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Ectoparasites of American Kestrels (*Falco sparverius*) Wintering on the Baja California Peninsula, Mexico

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ABSTRACT.—The American Kestrel (*Falco sparverius*) is a small raptor that may be attracted to agroecosystems during both breeding and wintering seasons. In North America, American Kestrels from northern areas may migrate southward and overwinter in southern territories, co-occurring with resident kestrels in agroecosystems of Baja California, Mexico. We captured 56 adults during autumn and winter (2018/2019 and 2019/2020) in the southern part of the peninsula, and we evaluated the prevalence of ectoparasites on these kestrels. We found ectoparasites on 23.2% of individuals: 14.2% had lice, 1.7% cimicid bugs, and 7.1% hippoboscids flies. Lice included *Degeeriella carruthi*, *Colpocephalum subzerafae*, and *Laemobothrion* spp. Cimicids bugs found on one male were identified as *Hesperocimex* sp., a cimicid often recorded on birds that nest in cavities of the giant cardón cactus (*Pachycereus pringlei*). The prevalent louse fly was identified as the potentially pathogenic *Icosta americana*. All the parasites we recorded were the first records on American Kestrels in Mexico.

KEY WORDS: Hesperocimex *sp.*; Icosta americana; *lice*; *Mexico*; *raptor*.

ECTOPARÁSITOS DE INDIVIDUOS DE *FALCO SPARVERIUS* QUE INVERNAN EN LA PENÍNSULA DE BAJA CALIFORNIA, MÉXICO

RESUMEN.—*Falco sparverius* es una rapaz de tamaño pequeño que puede ser atraída a los agro-ecosistemas, tanto durante la temporadas reproductiva como durante la invernada. En Norteamérica, los individuos provenientes de áreas septentrionales pueden migrar e invernar en agroecosistemas meridionales de Baja California, México, donde coexisten con individuos residentes. Se capturaron 56 adultos de *F. sparverius* durante el otoño e invierno del 2018/2019 y del 2019/2020 en el sur de la península, y se investigó la prevalencia de ectoparásitos. Un 23.2% de los individuos estaban parasitados (14.2% con piojos, 1.7% con insectos cimícidos y 7.1% con moscas hipobóscidas). Los piojos se identificaron como *Degeeriella carruthi*, *Colpocephalum subzerafae* y *Laemobothrion* sp. Los cimícidos encontrados en un macho fueron identificados como *Hesperocimex* sp., que a menudo se encuentran en nidos de aves que nidifican en cavidades del cardón gigante *Pachycereus pringlei*. La mosca hipobóscida se identificó como *Icosta americana*, una especie potencialmente patógena. Todos los parásitos observados en el presente estudio son reportados por primera vez para los *F. sparverius* de México.

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INTRODUCTION

Research on ectoparasites of raptors has been conducted primarily during the breeding season (Orozco-Valor et al. 2019, Sumasgutner et al. 2020); however, wintering surveys may also be important to understand the ecology and distribution of parasites affecting migratory raptors (McCabe et al. 2020). Several species of raptors migrate through North America in the autumn and spring, and the distribution of parasites may be influenced by these movements (Levesque-Beaudin and Sinclair 2021). In the southern United States and Mexico, a diverse assemblage of resident and migratory raptors can be found co-occurring in winter in higher densities in agroecosystems, where they may interact and use similar resources (Hunt et al. 2023). Migratory birds take advantage of seasonal opportunities (e.g., food resources); however, in recent decades, migratory birds have been associated with emerging and re-emerging diseases (Lawson et al. 2011). In this context, many hematophagous ectoparasites are considered potential vectors of microorganisms that cause disease among migratory birds, particularly when birds congregation and the possibility of transmission of ectoparasites increases (McClure 1984, Ostfeld et al. 1995, Georgopoulou and Tsiouris 2008, Vandegrift and Kapoor 2019). Such congregation may occur in agroecosystems in winter, where raptors may be attracted by predictable food sources (Littlefield and Johnson 2013, Airola et al. 2019).

