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ECTOPARASITES IN FREE-RANGING AMERICAN KESTRELS IN ARGENTINA: IMPLICATIONS FOR THE TRANSMISSION OF VIRAL DISEASES

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Abstract.—We described ectoparasitic species such as chewing lice, mites, and louse flies in free-ranging American Kestrels (*Falco sparverius*) in the semiarid forest of Argentina. From twenty-two adults and one juvenile American Kestrel captured (fourteen females and nine males) during four breeding seasons between 2005 and 2008, we found in seven birds (six females and one male) two louse species (*Laemobothrion tinnunculi* and *Degeeriella carruthi*), one mite species (*Ornithonyssus bursa*) and one louse fly (*Icosta americana*). Although the two louse species have been previously reported as parasites of American Kestrels, this is the first record for *O. bursa* in American Kestrels and the first for *I. americana* in Argentina. This finding is of particular interest because West Nile Virus (WNV) has been detected in *I. americana*, which

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suggests a potential role of this louse fly in the transmission of WNV in raptors in North America. Our results highlight the need for further studies on American Kestrel ectoparasites and also on host-parasite interactions for other neotropical raptors to better understand effects of parasitism on the health of those bird species and to detect possible vectors of infectious diseases.

KEY WORDS: *American Kestrel*; Falco sparverius; *Argentina*; *ectoparasites*; *lice*; *louse flies*; *mites*; *semiarid forest.*

ECTOPARÁSITOS EN EJEMPLARES SILVESTRES DE *FALCO SPARVERIUS* EN ARGENTINA: IMPLICANCIAS PARA LA TRANSMISIÓN DE ENFERMEDADES VIRALES

RESUMEN.—Describimos especies de ectoparásitos, tales como piojos, ácaros y moscas hipobóscidas en ejemplares silvestres de *Falco sparverius* del bosque semiárido de Argentina. En 22 adultos y un juvenil de *F. sparverius* (14 hembras y nueve machos) capturados durante las épocas reproductivas correspondientes a los años 2005–08, hallamos en siete aves (seis hembras y un macho) dos especies de piojos (*Laemobothrion tinnunculi* y *Degeeriella carruthi*), una de ácaro (*Ornithonyssus bursa*) y una de mosca (*Icosta americana*). Mientras que las dos especies de piojos han sido ya previamente reportadas como parásitos de *F. sparverius*, este es el primer registro para *O. bursa* en la especie, y el primero de *I. americana* en Argentina. Este último hallazgo es de particular interés debido a que el Virus del Oeste del Nilo (VON) ha sido detectado recientemente en *I. americana*, sugiriendo un rol activo de esta mosca en la transmisión del VON en rapaces de Norteamérica. Nuestros resultados destacan la necesidad de realizar nuevos estudios sobre los ectoparásitos de *F. sparverius* así como también sobre las interacciones hospedador-parásito en otras rapaces neotropicales para no sólo dilucidar los efectos de las parasitosis sobre el estatus sanitario de dichas especies, sino también para detectar posibles vectores de enfermedades infecciosas.

[Traducción del equipo editorial]

Ectoparasites in raptors include a variety of taxa such as biting midges (Diptera: Ceratopogonidae), black flies (Diptera: Simuliidae), blow flies (Diptera: Calliphoridae), louse flies (Diptera: Hippoboscidae), mosquitoes (Diptera: Culicidae), carnid flies (Diptera: Carnidae), cimicid bugs (Hemiptera: Cimicidae), fleas (Siphonaptera), chewing lice (Phthiraptera: Mallophaga), ticks (Acarina: Ixodida), mites (Acarina: Acaridae), and dermestid beetles (Coleoptera: Dermestidae; Philips 2007). These parasites can potentially produce direct and indirect pathological effects on their hosts (e.g., myiasis, anemia , hyperkeratosis, or feather damage) or act as vectors of infectious agents, like blood protozoans, filarid nematodes, bacteria, and viruses (e.g., Encephalomyelitis Virus, West Nile Virus; Turell 2009). However, despite the potential negative effects on bird survival and fitness, there are few data on ectoparasites for most neotropical raptors and also North American species. Ectoparasites of raptors have been decribed in South America (Mey and González-Acuña 2000, Valente et al. 2001, Brum and Rickes 2003, Estrada-Peña et al. 2003, Graciolli and Barros de Carvalho 2003, Whiteman et al. 2004, Graciolli and Bispo 2005, San Martin et al. 2005, Whiteman and Parker 2005, Estrada-Peña et al. 2006, González-Acuña et al. 2006, Whiteman et al. 2006a, 2006b, Valim and Palma 2007, González-Acuña et al. 2008, Santillán et al. 2009, González-Acuña et al. 2011).

