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Original Article
Özgün Araştırma

Chewing lice (Insecta: Psocodea, Phthiraptera) and Hard ticks (Acari: Ixodida) species detected in some wild birds found dead on highways in Türkiye

Gökhan Eren[1*]

[1] *Artvin (Borkça) Directorate of Provincial Agriculture and Forestry, Artvin, Türkiye*

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Abstract: The material of this study consists of ectoparasitic specimens collected from birds (Aves) that were found dead and subsequently subjected to ectoparasitic examination during 2020-2024. During this period, 30 wild birds from seven provinces were examined, chewing lice infestation was detected in eleven individual hosts, and tick infestation was detected in two. Among the chewing lice species identified in the study, *Colpocephalum fregili*, *Philopterus fortunatus*, *P. modularis,* and *P. peripariphilus* are new records for chewing lice fauna of wild birds in Türkiye. In addition, *Ixodes ricinus* detected in the European honey buzzard (*Pernis apivorus*) is a new host-ectoparasite association for the tick fauna of Türkiye.

Keywords: *Acronirmus*, *Colpocephalum*, *Ixodes ricinus*, *Philopterus*.

Türkiye'de karayollarında ölü bulunan bazı yabani kuşlarda tespit edilen Çiğneyici bit (Insecta: Psocodea, Phthiraptera) ve Sert kene (Acari: Ixodida) türleri

Özet: Bu çalışmanın materyalini 2020-2024 yılları arasında ölü bulunan ve sonrasında ektoparazit incelemesine tabi tutulan kuşlardan (Aves) toplanan ektoparazit örnekleri oluşturmaktadır. Bu dönemde yedi ilden 30 yabani kuş incelenmiş, 11 konakta çiğneyici bit, iki konakta da kene enfestasyonu tespit edilmiştir. Çalışmada tespit edilen çiğneyici bit türlerinden *Colpocephalum fregili*, *Philopterus fortunatus*, *P. modularis* ve *P. peripariphilus* Türkiye yabani kuşlarınının çiğneyici bit faunası için yeni kayıttır. Ayrıca Arı şahin (*Pernis apivorus*)'inden tespit edilen *Ixodes ricinus*, Türkiye kene faunası için yeni bir konak-ektoparazit birlikteliği niteliği taşımaktadır.

Anahtar kelimeler: *Acronirmus*, *Colpocephalum*, *Ixodes ricinus*, *Philopterus*.

Introduction

Ectoparasitic studies on the ornitofauna of Türkiye focus mainly on chewing lice (Phthiraptera: Amblycera, Ischnocera) (Eren et al. 2022; Yılmaz et al. 2022; Dik et al. 2024; Zerek et al. 2024) and partly on ticks (Acari: Ixodida) (Keskin and Erciyas-Yavuz 2019), feather mites (Sarcoptiformes: Astigmata) (Gürler et al. 2013; Eren et al. 2022) and keds (Diptera: Hippoboscidae) (Merdivenci 1970; Girişgin et al. 2022).

Geographically, some crucial features of Türkiye, located in the Palearctic realm, have increased diversity in birds, such as in all other species. For example, these features include being situated on the Mediterranean/Black Sea Flyway, having various climate and habitat types, and having wetlands that birds can use for roosting, breeding, and wintering. Although Türkiye's current bird list is diverse, with 500 species (Karataş et al. 2021a; 2021b), the studies carried out have not sufficiently revealed the diversity of ectoparasites. Multidisciplinary studies are needed because capturing these birds and examining their ectoparasites is very difficult for scientists. For large-scale studies, conducting studies at ringing stations is usually necessary. Turkish scientists are fortunate for such studies because there are four ringing stations in Türkiye: Cernek Bird Ringing Station (Samsun), Eymir Bird Ringing Station (Ankara), Aras Bird Research and Education Center (Iğdır), Boğazkent Applied Environmental Education and Bird Ringing Station (Antalya) (Anonymous 2023). Many studies have been conducted at these ringing stations, and numerous ectoparasite species (ticks, feather mites and chewing lice) have been reported on birds (Gürler et al. 2013; Keskin and Erciyas-Yavuz 2015; Dik et al. 2017; 2024). Apart from ringing stations, another method of collecting

Yazışma adresi / Correspondence: *Gökhan Eren, Artvin (Borkça) Directorate of Provincial Agriculture and Forestry, Artvin, Türkiye e-mail: gokhaneren54@gmail.com*

ORCID IDs of the authors: *[1]0000-0002-2109-5059*

ectoparasites from birds is to collect them from injured birds brought to the animal hospitals and rehabilitation centres of the Veterinary Faculties, from birds brought dead to parasitology laboratories of the Veterinary Faculties, and from birds found dead during field studies (Dik and Kandır 2021; Girişgin et al. 2022; Zerek et al. 2024). There are some disadvantages in such studies. Because it is impossible to subject a large number of birds to ectoparasite examination in a short time. In addition to this, ectoparasite density may be low or absent in dead birds, depending on the post-mortem period. Studies of this type have been conducted from time to time in Türkiye, and many chewing lice, ticks, feather mites, and Hippoboscid flies have been reported on injured or dead birds (Eren et al. 2022; 2023; Zerek et al. 2024). Many of these are new records for the Turkish fauna.

