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Knemidokoptic mite infestation of island populations of Red-winged Blackbirds (*Agelaius phoeniceus*)

James S. Marshall[1,2]* and Sarah K. Winnicki[1,3]

ABSTRACT—Knemidokoptic mites infest many bird species around the world and may lead to decreased survival, although relatively few studies have documented long-term effects on populations. We present 9 years of data monitoring the survival of Red-winged Blackbirds (*Agelaius phoeniceus*) in islands of Lake Erie, Ohio, USA. Blackbirds in our study first appeared with mite infestation in 2012. Percentage of the total number of blackbirds infested with mites peaked at 7.3% in 2013 and persisted at 5–6% through the summer of 2018. We saw no differences in infestation rates based on blackbird sex or age. Unlike most other studies, in subsequent years we did recapture birds that had previously had infestations, and we detected no decline in recapture rate due to mite infestation. While that does not mean that blackbirds do not experience negative consequences of infestation, our evidence does suggest that low-level infestation may be persistent in a population without dramatic declines in survivorship. *Received 8 January 2021. Accepted 21 January 2022.*

Key words: Icteridae, parasites, survivorship.

[1] F.T. Stone Laboratory and Ohio Sea Grant, The Ohio State University, Put-in-Bay, OH, USA

[2] Department of Chemical & Biological Sciences, Rockford University, Rockford, IL, USA

[3] Program in Ecology, Evolution, and Conservation, University of Illinois at Urbana-Champaign, Urbana, IL, USA

* Corresponding author: jmarshall@rockford.edu

Infestación con ácaros knemidokópticos de poblaciones insulares del tordo *Agelaius phoeniceus*

RESUMEN (Spanish)—Los ácaros knemidokópticos infestan muchas especies de aves en todo el mundo y podrían conducir a menor sobrevivencia, aunque relativamente pocos estudios han documentado los efectos a largo plazo en sus poblaciones. Presentamos 9 años de datos de monitoreo de sobrevivencia de tordos *Agelaius phoeniceus* en islas del lago Erie, Ohio, EU. Los tordos infestados con ácaros aparecieron por primera vez en nuestro estudio en 2012. El porcentaje del total de tordos infestados con ácaros alcanzó un máximo de 7.3% en 2013 y persistió en porcentajes entre 5–6% hasta el verano de 2018. No observamos diferencias en las tasas de infestación con base en el sexo o edad del tordo. A diferencia de la mayoría de otros estudios, en años subsecuentes recapturamos aves que previamente estaban infestados y no detectamos declines en la tasa de recaptura debido a infestaciones de ácaros. Si bien esto no significa que los tordos no experimentan consecuencias negativas por estar infestados, nuestra evidencia sugiere que un nivel bajo de infestación podría persistir en una población sin declines dramáticos en sobrevivencia.

Palabras clave: Icteridae, parásitos, sobrevivencia.

Knemidokoptic mite infestations have been reported from a wide range of species in North America (Kirmse 1966, Pence et al. 1999, Benkman et al. 2005), South America (Latta 2003), Europe (Dabert et al. 2013, Martinho et al. 2017), Asia (Mainka et al. 1994), and Africa (Goulding et al. 2012, van Velden et al. 2017). Infestation rates can vary from relatively low to quite high (<5–40% in Cape Wagtails [*Motacilla capensis*]) and reach 60% in migratory American Robin (*Turdus migratorius*) populations (Pence et al. 1999, Goulding et al. 2012). Some studies show parasitism effects on fitness components (Latta 2003, Benkman et al. 2005, van Velden et al. 2017), but most studies are anecdotal, recording unusually high incidence (Pence et al. 1999) or first appearances (Martinho et al. 2017). Few investigations assess mite infestation dynamics in a population over longer time periods (van Velden et al. 2017).

The typical mite infestation first manifests as lesions, sometimes referred to in the literature as "mange" (Kirmse 1966). More advanced cases include hyperkeratosis on the legs in which the tarsometatarsus and toes are covered in extensive keratinized growths (Dabert et al. 2013). These often result in loss of digits or feet (Goulding et al. 2012) and almost certainly involve other negative fitness consequences, including increased rates of secondary infection.

