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

Martín G. Frixione,1,2 Tomás López-Avendaño,2 and Carmen Guzmán-Cornejo3*

1CONICET-CCT Centro Nacional Patagónico, CESIMAR, Bvd. Brown 2825, 9120 Puerto Madryn, Argentina
2Centro de Investigaciones Biológicas del Noroeste, La Paz, B.C.S. México. Av. Instituto Politécnico Nacional 195, Playa Palo de Santa Rita Sur, 23096 La Paz, Mexico
3Laboratorio de Acarología, Departamento de Biología Comparada, Facultad de Ciencias, Universidad Nacional Autónoma de México, Av. Universidad 3000, Ciudad Universitaria, 04510 Ciudad de México, Mexico

**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% hippoboscid flies. Lice included *Degeeriella carruthi*, *Colpocephalum subzerafae*, and *Laemobothrion* spp. Cimicids 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 agroecosistemas tanto durante la temporada 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 lice, 1.7% con cimicidos y 7.1% con moscas hipobósridas). Los lice fueron identificados como *Degeeriella carruthi*, *Colpocephalum subzerafae*, y *Laemobothrion* spp. Los cimicidos encontrados en un macho fueron identificados como *Hesperocimex* sp., a cimicid que a menudo se encuentra en nidos de aves que nidifican en cavidades del cardón gigante *Pachycereus pringlei*. La mosca hipobósrida 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.

[Traducción de los autores editada]
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 congregate 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 (McCure 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 *sarcocaule* 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 subserafae* (Tendeiro 1988, Bush and Clayton 2023, Bush et al. 2023), *Lomobothrius tinnunculi*, *Nosophon lucidum*, and *Degeriella 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 hematophagous flies (*Carnus hemapterus, Icota 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. subseraefae* (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 km²) 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).
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).

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%; Supplementary Material Fig. S1); suborder Amblycera Laemobothriidae: *Laemobothrion* sp. (1.7%; Fig. S2) and Menoponidae (*Colpocophalum 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 hematophagous 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 Phthirapteran 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) and South America (González-Acuña and Lohse 2011, Liébana et al. 2011). *Colpocophalum subzerafae* was recently recorded for the American Kestrel in a temperate dry climate in northern Utah, United States (Bush et al. 2023). *Colpocophalum 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

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<tr>
<td>Phthiraptera</td>
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<td>0</td>
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<td>Winter</td>
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<td>11.7%</td>
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<td>Winter</td>
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<td>Hemiptera</td>
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the Baja California peninsula, the cimicid *Hesperocimex cochimiensis* is found in cavities made by woodpeckers in giant *cardon cacti* and in *cero* 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 hematothaphagous 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, Lièbana 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: *Laemobothrium* sp. Fig. S3: *Colpocephalum subzerafae*. Fig. S4: Dorsal view of *Cimicidae: Hesperocimex* sp. Fig. S5: *Icosta americana*.

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