The American Kestrel (*Falco sparverius*) is a small falcon with a widespread distribution that encompasses all of the American continent from Alaska and Canada to Tierra del Fuego (Argentina) and Islas Malvinas, and includes a variety of natural landscapes and human-modified habitats (Woods 1988, del Hoyo et al. 1994, Smallwood and Bird 2002). The great majority of studies of ectoparasites in American Kestrels have been conducted in North America and the primary parasites described have been myiasis (*Protocalliphora* spp.; Balgooyen 1976), carnid flies (*Carnus hemapterus*; Dawson and Bortolotti 1997), lice (*Laemobothrion tinnunculi, Nosopon lucidun, Degeeriella carruthi*; Price et al. 2003), ticks (*Ornithodoros aquilae*; Morishita et al. 2001) and mites (*Dubininia* ssp., *Tytodectes cerchneis*, *Blankaartia velascoi*, *Boydaia falconis*, *Ptilonyssus cerchneis*; Philips 2000). By contrast, information about ectoparasites associated with free-living American Kestrels in their austral range is limited to reports of three lice and one louse fly species (Bequaert 1955, Cicchino and Castro 1998a, 1998b, González-Acuña et al. 2008, González-Acuña et al. 2011). To address this knowledge gap, we examined the occurrence of ectoparasite species in free-ranging American Kestrels in central Argentina.

Table 1. Ectoparasite species and prevalence in American Kestrel in Argentina.

Ectoparasite Species	Number of Ectoparasites				Prevalence
	Adult Males	Adult Females	Nymph	Total	
Acarina: Dermanyssidae					
Ornithonyssus bursa		2	1	3	8.7
Diptera: Hippoboscidae					
Icosta americana		1		1	4.35
Phthiraptera					
Amblycera: Laemothriidae					
Laemobothrion tinnunculi	6	8	4	18	17.4
Ischnocera: Philopteridae					
Degeeriella carruthi	1	3		4	4.35

Methods

Our study was conducted in the Parque Luro Reserve (36°55′S, 64°16′W), central Argentina. The reserve (7604 ha) is located in the province of La Pampa and the landscape consists mainly of xerophytic open forest of caldén (*Prosopis caldenia*), which represents the characteristic landscape of the Espinal biome in the semiarid pampas of Argentina (Sarasola et al. 2005). Kestrels were captured using bal-chatri traps (Berger and Müeller 1959) baited with mice (*Mus musculus*) during four breeding seasons (from November to February) between 2005 and 2008. Birds were aged, sexed, banded, and handled for 8–10 min, during which time the ectoparasites were visually detected, collected, and preserved in vials with 70% ethanol. Collected mites were clarified using lactic acid and slide-mounted in the same medium for identification following the standard technique (Krantz 1978). Lice were slide-mounted in synthetic Canada Balsam following conventional procedures (Palma 1978). Ectoparasites were identified by expert entomologists using a compound microscope for lice and mites and a stereo microscope for the louse fly. Taxonomic keys and reference collections from the Universidad Nacional of Mar del Plata were used to ensure the correct identification of ectoparasites (Maa 1969, Krantz 1978, Micherdzinski 1980, Gaud and Atyeo 1996, Graciolli and Barros de Carvalho 2003, Price et al. 2003). We calculated the prevalence (P) as: $P =$ (number of hosts infested with one or more individuals of a particular parasite species)/(number of birds examined) $\times$ 100 (Bush et al. 1997).

