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The monitoring of feather mites (Acari, Astigmata) of the Warbler (Aves: Sylviidae) species in the Kızılırmak delta, Samsun, Turkey

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Abstract: Feather mites (Astigmata) are among the most common ectosymbionts that live on birds. The present research was conducted between 2010 and 2013 in the Kızılırmak delta Cernek Bird Ringing Station in Samsun, Turkey. Assessments of the taxonomy, collection methods, and the periodic host-species relationships of the mites collected were conducted for 591 individuals of 10 bird species belonging to the family Sylviidae captured using mist nets during the bird migration periods. Ten feather mite species were identified from the families Proctophyllodidae, Analgidae, and Trouesartidae. These species are *Strelkoviacarus quadratus* (Haller, 1882); *Dolichodectes edwardsi* (Trouessart, 1885); *Proctophyllodes cetti* Badek, Mironov, and Dabert, 2008; *Proctophyllodes clavatus* Fritsch, 1961; *Proctophyllodes doleophyes* Gaud, 1957; *Proctophyllodes sylvia* Gaud, 1957; *Trouessartia bifurcata* (Trouessart) 1884; *Trouessartia inexpectata* Gaud, 1957; and *Trouessartia trouessarti* Oudemans, 1904. Among these species, *Trouessartia bifurcata* (Trouessart) 1884 is a new record for Turkey. New host records were reported from Turkey for 7 feather mite species. The least damaging method for the birds is to collect mites directly by using a stereomicroscope and forceps. The maximum number of feather mite species (7) was detected on *Sylvia atricapilla* and the minimum (1) on *Phylloscopus trochilus. Proctophyllodes clavatus* and *Proctophyllodes sylvia* were the most commonly recorded feather mite species.

Key words: Astigmata, Sylviidae, feather mites, Kızılırmak delta, birds, host, Turkey

1. Introduction

Feather mites are permanent parasites or symbionts forming a large group of astigmatic mites living on the skin and feathers of birds (Peterson, 1975; O'Connor, 1982; Gaud and Atyeo, 1996; Dabert and Mironov, 1999; Mironov, 1999; Proctor and Owens, 2000; Proctor, 2003). They occupy four main microhabitats on the host: down and contour feathers, flight and tail feathers, skin surface, and inside the quill. It is estimated that the extent number of feather mite species could be over 10,000 (Gaud and Atyeo, 1996). Known mites currently include approximately 2500 species in 450 genera with 34–38 families and have been recorded in all recent bird orders. The great majority of these mites occupy microhabitats in the plumage with a small number of them being specialized for living on the skin or in nasal cavities (Gaud and Atyeo, 1996; Dabert and Mironov, 1999; Mironov, 2003; Proctor, 2003).

Studies on feather mite diversity were conducted in most of the mainland countries of Europe (Černý, 1979; Rojas et al., 1991; Behnke et al., 1995; Mironov, 1996, 1997; Mironov and Wauthy, 2005). In Turkey, research on mites to date has usually focused on the plant, water, soil, and house dust mites but little on feather mites. According to those few studies conducted on feather mites, the following species were recorded: *Ptiloxenus major* (Megninand Trouessart, 1884), *Pseudolichus solutocurtus* (Dubinin, 1956), and *Dermoglyphus* sp. from the Partridge (*Alectoris chuckar)* (Aksın and Erdoğmuş, 2005; Aksın, 2010); *Xoloptes claudicans* (Robin, 1877), *Periexocaulus acanthus* (Gaud and Mouchet, 1959), and *Megninia ginglymura* Megnin, 1877 from the Quail (*Coturnix coturnix)* (Aksın, 2011); *Freyana anatina* (Koch, 1844) from wild ducks (Aksın, 2007); and *Chauliacia canarisi* (Gaud and Atyeo, 1967) from the Alpine Swift (*Tachymarptis melba*) (Peterson et al., 1980).

Gürler et al. (2013) conducted a more comprehensive research in the Kızılırmak delta during 2009–2010, and evaluated a total of 196 birds from 42 species for the presence of mites, and recorded 30 feather mite species for the first time in Turkey. The Kızılırmak delta (21,700 ha) has protected status as a Ramsar Convention protected area in accordance with the Convention on Wetlands of International Importance. There are a total of 14 different habitat types described: brackish lakes, freshwater lakes,

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** Deceased

streams, wet meadows, reed fields, salt marshes, mixed broad-leaved forest, mixed broad-leaved flooded forests, coastal dunes, dune shrub communities, dune herbaceous plant communities, agricultural areas, residential areas, and other habitat types (Vural et al., 2007).

