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Research Article



Data on the Chewing Lice (Phthiraptera) Parasitizing the Accipitrid Birds (Accipitriformes) in Turkey

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Abstract | The present survey paper documents the chewing lice (Phthiraptera: Amblycera, Ischnocera) associated with the Accipitriformes of Turkey. A total of 182 accipitrid birds belonging to 14 species, and 9 genera were surveyed. For the collection of lice, feathers of birds were carefully examined; an insecticide was applied on birds into a breathable paper bags from where lice were transferred to collection tubes. Of the 182 birds, 151 (82.97%) were infested with 21 chewing lice species including 8 species of *Colpocephalum*: *C. apivorus*, *C. zebra*, *C. trachelioti*, *C. impressum*, *C. polonum*, *C. nanum*, *C. turbinatum*, *C. milvi*, 6 species of *Degeeriella*: *D. phlyctopygus*, *D. leucopleura*, *D. aquilarum*, *D. nisus*, *D. fusca*, *D. fulva*, 2 species of *Laemobothrion*: *L. vulturis*, *L. maximum*, 2 species of *Craspedorrhynchus*: *Cr. fraterculus*, *Cr. platystomus*, 2 species of *Falcolipeurus*: *F. suturalis*, *F. quadripustulatus* and one species of *Kurodaia fulvofasciata*. Among birds, *Buteo* (Buzzards) were the most prevalent (73.63%), with 6 species of lice on *B. buteo* and 5 on *B. rufinus*; 3 each on *Aegypius monachus*, *Aquila heliaca*, *Aq. nisus*, and *Circus aeruginosus*; 2 each on *Pernis apivorus*, *Ci. pygargus* and *Milvus migrans*; and one each on *Circaetus gallicus*, *Hieraaetus pennatus*, *Aq. chrysaetos* and *Aq. gentilis*. *Circus cyaneus*, *Ci. macrourus*, *Clanga clanga* and *Accipiter brevipes* were not found infested with the louse. There are some lice species reported for the first time in Turkey, put new records for the hosts and the country on record. Many Turkish birds are, however, yet to be screened for chewing louse infestation.

Keywords | Accipitriformes; Amblycera; Ischnocera; Phthiraptera; Turkey.

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INTRODUCTION

Of around 10,500 species of birds reported globally (Gill et al., 2016), around 500 have been reported by Şekercioğlu (2006) and Kirwan et al. (2008) in Turkey. Accipitriformes include around 225 species in the world of diurnal, carnivorous prey birds with a sharp-hooked beak, longer and broader wings, and strong legs with raptorial claws including eagles, hawks, vultures, etc. These are di-

morphic, monogamous and long-lived with low reproductive rates.

Among various parasitic diseases, ectoparasites of birds are of great importance which can penetrate the skin, into the air sacs or under the feathers consuming dead cells of the skin and tissue fluids and/or sucking blood (Phillip, 1963; Panda and Ahluwalia, 1983; Johnson and Clayton, 2003). Chewing lice (Phthiraptera: Amblycera, Ischnocera)

are important ectoparasites of birds causing irritation, ill health, reduced haemoglobin and erythrocyte values and hyperchromic anemia (Jungmann et al., 1970), erosive stomatitis (Dik, 2006a), and lameness due to heavy louse infestation (Jungmann et al., 1970; Okaeme, 1989; Kumar and Kumar, 2016; Mishra et al., 2017). These can act as vectors for many diseases and pathogens (Pavlovic et al., 1989; Dik et al., 2017). Chewing lice are cosmopolitan and permanent obligate ectoparasites primarily of birds (Price et al., 2003). They usually cause subclinical infestation causing direct effect through irritation and an indirect effect through the transmission of various other blood-borne parasites e.g. filarial worms (Cohen et al., 1991; Clayton et al., 2008; Mehlhorn et al., 2012; Dik et al., 2017).

From Turkey, İnci et al. (2010a) elaborated a review on the lice fauna of Turkey in various mammalian and avian host species and two suborders, three families, 37 genera and 79 species of bird lice have been reported from Turkey. Of these, 43 species were from Ischnocera (Phlopterae), 35 from Menoponidae and one from Laemobothridae. The prevalence of ectoparasites with at least one chewing louse was reported to be 41.4% in wild birds of seven different species from the Cappadocia region of Turkey (İnci et al., 2010b). Scanning electron microscopic (SEM) morphology of a louse species *Craspedorrhynchus platystomus* (Burmeister, 1838) procured from a representative member of Accipitriformes i.e. Long-Legged Buzzard (*Buteo rufinus*) has also been documented earlier (Dik et al., 2013a; 2018). *Colpocephalum trachelioti* (n=3) was found for the first time in Turkey on the wounded black vulture (*Aegypius monachus*) on Türkmen Mountain, between Eskisehir and Kütahya, Turkey (Price and Beer, 1963).

Some of the examples of louse reports from different wild birds of Turkey include *Laemobothrion maximum* (Scopoli, 1763), *Degeeriella fulva* (Giebel, 1874), *Craspedorrhynchus platystomus* (Burmeister, 1838), *Colpocephalum nanum* (Piaget, 1890) and *Kurodaia fulvofasciata* (Piaget, 1880) from Long-Legged Buzzard (*B. rufinus*) (Dik, 2006b; Gülanber et al., 2006; Dik and Özkayhan, 2007; Dik and Uslu, 2009; Göz et al., 2015). *Craspedorrhynchus fraterculus* (Eichler and Złotorzycka, 1975), *Degeeriella aquilarum* (Eichler, 1943) and *Colpocephalum impressum* (Rudow, 1866) were recovered from the Imperial Eagle (*Aquila heliaca*) and *Degeeriella fusca* (Denny, 1842) was recovered from the Mars Harrier (*Circus aeruginosus*) (Dik and Uslu, 2009), *Degeeriella nisus* (Giebel, 1866) and *K. fulvofasciata* were found on the Common Buzzard (*B. buteo*). *Colpocephalum subzerfae* (Tendeiro, 1988), *Degeeriella rufa* (Burmeister, 1838) and *Laemobothrion tinnunculi* (Linnaeus, 1758) were recovered from Common Kestrel (*Falco tinnunculus*) (Esatgil et al., 2012; Dik et al., 2013b; Girişgin et al., 2013). The present report describes the results of chewing louse infestation in

183 accipitrid birds surveyed from various areas of Turkey and the fauna of Chewing lice in Turkey was updated.