The American Kestrel (*Falco sparverius*) is a small and sexually dimorphic raptor distributed throughout the Americas (Bird et al. 1987, Smallwood and Bird 2002, Sarasola et al. 2003). Populations in Canada and the United States have been steadily declining during recent decades (McClure et al. 2017, Ely et al. 2018). In the Baja California peninsula, resident kestrels (considered to be of the subspecies *F. s. peninsularis*) are smaller and use the *sarcocaulle* habitat for breeding (Frixione and Rodríguez-Estrella 2021), and migratory kestrels are in the area from October until late March, when they move to northern breeding territories to start the breeding season.

A diverse array of ectoparasites has been recorded from the American Kestrel. In North America, lice species such as *Colpocephalum subzerafae* (Tendeiro 1988, Bush and Clayton 2023, Bush et al. 2023), *Laemobothrion tinnunculi*, *Nosopon lucidum*, and *Degeeriella carruthi* (Galloway et al. 2014, Bush and Clayton 2023, Bush et al. 2023, Price et al. 2003) have been reported on kestrels in the United States and Canada. Different species of hematophagus flies (*Carnus hemapterus*, *Icosta americana*, and *Ornithoica vicina*; Mueller 1969, Dawson and Bortolotti 1997) have also been documented on North American kestrels. In South America, lice such as *L. tinnunculi*, *D. carruthi*, and *C. subzerafae* (Liébana et al. 2011); fleas (*Polygenis platensis*; Orozco-Valor et al. 2019) and louse flies such as *I. americana* have been recorded in Argentina and Chile (González-Acuña and Lohse 2011, Liébana et al. 2011).

Although most of the records of kestrel ectoparasites have been recorded in North America, the ectoparasite community of the species in Mexico is little studied. The aim of this study was to examine and identify ectoparasites of the American Kestrel in an agroecosystem during the nonbreeding season in northwestern Mexico.

METHODS

We studied kestrels in an agroecosystem (1372 km^2) located in the desert plains of the southern part of the Baja California peninsula, Mexico (24.78°N–25.43°N; 111.40°W–112.03°W). The climate in the southern region of the peninsula is considered arid subtropical with an annual average temperature of 22–24°C (García 1973). Mean annual rainfall is <200 mm, and most precipitation occurs in association with tropical cyclones (Marín-Monroy et al. 2020).

Capture and Examination of Kestrels. We use bal chatri traps to capture American Kestrels during autumn and winter, 2018–2020. We conducted autumn samplings on 6–11 November 2018 and 16–19 December 2019; we sampled in winter on 19–23 February 2019 and 28 February to 2 March 2020. We banded each kestrel and sexed them based on plumage coloration. For ectoparasite collection, we examined birds during a 10-min visual census, in which we systematically searched for evidence of ectoparasite occurrence. During this census, we deflected feathers of the throat (gulum), breast, belly, and cloacal region (crissum) with forceps (Bush and Clayton 2023). Additionally, we extended the birds' wings and brushed them over a white paper for the further collection of parasites. Once detected, ectoparasites were collected and preserved in vials with 90% ethanol.

Processing of Ectoparasites. Ectoparasites were processed in the Laboratorio de Acarología, Facultad de Ciencias, Universidad Nacional Autónoma de México (UNAM). Lice and bugs were cleaned for about 18–48 hr in KOH 10%, placed in distilled water, and then dehydrated using a graded alcohol series, and, finally, the specimens were mounted on slides in Canada balsam (Palma 1978, Guzmán-Cornejo et al. 2012). We then observed them, using a compound microscope (Leica ICC50 HD)

Table 1. Seasonal prevalence (P) and intensity (I) of different orders of ectoparasites found on the American Kestrel (*Falco sparverius*; $n = 56$) captured in Valle de Santo Domingo, Baja California Sur, Mexico (N = number of captured kestrels evaluated; n = number of infested individuals).

AQ: 2

Order	Year	Season	N	n	P	I (Range)
Phthiraptera	2018–2019	Autumn	16	0	0%	—
		Winter	17	2	11.7%	11.5 (2–21)
	2019–2020	Autumn	10	1	10%	1
		Winter	13	5	38.4%	1.2 (1–3)
Diptera	2018–2019	Autumn	16	0	0%	—
		Winter	17	3	17.6%	1
	2019–2020	Autumn	10	0	0%	—
		Winter	13	1	7.6%	1
Hemiptera	2018–2019	Autumn	16	0	0%	—
		Winter	17	0	0%	—
	2019–2020	Autumn	10	0	0%	—
		Winter	13	1	7.6%	4

for lice and a stereo microscope (Nikon SMZ645) for the louse flies. We identified specimens to the lowest possible taxonomic level, using specialized keys for each group of arthropods (Emerson 1953, Clay 1958, Maa 1969, Tendeiro 1988, Santos Murgas et al. 2014).