The aim of our research was to assess the taxonomy, collection methods, and the periodic host-species relationships of feather mites belonging to the family Sylviidae in the Kızılırmak delta.

2. Materials and methods

The research was conducted during the spring and autumn bird migration periods between 2010 and 2013 in the Kızılırmak delta Cernek Bird Ringing Station (41°36′N and 36°03′E) in Samsun, Turkey (Figure 1). The examined species were Warblers (Sylviidae), which have different times for migration depending on the migration route. For taxonomical identification and determining the periodic host-species relationship, mites were collected from 591 individuals of 10 bird species belonging to the family Sylviidae (Table 1). Birds were captured with mist nets during the bird migration period and placed in separate paper containers to prevent contamination among individuals (Watson and Amerson, 1967). The mite collection methods included pyrethrin in powder form, collection of tertial wing and tail feathers, and collection of visually identified mites with forceps (Watson and Amerson, 1967; Clayton and Walther, 1997). Mite material was stored in 70% ethanol and samples were mounted on microscope slides in Hoyer's medium (Evans, 1992). Mite identification was performed under a compound microscope, Olympus (CX21). All the feather mites identified in the present study were deposited at the Metin Aktaş Zoology Museum (Gazi University). Scientific names and systematics of birds follow Gill and Donsker (2017).

3. Results

Out of 591 sampled birds, 370 (62.6%) birds carried mites (Table 1) of which 78% were adults, 18% tritonymphs, 3.7% protonymphs, and 0.3% larvae. Of the adult mites, 54.2% were male and 45.8% were female. The feather mite prevalence were not demonstrated when the sample number was less than 4. Ten feather mite species were identified with the prevalence from the suborder Astigmata of 3 families: 2 from the family Analgidae, 5 from the Proctophyllodidae, and 3 from the Trouessartiidae. The 10 species were *Strelkoviacarus quadratus* (Haller, 1882); *Dolichodectes edwardsi* (Trouessart, 1885); *Proctophyllodes cetti* Badek, Mironov, and Dabert, 2008; *Proctophyllodes*

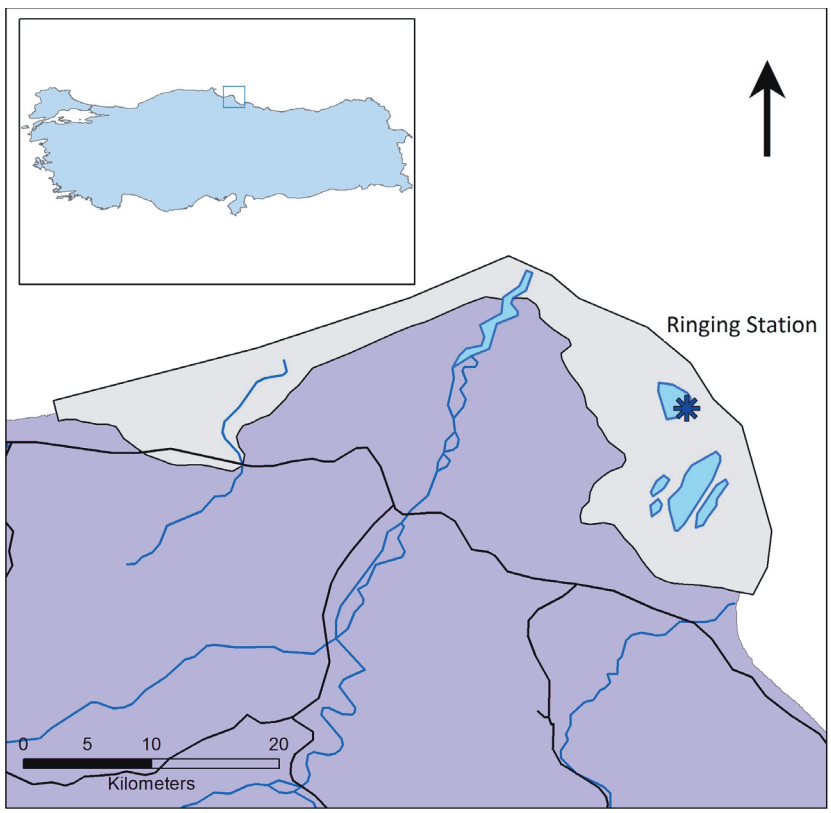

Figure 1. The Kızılırmak delta, Samsun, Turkey.