MATERIALS AND METHODS

Collection of birds and their chewing lice: A total of 182 accipitrid birds (live and dead) belonging to nine genera and fourteen species, collected from various regions of the country (Fig. 1) are examined in the present study in Turkey during 1988-2019 at various regions throughout the country (Table 1). Each bird was carefully examined for louse infestation. Feathers of each dead bird were carefully rubbed, over a white piece of paper or in a bathtub. Washing was performed under the tap water in nylon bags and bag contents were transferred to the Petri dishes and examined macroscopically and microscopically for the presence of chewing lice. In the case of live birds, an insecticide (a synthetic pyrethroid) was applied at the recommended doses (0.5-1oz per bird) to eliminate the lice (Sato, 2019). Birds were placed in breathable paper bags or carton boxes for 20-30 minutes. The lice fallen on the bottom or from the skin of the birds were transferred with the fine forceps to the collection tube (Fig. 2).

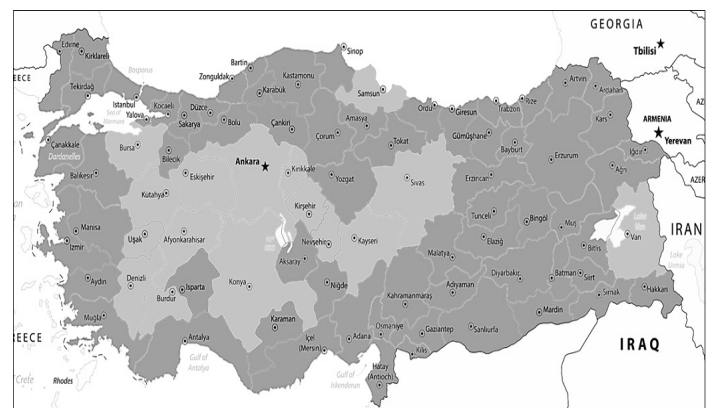


Figure 1: The map of Turkey, showing the areas in light gray colour that were visited for the collection of birds.

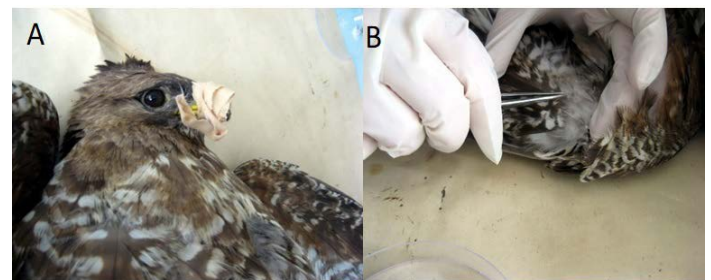


Figure 2: Restraining (A) and collection (B) of louse specimens from accipitrid birds.

Preservation and mounting process for the chewing lice: Collected lice samples were preserved in sample collection tubes containing 70% ethanol. Clearing of lice specimens was done with 10% Potassium hydroxide (KOH) for 24

Table 1: An inventory of chewing lice (Phthiraptera: Amblycera, Ischnocera) fauna of Accipitriform birds (Aves) in Turkey.

Bird Genera	Bird species examined	Number of bird examined	Number of birds infested	Lice species
<i>Accipiter</i>	<i>Ac. brevipes</i>	1	0	-
	<i>Ac. badius</i>	9	0	-
	<i>Ac. gentilis</i>	2	1	<i>Colpocephalum polonium</i>
	<i>Ac. nisus</i>	11	7	<i>Colpocephalum nanum</i> , <i>Degeeriella nisus</i> , <i>Kurodaia fulvofasciata</i>
<i>Aegyptius</i>	<i>Ae. monachus</i>	4	4	<i>Colpocephalum trachelioti</i> , <i>Falcolipeurus quadripustulatus</i> , <i>Laemobothrion vulturis</i>
<i>Aquila</i>	<i>Aq. fasciata</i>	0	0	-
	<i>Aq. heliaca</i>	2	1	<i>Colpocephalum impressum</i> , <i>Craspedorrhynchus fraterculus</i> , <i>Degeeriella aquilarum</i>
	<i>Aq. chrysaetos</i>	7	1	<i>Laemobothrion maximum</i>
	<i>Aq. nipalensis</i>	0	0	-
<i>Buteo</i>	<i>B. buteo</i>	49	42	<i>Colpocephalum nanum</i> , <i>Craspedorrhynchus platystomus</i> , <i>Degeeriella fulva</i> , <i>Degeeriella nisus</i> , <i>Falcolipeurus suturalis</i> , <i>Kurodaia fulvofasciata</i> , <i>Laemobothrion maximum</i>
	<i>B. lagopus</i>	0	0	-
	<i>B. rufinus</i>	85	72	<i>Colpocephalum nanum</i> , <i>Craspedorrhynchus platystomus</i> , <i>Degeeriella fulva</i> , <i>Kurodaia fulvofasciata</i> , <i>Laemobothrion maximum</i>
<i>Circaetus</i>	<i>C. gallicus</i>	3	1	<i>Colpocephalum turbinatum</i> , <i>Degeeriella leucopleura</i> , <i>Falcolipeurus quadripustulatus</i>
<i>Circus</i>	<i>C. aeruginosus</i>	5	5	<i>Degeeriella fusca</i> , <i>Colpocephalum turbinatum</i> , <i>Kurodaia fulvofasciata</i>
	<i>C. cyaneus</i>	1	0	-
	<i>C. macrourus</i>	1	0	<i>Myrsidea</i> sp. (Contamination due to preying?)
	<i>C. pygargus</i>	4	1	<i>Colpocephalum</i> sp., <i>Degeeriella</i> sp.
<i>Clanga</i>	<i>C. clanga</i>	1	-	-
	<i>C. pomarina</i>	0	0	-
<i>Elanus</i>	<i>E. caeruleus</i>	0	0	-
<i>Gypaetus</i>	<i>G. barbatus</i>	0	0	-
<i>Gyps</i>	<i>G. fulvus</i>	0	0	-
<i>Halieaetus</i>	<i>H. albicilla</i>	0	0	-
<i>Hieraetus</i>	<i>H. pennatus</i>	1	1	<i>Laemobothrion maximum</i>
<i>Milvus</i>	<i>M. migrans</i>	2	2	<i>Colpocephalum milvi</i> , <i>Laemobothrion</i> sp. (N)
	<i>M. milvus</i>	0	0	-
<i>Neophron</i>	<i>N. percnopterus</i>	0	0	-
<i>Pernis</i>	<i>P. apivorus</i>	3	3	<i>Colpocephalum apivorus</i> , <i>C. zebra</i> , <i>Degeeriella phlyctopygus</i>
	<i>P. ptilorhynchus</i>	0	0	-
<i>Pandion</i>	<i>P. haliaetus</i>	0	0	-
Total		182	151	Overall prevalence: 82.97%