We report mite infestation data from a long-term study of breeding Red-winged Blackbird (*Agelaius phoeniceus*) island populations of Lake Erie, Ohio. We observed persistent low levels of the infestation for most years of the study. We also assessed the patterns of infestation by age and sex, as well as noting a few birds surviving more than 1 year with infestations. These data will help to better understand the interaction between this ectoparasite and one of its hosts over multiple years.

Methods

We captured Red-winged Blackbirds as part of a long-term study of summer breeding birds conducted every summer in June and July from 2010 to 2018 as part of the Stone Laboratory Research Experience for Undergraduates program. The start of our project each year corresponds with the end of the first breeding attempt for the blackbirds. Many, but not all, females will attempt a second brood during the course of the project each year.

We caught all birds in passive 6 and 12 m mist nets at 5 sites on 4 islands in Lake Erie: Gibraltar Island (41°39′29.6″N, 82°49′16.5″W), Scheeff Preserve on South Bass Island (41°39′54.6″N, 82°47′46.2″W), the grounds around the Bayview office of Stone Laboratory on South Bass Island (41°39′29.6″N, 82°49′16.5″W), East Point Nature Preserve on Middle Bass Island (41°41′45.1″N, 82°46′52.8″W), and vineyards on North Bass Island (41°42′35.4″N, 82°48′59.7″W). The Gibraltar and Bayview office sites are residential areas with a mix of buildings, mowed lawn, shrubs, and mixed mature hardwood trees. The preserve habitats include open habitats in the shrub stage of secondary succession and stands of mixed hardwood trees. Although all sites are adjacent to some Lake Erie shore, none include any wetland habitat. We visited all sites once a week for 4 weeks each summer with the exception of the Bayview site, which we only visited once each summer. We had mist nets up for about 4 h each morning, weather permitting.

We banded each bird with an aluminum federal band and took a series of morphological measurements (unflattened wing chord, mass, and fat score). For Red-winged Blackbirds, we also measured tarsus and 3 bill dimensions (width, length, and depth) as part of a separate project. Finally, we recorded presence or absence of symptoms of mite infestation. Because birds can spread mite infestation through contact (Kirmse 1966), we washed all equipment and hands with soap and water, or if not available, with hand sanitizer, after handling a bird with mite infestation. In some cases where we could not sterilize weighing equipment, we omitted mass measurements.

We used a multiple logistic regression with infestation as the dichotomous response variable to investigate the effects of year, Julian date, age, sex, and size on mite infestation. We divided wing chord by tarsus to provide an index of bird size. We then used χ^2 tests of independence to compare infestation rates between male and female blackbirds, second-year (SY) and after-second-year

Table 1. Age and sex class overall rates of mite infestation in Red-winged Blackbirds from 4 islands in Lake Erie, Ohio, 2010–2018.

Age and sex class	% Birds infested	*n*
After second year female	4.4	297
Second year female	4.0	251
After second year male	10.7	75
Second year male	5.4	334

(ASY) blackbirds, and SY and ASY male blackbirds. We used IBM SPSS Statistics for Windows, Version 27 (IBM Corp., Armonk, New York, USA), for our analysis.

Results

Between June of 2010 and July of 2018, we captured and banded 957 adult Red-winged Blackbirds. Of these, 251 were SY females, 297 were ASY females, 334 were SY males, and 75 were ASY males. Across all years, infestation rates varied among the groups from a low of 4.0% in SY females to a high of 10.7% in ASY males (Table 1).

We found no significant effects of year, date of capture, age, sex, or size on infestation rates in our logistic regression analyses ($P > 0.05$). Infestation rate did vary across the years, and year did approach significance in the model (Wald = 3.3, $P = 0.069$), but did not ultimately produce a better model than the null model.

