

Article

Lice, Flies, Mites, and Ticks on Raptors (Accipitriformes, Falconiformes and Strigiformes) in Rescue Centers in Central Italy

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Abstract: This study aims to assess the occurrence of external arthropods on deceased raptors in rescue centers in Tuscany, central Italy. The examined diurnal raptors include 17 common buzzards (*Buteo buteo*), two European honey buzzards (*Pernis apivorus*), seven sparrowhawks (*Accipiter nisus*), six common kestrels (*Falco tinnunculus*), a western osprey (*Pandion haliaetus*), and a peregrine falcon (*Falco peregrinus*). Nocturnal raptors included seven barn owls (*Tyto alba*), ten tawny owls (*Strix aluco*), 22 little owls (*Athene noctua*) and two scops owls (*Otus scops*). The skin and the feathers of each animal were examined, and arthropods were collected, fixed, and microscopically identified. In 48 out of the 75 examined birds (64%), at least a single arthropod species was found. Identified arthropods included chewing lice (*Degeeriella fulva*, *D. rufa*, *Colpocephalum turbinatum*, *C. apivorus*, *Nosopon lucidum*, *N. clayae*, *Craspedorrhyncus platystomus*, *Laemobothrion tinnunculi*, *Kurodaia subpachygaster*, *Strigiphilus cursitans*), hippoboscid flies (*Ornithomya avicularia*), chigger and feather mites (*Kramerella lunulata*, *K. lyra*, *Kramerella* sp., *Glaucalges attenuatus*, *Hieracolichus nisi*, *Hieracolichus* sp., *Neotrombicula autumnalis*) and ticks (*Haemaphysalis* sp.). Most of the identified mite, fly and tick species are the first records in raptors in Italy. Moreover, this study presents the first record of *Hieracolichus* sp. and *N. autumnalis* mites in *P. haliaetus* and *F. tinnunculus*, respectively.

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Keywords: raptors; Accipitriformes; Falconiformes; Strigiformes; external Arthropods; central Italy

1. Introduction

Arthropods associated with raptors include lice, mites, ticks, fleas, and flies [1–5]. Chewing lice and feather mites are frequently reported in raptors, which in most cases show no clinical signs [2,4,6–8]. However, some raptor ectoparasites may cause severe damage to the feathers, feather loss, intense pruritus and consequent weakness, restlessness, self-induced lesions, and may become fatal to the host birds in more severe cases [1,5,7,9]. Moreover, chigger mites, ticks, and hippoboscid flies may cause anemia and crusted and ulcerative dermatitis, frequently complicated with secondary bacterial infections, and may act as vectors of several pathogens [1,2,7,8,10]. External parasites may negatively affect the natural and captive populations or may face extinction with their hosts [11].

Previous studies carried out in Italy deal mainly with chewing lice [12–19], whereas data about mites, ticks, and flies of raptors are completely lacking.

This study aimed to assess the occurrence of arthropods associated with diurnal and nocturnal deceased raptors in wildlife rescue centers in different areas of Tuscany (central Italy).

2. Results and Discussion

In the geographical area considered in the present study [20], and in Italy [21,22], the buzzard (*Buteo buteo*) and the little owl (*Athene noctua*) are included among the prevalent diurnal and nocturnal raptor species, respectively. This could explain the high number of deceased specimens of these two raptor species examined in this study.

This study showed a high prevalence of external arthropods in examined raptors, as 48 out of the 75 examined birds (64%) scored positive for at least one arthropod species. Out of the ten raptor species examined, eight species were found to be positive for the presence of external arthropods. Only the two scops owls (*Otus scops*) and the single peregrine (*Falco peregrinus*) scored negatively. However, the found prevalence may be underestimated considering that several ectoparasite species may leave their deceased bird hosts.