Table 1. Species and migration status of the examined birds.

Species	Migrating statuses	Number of infected/ examined birds	Rate of infected birds
Acrocephalus arundinaceus	Migratory	5/7	71.4
Acrocephalus scirpaceus	Migratory	4/16	25.0
Cettia cetti	Resident	52/87	59.8
Phylloscopus collybita	Partially migratory	23/67	34.3
Phylloscopus trochilus	Migratory	2/6	33.3
Sylvia atricapilla	Migratory	148/156	94.9
Sylvia borin	Migratory	114/158	74.5
Sylvia communis	Migratory	9/33	27.3
Sylvia curruca	Migratory	6/31	19.4
Sylvia melanocephala	Partially migratory	7/30	23.3
Total		370/591	62.6

clavatus Fritsch, 1961; *Proctophyllodes doleophyes* Gaud, 1957; *Proctophyllodes sylvia* Gaud, 1957; *Trouessartia bifurcata* (Trouessart) 1884; *Trouessartia inexpectata* Gaud, 1957; and *Trouessartia trouessarti* Oudemans, 1904 (Table 2). Among these species, *Trouessartia bifurcata* (Trouessart) 1884 is a new record for Turkey.

The maximum number of mite species (7) was detected on *Sylvia atricapilla* and the minimum (1) on *Phylloscopus trochilus* (Figure 2).

Proctophyllodes clavatus and *Proctophyllodes sylvia* were the most commonly recorded feather mite species (Figure 3).

During the spring migration period (March–May) fewer birds were captured compared to the autumn period (August–October). The majority of the feather mites were collected in August and September (Figure 4), with *Sylvia borin* and *Sylvia atricapilla* being the most commonly captured bird species and *Phylloscopus trochilus* and *Acrocephalus arundinaceus* being the least common.

4. Discussion

Birds can host numerous different ectoparasites (lice, fleas, flies, mites, and ticks). However, in the present study, no ectoparasite other than feather mites was detected on the sampled Sylviidae members.

In the earliest studies, 7 species of feather mites were identified in Turkey (Peterson et al., 1980; Aksın and Erdoğmuş, 2005; Aksın, 2007, 2010, 2011). In the previous research conducted by Gürler et al. (2013) during 2009–2010 in the Kızılırmak delta, 30 feather mite species were recorded for the first time in Turkey. In our research, only 1 new species of mite was recorded and 9 were previously recorded in Turkey. Among these 10 species, *Trouessartia bifurcata* (Trouessart) 1884 is a new record for Turkey. This brings the total number of mite species reported in Turkey to 38.

In the present study, new host records were reported from Turkey for feather mites: *Dolichodectes edwardsi* (on *Sylvia borin*), *Proctophyllodes clavatus* (on *Phylloscopus collybita* and *Sylvia atricapilla*), *Proctophyllodes doleophyes* (on *Acrocephalus scirpaceus* and *Sylvia borin*), *Proctophyllodes sylvia* (on *Acrocephalus scirpaceus*, *Phylloscopus collybita*, *Cettia cetti*, and *Sylvia communis*), *Trouessartia inexpectata* (on *Sylvia atricapilla* and *Phylloscopus collybita*), and *Trouessartia trouessarti* (on *Sylvia atricapilla*). New host records were added to the feather mites checklist for Turkey: *Dolichodectes edwardsi* (on *Acrocephalus arundinaceus*), *Proctophyllodes clavatus* (on *Sylvia melanocephala* and *Sylvia communis*), *Proctophyllodes sylvia* (on *Sylvia borin* and *Sylvia curruca*), *Trouessartia bifurcata* (on *Acrocephalus arundinaceus* and *Sylvia atricapilla*), and *Trouessartia trouessarti* (on *Acrocephalus arundinaceus*). Gürler et al. (2013) conducted the first feather mite research in the Kızılırmak delta during 2009–2010. The present research was conducted during 2010–2013. *Analges spiniger*, *Strelkoviacarus quadratus*, and *Proctophyllodes cetti* were identified on the same species of birds in both studies (Table 3). Other studies conducted in the Czech Republic during 1972–1973 (Černý, 1979), in Asia during 1963–1971 (McClure et al., 1973), and in Granada, Spain 1991 (Rojas et al., 1991) also found the same feather mite species on the Sylviidae species. The most common species of mites were *Proctophyllodes clavatus* and *Proctophyllodes sylvia*, which is a similar finding to the research in Portugal (Behnke et al., 1995) on feather mites of Passeriformes.