Results

We captured 22 adult (13 females, 9 males) and one juvenile female American Kestrels. From seven of these birds (five adult females, one adult male, and one juvenile female), we collected four ectoparasite species: two lice (Phthiraptera), one mite (Acarina), and one louse fly (Diptera; Table 1). Of 22 lice collected from six American Kestrels, 18 were identified as *Laemobothrion tinnunculi* (Amblycera: Laemothriidae) and four as *Degeeriella carruthi* (Ischnocera: Philopteridae). All the individuals of *D. carruthi* were adults, but for *L. tinnunculi,* both adults and nymphs were found. We found individuals of both sexes for these two lice species (Table 1). Three blood-sucking mites (two adults and one nymph) of species *Ornithonyssus bursa* (Acarina: Dermanyssidae) were isolated from two adult female kestrels. Finally, we found one louse fly *Icosta americana* (Diptera: Hippoboscidae) on one adult female kestrel (Table 1).

Discussion

In Argentina, the lice *L. tinnunculi* and *D. carruthi* were reported as parasites of American Kestrels only in the Buenos Aires province, until this study (Cicchino and Castro 1998a, 1998b). Many studies on lice that parasitize raptors have shown that lice species or genera have a high degree of host-specificity (Price and Beer 1963, Pérez et al. 1996, Morishita et al. 2001, González-Acuña et al. 2008). That is the case for the two lice species we found: *L. tinnunculi* has only been found parasitizing members of the genus *Falco* in Chile (González-Acuña et al. 2008) and worldwide (Morishita et al. 2001, Price et al. 2003), whereas *D. carruthi* is even more specialized, parasitizing only American Kestrels (Price et al. 2003, González-Acuña et al. 2008). Although our sample size was small, we found that *L. tinnunculi* had the highest prevalence among the sampled kestrels. However, in American Kestrels in Chile, *D.*

carruthi was the most common louse species found between 2001 and 2006 (González-Acuña et al. 2008), and *D. carruthi* and *L. tinnunculi* were equally prevalent between 2001 and 2009 (González-Acuña et al. 2011). Such a difference in species prevalence might be explained by the fact that kestrels sampled in Chile were from museum and rehabilitation centers and thus may not have harbored the parasite levels typical of free-living birds, as in our study. One other louse species known from American Kestrels in Argentina is *Nosopon lucidum* (Amblycera: Menopodidae; Cicchino and Castro 1998a); however, we did not find it in our study, possibly because of our small sample size.

The tropical fowl mite (*Ornithonyssus bursa*) has been frequently found parasitizing several taxa of birds and mammals, including humans, throughout the warmer regions of the world (Philips 1990, Mullen and O'Connor 2009). *O. bursa* found in our study represents the first record of this species as a parasite of American Kestrels. In Argentina, *O. bursa* is considered a parasite of chickens (*Gallus gallus domesticus*), Rock Pigeons (*Columba livia*) and House Sparrows (*Passer domesticus*), and is a common invader into human dwellings, dispersing from birds' nests on the roofs, windows, and chimneys (Lareschi and Mauri 1998, Semenas and Rocha 1998, P. Martínez pers. comm.). Among raptors, *O. bursa* has been reported for several species of the families Accipitridae, Cathartidae, and Strigidae, but for only one species of Falconidae, the Nankeen Kestrel (*Falco cenchroides*) from Australia (Domrow 1977, Philips 2000). This mite usually feeds near vents, and as a consequence of its haematophagus habits, is a transmitter of the encephalitis viruses (Philips 2007). Its effects on its hosts can be deleterious in some cases, as it has been observed in nestling Snail Kites (*Rostrhamus sociabilis*) and captive adult Eurasian Sparrowhawks (*Accipiter nisus*; Sykes and Forrester 1983, Philips 2000). For example, at high infestation rates, this mite may cause anemia and weight loss in its hosts (Philips 2000). The low number of mites we found on the infected American Kestrel in Argentina might have been an artifact of our methodology, as the birds were only inspected visually for a short amount of time.

