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PREVALENCE AND HOST–PARASITE LIST OF SOME NASAL MITES FROM BIRDS (ACARINA: RHINONYSSIDAE, SPELEOGNATHIDAE)

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ABSTRACT: A survey of nasal mites, primarily from birds in Texas, was reported and comparisons with the other major studies were made. Of 103 host species examined, 40 were parasitized, and of 502 individual birds examined, 87 were parasitized (17% prevalence). It was shown that the prevalence of infection was significantly dependent on the bird taxa examined, which indicates that the evolution of the hosts has affected the nasal mites' ability to parasitize their avian hosts. It was also shown that the prevalence of rhinonyssid nasal mites in their hosts seems to differ significantly between geographic regions.

As part of a systematic survey of the nasal mites from birds of North and Central America that was begun in 1974, I have accumulated a large host–parasite list along with the prevalence of these parasites. Now that I have essentially completed my taxonomic studies (Spicer, 1977a, 1977b, 1978, 1984), I am presenting these data as Pence (1973) did for his extensive study of Louisiana birds. The usefulness of this information is in its potential for comparison with other studies (Maa and Kuo, 1965; Domrow, 1969; Pence, 1973; Spicer, 1984) in an attempt to determine the evolutionary biology of these endoparasites. In addition, it is clear that studies requiring large-scale collecting of birds are becoming increasingly more difficult. Consequently, this study can serve as a guide to future researchers for determining the most important questions that remain unanswered.

MATERIALS AND METHODS

Birds were collected mostly by shooting, but some were obtained from mist nets or as road-kills. Although most of these birds came from Texas, some also came from other states and Mexico. The birds from Texas were collected primarily from 4 counties (listed in order of decreasing importance): Tarrant, Hood, Mason, and Gillespie. Voucher specimens of some hosts have been deposited in the Fort Worth Museum of Science and History, Fort Worth, Texas. The specimens were usually frozen until they were examined. Mites were collected manually by splitting the upper beak between the nostrils and examining the nares and turbinates with a probe under a dissecting scope. None of the hosts reported in this paper were examined using Yunker's technique (1961) because Wilson (1964) demonstrated that this technique was not as effective in obtaining nasal mites as was the dissection method. Therefore, for the sake of comparison, only specimens that were dissected manually are included in this study. Consequently, not all the mites and their hosts reported in my previous papers can be accounted for in this host–parasite list, and none of the material presented in Spicer (1984) is included. Mites were cleared in lactophenol, mounted in Hoyer's media, and rung with Zut's compound or General Electric wire paint. The mite specimens are retained in the author's collection. The names and classification used for the hosts in the present study are those of the A.O.U. checklist (1983). Usage of the ecological parasitology terms follows the recommendations of Margolis et al. (1982).

RESULTS AND DISCUSSION

Forty of 103 bird species (39%) were parasitized with nasal mites (Table I). This is very similar to values recorded in previous studies. Maa and Kuo (1965) reported that 45% of the bird species examined in Taiwan were infected. Pence (1973) also reported that a high proportion, 48%, of the Louisiana bird species were parasitized. Domrow's (1969) studies on Australian birds revealed that about 36% of the species he examined were infected, which is very close to the 33% value Spicer (1984) reported for some Guatemalan bird species. However, the study by Spicer (1984) used Yunker's technique to recover the

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TABLE I. *Host–parasite list and prevalence of the Rhinonyssidae and Speleognathidae families of nasal mites from birds.*