ASY blackbirds were slightly more likely to be infested (5.6%) than SY blackbirds (4.8%), but this difference was not significant ($\chi^2 = 0.35$, df = 1, $P = 0.56$). Male blackbirds were also more likely to be infested (6.4%) than female blackbirds (4.2%), but this difference was also not significant ($\chi^2 = 2.25$, df = 1, $P = 0.13$). Finally, although ASY males were twice as likely to be infested (10.7%) as SY males (5.4%), this difference was also not statistically significant ($\chi^2 = 2.87$, df = 1, $P = 0.090$).

Infestation rates also varied over time (Fig. 1). We detected no infested blackbirds in the first 2 years (2010 and 2011). The highest rates were in 2013 (7.3%) and 2014 (6.0%), with sustained infestation rates generally 5–6% between 2015 and 2018.

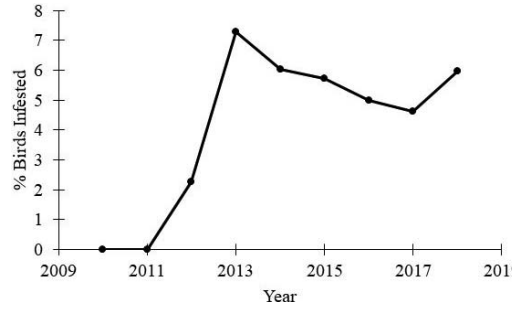

Figure 1. Annual rate of mite infestation in Red-winged Blackbirds from 4 islands in Lake Erie, Ohio, 2010–2018.

Over the 9 years of our study, we recaptured 40 Red-winged Blackbirds in a year subsequent to their initial capture: 24 females and 16 males. Most were uninfested in both encounters. One female and 2 males, however, were recaptured with mite infestation after initially captured without infestation. We also recorded 2 males that had a mite infestation on initial capture but had no evidence of mite infestation when recaptured. We captured 1 female on 28 June 2016 with mite infestation that we recaptured on 14 July 2018 still with mite infestation. This is the only infested bird that we have recaptured in a later year.

Finally, we caught a male blackbird in June of 2013 with mite infestation and a mass of 57.1 g (compared to the mean for male blackbirds that year of 63.2 ± 0.4 g). We recaptured that male 14 d later with a mass of 41 g, a 28% decrease. Blackbirds recaptured within a season usually vary in mass by less than 1 g. We did not capture that male again.

Of the 49 blackbirds captured with mite infestation, we recaptured 3 for a recapture rate of 6.1% for infested birds. This is higher than the overall recapture rate of 4.1% for uninfested blackbirds, but the difference is not statistically significant ($\chi^2 = 0.49$, $P = 0.49$).

Discussion

Our data show a persistent low level of mite infestation in Red-winged Blackbirds on the Lake Erie islands from at least as far back as 2012. Once we started detecting mite infestation in the population, the levels have been relatively steady across years regardless of age or sex of the blackbirds. Infestation, however, does not seem to

be significantly decreasing the recapture probability of blackbirds despite some anecdotal indications of negative impacts on heavily infested individuals.

Several authors have noted Red-winged Blackbirds as hosts for knemidokoptic mites (Olive 1952, Herman et al. 1962, Kirmse 1966). Kirmse's work (1966) involved the most extensive survey and took place in an environment similar to our Lake Erie study sites, especially birds studied at Long Point, Ontario, on Lake Erie. He reported infestation rates ranging from low levels similar to ours (4.2% of 546 birds) to much higher levels (40% of 446 birds). Kirmse (1966) speculated that gregarious birds like blackbirds, once infested, could potentially quickly spread mites to other birds. His own experiments successfully demonstrated transmission from infested to healthy birds within the close proximity of cages, although the lack of transmission to other species implied a degree of mite host specificity. Kirmse (1966) also postulated that warm environments and mild injury accelerate the rate of lesion development and increase the probability of infestation. It is not clear when Kirmse (1966) sampled the blackbirds in his study. We caught blackbirds in the middle of summer when many birds were producing a second brood. Toward the end of our sampling each year, blackbirds were beginning to gather in larger flocks including hatch-year birds. It is possible that sampling in August and September would have recorded higher infestation rates as infested birds mingled with healthy susceptible birds including recent fledglings.