Hippoboscid louse flies are blood-feeders and obligate ectoparasites usually associated with birds and mammals (Graciolli and Barros de Carvalho 2003, Philips 2007, Valim and Gazêta 2007, Lloyd 2009). Louse flies transmit several parasites or disease agents such as protozoans (*Trypanosoma* sp., *Haemoproteus* sp., *Leucocytozoon* sp., *Plasmodium* sp.), filarial nematodes (*Dipetalonema dracunculoides*) and bacteria (*Bartonella schoembuchensis, Corynebacterium lipoptenae*; Krone 2007, Lloyd 2009). In some cases, louse flies are used as a mode of phoretic transmission by lice and feather and skin mites, but not by haematophagous mites; however, this is not the most frequent mode of transmission among birds (Keirans 1975, Jovani et al. 2001, Price et al. 2003, Whiteman et al. 2006b, Philips 2007). *Icosta americana* has been reported from owls (Black-capped Screech-Owl [*Megascops atricapilla*], Long-tufted Screech-Owl [*M. sanctaecatarinae*], Tropical Screech-Owl [*M. choliba*] and Burrowing Owl [*Athene cunicularia*]) in Brazil (Graciolli and Barros de Carvalho 2003, Graciolli and Bispo 2005), and from American Kestrels in Wisconsin, U.S.A. (Mueller et al. 1969) and Bolivia (Bequaert 1955), but there is no record of this louse fly parasitizing American Kestrels in Argentina or elsewhere (Smallwood and Bird 2002).

Importantly, the louse fly *I. americana* is considered a potential vector for West Nile Virus (WNV) in raptors of North America (Farajollahi et al. 2005, Philips 2007, Lloyd 2009). As this virus spread in North America since 1999, it caused significant morbidity and mortality in native birds, including American Kestrels (Komar et al. 2003, Gancz et al. 2004, Marra et al. 2004, Nemeth et al. 2007, Saito et al. 2007). Furthermore, WNV has been proposed as one possible cause of the decline of American Kestrel populations in North America (Medica and Bildstein 2009).

There is evidence that this flavivirus became established in Argentina during 2005, and it has been detected on free-ranging birds (Díaz et al. 2008), including American Kestrels (L. Díaz pers. comm.), in the northern Argentinean provinces of Chaco, Cordoba, and Tucumán. These data, combined with our observation and the fact that emerging infectious diseases have the potential to devastate wildlife populations, underscore the need for additional studies to determine the potential impact of hematophagous species (particularly *Icosta americana* and *Ornithonyssus bursa*) on this and other avian species in the region and to assess their role in the transmission of viral diseases.

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LITERATURE CITED

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 New Series* 35:233–416.

BERGER, D.D. AND H.C. MÜELLER. 1959. The bal-chatri: a trap for birds of prey. *Bird-Banding* 30:19–27.

BRUM, J.G.W. AND E.M. RICKES. 2003. *Laemobothrion glutinans* Nitzch, 1861 e *Cuculiphilus alternatus* (Osborn, 1902) (Mallophaga: Amblycera) em urubu (*Coragyps atratus*) em área do Parque Zoologico do Rio Grande do Sul. *Arquivos do Instituto Biologico* 70:497–498.

BUSH, A., K. LAFFERTY, J. LOTZ, AND A. SHOSTACK. 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *Journal of Parasitology* 83:575–583.

CICCHINO, A. AND D. DEL C. CASTRO. 1998a. Amblycera. Pages 84–103 *in* J. Morrone and S. Coscarón [EDS.], Biodiversidad de artrópodos Argentinos: una perspectiva biotaxonómica. Ediciones Sur, La Plata, Argentina.

——— AND ———. 1998b. Ischnocera. Pages 104–124 *in* J. Morrone and S. Coscarón [EDS.], Biodiversidad de artrópodos Argentinos: una perspectiva biotaxonómica. Ediciones Sur, La Plata, Argentina.

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

DEL HOYO, J., A. ELLIOTT, AND J. SARGATAL [EDS.]. 1994. Handbook of the birds of the world, Vol. II, New World vultures to guineafowl. Lynx Edicions, Barcelona, Spain.

DÍAZ, L., N. KOMAR, A. VISINTIN, M.J. DANTUR JURI, M. STEIN, R.L. ALLENDE, L. SPINSANTI, B. KONIGHEIM, J. AGUILAR, M. LAURITO, W. ALMIRON, AND M. CONTIGIANI. 2008. West Nile virus in birds, Argentina. *Emerging Infectious Diseases* 14:689–691.