Hosts examined	Parasite	Prevalence
ORDER ANSERIFORMES		
Family Anatidae		
Gadwall (*Anas strepera*)	–	0/2
American wigeon (*Anas americana*)	–	0/1
Shoveler (*Anas clypeata*)	*Ophthalmognathus womersleyi*	1/2
Ring-necked duck (*Aythya collaris*)	–	0/1
Lesser scaup (*Aythya affinis*)	*Rhinonyssus rhinolethrum*	1/5
ORDER FALCONIFORMES		
Family Accipitridae		
Red-tailed hawk (*Buteo jamaicensis*)	–	0/1
ORDER CHARADRIIFORMES		
Family Charadriidae		
Killdeer (*Charadrius vociferus*)	*Rhinonyssus strandtmanni*	1/4
ORDER COLUMBIFORMES		
Family Columbidae		
Mourning dove (*Zenaida macroura*)	*Tinaminyssus zenaidurae*	1/1
ORDER CUCULIFORMES		
Family Cuculidae		
Yellow-billed cuckoo (*Coccyzus americanus*)	–	0/4
ORDER STRIGIFORMES		
Family Strigidae		
Screech owl (*Otus asio*)	–	0/4
Burrowing owl (*Speotyto cunicularia*)	–	0/1
Barn owl (*Tyto alba*)	–	0/1
ORDER CAPRIMULGIFORMES		
Family Caprimulgidae		
Chuck-will's-widow (*Caprimulgus carolinensis*)	–	0/1
ORDER APODIFORMES		
Family Apodidae		
Chimney swift (*Chaetura pelagica*)	–	0/1
Family Trochilidae		
Black-chinned hummingbird (*Archilochus alexandri*)	–	0/1
Buff-bellied hummingbird (*Amazilia yucatanensis*)	*Ptilonyssus mariacastroae*	2/3
ORDER CORACIIFORMES		
Family Alcedinidae		
Belted kingfisher (*Ceryle alcyon*)	–	0/2
ORDER PICIFORMES		
Family Picidae		
Northern flicker (*Colaptes auratus*)	–	0/2
Red-bellied woodpecker (*Melanerpes carolinus*)	–	0/1
Yellow-bellied sapsucker (*Sphyrapicus varius*)	–	0/2
Ladder-backed woodpecker (*Picoides scalaris*)	–	0/5
Downy woodpecker (*Picoides pubescens*)	–	0/5
ORDER PASSERIFORMES		
Family Tyrannidae		
Vermilion flycatcher (*Pyrocephalus rubinus*)	–	0/3
Tropical kingbird (*Tyrannus melancholicus*)	–	0/2
Great crested flycatcher (*Myiarchus crinitus*)	–	0/1
Eastern phoebe (*Sayornis phoebe*)	–	0/2
Yellow-bellied flycatcher (*Empidonax flaviventris*)	–	0/1
Least flycatcher (*Empidonax minimus*)	*Ptilonyssus tyrannus*	1/2
Empidonax sp.	*Ptilonyssus tyrannus*	1/1
	Sternostoma pencei	1/1
	Combined	1/1
Family Alaudidae		
Horned lark (*Eremophila alpestris*)	*Ptilonyssus capitatus*	2/3