Table 2. Host species and prevalence of the identified feather mites.

Family	Feather mite species	Host species (infected/ examined individuals)	Prevalence (%)*
Proctophyllodidae	*Dolichodectes edwardsi*	*Acrocephalus arundinaceus* (2/3)	-
Analgidae	*Analges spiniger*	*Cettia cetti* (2/5)	40.0
		Sylvia atricapilla (5/8)	62.5
		Sylvia borin (17/18)	94.4
		Sylvia communis (1/2)	-
	Strelkoviacarus quadratus	*Sylvia atricapilla* (7/7)	100.0
		Cettia cetti (22/35)	62.9
		Sylvia borin (3/4)	-
	Proctophyllodes cetti	*Cettia cetti* (24/40)	60.0
	Proctophyllodes clavatus	*Acrocephalus scirpaceus* (1/4)	-
		Phylloscopus collybita (5/16)	31.3
		Sylvia atricapilla (4/5)	80.0
		Sylvia borin (75/114)	65.8
		Sylvia communis (5/22)	22.7
		Sylvia curruca (5/29)	17.2
		Sylvia melanocephala (5/13)	38.5
	Proctophyllodes doleophyes	*Acrocephalus scirpaceus* (1/4)	-
		Phylloscopus collybita (5/17)	29.4
		Phylloscopus trochilus (2/6)	33.3
		Sylvia borin (1/2)	-
		Sylvia communis (1/6)	16.7
	Proctophyllodes sylvia	*Acrocephalus scirpaceus* (1/4)	-
		Cettia cetti (3/6)	50.0
		Phylloscopus collybita (10/18)	55.6
		Sylvia atricapilla (126/130)	96.9
		Sylvia borin (18/20)	90.0
		Sylvia communis (2/3)	-
		Sylvia curruca (1/2)	-
		Sylvia melanocephala (1/7)	14.3
Trouessartidae	*Trouessartia bifurcata*	*Sylvia atricapilla* (2/2)	-
		Cettia cetti (1/1)	-
		Acrocephalus arundinaceus (1/1)	-
	Trouessartia inexpectata	*Phylloscopus collybita* (3/16)	18.8
		Sylvia atricapilla (2/2)	-
		Sylvia melanocephala (1/10)	10.0
	Trouessartia trouessarti	*Acrocephalus arundinaceus* (2/3)	-
		Acrocephalus scirpaceus (1/4)	-
		Sylvia atricapilla (2/2)	-

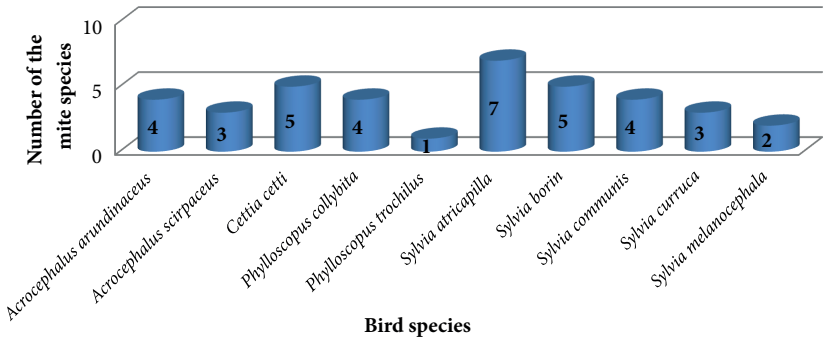

Figure 2. Number of the feather mite species identified on members of the family Sylviidae.

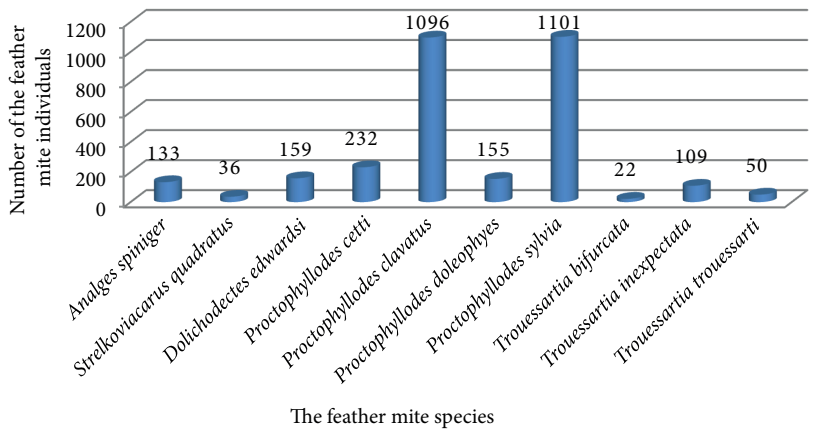

Figure 3. Number of individuals of each feather mite species.