hours followed by washing in the distilled water for 24 hours to remove KOH. After washing, dehydration was performed in 70% and 99% graded ethanol for 24 hours.

Slide mounting was done using Canada balsam.

Microscopy and determination of the chewing lice species:

The morphological features of the specimens were examined under trinocular stereo zoom microscope (Nikon SMZ745T) using the keys described elsewhere (Eichler, 1944; Clay, 1958; Price and Beer, 1963; Tendeiro et al., 1979; Gállego et al., 1987; Pérez-Jiménez et al., 1988; Dik et al., 2011; 2013b; Nelson and Price, 1965). Photographs were made using the Leica DM 750 Trinocular Microscope for all species but except larger specimens for which stereomicroscope was used. Data of taxonomy was compiled and percentages of the species of different genera were calculated. Careful handling of the birds for the collection of lice specimens was done using the guidelines to the use of wild birds in the research (Fair et al., 2010).

RESULTS

A total of 182 individuals were examined for chewing lice and prevalence 82.97% was found. Twenty-one chewing lice species belonging to 10 Amblyceran species were identified including *Colpocephalum apivorus* (Tendeiro, 1958), *C. impressum* (Rudow, 1866), *C. nanum* (Piaget, 1890), *C. polonum* (Eichler and Złotorzycka, 1971), *C. trachelioti* (Price and Beer, 1963), *C. turbinatum* Denny, 1842, *C. zebra* Burmeister, 1838, *Kurodaia fulvofasciata* (Piaget, 1880) of family Menoponidae; *Laemobothrion maximum* (Scopoli, 1763) and *L. vulturis* (Fabricius, 1775) of family Laemobothriidae; and 8 Ischnoceran species were included *Craspedorrhynchus fraterculus* (Eichler and Złotorzycka, 1975), *Cr. platystomus* (Burmeister, 1838), *Degeeriella fulva* (Giebel, 1874), *D. fusca* (Denny, 1842), *D. leucopleura* (Nitzsch [in Giebel], 1874), *D. nisus* (Giebel, 1866), *D. phlyctopygus* (Nitzsch [in Giebel], 1861) and *Falcolipeurus suturalis* (Rudow, 1869) were detected on the infested birds (Table 1).

Besides these, a third-stage nymph of the genus *Myrsiidea* was also collected from *Circus macrourus*, a nymph of *Colpocephalum* species from *Buteo rufinus*, a few nymphs of *Laemobothrion* species from *Aquila chrysaetos* and *Milvus migrans*, and three specimens of *Colpocephalum* species probably *C. flavescens* [nom. dub.]. The genera *Colpocephalum* in suborder Amblycera, and *Degeeriella* in suborder Ischnocera were very common. Presently, eight species in the genus *Colpocephalum* and six species in the genus *Degeeriella* were detected. The highest infestation rate was recorded in common buzzard with six species and Long-Legged Buzzard with five species; 85.71% and 84.71%, respectively.

Phthirapteran: Amblycera: Laemobothriidae

Laemobothrion maximum (Scopoli, 1763) (Fig. 3)

Material Examined: 1♂ 1♀ 1N; ex. *Buteo buteo*; 2006; Van, Turkey. 1N; 20 November 2006; Develi Kayseri, Turkey. 1N; 23 January 2007; Sivas, Sivas, Turkey. 1♀, 1N; 7 Octo-

ber 2007; Nevşehir, Nevşehir, Turkey. 1♀; 13 August 2008; Tomarza, Kayseri, Turkey. 2♀; 9 November 2009; Sivas, Turkey. 1♂ 4♀ 1N; between 2008 and 2012; Karacabey, Bursa, Turkey. 1♂ 1♀ 1N; ex. *Buteo rufinus*; 30 September 2019; Akdağ, Beydilli, Turkey. 1♂ 1♀ 10N; 9 August 2018; Küçük Hüyük, İhsaniye, Afyonkarahisar, Turkey. 1♂ 5N; 11 August 2018; Tokuşlar village, Sinanpaşa, Afyonkarahisar, Turkey. 1♀; 14 October 2018; Ahmetpaşa, Sinanpaşa, Turkey. 1♂ 2♀; 1988; Konya, Turkey. 1♂ 1N; in back and chest feathers; 1990; Konya, Turkey. 1♀; 2006; Kirikkale, Turkey. 21♂ 35♀ 44N; 22 November 2006; İçeri Çumra-Konya, Turkey. 3♂; 3 May 2007; Konya Zoo, Konya, Turkey. 1♀ 8N; 18 February 2008; Ankara, Turkey. 2♂ 2♀; 20 November 2005; Tomarza, Kayseri, Turkey. 1N; 23 January 2007; Kayseri, Turkey. 1♀ 4N; 17 March 2011; Veterinary Faculty, Afyonkarahisar, Turkey. 1♀ 3N; 4 April 2011; Veterinary Faculty, Konya, Turkey. 1♂; 26 October 2011; Veterinary Faculty, Konya, Turkey. 1♂ 4♀ 1N; 6 January 2012; Veterinary Faculty, Konya, Turkey. 1♀ 4N; 3 April 2012; Konya, Turkey. 1♂ 1♀; 3 December 2013; Konya, Turkey. 1♂ 2♀ 7N; 14 January 2014; Konya, Turkey. 2♂ 3♀ 5N; 22 February 2019; Veterinary Faculty, Konya, Turkey. 1♂; ex. *Hieraaetus pennatus* (as *Aquila pennatus* in the text); 2010; Veterinary Faculty Hospital, Bursa, Turkey.