TABLE I. *Continued.*

Hosts examined	Parasite	Prevalence
Family Hirundinidae		
Mangrove swallow (*Tachycineta albilinea*)	*Sternostoma hirundinus*	1/1
Barn swallow (*Hirundo rustica*)	*Ptilonyssus echinatus*	1/1
Cliff swallow (*Hirundo pyrrhonota*)	*Ptilonyssus echinatus*	2/8
Family Corvidae		
Blue jay (*Cyanocitta cristata*)	—	0/4
Scrub jay (*Aphelocoma coerulescens*)	—	0/1
Family Paridae		
Carolina chickadee (*Parus carolinensis*)	—	0/7
Tufted titmouse (*Parus bicolor*)	—	0/15
Family Remizidae		
Verdin (*Auriparus flaviceps*)	—	0/2
Family Aegithalidae		
Bushtit (*Psaltriparus minimus*)	—	0/1
Family Certhiidae		
Brown creeper (*Certhia familiaris*)	—	0/1
Family Troglodytidae		
House wren (*Troglodytes aedon*)	*Ptilonyssus vossi*	2/6
Winter wren (*Troglodytes troglodytes*)	—	0/2
Bewick's wren (*Thryomanes bewickii*)	—	0/21
Carolina wren (*Thryothorus ludovicianus*)	—	0/1
Canyon wren (*Catherpes mexicanus*)	—	0/1
Family Muscicapidae		
Subfamily Sylviinae		
Blue-gray gnatcatcher (*Polioptila caerulea*)	—	0/11
White-lored gnatcatcher (*Polioptila albiloris*)	*Ptilonyssus sairae*	1/5
Golden-crowned kinglet (*Regulus satrapa*)	—	0/10
Ruby-crowned kinglet (*Regulus calendula*)	*Ptilonyssus acrocephali*	11/38
Subfamily Turdinae		
American robin (*Turdus migratorius*)	*Ptilonyssus euroturdi*	2/7
Hermit thrush (*Hylocichla guttata*)	—	0/4
Family Mimidae		
Northern mockingbird (*Mimus polyglottos*)	*Ptilonyssus mimi*	2/10
Tropical mockingbird (*Mimus gilvus*)	—	0/2
Brown thrasher (*Toxostoma rufum*)	*Ptilonyssus toxostomae*	2/8
Curve-billed thrasher (*Toxostoma curvirostre*)	—	0/1
Gray catbird (*Dumetella carolinensis*)	*Sternostoma dumetellae*	1/1
Family Bombycillidae		
Cedar waxwing (*Bombycilla cedrorum*)	—	0/4
Family Vireonidae		
Bell's vireo (*Vireo bellii*)	*Ptilonyssus hoseini*	2/2
Mangrove vireo (*Vireo pallens*)	—	0/1
Family Emberizidae		
Subfamily Parulinae		
Black-and-white warbler (*Mniotilta varia*)	—	0/1
Orange-crowned warbler (*Vermivora celata*)	*Ptilonyssus sairae*	1/6
Nashville warbler (*Vermivora ruficapilla*)	*Ptilonyssus sairae*	1/3
Mangrove warbler (*Dendroica erithachorides*)	*Ptilonyssus sairae*	1/2
Magnolia warbler (*Dendroica mangolia*)	—	0/1
Yellow-rumped warbler (*Dendroica coronata*)	*Ptilonyssus sairae*	8/19
	Ptilonyssus morofskyi	1/19
	Combined	9/19
Black-throated-green warbler (*Dendroica virens*)	—	0/2
Mourning warbler (*Oporornis philadelphia*)	—	0/1
Wilson's warbler (*Wilsonia pusilla*)	*Ptilonyssus sairae*	1/4
American redstart (*Setophaga ruticilla*)	—	0/1
Subfamily Thraupinae		
Summer tanager (*Piranga rubra*)	—	0/3

TABLE I. *Continued.*

Hosts examined	Parasite	Prevalence
Subfamily Cardinalinae		
Northern cardinal (*Cardinalis cardinalis*)	—	0/6
Painted bunting (*Passerina ciris*)	*Ptilonyssus sairae*	1/4
Dickcissel (*Spiza americana*)	*Ptilonyssus icteridius*	1/3
	Boydaia pheucticola	2/3
	Combined	3/3
Subfamily Emberizinae		
Rufous-sided towhee (*Pipilo erythrophthalmus*)	—	0/4
Brown towhee (*Pipilo fuscus*)	—	0/5
Blue-black grassquit (*Volatinia jacarina*)	—	0/1
Savannah sparrow (*Passerculus sandwichensis*)	*Ptilonyssus sairae*	4/18
Grasshopper sparrow (*Ammodramus savannarum*)	*Ptilonyssus sairae*	2/4
Le Conte's sparrow (*Ammodramus lecontei*)	—	0/1
Vesper sparrow (*Pooecetes gramineus*)	*Ptilonyssus sairae*	1/1
Lark sparrow (*Chondestes grammacus*)	*Ptilonyssus sairae*	3/12
Black-throated sparrow (*Amphispiza bilineata*)	—	0/3
Dark-eyed junco (*Junco hyemalis*)	*Ptilonyssus sairae*	1/42
Rufous-crowned sparrow (*Aimophila ruficeps*)	*Ptilonyssus sairae*	2/12
Chipping sparrow (*Spizella passerina*)	*Ptilonyssus sairae*	1/6
Clay-colored sparrow (*Spizella pallida*)	—	0/5
Field sparrow (*Spizella pusilla*)	*Ptilonyssus sairae*	2/11
Harris sparrow (*Zonotrichia querula*)	*Ptilonyssus sairae*	3/22
	Ptilonyssus morofskyi	1/22
	Combined	4/22
White-crowned sparrow (*Zonotrichia leucophrys*)	—	0/2
White-throated sparrow (*Zonotrichia albicollis*)	*Ptilonyssus morofskyi*	1/4
Fox sparrow (*Passerella iliaca*)	—	0/4
Lincoln's sparrow (*Melospiza lincolnii*)	—	0/1
Song sparrow (*Melospiza melodia*)	*Ptilonyssus sairae*	2/12
Subfamily Icterinae		
Eastern meadowlark (*Sturnella magna*)	*Ptilonyssus icteridius*	4/7
	Boydaia sturnellae	1/7
	Combined	5/7
Great-tailed grackle (*Quiscalus mexicanus*)	—	0/1
Brown-headed cowbird (*Molothrus ater*)	*Ptilonyssus sairae*	1/4
Orchard oriole (*Icterus spurius*)	—	0/1
Family Fringillidae		
Purple finch (*Carpodacus purpureus*)	*Ptilonyssus melissae*	2/10
House finch (*Carpodacus mexicanus*)	—	0/3
Pine siskin (*Carduelis pinus*)	—	0/1
American goldfinch (*Carduelis tristis*)	*Ptilonyssus sairae*	2/5
Lesser goldfinch (*Carduelis psaltria*)	—	0/2
Family Passeridae		
House sparrow (*Passer domesticus*)	—	0/1