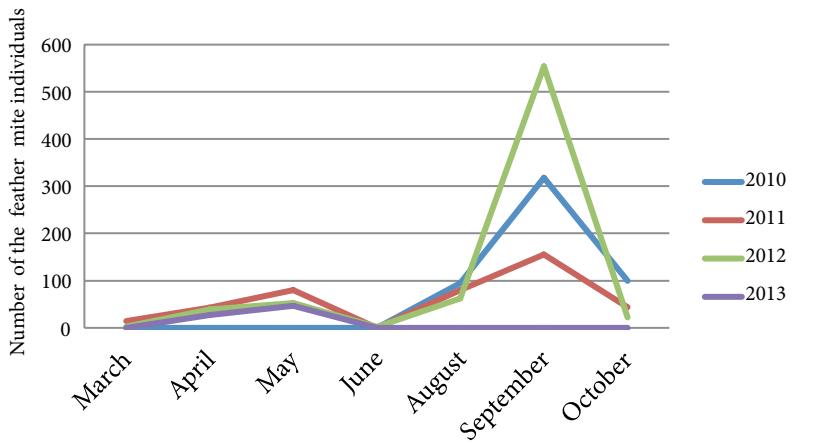

Figure 4. Monthly and annual comparison of the number of feather mite individuals.

Generally, birds change plumage before the spring migration and there is an increase in the mite population towards the end of the summer (McClure, 1989). This was reflected in our results as lower numbers of feather mites found in spring compared to autumn (August and September). The prevalence of the feather mites on many passerines in western Europe was over 60% (Behnke et al., 1995). Other research was carried out in Urra, Spain in 2011. They found high prevalence on Sylviidae species: *Sylvia atricapilla* 100%, *Sylvia melanocephala* 17%,

Table 3. The feather mite species recorded on the family Sylviidae in Turkey.

Mite species	2009–2010 Gürler et al., 2013	2010–2013 (present study)
Analges spiniger	*Cettia cetti* *Sylvia atricapilla* *Sylvia borin* *Sylvia communis*	*Cettia cetti* *Sylvia atricapilla* *Sylvia borin* *Sylvia communis*
Strelkoviacarus quadratus	*Sylvia atricapilla*	*Sylvia atricapilla*
Dolichodectes edwardsi	*Cettia cetti* *Sylvia melanocephala*	*Acrocephalus arundinaceus* *Cettia cetti* *Sylvia borin*
Proctophyllodescetti	*Cettia cetti*	*Cettia cetti*
Proctophyllodes clavatus	*Sylvia borin* *Sylvia curruca*	*Acrocephalus scirpaceus* *Phylloscopus collybita* *Sylvia atricapilla* *Sylvia melanocephala* *Sylvia borin* *Sylvia curruca* *Sylvia communis*
Proctophyllodes doleophyes	*Phylloscopus collybita* *Phylloscopus trochilus* *Sylvia communis*	*Acrocephalus scirpaceus* *Phylloscopus collybita* *Phylloscopus trochilus* *Sylvia borin* *Sylvia communis*
Proctophyllodes sylvia	*Sylvia atricapilla* *Sylvia melanocephala*	*Acrocephalus scirpaceus* *Phylloscopus collybita* *Sylvia atricapilla* *Sylvia melanocephala* *Cettia cetti* *Sylvia borin* *Sylvia curruca* *Sylvia communis*
Trouessartia bifurcata	-	*Acrocephalus arundinaceus* *Sylvia atricapilla* *Cettia cetti*
Trouessartia inexpectata	*Sylvia melanocephala*	*Phylloscopus collybita* *Sylvia atricapilla* *Sylvia melanocephala*
Trouessartia trouessarti	*Acrocephalus scirpaceus*	*Acrocephalus arundinaceus* *Acrocephalus scirpaceus* *Sylvia atricapilla*

Phylloscopus collybita 50%, and *Phylloscopus trochilus* 30% (Tarakini and Bastian, 2012). Our result for the Sylviidae species showed a prevalence ranging from 14.3% to 100%: *Acrocephalus arundinaceus* 66.7%, *Acrocephalus scirpaceus* 20%, *Cettia cetti* 62.9%, *Phylloscopus collybita* 55.6%, *Phylloscopus trochilus* 33.3%, *Sylvia atricapilla* 96.9%, *Sylvia borin* 94.4%, *Sylvia communis* 22.7%, *Sylvia curruca* 17.2 %, and *Sylviia melanocephala* 38.5%. Our prevalence range was a similar finding to that of the research in Urra, Spain on the feather mites found on the Sylviidae.