Statistical Analysis. We calculated the prevalence of each ectoparasite category, where prevalence was defined as the percentage of kestrels parasitized by at least one ectoparasite. We calculated infestation intensity as the mean number of ectoparasites found on infested kestrels; however, intensity may be underestimated because no fumigation procedure was carried out.

RESULTS

We captured 56 kestrels (31 females and 25 males), 33 in 2018–2019 and 23 in 2019–2020. Parasites infested 13 kestrels (23.2%); 12 of these were captured during late winter (February–March), and one was caught in late autumn (December; Table 1).

AQ: 1

T1

We found lice on 14.2% of individuals (order Phthiraptera), and infested kestrels were mostly males (88.8%). We also found cimicid bugs (order Hemiptera) on one male (1.7%), and hippoboscid flies (order Diptera) on four (7.1%) kestrels (three females, one male).

Lice were represented by three taxa in two suborders and three families: suborder Ischnocera: Philopteridae (*Degeeriella carruthi*, 1.7%; Supplemental Material Fig. S1); suborder Amblycera Laemobothriidae: *Laemobothrion* sp. (1.7%; Fig. S2) and Menoponidae (*Colpocephalum subzerafae*, 8.9%; Fig. S3). We also found four hemipteran nymphs of the family Cimicidae (*Hesperocimex* sp.; Fig. S4) on one kestrel. Of the dipterans, we identified the hemathophagous louse fly *Icosta americana* (Fig. S5), a species in the family Hippoboscidae and considered of medical importance. These flies were found singly on each infested kestrel (Table 1).

DISCUSSION

For Mexico, this is the first report of the Phthiropteran species *C. subzerafae* and *D. carruthi*, the cimicid bug *Hesperocimex* sp., and the louse fly *I. americana* on the American Kestrel. Lice of other species have been recorded from other raptors in Mexico (Morishita et al. 2001, de Oliveira et al. 2011, Bolaños-García et al. 2018). Lice of various species have already been reported for the American Kestrel in North America (Tendeiro 1988, Morishita et al. 2001, Price et al. 2003, Bush and Clayton 2023, Bush et al. 2023) and South America (González-Acuña and Lohse 2011, Liébana et al. 2011). *Colpocephalum subzerafae* was recently recorded for the American Kestrel in a temperate dry climate in northern Utah, United States (Bush et al. 2023). *Colpocephalum subzerafae* and *D. carruthi* were both found on kestrels inhabiting the subtropical islands of the Bahamas (Bush and Clayton 2023).

In the order Hemiptera, cimicids, blood-feeding ectoparasites primarily found on birds and bats (Usinger 1966), were found on North American Golden Eagles (*Aquila chrysaetos*) and Bald Eagles (*Haliaeetus leucocephalus*; Grubb et al. 1986, Morales-Yañez and Rodríguez-Estrella 2019, Dudek et al. 2021). Part of the life cycle of cimicids occurs in nests of cavity-nesting birds, in cavities made primarily by woodpeckers in western North America. In northwestern Mexico and southwestern US region, three cimicid of the *Hesperocimex* genera are distributed separately in three different areas (Ryckman et al. 1963). Throughout

the Baja California peninsula, the cimicid *Hesperocimex cochimiensis* is found in cavities made by woodpeckers in giant *cardon* cacti and in *cirio* trees (*Idria columnaris*) and used by Purple Martins (*Progne subis*) and the Violet-green Swallows (*Tachycineta thalassina*; Ryckman et al. 1963), both of which are secondary cavity nesters, like the American Kestrel. This incidental ecological information may suggest that the specimens we found on a male kestrel may be *H. cochimiensis*; however, because we obtained only nymphs, we could positively identify it only to the generic level. To the best of our knowledge, there are no records of cimicids for small raptors in the Americas, so this record represents the first such report for the American Kestrel.