Identified arthropods included chewing lice (*Degeeriella fulva*, *D. rufa*, *Colpocephalum turbinatum*, *C. apivorus*, *Nosopon lucidum*, *N. clayae*, *Craspedorrhyncus platystomus*, *Laemobothrion tinnunculi*, *Kurodaia subpachygaster*, *Strigiphilus cursitans*), hippoboscid flies (*Ornithomya avicularia*), chigger and feather mites (*Kramerella lunulata*, *K. lyra*, *Kramerella* sp., *Glaucalgus attenuatus*, *Hieracolichus nisi*, *Hieracolichus* sp., *Neotrombicula autumnalis*) and ticks (*Haemaphysalis* sp.) (Table 1, Figures 1 and 2).

More specifically, the species *D. fulva*, *C. turbinatum*, *C. platystomus* and *O. avicularia* were identified in the buzzard (*B. buteo*), *N. clayae*, *C. apivorus* and *H. nisi* were identified in the honey buzzard (*Pernis apivorus*), while *D. rufa*, *N. lucidum*, *L. tinnunculi*, *N. autumnalis* and *Haemaphysalis* sp. were identified in the kestrel (*Falco tinnunculus*) (Table 1, Figures 1 and 2). *H. nisi* was also identified in the sparrowhawk (*A. nisus*). Moreover, *Hieracolichus* spp. mites were also identified in the single examined osprey (*P. haliaetus*). However, based on the morphology and dimensions of adults and according to the keys used for the identification of the species within this genus [9,11,23,24], it was not possible to identify the species (Table 1, Figures 1 and 2).

Arthropod species of nocturnal raptors included *S. cursitans* and *K. lunulata* identified in the little owl (*A. noctua*), *K. subpachygaster* and *Kramerella* sp. identified in the tawny owl (*Strix aluco*), and *K. lunulata*, *K. lyra* and *G. attenuatus* (14.29%, 1/7) identified in the barn owl (*Tyto alba*) (Table 1, Figures 1 and 2).

In most positive birds, intensity was high (Table 1), especially in the case of lice and feather mites. More specifically, a high intensity of at least a single identified louse and/or mite species was observed in each positive diurnal and nocturnal raptor (Table 1). Although lesions associated with some arthropod species identified in this study were previously described in raptors [1,7], no macroscopic lesions were found in the skin or in the feathers of birds found positive for lice and feather mites.

Table 1. External arthropods identified in raptors in Tuscany (central Italy).

Bird (N. Examined)	Lice ° (Prevalence)	Flies ° (Prevalence)	Mites ° (Prevalence)	Ticks ° (Prevalence)
Diurnal Raptors				
Osprey (<i>Pandion haliaetus</i>) (1)			<i>Hieracolichus</i> sp. (100%, 1/1) *	
Buzzard (<i>Buteo buteo</i>) (17)	<i>Degeeriella fulva</i> (41.18%, 7/17) * <i>Colpocephalum turbinatum</i> (11.76%, 2/17) * <i>Craspedorrhyncus platystomus</i> (5.88 %, 1/17) *	<i>Ornithomya avicularia</i> (5.88 %, 1/17)		
Honey buzzard (<i>Pernis apivorus</i>)	<i>Nosopon clayae</i> (50%, 1/2) *		<i>Hieracolichus nisi</i> (100%, 2/2) *	

(2)	<i>Colpocephalum apivorus</i> (50%, 1/2) *		
Sparrowhawk (<i>Accipiter nisus</i>) (7)			<i>Hieracolicus nisi</i> (42.86%, 3/7)*
	<i>Degeeriella rufa</i> (50%, 3/6) *		
Kestrel (<i>Falco tinnunculus</i>) (6)	<i>Nosopon lucidum</i> (16.67%, 1/6) *	<i>Neotrombicula autumnalis</i>	<i>Haemaphysalis</i> sp. (16.67%, 1/6) (16.67%, 1/6)
	<i>Laemobothrion tinnunculi</i> (16.67%, 1/6)		

Nocturnal Raptors

			<i>Kramerella lunulata</i> (14.29%, 1/7)
Barn owl (<i>Tyto alba</i>) (7)			<i>Kramerella lyra</i> (14.29%, 1/7) *
			<i>Glaucalges attenuatus</i> (14.29%, 1/7)
Tawny owl (<i>Strix aluco</i>) (10)	<i>Kurodaia subpachygaster</i> (50%, 5/6) *		<i>Kramerella</i> sp. (50%, 3/6) *
Little owl (<i>Athene noctua</i>) (22)	<i>Strigiphilus cursitans</i> (27.27%, 6/22) *		<i>Kramerella lunulata</i> (86.36%, 19/22) *

° External arthropod species/genus; * high intensity (>100 individuals per single bird; mean number of 50 mites per feather upon examination of at least 15 feathers/single bird was considered indicative of high intensity in the case of feather mites).