Laemobothrion vulturis (Fabricius, 1775) (Fig. 4)

Material Examined: 1♂ 1♀; ex. *Aegypius monachus*; 10 December 2010; Türkmen Mountain, Kütahya, Turkey.

Remarks: New country record.

Phthirapteran: Amblycera: Menoponidae

Colpocephalum apivorus Tendeiro, 1958 (Fig. 5)

Material Examined: 1♀; ex. *Pernis apivorus*; July 2014; Van, Turkey.

Remarks: New country record.

Colpocephalum impressum Rudow, 1866 (Fig. 6)

Material Examined: 1♀; ex. *Aquila heliaca*; 3 January 2008; Konya Zoo, Konya, Turkey.

Colpocephalum nanum Piaget, 1890 (Fig. 7)

Material Examined: 2♀; ex. *Accipiter nisus*; 2 June 2011; Eskişehir, Turkey. 1♀; ex. *Buteo*; 5 February 2007; Tomarza, Kayseri, Turkey. 1♀; 16 April 2009; Develi, Kayseri, Turkey. 1♂; 24 September 2009; Sivas, Turkey. 1♂; 6 October 2009; Kırşehir, Turkey. 1♀; 2008; Karacabey, Bursa, Turkey. 1♂; 2010; Samsun, Turkey. 3♂ 4♀; 27 November 2017; Afyonkarahisar, Turkey. 5♂ 3♀; ex. *B. rufinus*; 2005; Kırkkale, Turkey. 2♂; 22 November 2006; İçeri Çumra, Konya, Turkey. 17♂ 42♀ 6N; 2006; Uludere, Eskişehir, Turkey. 8 adult 1N; 21 June 2010; Veterinary Faculty Konya, Turkey. 1♀; 7 July 2006; Yeşilhisar, Kayseri, Turkey. 2♀; 15 May 2009; Sivas, Turkey. 1♂ 1♀; 20 July 2009, 20 October 2009; Tomarza, Kayseri, Turkey. 1♂ 1♀; 6 October

2009; Nevşehir, Turkey. 10♂ 19♀ 9N; 17 March 2011; Veterinary Faculty, Afyonkarahisar, Turkey. 25♂ 46♀ 18N; 26 October 2011, 29 March 2016, 25 May 2016; Veterinary Faculty, Konya, Turkey. 1♂; 5 November 2011; Çumra, Konya, Turkey. 1♂ 2♀; 23 April 2012; Burdur, Turkey. 48♂ 49♀ 86N; 8 August 2011, 25 April 2012, 3 December 2013, 19 January 2017, 23 January 2017, 6 August 2018, 22 February 2019; Konya, Turkey. 1♂ 1♀ 3N; 11 December 2015; Baksan, Eskişehir, Turkey. 2♂ 3♀ 4N; 29 January 2016; Fidanlık, Eskişehir, Turkey. 110 specimens; 10 August 2018; Bolvadin, Turkey. 2♀; 1♀; 26 December 2016; Konya, Turkey.

Remarks: New host record.

***Colpocephalum polonum* (Eichler and Złotorzycka, 1971) (Fig. 8)**

Material Examined: 6♂ 16♀ 12N; ex. *Accipiter gentilis*; 8 August 2010; Kızılınler, Tepebaşı, Eskişehir, Turkey.

***Colpocephalum trachelioti* (Price and Beer, 1963) (Fig. 9)**

Material Examined: 3♂; ex. *Aegypius monachus*; 2003; Türkmen Mountain, Kütahya, Turkey. 4♂ 9♀; 10 December 2010; Türkmen Mountain, Kütahya, Turkey. 2♂ 10♀ 3N; 10 September 2015; Eskişehir, Türkmenbaba, Turkey. 15♂ 6♀ 2N; 26 December 2016; Kulu Veterinary Clinic, Kulu, Konya, Turkey.

***Colpocephalum turbinatum* Denny, 1842 (Fig. 10)**

Material Examined: 1♂; ex. *Circus aeruginosus*; 6 April 2012; Eskişehir, Turkey. 10♂ 15♀ 18N; 13 October 2014; Cernek Lake, Bafra, Samsun, Turkey.

Remarks: New host record.