The presence of a cimicid on a male kestrel suggests it may have used a microhabitat (cavity) because these ectoparasites spend a large part of their life cycle in such cavities. During late winter, breeding-age males defend valuable territories against other males and display to females using a combination of behaviors including vocalizations, aerial maneuvers, and nest-cavity inspections (Willoughby and Cade 1964, Balgooyen 1976). Nest-cavity inspections may be an important behavior that allows assessment of the quality of the local habitat, and also functions as a courtship display (Duncan and Bird 1989). Cavity inspection by males could amplify the first contact of the cimicids with the breeding birds during the end of winter, with males being the most exposed to these ectoparasites during the stages prior to egg-laying.

In the case of lice, we suggest that intense prebreeding behavior during late winter (February–March) conducted by resident males (intensive food provisioning of males to the females, defense of valuable breeding territories, and other displays) might reduce the time they invest in grooming, the first line of defense against ectoparasites (Clayton et al. 2010). If so, that might decrease the number of ectoparasites eliminated, and might account for a relative increase in lice prevalence on males. In many vertebrate species, males are the more intensely parasitized sex and energetic constraints during courtship could be of importance for males (Cowan et al. 2007, Bacelar et al. 2011, Patterson et al. 2015).

The Hippoboscid flies may act as vectors or hosts of etiological agents and are permanent obligate hematophagous ectoparasites mostly found on birds and mammals (domestic and wild) (Rodhain 2015). Larger species of raptors are usually infested by some kind of hematophagous fly (Rodríguez-Estrella and Rivera-Rodríguez 2019, McCabe et al. 2020, Levesque-Beaudin and Sinclair 2021). Mueller et al. (1969) suggested the "importation" of *I. americana* to northern areas by large raptors returning from southern overwintering areas. We consider this to be possible for western North America, where several larger raptors migrate from subtropical climates to northern areas during springtime. In our study area, the louse fly *I. americana* was detected on nestling Great Horned Owls (*Bubo virginianus*; Bolaños-García et al. 2018), and our detection of this hippoboscid on kestrels is the second record of it on birds of the Baja California peninsula. This species has been reported on American Kestrels in Argentina and Bolivia (Bequaert 1955, Liébana et al. 2011), and this is the second record for the American Kestrel in North America (Mueller et al. 1969) and the first in Mexico. It is likely that low prevalence and seasonal fluctuations hinder detections of this ectoparasite on kestrels. Doherty and Moon (2017) found American Kestrels in the Midwestern United States had significantly lower number of flies than expected if flies were distributed at random on raptor communities based on body size.

In conclusion, Phthirapteran species and the hematophagous louse fly *I. americana* we recorded in this study represent the first records for the American Kestrel in Mexico. In addition, the cimicids (*Hesperocimex* sp.) found in the current study have not been previously reported for the American Kestrel, and we suggest that the courtship display of nest prospecting by this secondary cavity nester might explain their occurrence. Lice were found mostly on males; these findings suggest a differential infection by parasite taxa related to contrasting behavioral constraints of the sexes in winter. Although prevalence of *I. americana* was low, this record represented the highest prevalence recorded for the species, suggesting this fly should be considered as a potential source of emergent disease. Future research should focus on the life cycles of ectoparasites in the communities of these raptors, using molecular methods to explore lineages and other ecological information.

SUPPLEMENTAL MATERIAL (available online). Fig. S1: Ventral view of *Degeeriella carruthi* male. Fig. S2: *Laemobothrion* sp. Fig. S3: *Colpocephalum subzerafae*. Fig. S4: Dorsal view of Cimicidae: *Hesperocimex* sp. Fig. S5: *Icosta americana*.

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LITERATURE CITED

Airola, D. A., J. A. Estep, D. E. Krolick, R. L. Anderson, and J. R. Peters (2019). Wintering areas and migration

characteristics of Swainson's Hawks that breed in the Central Valley of California. Journal of Raptor Research 53:237–252.

Bacelar, F. S., A. White, and M. Boots (2011). Life history and mating systems select for male biased parasitism mediated through natural selection and ecological feedbacks. Journal of Theoretical Biology 269:131–137.

Balgooyen, T. G. (1976). Behavior and ecology of the American Kestrel (*Falco sparverius* L.) in the Sierra Nevada of California. University of California Publications in Zoology 103:1–83.

Bequaert, J. C. (1955). The Hippoboscidae or louse-flies (Diptera) of mammals and birds. Part II: Taxonomy, evolution and revision of American genera and species. Entomologica Americana 35:233–416.