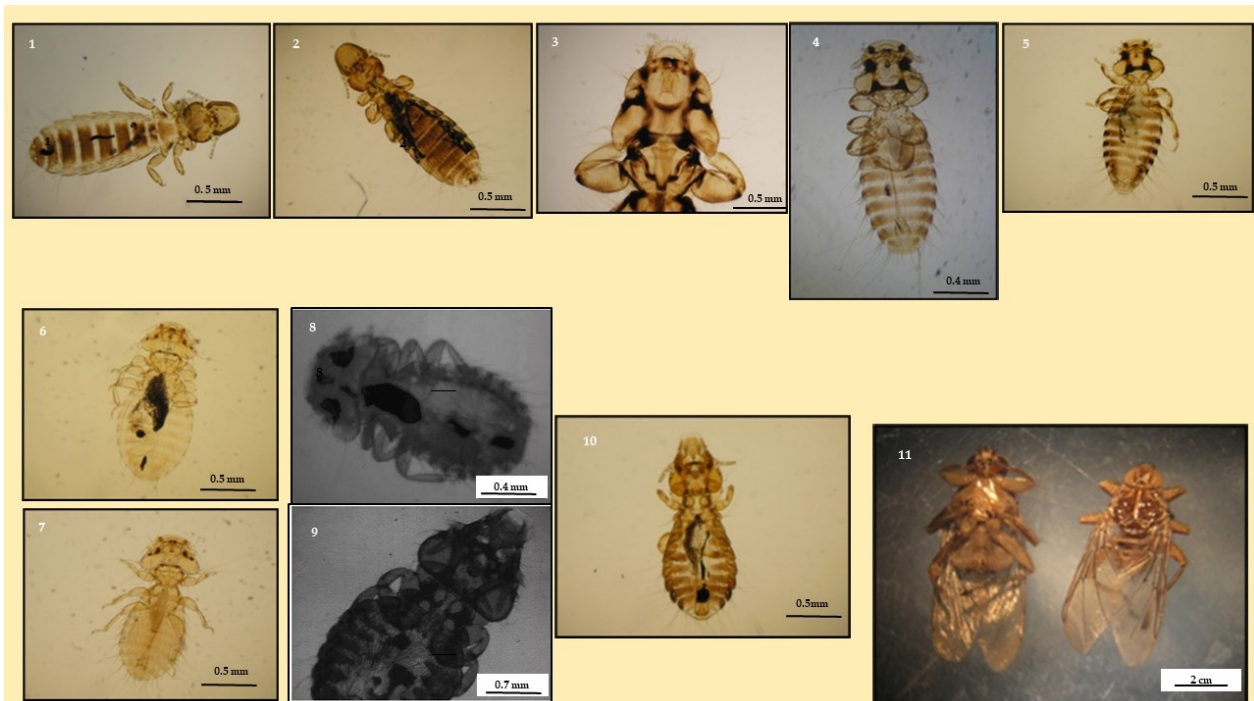


Figure 1. Louse (1–10) and hippoboscid fly (11) species identified raptors in Tuscany, central Italy. 1. *Degeeriella fulva* female; 2. *D. fulva* male; 3. *Laemobothrion tinnunculi* anterior end; 4. *Colpocephalum turbinatum* male; 5. *Colpocephalum apivorus* female; 6. *Nosopon lucidum* female; 7. *Nosopon clayae* male; 8. *Kurodaia subpachygaster*; 9. *Craspedorrhyncus platystomus*; 10. *Strigiphilus cursitans*; 11. *Ornithomya avicularia*.