As such studies increase in Türkiye, the ectoparasitic fauna of birds will be better understood, and the host-parasite associations will be brought into the open. This study aims to contribute to ectoparasitic studies on wild birds in Türkiye.

Materials and Methods

Chewing lice and tick specimens collected from birds found dead on highways (Table 1) during 2020-2024 were first preserved in Eppendorf tubes containing 70% Ethanol. In the identification phase, all the chewing lice specimens were cleaned with 10% Potassium Hydroxide (KOH), washed with distilled water and passed through a range of alcohol series. Finally, chewing lice specimens in Lactophenol were kept until they became transparent. In continuation, specimens that became transparent were mounted in Hoyer's solution on slides. All chewing lice slides were dried at room temperature for 1–2 weeks and then adhered to using clear nail polish. In tick specimens, a light microscope was used for larval stages and a stereo microscope for nymphal stages. Similar to the lice specimens, they were cleared in Lactophenol and then mounted in Hoyer's solution on slides. After drying at room temperature for 1–2 weeks, all glass slides were adhered to using clear nail polish. Finally, all chewing lice specimens were identified under a light microscope (MIC-B30/B Binocular Economic Microscope-Led-Achromat, Soif Optical Instruments Factory, China) using the relevant literature (Denny 1842; Price 1977; Price and Beer 1963; Zlotorzycka 1964; Price and Beer 1965; Zlotorzycka 1974; Price and Emerson 1977; Williams 1981; Mey 1988; Adam 2004; Adams et al. 2005; Gustafsson and Bush 2017), while tick specimens were identified under a light and stereo microscope (A23.3645-B2LD Zoom Stereo Microscope, Opto Edu Beijing Co Ltd, China) using the relevant literature (Estrada-Peña et al. 2017). In addition, all glass slides of chewing lice and tick species are deposited in Dr. Gökhan Eren's personal collection.

Table 1. List of chewing lice and hard tick species detected on the Avian hosts in the present study.

Number of avian hosts examined in the present study (n: examined/infested)	Host family	Location	Date
Strigiformes			
Asio otus (1/0)	Strigidae	Kemalpaşa, Artvin	02.09.2023
Bubo bubo (1/1)		Borçka, Artvin	05.01.2024
Accipitriformes			
Buteo rufinus (1/0)	Accipitridae	Borçka, Artvin	09.05.2024
Pernis apivorus (1/1)		Ondokuzmayıs, Samsun	20.05.2020
Charadriiformes			
Scolopax rusticola (1/0)	Scolopacidae	Borçka, Artvin	18.03.2023
Caprimulgiformes			
Caprimulgus europaeus (1/1)		Tortum, Erzurum	29.11.2022
Pelecaniformes			
Nycticorax nycticorax (1/0)	Ardeidae	Karasu, Sakarya	07.07.2023
Coraciiformes			
Merops apiaster (1/1)		Borçka, Artvin	13.09.2023

Number of avian hosts examined in the present study (n: examined/infested)	Host family	Location	Date
Columbiformes			
Columba livia (1/1)	Columbidae	Polatlı, Ankara	11.06.2021
Galliformes			
Coturnix coturnix (1/0)	Phasianidae	Borçka, Artvin	18.03.2023
Passeriformes			
Corvus corax (1/1)	Corvidae	Borçka, Artvin	10.04.2023
Corvus cornix (1/1)		Ardeşen, Rize	19.06.2024
Garrulus glandarius (1/0)		Karasu, Sakarya	18.02.2024
Pica pica (1/0)		Yakutiye, Erzurum	25.02.2024
Carduelis carduelis (1/0)	Fringillidae	Merkez, Artvin	26.03.2023
Fringilla coelebs (1/1)		Borçka, Artvin	09.11.2023
Delichon urbicum (1/1)	Hirundinidae	Borçka, Artvin	01.06.2023
Locustella fluviatilis (1/0)	Locustellidae	Borçka, Artvin	12.09.2023
Motacilla alba (1/0)	Motacillidae	Borçka, Artvin	22.06.2023
Erithacus rubecula (1/0)	Muscicapidae	Borçka, Artvin	07.05.2024
Periparus ater (1/1)	Paridae	Borçka, Artvin	25.11.2023
Passer domesticus (2/0)	Passeridae	Şavşat, Artvin	30.08.2023
Phylloscopus collybita (1/1)	Phylloscopidae	Borçka, Artvin	18.04.2023
Prunella modularis (1/1)	Prunellidae	Borçka, Artvin	29.11.2022
Sylvia atricapilla (1/0)	Sylviidae	Şavşat, Artvin	30.08.2023
Troglodytes troglodytes (1/0)	Troglodytidae	Borçka, Artvin	21.11.2023
Turdus merula (1/0)	Turdidae	Akçakoca, Düzce	12.04.2024
Turdus philomelos (2/0)		Borçka, Artvin	10.10.2023
		Karasu, Sakarya	07.04.2024