DOMROW, R. 1977. New records and species of *Laelaps* and allied genera from Australasia (Acari: Dermanyssidae). Part 2. *Proceeding of the Linnean Society of New South Wales* 101:185–217.

ESTRADA-PEÑA, A., J.M. VENZAL, D. GONZÁLEZ-ACUÑA, AND A.A. GUGLIELMONE. 2003. *Argas (Persicargas) keiransi* n. sp., (Acari: Argasidae), a parasite of the Chimango, *Milvago c. chimango* (Aves: Falconiformes) in Chile. *Journal of Medical Entomology* 40:766–769.

———, ———, ———, A.J. MANGOLD, AND A.A. GUGLIELMONE. 2006. Notes on New World Persicargas ticks (Acari: Argasidae) with description of female *Argas* (P.) *keiransi*. *Journal of Medical Entomology* 43:801–809.

FARAJOLLAHI, A., W.J. CRANS, D. NICKERSON, P. BRYANT, B. WOLF, A. GLASER, AND T.G. ANDREADIS. 2005. Detection of West Nile virus RNA from the louse fly *Icosta americana* (Diptera: Hippoboscidae). *Journal of the American Mosquito Control Association* 21:474–476.

GANCZ, A.Y., I.K. BARKER, R. LINDSAY, A. DIBERNARDO, K MCKEEVER, AND B. HUNTER. 2004. West Nile virus outbreaks in North American owls, Ontario, 2002. *Emerging Infectious Diseases* 10:2135–2142.

GAUD, J. AND W.T. ATYEO. 1996. Feather mites of the world (Acarina, Astigmata): the supraspecific taxa. Part I: Text and Part II: Illustrations of feather mite taxa. *Annales du Musée Royale de l'Afrique Centrale, Sciences Zoologiques, Tervuren, Belgique* 277:3–193.

GONZÁLEZ-ACUÑA, D., K. ARDILES, R.A. FIGUEROA R., C. BARRIENTOS, L. MORENO, AND A. CICCHINO. 2008. Lice of Chilean diurnal raptors. *Journal of Raptor Research* 42:281–286.

———, A. CICCHINO, R.C. MUÑOZ, AND R.A. FIGUEROA. 2006. Lice of Chilean owls: a first description. *Journal of Raptor Research* 40:301–302.

———, E. LOHSE, A. CICCHINO, S. MIRONOV, R.A. FIGUEROA R., K. ARDILES, AND M. KINSELLA. 2011. Parasites of the American Kestrel (*Falco sparverius*) in south-central Chile. *Journal of Raptor Research* 45:188–193.

GRACIOLLI, G. AND C.J. BARROS DE CARVALHO. 2003. Hippoboscidae (Diptera, Hippoboscoidea) no Estado do Paraná, Brasil: chaves de identificação, hospedeiros e distribuição geográfica. *Revista Brasileira de Zoologia* 20:667–674.

——— AND A.A. BISPO. 2005. Hippoboscidae (Diptera) ectoparasitos sobre seis espécies de corujas (Strigiformes) no estado do Paraná, Sul do Brasil. *Revista Brasileira de Ornitologia* 13:181–182.

JOVANI, R., J.L. TELLA, D. SOL, AND D. VENTURA. 2001. Are hippoboscid flies a major mode of transmission of feather mites? *Journal of Parasitology* 87:1187–1189.

KEIRANS, J.E. 1975. A review of the phoretic relationship between Mallopahga (Phthiraptera: Insecta) and Hippoboscidae (Diptera: Insecta). *Journal of Medical Entomology* 12:71–76.

KOMAR, N., S. LANGEVIN, S. HINTEN, N. NEMETH, E. EDWARDS, D. HETTLER, B. DAVIS, R. BOWEN, AND M. BUNNING. 2003. Experimental infection of North American birds with the New York 1999 strain of West Nile virus. *Emerging Infectious Diseases* 9:311–322.

KRANTZ, G.W. 1978. A manual of acarology, Second Ed. Oregon State Univ. Book Stores, Inc., Corvallis, OR U.S.A.