Figure 2. Mite (1–11) and tick (12) species identified in raptors in Tuscany, central Italy. 1. *Neotrombicula autumnnalis* larva; 2. *Hieracolichus* sp. male; 3. *Hieracolichus* sp. female; 4. *Hieracolichus nisi* male; 5. *H. nisi* female; 6. *Glaucalges attenuatus* female; 7. *Kramerella lunulata* female; 8. *Kramerella lyra* male; 9. *K. lyra* female; 10. *Kramerella* sp. male; 11. *Kramerella* sp. female; 12. *Haemaphysalis* sp. larva.

In some birds, more arthropod species were concurrently identified. Among diurnal raptors, two different chewing lice species, namely *D. rufa* and *L. tinnunculi*, and larvae of the tick *Haemaphysalis* sp. (Table 1; Figure 1(2,3); Figure 2(12)), were identified in a kestrel (*F. tinnunculus*). Another kestrel (*F. tinnunculus*) was instead found to be concurrently positive for *D. rufa* and *N. lucidum* (Table 1; Figure 1(2,6)). The two honey buzzards (*P. apivorus*) were found to be positive for both chewing lice and mites; more specifically *N. clayae* or *C. apivorus* (Table 1; Figure 1: 5, 7) and *H. nisi* (Table 1; Figure 2(4,5)) were concurrently found in these two honey buzzards.

The 17 buzzards (*B. buteo*) scored free from mites but a high number of chewing lice were counted in seven of these birds. All these animals scored positive for the species *D. fulva* (Table 1; Figure 1(1)), and *C. turbinatum* (Table 1; Figure 1(4)) or *C. platystomus* (Table 1; Figure 1(9)) were concurrently identified in two and one out of these seven positive buzzards, respectively.

Among nocturnal raptors, three different mite species, namely *K. lunulata*, *K. lyra* and *G. attenuates*, were identified in a barn owl (*T. alba*) (Table 1; Figure 2(6–9)), while six little owls (*A. noctua*) were found to be positive for both chewing lice, *S. cursitans* (Table 1; Figure 1(10)) and mites, *K. lunulata* (Table 1; Figure 2(7)).

On another buzzard, adults of the hematophagous hippoboscid fly *O. avicularia*, were identified (Table 1; Figure 1(11)). *O. avicularia* has been reported to infest a high number of bird species, including raptors [25], in which it may cause severe anemia, especially in younger subjects [26]. Moreover, this fly species can be the vector of several pathogens of raptors, including *Haemoproteus* spp. and *Trypanosoma* spp. [25,27,28]. Interestingly, hippoboscid flies may act as phoretic hosts for several *Degeeriella* species that can be transported to new bird hosts [29].

A high number of *N. autumnnalis* larvae were identified on a kestrel (*F. tinnunculus*) and in the bag used to transport this animal (Table 1; Figure 2(1)). In birds, larvae of

Neotrombicula spp. mites can be found mainly between the keel of the sternum and the cloaca or on the skin of the wings [30,31], as in the kestrel that scored positive in this study. After about 2–5 days from the beginning of the infestation, larvae leave the birds to reach the ground and molt to nymphs [30]. In heavily infested birds, parasitic larvae of *N. autumnalis* may cause dermatitis and intense pruritus, starvation, self-induced lesions, and secondary bacterial infections [30,31]. However, no lesions were observed in the *N. autumnalis*-infested kestrel in this study.

In Italy, parasitic larvae of *N. autumnalis* generally infest birds during the summer [30]. However, in this study the positive kestrel was examined in January. Interestingly, in the Czech Republic some chigger mites (*Ascoschoengastia latyshevi*) were also rather frequently found on birds, even during winter months [32].

Eight ticks were counted in another kestrel and identified as larvae of *Haemaphysalis* sp. (Table 1; Figure 2(12)). Among species of the genus *Haemaphysalis*, larvae and nymphs of the species *Haemaphysalis punctata* are commonly found on birds, especially passerines but also other birds in the Apennine areas of Italy, as Tuscany [16,33].

