species of avian hosts representing several families, but all occupying comparable ecological niches, indicates that host specificity is not dependent on definitive host physiology. Rather, it is probably dependent on the occurrence of the intermediate host(s) which is restricted to a particular habitat."

The overlapping diets and range of Bobwhite and Wild Turkeys from this study suggest that intermediate hosts may not be the only limiting factor for *O. petrowi* development. Wild Turkeys are opportunistic foragers with diets similar to Bobwhites (Glover and Bailey 1949, Peterson 2007). A compositional analysis of Wild Turkey diets from our sample revealed at least 74% of individuals consumed arthropods across 9 taxonomic orders including: Araneae, Blatarria, Coleoptera, Hemiptera, Homoptera, Hymenoptera, Lepidoptera, Mantodea, and Orthoptera

(Rolling Plains Quail Research Ranch, Roby, TX , unpubl. data). It is likely that all Wild Turkeys consumed arthropods during the study, but these estimates are a function of sampling bias (i.e., crop, gizzard-content analysis). By documenting DNA from *O. petrowi* in various species of cockroaches, crickets, and grasshoppers, Almas et al. (2018) identified arthropods of these groups as potential intermediate hosts. Successful in vitro infection of Bobwhites has been demonstrated using *Brachystola magna* Girard, C. (Plains Lubber Grasshoppers; Kistler et al. 2016), but their occurrence in Bobwhite diets has not been documented. However, Plains Lubber Grasshoppers were noted in the diet of Wild Turkeys from our sample. Nonetheless, we presume that Wild Turkeys in this study were consuming arthropods infected with *O. petrowi* larvae.

Peak mean abundance of eyeworms for Bobwhites in the region occurs during May–July, which coincided with our Wild Turkey collection period (Dunham et al. 2017, Jackson and Green 1964). Thus, the probability of detecting infection of *O. petrowi* in Wild Turkeys should have been the highest during our sampling period. Further, our hunter-harvested sample (October–February) of Bobwhite likely provides conservative estimates of Bobwhite infection. Anatomical differences, i.e., greater distance and stronger physical gradient from crop to lacrimal ducts in Wild Turkeys (~20 cm), may preclude immigration by eyeworm larvae. However, Wild Turkey poults would not be subject to this limitation. As documented in various mammals (Villalba et al. 2014), there is also a possibility that Wild Turkeys have the ability to self-medicate by consuming natural anthelmintics from plants not available to Bobwhite. For example, 9% of Wild Turkeys from our sample were documented consuming *Equisetum* spp. (horsetails)—plants containing silica that could serve as an anthelmintic (Wiewióra et al. 2015). However, this retroductive hypothesis does not appear to ubiquitously explain lack of eyeworm documentation in the literature, and the proportion of individuals consuming notable plants in this study was low.

A survey of 35 sites across the Rolling Plains indicated that our study site had one of the highest prevalence rates of eyeworms in Bobwhites during 2011–2013 (Bruno 2014, Dunham et al. 2016a). Our results are limited to 1 area and 1 year, but we feel that the sample size was sufficient to document prevalence of *O. petrowi* in Wild Turkeys. Coupled with the lack of documentation in the literature, Wild Turkeys do not appear to be suitable hosts for *O. petrowi*. Understanding why Wild Turkeys are rarely infected by *O. petrowi*, despite numerous infections of other galliforms in the same region may help better understand the life cycle of *O. petrowi*.

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