Bird, D. M., and R. Bowman (Editors) (1987). The Ancestral Kestrel: Proceedings of a Symposium on Kestrel Species. The Raptor Research Foundation and Macdonald Raptor Research Centre of McGill University, Ste. Anne de Bellevue, QC, Canada.

Bolaños-García, R., R. Rodríguez-Estrella, and C. Guzmán-Cornejo (2018). Ectoparasites associated with a Great Horned Owl nesting (Aves: Strigidae) population in fragmented landscape of Baja California peninsula, Mexico. Acta Zoológica Mexicana 34:1–15.

Bush, S., and D. H. Clayton (2023). Grooming time predicts survival: American Kestrels, *Falco sparverius*, on a subtropical island. American Naturalist 201:603–609.

Bush, S., M. Waller, J. Herman, K. Hobbs, A. Clayton, J. Watson, D. Oleyar, and D. Clayton (2023). Birds groom more in regions with higher parasite pressure: A comparison of temperate and subtropical American Kestrels. Animal Behavior 201:125–135.

Clay, T. (1958). Revisions of Mallophaga Genera: Degeeriella from the Falconiformes; British Museum of Natural History, London, UK.

Clayton, D. H., J. Koop, C. Harbison, B. Moyer, and S. Bush (2010). How birds combat ectoparasites. Open Ornithology Journal 3:41–71.

Cowan, K. M., D. Shutler, T. B. Herman, and D. T. Stewart (2007). Extreme male-biased infections of masked shrews by bladder nematodes. Journal of Mammalogy 88:1539–1543. doi:10.1644/06-mamm-a-398r1.1.

Crawley, M. J. (1993). GLIM for Ecologists. Blackwell Scientific Publisher, Oxford, UK.

Dawson, R. D., and G. R. Bortolotti (1997). Ecology of parasitism of nestling American Kestrels by *Carnus hemapterus* (Diptera: Carnidae). Canadian Journal of Zoology 75:2021–2026.

de Oliveira, J., T. Santos, C. Vaughan, and H. Santiago (2011). External parasites of raptors (Falconiformes and Strigiformes): Identification in an *ex situ* population from Mexico. Revista de Biología Tropical 59:1257–1264.

Doherty, R., and R. D. Moon (2015). Species-based variations in Hippoboscid infestation in mid-western raptors. https://conservancy.umn.edu/bitstream/handle/11299/169424/DohertyRobin_Species-Based%20Variation.pdf?sequence=1.

Dudek, B. M., M. T. Henderson, S. F. Hudon, E. J. Hayden, and J. A. Heath (2021). Haematophagous ectoparasites lower survival of and have detrimental physiological effects on Golden Eagle nestlings. Conservation Physiology 9:coab060. doi:10.1093/conphys/coab060.

Duncan, J. R., and D. M. Bird (1989). The influence of relatedness and display effort on the mate choice of captive female American Kestrels. Animal Behaviour 37:112–117.

Ely, T. E., C. W. Briggs, S. E. Hawks, G. S. Kaltenecker, D. L. Evans, F. J. Nicoletti, J. F. Therrien, O. Allen, and J. P. DeLong (2018). Morphological changes in American Kestrels (*Falco sparverius*) at continental migration sites. Global Ecology and Conservation 15:e00400. doi:10.1016/j.gecco.2018.e00400.

Emerson, K. C. (1953). New North American Mallophaga. Journal of Kansas Entomological Society 26:132–136.

Frixione, M. G., and R. Rodríguez-Estrella (2021). Trophic segregation of the Burrowing Owl and the American Kestrel in fragmented desert in Mexico. Journal of Natural History 54:2713–2732. doi:10.1080/00222933.2020.1865470.

Galloway, T. D., H. C. Proctor, and S. V. Mironov (2014). Chewing lice (Insecta: Phthiraptera: Amblycera, Ischnocera) and feather mites (Acari: Astigmatina: Analgoidea, Pterolichoidea): Ectosymbionts of Grassland Birds in Canada. Arthropods of Canadian Grasslands 3:139–188.

García, E. (1973). Modificaciones al sistema de clasificación climática de Köppen (para adaptarlo a las condiciones de la República Mexicana). Universidad Nacional Autonoma de México, Instituto de Geografía, Mexico City, Mexico.