nasal mites. Therefore, the level of infection for those species should be considered the minimum possible estimate.

Although the major studies (those examining over 100 host species; Maa and Kuo, 1965; Domrow, 1969; Pence, 1973; present study) report very similar values of infection rates at the species level, they are statistically different ($\chi^2 = 8.27$, df = 3, $P < 0.05$). This might suggest that different avifaunas are parasitized differently. However, Pence (1973) has noted that these rates may not reflect the true infection of host species because many bird species are poorly represented in the sampling. This is undoubtedly true with the present study, as it is statistically much more likely that a host species will be found infected if more than 10 specimens of that host were examined ($\chi^2 = 5.57$, df = 1, $P < 0.025$). Nonetheless, all these studies indicate that most bird species are parasitized by avian nasal mites.

Of the 502 individual birds examined in this study, 87 were parasitized by nasal mites (Table I). This represents a prevalence of 17%, which is very similar to values reported by other workers. Hyland (1963) initially indicated that about 25% of the birds he examined were parasitized, but he did not give specific examples. Maa and Kuo (1965) reported that 18% of the birds from Taiwan were parasitized even though about half the birds were examined using Yunker's technique. However, when they dissected some of the host specimens that had been previously examined by Yunker's technique, they found very few additional mites. This differs from Wilson's (1964) study, which demonstrated an appreciable discrepancy of about 20% between techniques. Spicer (1984) also recorded a high prevalence of 24% infection among Guatemalan birds using Yunker's technique which seems to indicate that at least in some instances this technique may perform better than Wilson's (1964) study suggests. Finally, Pence (1973) reported the lowest prevalence of 16% in the Louisiana birds that he examined.

Although a significant difference was found between studies in the proportion of different host species infected, no difference was found between the major studies (those examining over 500 hosts; Maa and Kuo, 1965; Pence, 1973; present study) on overall prevalence ($\chi^2 = 3.68$, df = 2, $P > 0.25$). This is surprising because of the dramatic difference between the prevalence of nasal mites between taxa of birds. Combining the prevalences reported by Pence (1973) and the present study at the family and subfamily level, it is possible to test whether prevalence is independent of the family of birds being examined. This test indicates that the prevalence of parasitism in nasal mites is extremely dependent on the group of birds being examined ($\chi^2 = 147.79$, df = 18, $P < 0.001$), which suggests that the phylogeny of the birds greatly affects the nasal mite's ability to parasitize its host. This observation is not entirely unexpected, as Maa and Kuo (1965) reported differences between certain bird orders that they examined and suggested that the structure of the nasal passages of the host may have some effect on the ability of these parasites to infect a host. In addition, it is well known that the phylogenetic history of an organism can be an important factor governing the attributes that they now possess (Lauder, 1982; Cheverud et al., 1985; Felsenstein, 1985). In this case, the evolution of the host has seemingly affected the ability of the parasite to infect its avian host.