Haemaphysalis punctata is a three-host tick known to be from Europe, northwestern Africa, and southwestern Asia [34]. *Haemaphysalis punctata* larvae and nymphs may infest birds [35,36]. In Europe, *H. punctata* has mainly a Mediterranean distribution [37]. However, migrating birds are considered to play an important role in introducing this tick species to other European areas [38,39]. Under conditions of high parasite load, this tick may be responsible for anemia, reduced growth, and weight loss and may be the vector of several bacterial and viral pathogens in infested birds [40].

Among external arthropods frequently reported in owls [1,2,41,42], *K. subpachygaster* lice (Table 1; Figure 1: 8) were identified in three out of ten examined tawny owls (*S. aluco*), while different *Kramerella* spp. mites (Table 1; Figure 2(7–11)) were identified in almost all positive owls examined.

3. Materials and Methods

Seventy-five deceased diurnal and nocturnal raptors were examined from 1998 to 2005 for occurrence of external arthropods. Examined diurnal raptors (Accipitriformes and Falconiformes) included 17 common buzzards (*B. buteo*), two European honey buzzards (*P. apivorus*), seven sparrowhawks (*A. nisus*), six common kestrels (*F. tinnunculus*), a western osprey (*P. haliaetus*), and a peregrine falcon (*F. peregrinus*) (Table 1). Among nocturnal raptors (Strigiformes), seven barn owls (*T. alba*), ten tawny owls (*S. aluco*), 22 little owls (*A. noctua*) and two scops owls (*O. scops*) were examined.

Raptors were wounded or diseased and died from a few hours (40/75) to ten days after their arrival in wildlife rescue centers located in different areas of Tuscany (central Italy), including the districts of Florence (43°46'N, 11°15'E), Lucca (43°50'N, 10°30'E), Pisa (43°43'N, 10°23'E) and Livorno (43°33'N, 10°18'E).

The examined birds had not been treated with antiparasitic drugs and were single-caged. In most cases (44/75 birds), deceased birds were placed in clean bags, refrigerated, and transported to the laboratory soon after their death. In other cases, birds were placed in a bag and refrigerated about 24–48 h after the death. The skin and the feathers of each animal and the respective bags were macroscopically inspected, and the feathers were also microscopically observed under a stereomicroscope. Arthropods were collected by means of needles, fine brushes, or tweezers, counted, and fixed in 70% ethanol. Collected and fixed arthropods were mounted in Hoyer medium and microscopically examined under an optical or a stereomicroscope equipped with an ocular micrometer, and species/genus identification was based on morphological and metrical features.

The overall prevalence was calculated as the number of birds among those examined that were found to be positive with one or more individual of at least a single external arthropod. The prevalence of each arthropod species in each bird species was also calculated. Furthermore, concurrent arthropod species found in a single bird host and the intensity of infestation of each arthropod species in a single bird host were also evaluated

[43]. Intensity was considered high when the number of each arthropod species counted in a bird host was higher than 100. However, a mean number of 50 mites per feather upon examination of at least 15 feathers was considered as indicative of high intensity in the case of feather mites [44,45].

The keys and descriptions by Séguy [29], Price and Beer [46–48], Clayton and Price [49], Lapage [50], Price et al. [51] and Manilla [12–15] were used for louse genus/species identification. Chigger and feather mites were identified according to keys and descriptions given by Brennan and Jones [52], Canestrini and Kramer [23], Gaud and Atyeo [24,53], Kranz [54], Stekolnikov [55,56], Philips [8], and Manfredini [30]. The Hippoboscid fly species was identified based on identification data reported by Neveau Lemarie [57], Séguy [29], Oboňa et al. [25], and Hill et al. [58]. Finally, descriptions given by Nosek [36], Kranz [54], Manilla [15,16], Pfäffle et al. [35], Iori et al. [59] and Nuttall [60] were used for the identification of tick larvae.

4. Conclusions

External arthropods identified in this survey were previously reported in examined raptor species in different areas worldwide [1,2,5,8,25,46–49,61]. However, most of the mite, fly, and tick species identified in this study are the first record in raptors in Italy. Moreover, this study is the first report of *Hieracolichus* sp. in the osprey (*P. haliaetus*) and of *N. autumnalis* in the kestrel (*F. tinnunculus*).

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