***Colpocephalum zebra* Burmeister, [20] (Fig. 11)**

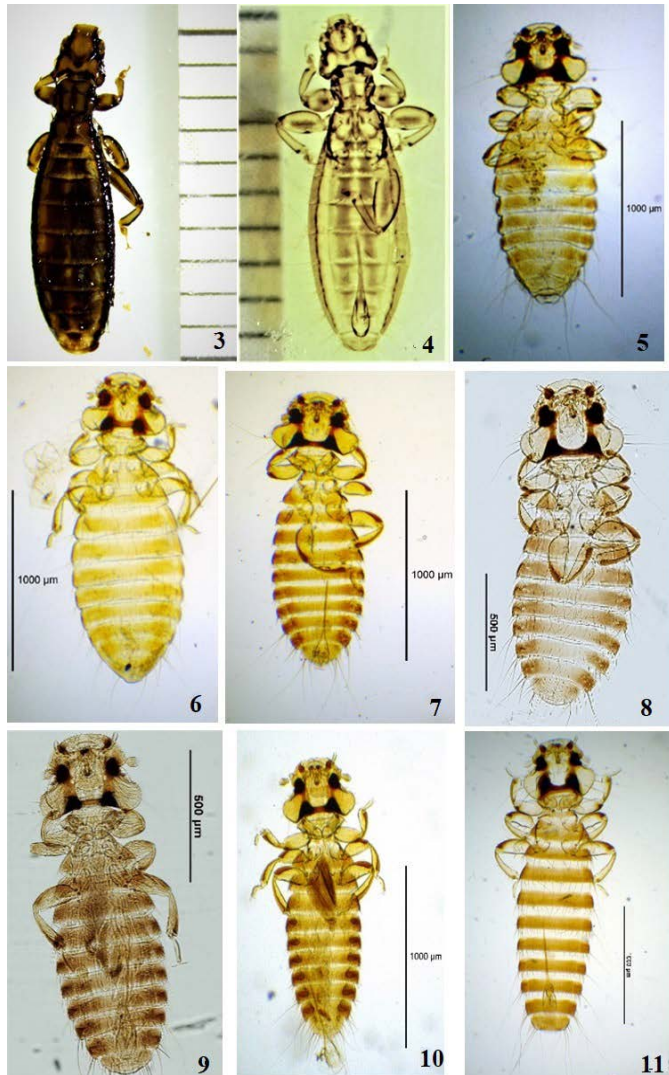
Material Examined: 1♂; ex. *Pernis apivorus*; 15 December 2005; Tomarza, Kayseri, Turkey.

Remarks: New host record.

***Kurodaia fulvofasciata* (Piaget, 1880) (Fig. 12)**

Material Examined: 1♂; *Circus aeruginosus*; July, 2014; Veterinary Faculty, Van, Turkey. 1♀; July, 2014; Veterinary Faculty, Van, Turkey. 1♀ 1N; ex. *Accipiter nisus*; 19 December 2015; Eskişehir Merkez, Turkey. 4♀; ex. *Buteo buteo*; 27 March 2007; Bozdağ, Konya, Turkey. 1♀; 28 February 2011; Veterinary Faculty, Konya, Turkey. 1♂ 2♀; 20 December 2013; Veterinary Faculty, Konya, Turkey. 11♂ 32♀ 4N; 2010; Samsun, Turkey. 1♂ 4♀; 12 November 2015; Veterinary Faculty Konya, Turkey. 2♂ 1♀; 2 January 2017; Konya, Turkey. 1♀ 1N; 20 September 2019; Dinar, Afyonkarahisar, Turkey. 9♂ 2♀ 8N; ex. *B. rufinus*; July, 2014; Veterinary Faculty, Van, Turkey. 2♂ 1♀; 2 January 2017; Konya, Turkey. 108 specimens; 10 August 2018; Bolvadin, Turkey.

Remarks: New host record.



Figures 3-11: 3. *Laemobothrion maximum* (Scopoli, 1763) Female, original; 4. *Laemobothrion vulturis* (Fabricius, 1775) Male, original; 5. *Colpocephalum apivorus* Tendeiro, 1958 Female, original; 6. *Colpocephalum impressum* Rudow, 1866 Female, original; 7. *Colpocephalum nanum* Piaget, 1890 Male, original; 8. *Colpocephalum polonum* (Eichler and Złotorzycka, 1971) Female, original; 9. *Colpocephalum trachelioti* (Price and Beer, 1963) Male, original; 10. *Colpocephalum turbinatum* Denny, 1842 Male, original; 11. *Colpocephalum zebra* Burmeister, 1838 Male, original.

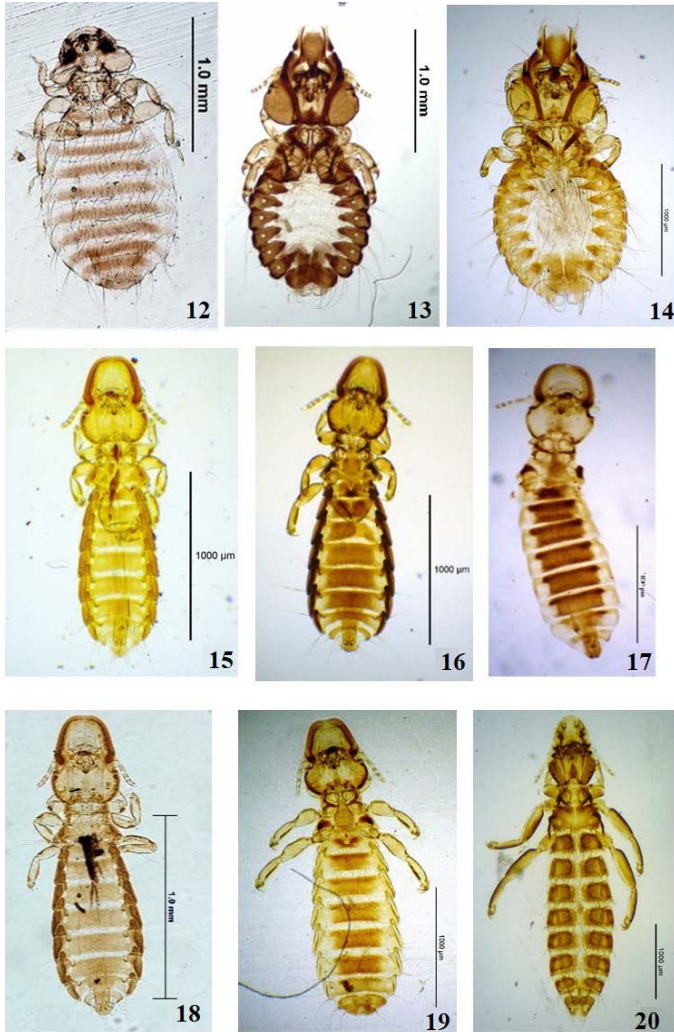
Phthirapteran: Ischnocera: Philopteridae

***Craspedorrhynchus fraterculus* Eichler and Złotorzycka, 1975 (Fig. 13)**

Material Examined: 34♂ 39♀ 15N; ex. *Aquila heliaca*; 30 January 2008; Hay Bah, Konya, Turkey.