Georgopoulou, I., and V. Tsiouris (2008). The potential role of migratory birds in the transmission of zoonoses. Veterinaria Italiana 44:671–677.

González-Acuña, D., and E. Lohse (2011). Parasites of the American Kestrel (*Falco sparverius*) in south-central Chile. Journal of Raptor Research 45:188–193. doi:10.3356/JRR-10-68.1.

Grubb, T. G., W. L. Eakle, and B. N. Tuggle (1986). *Haematosiphon inodorus* (Hemiptera: Cimicidae) in a nest of a Bald Eagle (*Haliaeetus leucocephalus*) in Arizona. Journal of Wildlife Diseases 22:125–127.

Guzmán-Cornejo, C., L. García-Prieto, G. Rivas, B. Mendoza-Garfias, D. Osorio-Sarabia, and G. Montiel-Parra (2012). Manual de Prácticas de Metazoarios Parásitos de Vertebrados. Las Prensas de Ciencias, Universidad Nacional Autónoma de México, Mexico.

Hunt, A. R., J. L. Watson, J. M. Winiarski, R. R. Porter, and J. A. Heath (2023). American Kestrel migration: Insights and challenges from tracking individuals across the annual cycle. Journal of Raptor Research 57:164–175.

Ishak, H. D., C. Loiseau, A. C. Hull, and R. N. M. Sehgal (2010). Prevalence of blood parasites in migrating and wintering California hawks. Journal of Raptor Research 44:215–223.

Lawson, B., R. A. Robinson, A. Neimanis, K. Handeland, M. Isomursu, E. O. Agren, and A. A. Cunningham

(2011). Evidence of spread of the emerging infectious disease, finch trichomonosis, by migrating birds. EcoHealth 8:143–153.

Levesque-Beaudin, V., and B. J. Sinclair (2021). Louse fly (Diptera, Hippoboscidae) associations with raptors in southern Canada, with new North American and European records. International Journal for Parasitology: Parasites and Wildlife 16:168–174. doi:10.1016/j.ijppaw.2021.09.007.

Liébana, M. S., M. Á. Santillán, A. C. Cicchino, J. H. Sarasola, P. Martínez, S. Cabezas, and M. S. Bó (2011). Ectoparasites in free-ranging American Kestrels in Argentina: Implications for the transmission of viral diseases. Journal of Raptor Research, 45:335–341.

Littlefield, C., and D. H. Johnson (2013). Migration and habitat preferences of Swainson's Hawks at an autumn stopover site in northwestern Texas. Journal of Raptor Research 47:54–59.

Maa, T. C. (1969). Revision of *Icosta* (= *Lynchia* Auctt.) with erection of a related genus Phthona (Diptera: Hippoboscidae). Pacific Insects Monographs 20:25–203.

Marín-Monroy, E. A., V. Hernández-Trejo, E. Romero-Vadillo, and A. Ivanova-Boncheva, (2020). Vulnerability and risk factors due to tropical cyclones in coastal cities of Baja California Sur, Mexico. Climate 8:144. doi:10.3390/cli8120144.

McCabe, R. A., J. P. Receveur, J. L. Houtz, K. L. Thomas, M. E. Benbow, J. L. Pechal, and J. R. Wallace (2020). Characterizing the microbiome of ectoparasitic louse flies feeding on migratory raptors. PLoS ONE 15: e0234050. doi:10.1371/journal.pone.0234050.

McClure, C. J. W., S. E. Schulwitz, R. Van Buskirk, B. P. Pauli, and J. A. Heath (2017). Commentary: Research recommendations for understanding the decline of American Kestrels (*Falco sparverius*) across much of North America. Journal of Raptor Research 51:455–464.

McClure, H. E. (1984). The occurrence of hippoboscid flies on some species of birds in southern California. Journal of Field Ornithology 55:230–240.

Morales-Yañez, I., and R. Rodríguez-Estrella (2019). Golden Eagle nestlings infested by Mexican chicken bugs in Chihuahua, Mexico. Journal of Raptor Research 53:111–113.

Morishita, T. Y., J. W. Mertins, D. G. Baker, C. M. Monahan, and D. L. Brooks (2001). Occurrence and species of lice on free-living and captive raptors in California. Journal of Avian Medicine and Surgery 15:288–292. doi:10.1647/1082-6742(2001)015[0288:OASOLO]2.0.CO;2.