Given that the infestation rates we observed fall within the lower end of the range of rates reported for Red-winged Blackbirds, how do those rates compare to rates observed in other species? A large number of species have never been observed with mite infestation (Dabert et al. 2013). Kirmse (1966) reported low infection rates among several other icterids, including 1.3% (out of 152) in Brown-headed Cowbirds (*Molothrus ater*) and 6.2% (out of 86) in Common Grackles (*Quiscalus quiscula*) caught at Long Point, Ontario. He also noted 1 infested Black-capped Chickadee (*Poecile atricapillus*). European studies have found infestation in other parids (Martinho et al. 2017). Pence et al. (1999) reported rough estimates of 60–80% infestation rates in migrating flocks of several hundred American Robins in Oklahoma in the winters of 1993–1994 and 1994–1995. These are not based on capture data, however, and they report no baseline data from non-epizootic years.

Our study takes place on islands. It is possible that island populations are subject to unusual conditions, both for blackbirds and for mites. In a study of Cape Wagtails on Dassen Island, South Africa, Goulding et al. (2012) observed a high infestation rate of 42% in 117 sampled birds. This is well above our highest annual observed rate of 7.3% in 2013. The authors speculated that the larger roosts on the island allow for greater transmission, although they also proposed that increased physiological stress might impair immune system function. Previous work clearly shows that parental effort has negative impacts on immune system function (Deerenberg et al. 1997, Nordling et al. 1998), but we did not see a comparably high rate of infestation in our breeding island population of blackbirds. This is similar to what van Velden et al. (2017) saw in Black Goshawks (*Accipiter melanoleucus*) where breeding populations never had an infestation rate above 5%.

Both van Velden et al. (2017) and Benkman et al. (2005) observed male-biased infestation rates. The rates in Black Goshawks, however, were based on very small sample sizes that may not indicate a biological trend. Benkman et al.'s (2005) work with Red Crossbills (*Loxia curvirostra* ssp.) shows annual variation based on sex with males having an overall higher infestation rate (37%) than females (27.5%) over 8 years of data. While we see a slightly higher infestation rate in male blackbirds, and particularly ASY males, none of the differences were statistically significant.

Several studies report impacts of mite infestation on either survival or reproduction of infested birds. Latta (2003) reports dramatic differences in return rates of Palm Warblers (*Setophaga palmarum*) and Prairie Warblers (*S. discolor*) to Dominican wintering grounds. In 2 years, no infested bird ever returned, despite overall return rates of well over 50% for uninfested birds. Benkman et al. (2005) found a 15% decrease in adult Red Crossbill survival in infested birds versus uninfested. The decline was so pronounced, particularly in males, that it appeared to be driving directional selection for smaller bill sizes. In Black Goshawks, both nesting success and breeding productivity decreased over 50% in pairs with at

least 1 infested adult (van Velden et al. 2017). While we do not have breeding success data for infested and uninfested blackbirds, we fail to detect any significant difference in survival. Part of the difficulty in detecting survival differences is the very low return rate of birds in our study. MARK analyses estimate annual recapture probabilities at or below 10% for all years of the study (JSM, 2019, unpubl. data). Unlike Latta (2003), however, we do have at least 3 records of infested birds returning, 2 without visible lesions, which to our knowledge is the first report of such recovery. Our anecdotal observation of mass loss in an infested male blackbird, however, does suggest that infestation could have detrimental survivorship consequences, although we cannot strictly attribute that mass loss to the mite infestation.

Overall, then, we see that Red-winged Blackbirds on the Lake Erie islands experience a low level of infestation that may not adversely affect the overall population. Further information on breeding success in these populations, however, might provide a better picture of the actual fitness impact of the mites. Sampling the population in the late summer and early fall might also provide insight into transmission rates, particularly between infested adults and hatch-year birds. We also note birds surviving and even recovering from infestation, the latter being a potentially unprecedented, and certainly uncommon, observation. Although studies do not suggest high levels of transmission between species (Kirmse 1966), the large population size and range of Red-winged Blackbirds could make them a potential reservoir species, warranting some renewed attention to interspecific interactions among infested and uninfested birds

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