Results

In this study, 30 individual specimens representing 11 species of six orders found to have died due to bird-vehicle on roads were subjected to ectoparasite examination between 2020-2024 (Table I and II). Dead bird specimens were found randomly during fieldwork, and only specimens with a short post-mortem period were examined (1-3 days). A total of twelve individuals were detected with ectoparasite infestation. It was determined in conducted microscopic examination that ticks specimens were *Haemaphysalis concinna* Koch, 1844 and *Ixodes ricinus* (Linnaeus, 1758), chewing lice specimens were *Acronirmus gracilis* (Burmeister, 1838) (Figure 1: I and J), *Brueelia apiastri* (Denny, 1842) (Figure 1: A), *Colpocephalum fregili* Denny 1842 (Figure 1: M and N), *Columbicola columbae* (Linnaeus, 1758) (Figure 1: L), *Kurodaia longipes* (Giebel, 1874) (Figure 1: O), *Menacanthus agilis* (Nitzsch, 1866) (Figure 1: E), *Meromenopon meropis* Clay & Meinertzhagen, 1941 (Figure 1: B), *Meropoecus meropis* (Denny, 1842) (Figure 1: C), *Mulcticola hypoleucus* (Denny,1842) (Figure 1: F), *Philopterus fortunatus* (Zlotorzycka, 1964) (Figure 1: K), *P. modularis* (Denny, 1842) (Figure 1: G and H), *P. peripariphilus* (Mey, 1988) (Figure 1: D), and *Strigiphilus strigis* (Pontoppidan 1763) (Figure 1: P). Among these species, *C. fregili*, *P. fortunatus*, *P. modularis*, and *P. peripariphilus* are new records for chewing lice fauna of Türkiye.

Table 2. List of chewing lice and hard tick species detected in the Avian hosts (*new record, **new host-ectoparasite association).

Host species	Chewing lice species	Tick species
Strigiformes		
Bubo bubo	*Kurodaia longipes* *Strigiphilus strigis*	-
Accipitriformes		
Pernis apivorus		*Ixodes ricinus***
Caprimulgiformes		
Caprimulgus europaeus	*Mulcticola hypoleucus*	-
Coraciiformes		
Merops apiaster	*Meropoecus meropis* *Meromenopon meropis* *Brueelia apiastri*	-
Columbiformes		
Columba livia	*Columbicola columbae*	-
Passeriformes		
Corvus corax	*Colpocephalum fregili**	-
Corvus cornix	*Colpocephalum fregili**	-
Delichon urbicum	*Acronirmus gracilis*	-
Fringilla coelebs	*Philopterus fortunatus**	-
Periparus ater	*Philopterus peripariphilus**	-
Phylloscopus collybita	*Menacanthus agilis*	-
Prunella modularis	*Philopterus modularis**	*Haemaphysalis concinna*