***Craspedorrhynchus platystomus* (Burmeister, 1838) (Fig. 14)**

Material Examined: 3♂ 1♀; ex. *Buteo buteo*; 5 September 2006, 19 February 2007; Pınarbaşı, Kayseri, Turkey. 2♀; 26 November 2007; Kırşehir, Turkey. 4♂ 12♀ 2N;



Figures 12-20: 12. *Kurodaia fulvofasciata* (Piaget, 1880) Female, original; 13. *Craspedorrhynchus fraterculus* Eichler and Złotorzycka, 1975 Female, original; 14. *Craspedorrhynchus platystomus* (Burmeister, 1838) Female, original; 15. *Degeeriella fulva* (Giebel, 1874) Male, original; 16. *Degeeriella fusca* (Denny, 1842) Male, original; 17. *Degeeriella leucopleura* (Nitzsch [in Giebel], 1874) Male, original; 18. *Degeeriella nisus* (Giebel, 1866) Male, original; 19. *Degeeriella phlyctopygus* (Nitzsch [in Giebel], 1861) Female, original; 20. *Falcolipeurus suturalis* (Rudow, 1869) Female, original.

18 April 2012; Karacabey, Bursa, Turkey. 1♀ 2N; 20 December 2013; Veterinary Faculty Konya, Turkey. 3♀ 7N; 2010; Samsun, Turkey. 102♂ 122♀ 100N; ex. *B. rufinus*; 1988, 1990, 22 January 2009, 4 April 2011, 19 April 2011, 26 October 2011, 16 November 2011, 6 January 2012, 10 February 2014, 29 March 2016, 22 May 2016, 19 January 2017, 23 January 2017, 6 July 2018; Konya, Turkey. 4♂ 6♀ 1N; 2005; Kırıkkale, Turkey. 2♂; 2006; Uludere, Eskişehir, Turkey. 10♂ 23♀ 7N; 3 May 2007, 7 December 2007; Konya Zoo, Konya, Turkey. 26 adult; 3 December 2013, Konya, Turkey. 9♂ 3♀; 13 November 2009; Veterinary Clinic, Antakya, Turkey. 1♂ 2N; 20 November 2005, 20 October 2009; Tomarza, Kayseri, Turkey. 12♂ 18♀ 2N; 17

March 2011; Veterinary Faculty, Afyonkarahisar, Turkey. 73♂ 79♀ 68N; 4 April 2011, 19 April 2011, 1♂ 2♀; 5 November 2011; Çumra, Konya, Turkey. 2♂ 4♀; 28 January 2012; Ankara, Turkey. 4♂ 6♀ 14N; 23 April 2012; Burdur, Turkey. 1♂; 29 January 2016; Fidanlık, Eskişehir, Turkey. 2♀ 1N; 2 April 2017; Banaz, Uşak, Turkey. 3N; 10 August 2018; Bolvadin, Afyonkarahisar, Turkey. 15♂ 14♀ 3N; 3 May 2018; Çay, Afyonkarahisar, Turkey. 3♂ 3♀ 2N; 3 March 2018; Afyonkarahisar, Turkey.

***Degeeriella fulva* (Giebel, 1874) (Fig. 15)**

Material Examined: 3♂ 2♀; ex. *Buteo buteo*; January 23, 2007, 24 September 2009; Sivas, Turkey. 3♀; 12 February 2007; Kayseri, Turkey. 2♂ 1♀; 19 February 2007; Pınarbaşı, Kayseri, Turkey. 1♂; 6 October 2009; Kırşehir, Turkey. 4♂ 7♀; 25 April 2012, 20 December 2013; Veterinary Faculty Konya, Turkey. 4♂ 6♀ 1N; 18 April 2012; Karacabey, Bursa, Turkey. 3♂ 4♀; 2010; Samsun, Turkey. 1♂ 2♀; 20 September 2019; Dinar, Afyonkarahisar, Turkey. 238♂ 216♀ 148N, 58 more specimens; ex. *B. rufinus*; 1988, 1990, 20 February 2005, 22 January 2009, 5 June 2010, 4 April 2011, 19 April 2011, 17 May 2010, 21 June 2010, 8 August 2011, 26 October 2011, 16 November 2011, 6 January 2012, 25 April 2012, 10 September 2012, 3 December 2013, 14 January 2014, 10 February 2014, 29 March 2016, 25 May 2016, 26 December 2016, 19 January 2017, 23 January 2017, 6 July 2018, 22 February 2019; Konya, Turkey. 43♂ 56♀ 27N; 22 November 2006; İçeri Çumra, Konya, Turkey. 3♂ 1♀ 1N; 2006; Uludere, Eskişehir, Turkey. 13♂ 19♀ 1N; 3 May 2007, 7 December 2007; Konya Zoo, Konya, Turkey. 1♂ 1♀; 16 April 2008; Karapınar, Konya, Turkey. 89 specimens; 20 March 2009; Konya Municipality Animal Shelter, Konya, Turkey. 5♂ 3♀; 13 November 2009; Animal Clinic Antakya, Turkey. 1♂ 1♀ 1N; 20 November 2005, 20 October 2009; Tomarza, Kayseri, Turkey. 1♀; 7 July 2006; Yeşilhisar, Kayseri, Turkey. 2♂ 2♀; 15 May 2009; Sivas Merkez, Sivas, Turkey. 3♀; 26 July 2009; Kayseri, Turkey. 12♂ 13♀ 2N; 17 March 2011; Veterinary Faculty Afyonkarahisar, Turkey. 1♀; 5 November 2011; Çumra, Konya, Turkey. 5♂ 8♀ 7N; 28 January 2012; Ankara, Turkey. 5♂ 4♀ 2N; 23 April 2012; Burdur, Turkey. 1♂ 1♀ 1N; 11 December 2015; Baksan, Eskişehir, Turkey. 3♂ 6♀ 23N; 29 January 2016; Fidanlık, Eskişehir, Turkey. 15♂ 19♀ 5N; 3 May 2018; Çay, Afyonkarahisar, Turkey. 9♂ 13♀; 3 March 2018, 18 July 2019; Afyonkarahisar, Turkey. 1♂; 11 November 2018; Erkmen Village, Afyonkarahisar, Turkey. 12♂ 14♀ 6N; 10 August 2018; Bolvadin, Afyonkarahisar, Turkey.