Maa and Kuo (1965) also reported some regional differences in prevalences between populations of the same host species and indicated that no satisfactory explanation was evident for the examples they cited. However, this is not an uncommon phenomenon for parasitic organisms (Marshall, 1981; Price, 1981; Pence et al., 1983). In the present study, a statistical approach, using a contingency table test, was adopted to determine if there were any regional differences between certain host species collected in the present study, taken primarily from Texas, and those of Pence (1973), collected from Louisiana. Although both studies examined over 100 host species, only a very few bird species were represented well enough for statistical analysis, and all of these were passerines. Due to the small sample sizes involved (when marginal totals are less than 40 and expectations are less than 5), it is recommended that an exact test be performed (Cochran, 1954). In this case, the Fisher-Irwin exact test was used to test for differences between geographic regions, rather than the usual contingency table chi-square (Fleiss, 1981). Only 10 host species fulfilled my requirements for the test by having marginal totals greater than 15. Of the 10 species tested, 2 of them, the ruby-crowned kinglet (*Regulus calendula*) and eastern meadowlark (*Sturnella magna*), were found to be different between studies (both $P = 0.01$). The other 8 host species tested, the brown thrasher (*Toxostoma rufum*), northern mockingbird (*Mimus polyglottos*), yellow-rumped warbler (*Dendroica coronata*), northern cardinal (*Cardinalis cardinalis*), tufted titmouse (*Parus bicolor*), Carolina chickadee (*Parus carolinensis*), American robin (*Turdus migratorius*), and rufous-sided towhee (*Pipilo erythrophthalmus*), did not show differences using the Fisher-Irwin exact test ($P > 0.1$). But this does not mean that populational differences may not be more common, because of the small sample sizes and the crude definition of populations in this case, it is possible that they have been underestimated. Many of the birds examined here are migratory, so there may be a mixing of different populations such that the prevalences are not representative of that region. This problem would tend to minimize the extent of population differentiation and not overestimate it. Therefore, it is likely that with better sampling more regional differences might be found. Nevertheless, even with limited sample sizes, it seems that there are discrete differences in the prevalence of nasal mite parasitism between some host populations.

Pence (1973) reported that he found multiple species infections in the same host, but did not give any specific indication of how often this occurred. In the present study, a multiple infection was encountered only once in an unidentified flycatcher of the genus *Empidonax* from Missouri (Spicer, 1984). This represents about

1% of the total birds parasitized and only about 0.2% of the birds examined. Hence, at least in this study, it seems that multiple species infections happen only very infrequently.

A total of 21 species of nasal mites in the family Rhinonyssidae and 3 species in the Speleognathidae were found in the present study (Table I). No members of either the Turbinoptidae or Cytoditidae were recovered. This pattern of relative frequency is very similar to that reported by Pence (1973), and is statistically the same in both studies ($\chi^2 = 4.02$, df = 3, $P > 0.25$). In the family Rhinonyssidae, which are by far the most common mites encountered, 1 species of *Tinaminyssus,* 2 species of *Rhinonyssus,* 3 species of *Sternostoma,* and 15 species of *Ptilonyssus* were found. This generic pattern of occurrence is also not statistically different between Pence (1973) and the present study ($\chi^2 = 4.03$, df = 6, $P > 0.5$). Pence (1973) supplies a more detailed analysis of the host-specificity and host–parasite relationships of the nasal mites and their avian hosts than presented in this article.

Although much remains to be learned about the topics examined here, some conclusions can be drawn. It is obvious that a large proportion of bird species are infected with nasal mites and that there are distinct differences in the prevalence of parasitism between geographic regions. In addition, it seems conclusive that the phylogenetic history of the host is an important factor affecting the prevalence of parasitism among bird taxa. However, what these various patterns indicate about the coevolution and cospeciation of these mites and their avian hosts currently remains unknown.

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