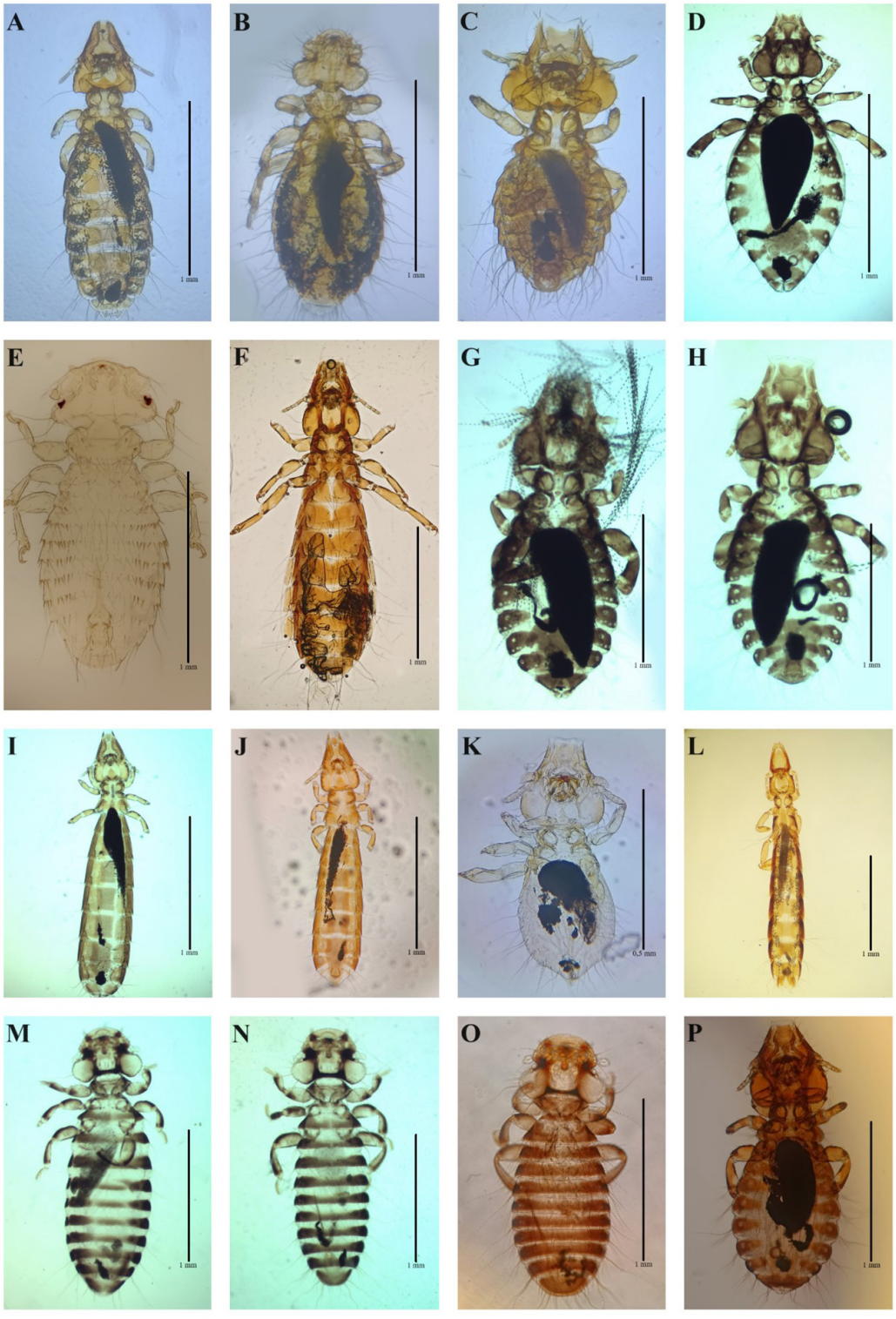

Figure 1. *A: Brueelia apiastri (♀); B: Meremonopon meropis (♀); C: Meropoecus meropis (♂); D: Philopterus peripariphilus (♀); E: Menacanthus agilis (♂); F: Mulcticola hypoleucus (♀); G: Philopterus modularis (♀); H: Philopterus modularis (♂); I: Acronirmus gracilis (♀); J: Acronirmus gracilis (♂); K: Philopterus fortunatus nymph; L: Columbicola columbae (♀); M: Colpocephalum fregili (♀); N: Colpocephalum fregili (♂); O: Kurodaia longipes (♂); P: Strigiphilus strigis (♀).*

Discussion

Parasitic lice were traditionally classified into four suborders under the order Phthiraptera, namely Amblycera, Anoplura, Ischnocera and Rhynchophthirina, but recent taxonomic and molecular studies suggest that they should be classified within the infraorder Phthiraptera within the suborder Troctomorpha under the order Psocodea (De Moya et al. 2021). Chewing lice that infest birds, namely, members of the class Aves, are found only in the suborders Amblycera (except for the family Abrocomophagidae, Boopiidae, Gyropidae, and Trimenoponidae, which infest mammals) and Ischnocera (except for the family Trichodectidae, which infest mammals), and about 4000 species have been described to date (Durden 2019). The suborder Amblycera consists of seven families, of which only members of Menoponidae, Laemobothriidae and Ricinidae cause bird infestation. In comparison, the suborder Ischnocera contains three families, of which only members of the Goniodidae and Philopteridae infest birds (Emerson and Price 1976; Price et al. 2003; Mey 2009).