***Degeeriella fusca* (Denny, 1842) (Fig. 16)**

Material Examined: 5♂ 7♀; ex. *Circus aeruginosus*; 19 April 2007; Konya Zoo, Konya, Turkey. 1♀; 6 April 2012; Eskişehir, Turkey. 1♀; July, 2014; Veterinary Faculty Van, Turkey. 2♂ 6♀; July, 2014; Van, Turkey.

Degeeriella leucopleura (Nitzsch [in Giebel], 1874) (Fig. 17)

Material Examined: 3♂; *Circaetus gallicus*; 2012; Veterinary Faculty University Hospital, Bursa, Turkey.

Remarks: New host record.

Degeeriella nisus (Giebel, 1866) (Fig. 18)

Material Examined: 18♂ 8♀ 2N; ex. *Accipiter nisus*; 10 December 2010; Yunak, Konya, Turkey. 12♂ 28♀ 7N; 7 April 2015, 4 September 2015; Lake Cernek, Samsun, Turkey. 2♂ 2N; 16 January 2017; Konya, Turkey. 15♂, 20♀; 13 April 2018; Selçuklu, Konya, Turkey. 1♂ 1♀ 1N; ex. *Buteo buteo*; 2012; Karacabey, Bursa, Turkey.

Degeeriella pblyctopygus (Nitzsch [in Giebel], 1861) (Fig. 19)

Material Examined: 1♀; ex. *Pernis apivorus*; 15 December 2005; Tomarza, Kayseri, Turkey. 1♀; 14 February 2012; Konya, Turkey. 2♂ 5♀; July, 2014; Van, Turkey.

Falcolipeurus suturalis (Rudow, 1869) (Fig. 20)

Material Examined: 1♂ 1♀; ex. *Buteo buteo*; 2012; Karacabey, Bursa, Turkey.

Remarks: New host record.

DISCUSSION

The results in the present study are similar with the previous studies (Pérez et al., 1996) that reported *Aegyptus monachus* with *L. vulturis* (Fabricius, 1775), *C. trachelioti* (Price and Beer, 1963) and *Aegypocercus brevicollis* (Burmeister, 1838); *Aquila chrysaetos* with *Colpocephalum* species and *Craspedorrhynchus aquilinus* (Denny, 1842), while *Aquila adalberti* was infested with *L. maximum* (Scopoli, 1763), *C. impressum* Rudow, 1866, *C. fraterculus* Eichler and Złotorzycka, 1975, *Colpocephalum* species and *Degeeriella leucopleura* (Nitzsch [in Giebel], 1874); *Circaetus gallicus* with *Falcolipeurus* species; *Buteo* with *L. maximum*, *C. nanum* Piaget, 1890 (*C. meridionale* in the text), *D. fulva* (Giebel, 1874), *C. platystomus* (Burmeister, 1838), *L. maximum*, *D. regalis* (Giebel, 1866) and *Craspedorrhynchus spatulatus* (Giebel, 1874) were found more prevalent in *Milvus* and *M. migrans*. *C. turbinatum* and *D. fusca* were found prevalent in *Circus aeruginosus*.

The prevalence of *Craspedorrhynchus* species in the current study is in accordance with previous studies of Hafez and Madbouly (1968) from Egypt from *Buteo buteo vulpinus* and Price et al. (2003) of *C. platystomus* from the Common Buzzard (*B. buteo*). Gállego et al. (1987) reported the species of genus *Craspedorrhynchus* from other birds including *Accipiter gentilis*, *Ac. velox*, *Aquila chrysaetos*, *Buteo borealis costariensis*, *B. erythronotus*, *B. swainsoni*, *Milvus milvus* and *Pernis apivorus* from the different countries including Ar-

gentina, Costa Rica, Czech Republic, France, Finland, Germany, Poland, Portugal, Russia, Spain and USA (Fasungova et al., 2008; Malysheva et al., 2018; Tomás et al., 2016; 2018). Different species of louse have been reported from the wild birds with special reference to Accipitriformes in various parts of the world including Turkey (Price and Beer, 1963; Shavsmannou, 1982; Kettle, 1983; Gállego et al., 1987; Pérez-Jiménez et al., 1988; Pérez et al., 1996; Miller et al., 1997; Rékási and Kiss, 2005; Adam, 2007; Dik and Yamac, 2008; İnci et al., 2010b; Dik et al., 2011; Girişgin et al., 2013; Dik et al., 2015a; Piross et al., 2015; Tomás et al., 2016; Grandón-Ojeda et al., 2019). Four louse species *L. maximum*, *C. nanum*, *D. fulva* and *C. platystomus* were reported from the Common Buzzards *Buteo buteo* and Steppe Buzzard *B. vulpinus* from Israel (Teodor and Costa, 1967; Yosef et al., 2019).