KRONE, O. 2007. Pathology. C, Endoparasites. Pages 318–328 *in* D.M. Bird and K.L. Bildstein [EDS.], Raptor management techniques manual. Hancock House Publishers, Blaine, WA U.S.A.

LARESCHI, M. AND R.A. MAURI. 1998. Dermanyssoidea. Pages 581–590 *in* J.J. Morone and S. Coscarón [EDS.], Biodiversidad de artrópodos Argentinos: una perspectiva biotaxonómica. Ediciones Sur, La Plata, Argentina.

LLOYD, J.E. 2009. Louse flies, keds, and related flies (Hippoboscoidea). Pages 339–352 *in* G.R. Mullen and L.A. Durden [EDS.], Medical and veterinary entomology, Second Ed. Academic Press, San Diego, CA U.S.A.

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

MARRA, P.P., S. GRIFFING, C. CAFFREY, A.M. KILPATRICK, R MCLEAN, C. BRAND, E. SAITO, A.P. DUPUIS, L. KRAMER, AND R. NOVAK. 2004. West Nile virus and wildlife. *BioScience* 54:393–402.

MEDICA, D.L. AND K.L. BILDSTEIN. 2009. Annual variation in West Nile virus antibodies in American Kestrels (*Falco sparverius*) in eastern Pennsylvania. *Journal of Raptor Research* 43:301–307.

MEY, E. AND D. GONZÁLEZ-ACUÑA. 2000. A new genus and species of Ischnocera (Insecta, Pthiraptera) of Chimango Caracara *Milvago chimango* from Chile with annotated checklist of chewing lice parasitizing caracaras (Aves, Falconiformes, Falconidae). *Rudolstädter Naturhistorische Schriften* 10:59–73.

MICHERDZINSKI, W. 1980. Eine taxonomische analyse der familie Macronyssidae Oudemans, 1936. I. Subfamilie Ornithonyssinae Lange, 1958 (Acarina, Mesostigmata). Pañstwowe Wydawnictwo Naukowe, Warszawa and Kraków, Poland.

MORISHITA, T.Y., J.W. MERTINS, D.G. BARKER, C.M. MONAHAN, AND D.L. BROOKS. 2001. Occurence and species of lice on free-living and captive raptors in California. *Journal of Avian Medicine and Surgery* 15:288–292.

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.

MULLEN, G.R. AND B.M. O'CONNOR. 2009. Mites (Acari). Pages 433–492 *in* G.R. Mullen and L.A. Durden [EDS.], Medical and veterinary entomology, Second Ed. Academic Press, San Diego, CA U.S.A.

NEMETH, N.M., S. BECKETT, E. EDWARDS, K. KLENK, AND N. KOMAR. 2007. Avian mortality surveillance for West Nile Virus in Colorado. *American Journal of Tropical Medicine and Hygiene* 76:431–437.

PALMA, R. 1978. Slide-mounting of lice: a detailed description of the Canada balsam technique. *New Zealand Entomology* 6:432–436.

PÉREZ, J.M., I. RUIZ-MARTÍNEZ, AND J.E. COOPER. 1996. Occurrence of chewing lice on Spanish raptors. *Ardeola* 43:129–138.

PHILIPS, J.R. 1990. What's bugging your birds? Avian parasitic arthropods. *Wildlife Rehabilitation* 8:155–203.

———. 2000. A review and checklist of the parasitic mites (Acarina) of the Falconiformes and Strigiformes. *Journal of Raptor Research* 34:210–231.

———. 2007. Pathology. B, Ectoparasites. Pages 311–317 *in* D.M. Bird and K.L. Bildstein [EDS.], Raptor management techniques manual. Hancock House Publishers, Blaine, WA U.S.A.

PRICE, R. AND J. BEER. 1963. Species of *Colocephalum* (Mallophaga: Menoponidae) parasitic upon the Falconiformes. *Canadian Entomologist* 95:731–763.

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 24, Champaign, IL U.S.A.

SAITO, E.K., L. SILEO, D.E. GREEN, C.U. METEYER, G.S MCLAUGHLIN, K.A. CONVERSE, AND D.E. DOCHERTY. 2007. Raptor mortality due to West Nile virus in the United States, 2002. *Journal of Wildlife Diseases* 43:206–213.