Menoponidae is one of the largest families of the order Amblycera and contains about 70 genera (Hopkins and Clay 1952; Price et al. 2003). In the present study, four species within four genera belonging to this family were detected from the examined birds. The genus *Colpocephalum* Nitzsch, 1818 includes approximately 100 described species associated with birds of the order Accipitriformes (hawks, eagles, ospreys, vultures) Ciconiiformes (wading birds, herons, and storks), Columbiformes (pigeons, doves, and, dodo birds), Cuculiformes (cuckoos, roadrunners, and koels), Falconiformes (falcons), Galliformes (game birds), Gruiformes (waterfowl, cranes, and rails), Pelecaniformes (pelicans, boobies, cormorants, and frigatebirds), Passeriformes (songbirds), Piciformes (woodpeckers and toucans), and Strigiformes (owls) (Price et al. 2003). In the previous studies conducted in Türkiye, has been reported fifteen species of *Colpocephalum*: *C. apivorus* Tendeiro, 1958, *C. eucarenum* Burmeister, 1838, *C. heterosoma* Piaget, 1880, *C. impressum* Rudow, 1866, *C. milvi* Tendeiro et al., 1979, *C. nanum* Piaget, 1890, *C. napiforme* Rudow, 1869, *C. nigrae* Price & Beer, 1965, *C. percnopteri* Price & Beer, 1963, *C. polonum* (Eichler & Zlotorzycka, 1971), *C. subzerafae* Tendeiro, 1988, *C. trachelioti* Price & Beer, 1963, *C. turbinatum* Denny, 1842, *C. zebra* Burmeister, 1838, and *C. zerafae* Ansari, 1955 **(**see the list of chewing lice on Türkiye published by Eren et al. (2022) and Dik et al. (2024)). *Colpocephalum fregili* Denny 1842 (Figure 1: M and N), on the common raven *Corvus corax* Linnaeus, 1758 (Passeriformes: Corvidae) and the hooded crow *Corvus cornix* Linnaeus, 1758 (Passeriformes: Corvidae), are reported herein for the first time in Türkiye. Moreover, this species has been reported from hosts of white-necked raven (*Corvus albicollis*) (Africa), pied crow (*Corvus albus*) (Africa), cape crow (*Corvus capensis*) (Africa), common raven (*Corvus corax*) (USA, Mexico, United Kingdom, and Africa), carrion crow (*Corvus corone*) (Cape Verdes, Egypt, Japan, and former Yugoslavia), Australian raven (*Corvus coronoides*) (Tasmania), chihuahuan raven (*Corvus cryptoleucus*) (Mexico and and USA), slender-billed cow (*Corvus enca*) (Borneo, Indonesia, and Philippines), rook (*Corvus frugilegus*) (Scotland and Russia), large-billed crow (*Corvus macrorhynchos*) (Myanmar, Thailand, British Malaya, and Philippines), torresian crow (*Corvus orru*), fish crow (*Corvus ossifragus*) (unknown location), fan-tailed raven (*Corvus rhipidurus*) (Ethiopia, Israel, Saudi Arabia, and Uganda), house crow (*Corvus splendens*) (Maldives, Myanmar, and India), gray crow (*Corvus tristis*) (New Guinea), piping crow (*Corvus typicus*) (Indonesia), azure-winged magpie (*Cyanopica cyanus*) (Japan), yellow-billed chough (*Pyrrhocorax graculus*) (United Kingdom), and red-billed chough (*Pyrrhocorax pyrrhocorax*) (Ireland and Wales) (Price and Beer 1965; Pfaffenberger et al. 1980; Gaponov 2023). *Menacanthus* Neumann, 1912 is also one of the larger genera of the family Menoponidae. This genus includes approximately 100 described species associated with birds of the order Passeriformes (songbirds), Piciformes (woodpeckers and toucans), Tinamiformes (tinamous), and Galliformes (game birds) (Cicchino 2003; Price et al. 2003; Palma and Price 2005; Bansal et al. 2013). In the previous studies conducted in Türkiye, has been reported thirteen species of *Menacanthus*: *M. abdominalis* (Piaget 1880), *M. agilis* (Nitzsch, 1866), *M. alaudae* (Schrank, 1776), *M. camelinus* (Nitzsch, 1874), *M. cornutus* (Schömmer, 1913), *M. curuccae* (Schrank, 1776), *M. eurysternus* (Burmeister, 1838), *M. fertilis* (Nitzsch, 1866), *M. gonophaeus* (Burmeister, 1838), *M. kaddoui* (Eichler & Mey, 1978), *M. lyali* (Rodriguez Caabeiro et al.,1983), *M. pusillus* (Nitzsch, 1866), and *M. stramineus* (Nitzsch, 1818) **(**see the list of chewing lice on Türkiye published by Eren et al. (2022) and Dik et al. (2024)). Moreover, *Menacanthus agilis* (Figure 1: E) detected in the current study has been reported on these hosts worldwide: Cetti's warbler (*Cettia cetti*) (Greece), spotted flycatcher (*Muscicapa striata*) (Egypt, Russia, and Spain), common redstart (*Phoenicurus phoenicurus*) (Egypt), common chiffchaff (*Phylloscopus collybita*) (Bulgaria, Egypt,

Greece, and Spain), wood warbler (*Phylloscopus sibilatrix*) (Russia), buff-throated Warbler (*Phylloscopus subaffinis*) (Thailand), and willow warbler (*Phylloscopus trochilus*) (Bulgaria, Egypt, and Spain) (Price 1977; Ilieva 2005; Martin-Mateo 2006; Karáth et al. 2013; Diakou et al. 2017; Gaponov 2023). The genus *Meromenopon* Clay & Meinertzhagen, 1941 includes six described species, and all of them are associated with bee-eaters (Meropidae Rafinesque, 1815) and rollers (Coraciidae Rafinesque, 1815) belonging to the order Coraciiformes (Price et al. 2003). In studies previously conducted in Türkiye, only *Meromenopon meropis* Clay & Meinertzhagen, 1941(Figure 1: B) in this genus has been reported from the European bee-eater (*M. apiaster* Linnaeus, 1758) (Dik et al. 2011; 2015; Göz et al. 2015; Dik et al. 2017; Dik and Kandır 2021; Girişgin et al. 2022; Dik et al. 2024). Apart from *Merops apiaster* (Afghanistan, Algeria, Czechia, Egypt, Greece, Hungary, Iran, Italy, Morocco, Romania, Saudi Arabia, and Slovakia) (Price and Emerson 1977; Mateo and Manilla 1993; Hoi et al. 1998; Petrescu and Costica 2001; El-Ahmed et al. 2012; Diakou et al. 2017; Nazarbeigy et al. 2021), this species also has also been reported on the *Merops bulocki* (Ghana and Nigeria), *Merops hirundineus* (Mozambique and Zimbabwe/former Rhodesia), *Merops nubicus* (Cameroon), *Merops orientalis* (Australia, India, and Thailand), *Merops ornatus* (Australia), *Merops persicus* (Algeria and Iran), *Merops philippinus* (Myanmar, India, and Thailand), and *Merops viridis* (India, Malaysia, Philippines, and Thailand), in studies conducted worldwide to date (Price and Emerson 1977; El-Ahmed et al. 2012; Torki et al. 2020; Nazarbeigy et al. 2021). The genus *Kurodaia* Uchida, 1926 includes 22 described species associated with owls of the order Strigiformes and diurnal birds of prey of the order Accipitriformes (Price et al. 2003). In the previous studies conducted in the Türkiye, has been reported three species of *Kurodaia*: *K. fulvofasciata* (Piaget, 1880) from the Levant sparrowhawk *Accipiter brevipes* (Severtzov, 1850), the Eurasian sparrowhawk *Accipiter nisus* (Linnaeus, 1758), the common buzzard *Buteo buteo* (Linnaeus, 1758), and the western marsh harrier *Circus aeruginosus* (Linnaeus, 1758) (Dik 2010; Dik et al. 2015; 2022; 2024), *K. longipes* (Giebel, 1874) from the Eurasian eagle-owl *Bubo bubo* (Linnaeus, 1758) (Dik et al. 2015), and *K. subpachygaster* (Piaget, 1880) from the barn owl *Tyto alba* (Scopoli, 1769) (Eren et al. 2022). *Kurodaia longipes* (Figure 1: O), detected in the present study, have also been reported from the Spotted Eagle-Owl (*Bubo africanus*) from Zimbabwe (former Rhodesia), from the Eurasian eagle-owl (*Bubo bubo*) from Belgium, Hungary, Romania, Russia, Spain, and United Kingdom, from Verreaux's eagle-owl (*Ketupa lactea*) from the Cameroun (Price and Beer 1963; Hellenthal et al. 2004; Mateo 2006; Ilieva 2009; Vas et al. 2012; Rékási et al. 2017).