The prevalence rates for different bird species from previous research on Passeriformes in the Kızılırmak

delta (Gürler et al., 2013) were lower than in Western Europe: *Cettia cetti* 21.4%, *Phylloscopus collybita* 16.7%, *Phylloscopus trochilus* 44.4%, *Sylvia atricapilla* 58.6%, *Sylvia borin* 25%, and *Sylvia melanocephala* 50%. This lower prevalence of the examined bird species could be caused by various reasons. Almost all passerines are migrants and were examined mainly in the period of migration when they undergo long-lasting and intensive flight activity. Under these conditions, mite populations could decrease or be eliminated. The differences between the studies could also reflect the peculiarities of Western and Eastern European passerine populations. To resolve these questions, a more extensive and long-term study of feather mite prevalence in Turkey and neighboring countries was recommended (Gürler et al., 2013), which was the starting point for the present study.

Our study, conducted over 3 years (2010–2013), focused on the family Sylviidae. Thanks to this research, new feather mite species and new hosts were added to the Turkish feather mites checklist (Table 3).

Acrocephalus arundinaceus, *Cettia cetti*, *Sylvia atricapilla*, and *Sylvia borin* showed a relatively high prevalence of mites, which is related to their increased population in the migration period. Periodic changes in the number of the individuals showed a similar fluctuation each year. In particular, the number of birds investigated increased in autumn after the breeding period. The identified mite species were usually adult with occasional nymphs. Based on ringing numbers, some birds were recaptured each year and were found to be carrying the same mite species (Table 4). This situation is an indication of the host specificity of feather mites, which supports the idea of a commensal relationship between host and mite.

The maximum number of mite species (7) were detected on *Sylvia atricapilla*, the minimum (1) on *Phylloscopus trochilus*, but *Sylvia borin* and *Sylvia atricapilla* were the most commonly captured bird species and *Phylloscopus trochilus* and *Acrocephalus arundinaceus* the least common. Future research focusing on the least commonly captured species may reveal new mite species for Turkey.

On average, only 26.4 individuals were caught per day at Cernek Ringing Station in spring compared to 89.7 individuals per day in autumn. The birds stop over for a shorter period and in fewer areas in order to reach breeding areas swiftly during the spring migration. However, during the autumn migration, the birds stop over for longer and in a greater area to regain energy before continuing to wintering sites (Barış et al., 2005). In the spring migration period, fewer migrating birds were caught than in the autumn period; thus fewer mites were collected in spring. This may be due to the population increase after the breeding season, climatic factors, hurry to reach the breeding grounds earlier, or use of alternative stopover sites (Newton, 2008).

Table 4. Recaptured bird species and their feather mites.

Bird species	Feather mite species
Cettia cetti	*Proctophyllodes cetti*
	Dolichodectes edwardsi
Sylvia borin	*Proctophyllodes clavatus*
Sylvia atricapilla	*Proctophyllodes sylvia*

Although different collection methods were tried, similar mite species were identified across 2010–2013. The least damaging method for the birds is to collect mites directly using a stereomicroscope and forceps. This method also yields more accurate results than removing them from the secondaries, tertials or tail feathers or using pyrethrin. The present study revealed that just a 2-year field work was adequate for determining the feather mites of the family Sylviidae, and since the same species were found each year, any field work in subsequent years would be for monitoring purposes.

The present study recorded presence of 10 feather mite species on 10 bird species during a survey of birds migrating through the Kızılırmak delta, with 1 mite species being a new record and 7 new hosts for the feather mite fauna of Turkey. Different collection methods were tried for comparison and evaluation. The findings of the present study will help researchers who conduct systematic and ecological research on feather mites. Future research calls for an interdisciplinary approach with experts from both ornithology and acarology. The fauna of the feather mites should be investigated in more detail with studies conducted in different geographic regions. There is a need for further research to determine the feather mite fauna in Turkey. With the increase in the number of similar studies, new species can be found and the distribution of species can be determined. Research conducted with more host species will also provide more information about these species. Comparing feather mite data with ringing data may provide new ecological information on the bird–mite relationship.

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