Mueller, J. F. (1969). Annotated bibliography of pathology in invertebrates other than insects. Journal of Parasitology 55:871. doi:10.2307/3277234.

Mueller, N. S., H. C. Mueller, and D. D. Berger (1969). Host records and phenology of louse-flies on Wisconsin birds. Wisconsin Academy of Sciences, Arts and Letters, 57:189–207.

Orozco-Valor, P. M., M. Á. Santillán, M. Lareschi, and J. M. Grande (2019). Ectoparasites of American Kestrels: Should fleas be considered? Journal of Raptor Research 53:446–448.

Ostfeld, R., O. M. Cepeda, K. R. Hazler, and M. C. Miller (1995). Ecology of Lyme Disease: Habitat associations of ticks (*Ixodes scapularis*) in a rural landscape. Ecological Applications 5:353–361. doi:10.2307/1942027.

Palma, R. L. (1978). Slide-mounting of Lice: A detailed description of the Canada balsam technique. New Zealand Entomologist 6:432–436. doi:10.1080/00779962.1978.9722313.

Patterson, J. E., P. Neuhaus, S. J. Kutz, and K. E. Ruckstuhl (2015). Patterns of ectoparasitism in North American red squirrels (*Tamiasciurus hudsonicus*): Sex-biases, seasonality, age, and effects on male body condition. International Journal for Parasitology: Parasites and Wildlife 4:301–306.

Petersen, L. R., A. A. Marfin, and D. J. Gubler (2003). West Nile virus. JAMA 290:524–528. doi:10.1001/jama.290.4.524.

Price R. D., R. A. Hellenthal, R. L. Palma, K. P. Johnson, and D. H. Clayton (2003). The Chewing Lice: World Checklist and Biological Overview. Illinois Natural History Survey Special Publication, Springfield, IL, USA.

R Core Team (2020). R: A language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Rodhain, F. (2015). Insects as vectors: Systematics and biology. Revue Scientifique et Technique (International Office of Epizootics) 34:83–96.

Rodríguez-Estrella, R., and L. B. Rivera-Rodríguez (2019). High prevalence of louse flies on Osprey nestlings in a Baja California colony. Journal of Raptor Research 53:142–149. doi:10.3356/JRR-17-59.

Ronca, S. E., J. C. Ruff, and K. O. Murray (2021). A 20-year historical review of West Nile virus since its initial emergence in North America: Has West Nile virus become a neglected tropical disease? PLoS Neglected Tropical Diseases 15(5):e0009190. doi:10.1371/journal.pntd.0009190.

Ryckman, R. E., and N. Ueshima (1963). *Hesperocimex cochimiensis* new species, from Baja California, Mexico (Hemiptera: Cimicidae). Proceedings of Entomological Society 65:24–79.

Santos Murgas, A., O. G. Lopez Chong, and M. J. Miller (2014). Hippoboscidae (Insecta: Diptera) ectoparasitos en aves de Panamá, claves de identificacion, hospederos y distribucion. Scientia 24:49–68.

Sarasola, J. H., M. A. Santillán, and M. A. Galmes (2003). Food habits and foraging ecology of American Kestrels in the semiarid forests of central Argentina. Journal of Raptor Research 37:236–243.

Smallwood, J. A., and D. M. Bird (2020). American Kestrel (*Falco sparverius*), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. doi:10.2173/bow.amekes.01.

Sumasgutner, P., A. Jenkins, A. Amar, and R. Altwegg (2020). Nest boxes buffer the effects of climate on

breeding performance in an African urban raptor. PLoS ONE 15(6):e0234503. doi:10.1371/journal.pone.0234503.

Tendeiro, J. (1988). Etudes sur les *Colpocephalum* (Mallophaga, Menoponidae) parasites des Falconiformes I. Groupe zerafae Price & Beer. Bonner Zoologische Beiträge 39:77–102.

Usinger, R. L. (1966). Monograph of cimicidae. Thomas Say Foundation 7:45.

Vandegrift, K. J., and A. Kapoor (2019). The ecology of new constituents of the tick virome and their relevance to public health. Viruses 11:529. doi:10.3390/v11060529.

Willoughby, E. J., and T. J. Cade (1964). Breeding behavior of the American Kestrel (sparrow hawk). Living Bird 3:75–96.

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