Philopteridae, belonging to the suborder Ischnocera, is the family with the richest species diversity, with about 140 genera (Price et al. 2003; Mey 2004). In the present study, eight species within seven genera belonging to this family were detected from the examined birds. The genus *Acronirmus* Eichler, 1953 includes seven described species associated with swallows (Hirundinidae Rafinesque, 1815) of the order Passeriformes (Gustafsson and Bush 2017). In this study, *Acronirmus gracilis* (Burmeister, 1838) (Figure 1: I and J), detected on the western house martin *Delichon urbicum* (Linnaeus, 1758) (Aves: Passeriformes: Hirundinidae), was recently reported by Dik et al. (2024) on the same host in Türkiye. In addition, *Acronirmus gracilis* associated with Hirundinidae species has been reported on swallows in many countries worldwide: *Cecropsis* spp. (Ghana, India, Israel, Kenya, Philippines, Scotland, Slovenia, and Thailand), *Delichon* spp. (Japan, Malaysia, Malawi, Nepal, and United Kingdom), *Hirundo* spp. (Bulgaria, Egypt, France, Germany, India, Indonesia, Ireland, Israel, Italy, Malaysia, Morocco, Poland, Philippines, Slovenia, Slovakia, Thailand, United Kingdom, USA, and Zambia), *Ptyonoprogne* spp. (Croatia), and *Riparia* spp. (India) (Gustafsson and Bush 2017; Sychra et al. 2024). The genus *Brueelia* Kéler, 1936 includes 150 described species associated with birds of the order Passeriformes (Gustafsson and Bush 2017). In studies previously conducted in Türkiye, *Brueelia apiastri* (Denny, 1842) (as *Meropsiella apiastri* in mostly studies) has been reported only from the European bee-eater (*M. apiaster* Linnaeus, 1758) (Dik et al. 2011; Göz et al. 2015; Dik et al. 2017; Girişgin et al. 2022; Dik et al. 2024). Additionally, within genus *Brueelia* Kéler, 1936, *B. biocellata* (Piaget, 1880), *B. cruciata* (Burmeister, 1838), *B. currucae* Bechet, 1961, *B. domestica* (Kellogg & Chapman, 1899), *B. fuscopleura* (Blagoveshtchensky, 1951), *B. iliaci* (Denny, 1842), *B. jacobi* Eichler, 1951, *B. lais* (Giebel, 1874), *B. locustellae* Fedorenko, 1975, *B. marginata* (Burmeister, 1838), *B. merulensis* (Denny, 1842), *B. munda* (Nitzsch, 1866), *B. nebulosa* (Burmeister, 1838), *B. tasniemae* Ansari, 1957, and *B. turdinulae* Ansari, 1956 species have also been reported in Türkiye (Eren et al. 2022; Girişgin et al. 2022; Dik et al. 2024). *Brueelia apiastri* (Denny, 1842) (Figure 1: A), detected on the European Bee-eater (*M. apiaster*) in this study, has been reported from