SAN MARTÍN, J., C. BREVIS, L. RUBILAR, R. SCHMASCHKE, A. DAUGSCHIES, AND D.A. GONZÁLEZ ACUÑA. 2005. Ectoparasitismo en tiuque común *Milvago chimango chimango* (Viellot, 1816) (Aves, Falconidae) en la zona de Ñuble, Chile. *Lundiana* 6:49–55.

SANTILLÁN, M.A., D.L. CARPINTERO, M.A. GALMES, AND J.H. SARASOLA. 2009. Presence of cimicid bugs (Hemiptera: *Cimicidae*) on a Crowned Eagle (*Harpyhaliaetus coronatus*) nestling. *Journal of Raptor Research* 43:255–256.

SARASOLA, J.H., L.A. BRAGAGNOLO, AND R.A. SOSA. 2005. Changes in woody plant structure in fire-disturbed calden forests of Parque Luro Reserve, Argentina. *Natural Areas Journal* 25:374–380.

SEMENAS, L. AND J.A. ROCHA. 1998. Un motivo poco común de crisis de llanto en un recién nacido. *Archivos Argentinos de Pediatría* 96:131–133.

SMALLWOOD, J.A. AND D.M. BIRD. 2002. American Kestrel (*Falco sparverius*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 602. The Academy of Natural Sciences, Philadelphia, PA and The American Ornithologists' Union, Washington, DC U.S.A.

SYKES, P.W. AND D.J. FORRESTER. 1983. Parasites of the Snail Kite in Florida and summary of those reported for the species. *Florida Field Naturalist* 11:111–116.

TURELL, M.J. 2009. Arthropod-related viruses of medical and veterinary importance. Pages 557–564 *in* G.R. Mullen and L.A. Durden [EDS.], Medical and veterinary entomology, Second Ed. Academic Press, San Diego, CA U.S.A.

VALENTE, A.L.S., R.M.M. PAULSEN, AND J.G.W. BRUM. 2001. *Colpocephalum maculatum* Piaget, 1880 (Mallophaga: Menoponidae) em gavião-carijó (*Rupornis magnirostris*) e Caracará (*Polyborus plancus*) no Rio Grande do Sul, Brasil. *Arquivos da Faculdade de Veterinária, UFRGS* 29:147–148.

VALIM, M.P. AND G.S. GAZÊTA. 2007. Associação forética dos ácaros *Myialges anchora* Sergent and Trouessart (Acaridida, Epidermoptidae) e *Ornithocheyletia hallae* Smiley (Actinedida, Cheyletiellidae) com *Pseudolynchia canariensis* (Macquart) (Diptera, Hippoboscidae). *Revista Brasileira de Entomologia* 51:518–519.

——— AND R. PALMA. 2007. The correct identity of a louse sample (Phthiraptera: Menoponidae) from the Roadside Hawk, *Rupornis magnirostris* (Gmelin) (Falconiformes: Accipitridae). *Neotropical Entomology* 36:157–159.

WHITEMAN, N.K., K.D. MATSON, J.L. BOLLMER, AND P.G. PARKER. 2006a. Disease ecology in the Galápagos Islands: host genetic diversity, parasite load and natural antibodies. *Proceedings of the Royal Society of London. Series B, Biological Sciences* 273:797–804.

——— AND P.G. PARKER. 2005. Using parasites to infer host history: a new rationale for parasite conservation. *Animal Conservation* 8:175–181.

———, P. SANCHEZ, J. MERKEL, H. KLOMPEN, AND P.G. PARKER. 2006b. Cryptic host specificity of an avian skin mite (Epidermoptidae) vectored by louseflies (Hippoboscidae) associated with two endemic Galápagos bird species. *Journal of Parasitology* 92:1218–1228.

———, D. SANTIAGO-ALARCON, K.P. JOHNSON, AND P.G. PARKER. 2004. Differences in straggling rates between two genera of dove lice (Insecta: Phthiraptera) reinforces population genetic and cophylogenetic patterns. *International Journal for Parasitology* 34:1113–1119.

WOODS, R.W. 1988. Guide to birds of the Falkland Islands. Anthony Nelson, Ltd., Shropshire, U.K.

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