One chewing louse, *Kurodaia haliaeti* (Denny, 1842) was collected from the nestling and adult ospreys (*Pandion haliaetus*) of Ontario, Canada (Miller et al., 1997). In Spain, *Gyps fulvus* was infested with *L. vulturis*, *C. turbinatum*, *Pterophilus* species, *Aegypocercus trigonoceps* (Giebel, 1874), *Falcolipeurus quadripustulatus*; *Neophron percnopteri* was infested with *Colpocephalum percnopteri*, *Ae. perspicuus* (Kellogg, 1914) and *Falcolipeurus frater* (Giebel, 1874). In California, the USA, seven raptor species of the birds were found infested with 11 chewing lice species (Morishita et al., 2001). Recently, *L. maximum* and *C. polonum* were found prevalent in vultures, the endangered species of India (Kushwaha, 2015). In a study conducted by Pérez-Jiménez et al. (1996), *Craspedorrhynchus* species have been found the most commonly infesting louse of the accipitrid birds, except vultures. Hafez and Madbouly (1968) reported *Craspedorrhynchus* species from *Buteo b. vulpinus* of Egypt. Later, an identification key for *Craspedorrhynchus* species from the falconiform birds of Spain was documented (Gállego et al., 1987). *K. fulvofasciata* has been reported from the Long-Legged Buzzard (*Buteo rufinus*) (Tendeiro et al., 1979), Common Buzzard, Little-banded Goshawk (shikra), Short-toed Snake Eagle, Rough-Legged Buzzard, Bald Eagle, etc. (Price et al., 2003). In Romania, of the total 186 birds, 30 species were surveyed with 76 individuals; of which 21 species hosted 31 chewing louse species belonging to 25 genera, 3 families and 2 suborders (Amblycera: Menoponidae: 6 species; Laemobothriidae: 2 species; Ischnocera: Philopteridae: 23 species) (Rékási and Kiss, 2005).

In Turkey, the prevalence of the lice was reported in *B. rufinus* (Long-Legged Buzzard), *B. buteo* (Common Buzzard), *Circaetus gallicus* (Short-toed Snake Eagle), *Aquila pennatus* (Booted Eagle) and *Accipiter nisus* (Sparrow Hawk) in the northwestern Turkey where *D. fulva*, *D. nisus*, *L. maximum*, *D. leucopleura*, *C. platystomus*, *C. nanum*, *F. suturalis* were

reported (Girişgin et al., 2013). Later, Göz et al. (2015) collected 108 specimens comprising 19 species of lice belonging to 15 genera from the wild birds of the Lake Van Basin, Eastern Turkey. Of these, *K. fulvofasciata* (Piaget, 1880) from the Long-Legged Buzzard and *Laemobothrion* species (nymph) from the Golden Eagle (*Aquila chrysaetos*), were recorded for the first time from Turkey. In a study conducted by İnci et al. (2010b), of the 246 birds examined for lice in which 33 (13.4%) were found infested with 25 louse species, included 17 Ischnoceran species belonging to 15 genera and eight Amblyceran species belonging to five genera with the highest infestation rate in the orders Accipitriformes (100%).

There could be many enabling causes that facilitate the settlement, growth, and propagation of the louse fauna e.g. increase in chewing lice population due to heavy rainfall, high temperature, sharing effect for livestock animals and solar radiation (Dik, 2006b). Birds undergo molting in post-breeding; the primary function of feather molting is to replace damaged feathers for thermoregulation and proper flight. Besides these, molting also helps in reducing the ectoparasites density (Dik et al., 2013b). To avoid the effects of molting, lice have developed strategies including migration to newly develop feathers. Ischnoceran lice are more affected by molting as compared to amblyceran lice due to having slow-moving speed. Another method used by birds to control ectoparasites density is preening which is the manipulation of plumage with foot scratching and bill (Dik et al., 2013b). Lice avoid preening by migrating to those body regions where birds cannot preen.

A wide spectrum of louse fauna has been reported so far from the Turkish aviary; however, many birds are still to be screened. So far, no species belonging to the genera *Acutifrons*, *Aegyptocercus*, *Cuculiphilus*, *Ctenigogus*, *Falcomenopon*, *Nosopon*, etc., parasitizing the accipitriform birds have been reported from Turkey. Although, Dik et al. (2015b) described *Ae. guralpi* as a new species from the Long-Legged Buzzard; however, later, Dik (2016) explained that this species is a synonym of *Neophiloaterus incompletus* (Denny, 1842) parasitizing on the Stork (*Ciconia ciconia*). In a few studies, the morphological characteristics such as chaetotaxy of the body or male genitalia of some of the specimens were too poor to be identified at the species level (Eichler, 1944). This can also lead to the reporting of the louse fauna less than the actual prevalence. Moreover, phylogenetic studies of the louse specimens from raptors of Turkey are yet to be conducted. The present report adds data in the inventory of chewing louse fauna of accipitrid birds of Turkey; however, despite the several studies on detecting of the chewing louse species of the accipitrid birds in Turkey, further faunistic and phylogenetic studies are needed.

CONCLUSION

The present survey study is concluded with the records of chewing lice fauna found in Turkey from the raptor birds of family Accipitridae (Accipitriformes). During the survey, 182 birds of Accipitridae found in Turkey were examined which contained 9 genera and 14 species. Of these birds, 82.97% birds were found infested with 19 chewing lice species, included 10 amblyceran species representing two families Menoponidae and Laemobothriidae, and 8 ischnoceran species of family Philopteridae. Among birds, the highest prevalence of infestation was recorded 73.63% in the genus *Buteo* (Buzzards), whereas the birds species *Circus cyaneus*, *C. macrourus*, *Clanga clanga* and *Accipiter brevipes* were not found infested with any of the louse species. Additionally, there were two species, *L. vulturis* and *C. apivorus* were reported first time in the country with new locality record and six species, *C. nanum*, *C. turbinatum*, *C. zebra*, *K. fulvofasciata*, *D. leucopleura* and *F. suturalis* were reported with new host associations. The results of this study provided a reference source of louse fauna from Accipitrid birds of Turkey, but still there are more raptor bird species to be screened for chewing louse infestation.

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CONFLICT OF INTEREST

There is no conflict of interest between the authors of this manuscript.

AUTHORS CONTRIBUTION

Conceived and designed the experiments: Bilal Dik.
 Performed the experiments: Bilal Dik.
 Analyzed the data: Saima Naz and Mohammad Sohail Sajid.
 Contributed in final drafting and processing of the manuscript tools: Bilal Dik, Saima Naz and Mohammad Sohail Sajid
 Wrote the paper: Bilal Dik and Saima Naz.

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