the same host in many countries to date: Egypt, Germany, Greece, Iran, Ireland, Malawi, Romania, South Africa, Sudan, Uganda, and Zambia (Williams 1981; Petrescu and Costica 2001; Mey 2003; Diakou et al. 2017; Gustafsson and Bush 2017; Nazarbeigy et al. 2021). In some of these studies, *Meropsiella apiastri* (Denny, 1842) was used as a synonym instead of *B. apiastri*. The genus *Columbicola* Ewing, 1929 includes approximately 90 species worldwide associated with pigeons and doves belonging to the order Columbiformes (Adams et al. 2005; Bush et al. 2009; Gustafsson and Bush 2015; Alotaibi et al. 2022**).** In studies previously conducted in Türkiye, has been reported three species in this genus including *Columbicola bacillus* (Giebel, 1866), *C. claviformis* (Denny, 1842), and *C. columbae* (Linnaeus, 1758) (Eren et al. 2022; Yılmaz et al. 2022). *Columbicola columbae*, of Old World origin, is the first species described in this genus. The expansion of the distribution area of feral and domestic pigeons descended from the Rock dove (*Columba livia*) due to anthropogenic effects has led to the reporting of this species in these pigeons worldwide (Adams et al. 2005). It has also been reported in pigeon species such as speckled pigeon (*Columba guinea*), yellow-eyed pigeon (*C. eversmanni*), stock dove (*C. oenas*), red-billed pigeon (*Patagioenas flavirostris*), laughing dove (*Spilopelia senegalensis*), black-billed wood-dove (*Turtur abyssinicus*), white-winged dove (*Zenaida asiatica*) (Adams et al. 2005; Adang et al. 2009; Principe et al. 2020; Garcia-Rejon et al. 2021). The genus *Meropoecus* Eichler, 1940 includes seven described species, and all of them are associated with bee-eaters (Meropidae Rafinesque, 1815) belonging to the order Coraciiformes (Price et al. 2003). In studies previously conducted in Türkiye, only *Meropoecus meropis* Clay & Meinertzhagen, 1941 (Figure 1: C) in this genus has been reported from the European bee-eater (*M. apiaster* Linnaeus, 1758) (Dik et al. 2011; Göz et al. 2015; Dik et al. 2017; Girişgin et al. 2022; Dik et al. 2024). This species has also been reported on the European bee-eater (*M. apiaster*) in many countries, including Germany (Mey 2003), Greece (Diakou et al. 2017), Hungary (Karáth et al. 2013), Italy (Martin Mateo and Manilla 1993), Romania (Petrescu and Costica 2001), Russia (Lyakhova and Kotti 2011), Saudi Arabia (El-Ahmed et al. 2012) and Slovakia (Hoi et al. 1998), and also on both the European bee-eater (*M. apiaster*) and the blue-cheeked bee-eater (*M. persicus*) in Algeria and Iran (Torki et al. 2020; Nazarbeigy et al. 2021). The genus *Mulcticola* Clay and Meinertzhagen, 1938 includes 18 described species associated with nightjar or nighthawk of the order Caprimulgiformes (Hopkins and Clay 1952; Price et al. 2003; Valim and Kuabara 2015). In the previous studies conducted in Türkiye, has been only reported a single species within the genus *Mulcticola* Clay and Meinertzhagen, 1938: *M. hypoleucus* (Denny,1842) from the European nightjar *Caprimulgus europaeus* (Aves: Caprimulgiformes: Caprimulgidae) (Dik 2009; Dik et al. 2017). Additionally, this species has been reported on the European nightjar (*C. europaeus*) in many countries, including Belarus, Belgium, Bulgaria, Czechia, Finland, Germany, Hungary, Poland, Romania, Spain, Russia, Tajikistan, and United Kingdom (Zhuk and Efremova 2008; Valim and Kuabara 2015; Evens et al. 2018). The genus *Philopterus* is a complex, and as a result of the studies carried out so far, 12 genera and over 200 species associated with songbirds of the order Passeriformes have been classified within this complex (Price et al. 2003; Mey 2004; Gustafsson et al. 2019; Najer et al. 2021). In the previous studies conducted in the Türkiye, has been reported twelve species of *Philopterus*: *P. atratus* Nitzsch, 1818, *P. coarctatus* (Scopoli 1763), *P. desertus* (Zlotorzycka 1964), *P. eurasiaticus* (Mey, 1982), *P. excisus* Nitzsch, 1818, *P. microsomaticus* Tandan 1955, *P. mirificus* (Zlotorzycka 1964), *P. montani* (Zlotorzycka, 1964) (as *P. fringillae* in the study), *P. picae* (Denny, 1842), *P. rapax* (Zlotorzycka 1964), *P. reguli* (Denny, 1842), and *P. sittae* Fedorenko 1978 (Eren et al. 2022; Yılmaz et al. 2022; Dik et al. 2024). *Philopterus fortunatus* (Zlotorzycka, 1964) (Figure 1: K) on the Eurasian chaffinch *Fringilla coelebs* Linnaeus, 1758 (Passeriformes: Fringillidae), *Philopterus modularis* (Denny, 1842) (Figure 1: G and H) on the dunnock *Prunella modularis* (Linnaeus, 1758) (Passeriformes: Prunellidae), and *Philopterus peripariphilus* (Mey, 1988) (Figure 1: D) on the coal tit *Periparus ater* (Linnaeus, 1758) (Passeriformes: Paridae) are reported herein for the first time in Türkiye. These *Philopterus* species have been reported several times previously from the same hosts in the Palearctic realm. In previous studies, they have been reported, *Philopterus fortunatus* on the Eurasian chaffinch (*F. coelebs*) in Belarus (Emelyanova 1981), Belgium (Hellenthal et al. 2004), Bulgaria (Ilieva 2009), Czechia (Balát 1977), Faroe Islands (Palma and Jensen 2016), Finland (Eichler and Hackman 1973), Greece (Diakou et al. 2017), Hungary (Vas et al. 2012), Poland (Zlotorzycka 1964), Slovakia (Bush et al. 2018), Portugal (Tomás 2021), Russia (Malysheva and Tolstenkov 2018), and Ukraine (Lunkashu 2008); *Philopterus modularis* on the dunnock (*P. modularis*) in Czechia (Sychra et al. 2011), Hungary (Vas et al. 2012), Ireland (O'Connor 2008),

