

First data on the ectoparasites (fleas, ticks, and lice) of the stone marten, *Martes foina* (Erxleben) in Turkey

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Abstract

Turkey is a natural land bridge connecting Europe and Asia, and has a rich terrestrial mammalian fauna, with more than 150 species within the seven orders. However, there is limited information on ectoparasites of wild animals, especially carnivores, in Turkey. In the present study, we provide the first data of ectoparasites (fleas, ticks, and lice) of stone marten, *Martes foina* (Erxleben) (Mammalia: Carnivora) in Turkey. A total of 38 ectoparasite specimens, three flea species [*Monopsyllus sciurorum sciurorum* (Schrank) (1 male), *Pulex irritans* L. (1 female), *Chaetopsylla rothschildi* Kohaut (3 males, 8 females)], two tick species [*Haemaphysalis erinacei* Pavesi (18 males, 4 females), *Ixodes redikorzevi* Olenov (1 female)], and a louse species [*Stachiella retusa* (Burmeister) (1 male and 1 nymph)], were collected from two road-killed stone marten in two different localities in Tokat province of Turkey. *Martes foina* is a new host record for all ectoparasite species detected in this study for Turkey. In addition, the presence of *Stachiella retusa* was reported in Turkey for the first time.

Introduction

The faunistic investigations of ectoparasites on wild animals are intended not only to provide ecological data but also to be useful to parasitological and epidemiological workers in a certain area. Turkey is a natural land bridge connecting Europe and Asia, and has a rich terrestrial mammalian fauna, with more than 150 species within the seven order (Kryštufek and Vohralík 2001, 2005, 2009; Özkurt and Bulut 2021). However, the number of reported ectoparasites in Turkey is limited to approximately 55 tick species (Bursalı et al. 2012, 2020; Keskin et al. 2014; Orkun and Karaer 2018; Keskin and Erciyas-Yavuz 2019; Orkun and Vatansever 2021; Keskin and Selçuk 2021), 130 flea species (Keskin et al. 2018; Keskin 2021) and approximately 250 lice species (Dik et al. 2017; Dik 2020). Although wild mammals have been an increasingly frequent object of studies on ectoparasite infestations and detection of vector-borne disease agents for the last decade, we have limited still information on distributions of ectoparasites and their associations with wild mammals, especially carnivores, in Turkey.

The stone marten, *Martes foina* (Erxleben) (Mammalia: Carnivora), considered an arboreal or semi-arboreal carnivore is one of the natively distributed carnivores throughout the Eurasian region (Abramov et al. 2006). The stone marten is a nocturnal carnivore and frequently inhabits pastures, rocky areas, and even urban or suburban environments where it is a frequent predator of poultry. This species is also widespread and abundant in Turkey (Yiğit et al. 1998; Arslan et al. 2020); but, according to our knowledge, there are no records of ectoparasites of the stone marten. In the present study, we aimed to contribute to the ectoparasite fauna of Turkey and improve our knowledge of distribution and host relationships of ectoparasites of the stone marten, in Turkey.

Material And Methods

During our parasitological studies on wild animals in Turkey, we found two road-killed stone marten from Tokat province (26.VII.2021, Kızılköy village, 40°22'43.2"N 36°40'44.7"E; 14.IV.2022, Çerçi village,

40°19'11.6"N 36°24'27.8"E) (Fig. 1). Ectoparasite specimens were manually removed from these stone marten with the help of tweezer and stored in 70% ethanol. Clearing and mounting procedures were carried out in accordance with Dik (2020) for lice, and Smit (1957) for fleas. Briefly, lice and fleas were cleared in 10% or 20% potassium hydroxide (KOH) for one day, later rinsed in distilled water, transferred to alcohol series (from 70–99%), and xylene respectively. Lice and fleas were individually mounted on the slides in Canada balsam. Lice were identified under a binocular light microscope (Leica DM750, Leica Microsystems GmnH, Wetzlar, Germany) and photographed with a digital camera (Leica DFC295 Leica Microsystems, Wetzlar, Germany) in Department of Parasitology, Faculty of Veterinary Medicine, Selçuk University, Konya, Turkey. The identification of the lice was carried out according to relevant literatures Werneck (1948) and Price et al. (2003). Fleas were identified under a binocular light microscope (Olympus CX41, Tokyo, Japan) using keys as referred by Hopkins and Rothschild (1953, 1956) and Beaucournu and Launay (1990). On the hand, ticks were examined under the stereo-microscope (SZ61, Olympus, Tokyo, Japan) and identified using morphological keys and descriptions given by Filippova (1977, 1997). Examination and identification of fleas and ticks were done in Parasitology Laboratory, Department of Biology, Tokat Gaziosmanpaşa University, Tokat, Turkey

All ectoparasites were deposited in the ectoparasite collection of the Parasitology Laboratory, Department of Biology, Tokat Gaziosmanpaşa University, Tokat, Turkey. Dead stone martens were also stored at -80 °C for further studies.