Russia (Stepanova 2022), Slovakia (Ošlejšková et al. 2021), and Spain (Martín Mateo 2006); *Philopterus peripariphilus* on the coal tit (*P. ater*) in Belgium (Hellenthal et al. 2004), Bulgaria (Ilieva 2009), Germany (Mey 2003), Hungary (Vas et al. 2012), and Slovakia (Ošlejšková et al. 2021). The genus *Strigiphilus* Mjöberg, 1910 includes 46 described species associated with owls of the order Strigiformes (Price et al. 2003; Shimada and Yoshizawa 2020). In the previous studies conducted in Türkiye, has been reported three species of *Strigiphilus*: *S. barbatus* (Osborn, 1902) from the long-eared owl *Asio otus* (Linnaeus, 1758) (Dik 2010; İnci et al. 2010; Dik et al. 2013), *S. cursitans* (Nitzsch, 1861) from the little owl *Athene noctua* (Scopoli, 1769) (Girişgin et al. 2013; 2022; Eren et al. 2022), *Strigiphilus strigis* (Pontoppidan 1763) from the Eurasian eagle-owl *Bubo bubo* (Linnaeus, 1758) (Dik and Uslu 2007; Dik et al. 2015), and *S. tuleskovi* Balat 1958 from the Eurasian scops owl *Otus scops* (Linnaeus, 1758) (Dik et al. 2024). In the present study, *S. strigis* (Pontoppidan 1763) (Figure 1: P) detected on the Eurasian eagle-owl (*B. bubo*), which has been reported on the same host species in previous studies in Bulgaria (Ilieva 2009), Hungary (Vas et al. 2012), Iran (Bahiraei et al. 2024), Spain (Martín Mateo et al. 2006), and Russia (Rékási et al. 2017).

Ticks (Ixodida) are obligate blood-sucking arthropods that infest terrestrial vertebrates such as mammals, birds and reptiles (Estrada et al. 2017). In traditional and current taxonomy, ticks are classified under five families: three extant families (Ixodidae, Argasidae, and Nuttalliellidae) and two extinct families (Deinocrotonidae and Khimairidae) (Chitimia-Dobler et al. 2024). In addition to their blood-sucking effects, ticks have zoonotic and vectorial potential, making them one of the most frequently studied parasitic arthropods in multidisciplinary parasitological research. Ticks act as vectors for many pathogens, including viruses, bacteria, protozoa and helminths, and transmit these pathogens to domestic and wild animals, including humans (de la Fuente et al. 2008; Guglielmone and Robbins 2018). In Türkiye, research has been carried out on tick fauna for many years, and host-parasite associations and the vector potential of existing ticks have been investigated. As a result of these studies, 55 tick species have been reported so far, including eight soft ticks (Argasidae) and forty-seven hard ticks (Ixodidae), from various vertebrate hosts (mammalian, avian, and reptilian), including humans (Merdivenci 1969; Keskin et al. 2014; İnci et al. 2016; Kar et al. 2017; Orkun and Karaer 2018; Keskin and Erciyas-Yavuz 2019; Bursalı et al. 2020; Keskin and Selçuk 2021; Orkun and Vatansever 2021; Zerek et al. 2023). Unfortunately, birds are one of the least studied host groups in tick-focused parasitological studies in Türkiye. Despite this, many species have been reported from birds. It is seen that 19 tick species have been reported in these studies: *Amblyomma* (1), *Dermacentor* (1), *Haemaphysalis* (4), *Hyalomma* (1), *Ixodes* (7), and *Rhipicephalus* (2) belonging to the hard ticks (Ixodidae); *Argas* (2) and *Ornithodoros* (1) belonging to the soft ticks (Argasidae) (Keskin and Erciyas-Yavuz 2019; Eren and Açıcı 2022; Zerek et al. 2023). Both *H. concinna* Koch, 1844, detected on the dunnock (*P. modularis*) and *Ixodes ricinus* (Linnaeus, 1758) detected on the European honey buzzard (*P. apivorus*) in the present study, have been reported on many hosts, which mammalian (Merdivenci 1969; Bursalı et al. 2012; İnci et al. 2016; Touray et al. 2023; Zerek et al. 2023), Avian (Keskin and Erciyas-Yavuz 2015; 2019; Eren and Açıcı 2022) and reptile (Arthur 1957; Keskin et al. 2012; Jabbarpour 2016; Eren et al. 2023) in previous studies conducted in Türkiye. European honey buzzard *P. apivorus* (Linnaeus, 1758) (Accipitriformes: Accipitridae) is a new host record for *I. ricinus* (Linnaeus, 1758) in Türkiye.

Conclusion

As a result, this study reported new records and host-parasite associations regarding the ectoparasitic fauna of birds in Türkiye. Another important aspect of this study is that it was conducted using ectoparasites collected from birds that died due to vehicle collisions on highways, which is the most dangerous anthropogenic impact for birds. In developed countries, the number of birds that die due to vehicle collisions is expressed in millions in many studies, but no comprehensive study has been conducted on this subject in Türkiye. As seen in the current study, including parasitologists in planned studies on the effects of vehicle-bird collisions on bird populations will contribute to research on bird parasites and expand the scope of the study.

Ethics committee permission: Ethics committee permission is not required for the study material, which consists of parasite specimens collected from birds found dead on the highways and in natural areas.

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