Results And Discussion

Several studies on some ectoparasites of wild mammals have been conducted in recent years; however, the faunal composition of ectoparasites of Turkish mammals, especially carnivores, is still far from being understood. In the present study, we provide the first data on the ectoparasites of the stone marten for Turkey. A total of 13 fleas, 23 ticks and two louse specimens were collected from two road-killed stone marten in Tokat province.

Three fleas taxa, *Monopsyllus sciurorum sciurorum* (Schrank) (1 male), *Pulex irritans* L. (1 female), and *Chaetopsylla rothschildi* Kohaut (3 males, 8 females) were found on stone martens. *Monopsyllus s. sciurorum* is a specific parasite of *Sciurus vulgaris* L., but it can be infested on other small mammals, birds, and also on their predators such as *Martes* spp. In early studies, *M. s. sciurorum* was found on some rodents, namely *Apodemus mystacinus* (Danford & Alston), *Apodemus* sp., *Dryomys laniger* (Felten & Storch), *Dryomys nitedula* (Pallas), *Glis glis* L., *Sciurus anomalus* Gmelin, *S. vulgaris* in Turkey (Keskin et al. 2018). Another flea species collected in this study, *P. irritans*, is known as human flea, but it believes that likely originates from large and possibly ground-living mammals (Brinck-Lindroth and Smit 2007). *Pulex irritans*, which have a cosmopolitan distribution, was also reported from some species of Carnivora, Chiroptera, Lagomorpha, and Rodentia in Turkey (Keskin et al. 2018); but we believe that the host range of this flea is more complex than is known today. *Chaetopsylla rothschildi* is a parasite of mustelids, and the distribution of this flea seems to essentially cover the European and near-eastern borders of the Mediterranean (France, Yugoslavia, Czechoslovakia, Hungary, Romania, Lebanon, and the

Caucasus) (Beaucournu 1973; Lewis and Lewis 1990). The presence of *C. rothschildi* in Turkey was given by Dinçer (1971) for the first time, based on 6 male and 22 female specimens from red foxes (*Vulpes vulpes*) in Ankara province. With the current study, we provide a second report of *C. rothschildi* for Turkey. *Martes foina* is a new host records for *M. s. sciurorum*, *P. irritans* and *C. rothschildi* fleas for Turkey.

Ticks collected from stone marten in this study were identified as *Haemaphysalis erinacei* Pavesi (18 males, 4 females), and *Ixodes redikorzevi* Olenev (1 female). *Haemaphysalis erinacei* is a hedgehog parasite, but can also infest carnivores, rodents, chiropters, and birds (Guglielmone et al. 2014). In Turkey, *H. erinacei* was collected from *Erinaceus concolor* Martin, *V. vulpes*, *Scarturus williamsi* (Thomas), *Ursus arctos* L., and also humans (Bursalı et al. 2012; Girişgin et al. 2018). There is a limited investigation on the vectorial capacity of *H. erinacei*; however, nevertheless, the presence of some zoonotic bacteria (*Yersinia pestis*, *Rickettsia massiliae*, *R. raoultii*, and *R. heilongjiangensis*) has been detected in *H. erinacei*. On the other hand, a single female *I. redikorzevi* specimen was collected on *M. foina*. There is an ongoing debate on the taxonomic status of *I. redikorzevi*, because it is not clear whether *I. redikorzevi* is a junior synonym of *Ixodes acuminatus* Neumann or not. This has been repeatedly questioned and debated in previous studies (Guglielmone et al. 2014; Keskin and Erciyas-Yavuz 2019; Keskin and Selçuk 2021). Detailed information on biology, distribution, and host associations of *I. redikorzevi* is Russian and has been given in Filippova (1977) and Filippova and Stekolnikov (2007). Keskin and Selçuk (2021) also summarized these information and provided geographical distribution and host associations of *I. redikorzevi* in Turkey. In the present study, *H. erinacei* and *I. redikorzevi* ticks were recorded as new host associations for *M. foina* for the first time in Turkey.

The lice on wild mammals in Turkey have poorly studied ectoparasites and they have been interestingly ignored. There are approximately 5,000 known species of lice which the majority (90%) of them are ectoparasites of birds; the remaining (10%) are parasites of mammals (Durden 2001). Lice are morphologically divided into two main groups, namely sucking lice (which have piercing-sucking mouthparts) and chewing lice (which have chewing mandibles). They are also traditionally organized into four groups or suborders within the order Phthiraptera (more recently, Psocodea, in part), namely Anoplura, Amblycera, Ischnocera, and Rhynchophthirina.

With more than 3000 described valid species, Ischnocera is the most specious suborder within the parasitic lice. Suborder Ischnocera is divided into two families, namely Philopteridae and Trichodectidae. The members of Philopteridae are specific parasites of birds, except the genus *Trichophilopterus* which infests on lemurs, whereas all known species of the family Trichodectidae infest mammals exclusively (Durden 2001, 2019; Clayton et al. 2008). Family Trichodectidae is widely distributed over the world and represented by more than 360 species, but only 12 species, namely *Bovicola* Ewing [seven species: *B. bovis* (L.), *B. caprae* (Gurtl), *B. crassipes* (Rudow), *B. limbatus* (Gervais), *B. equi* (Denny), *B. ocellatus* (Piaget), *B. ovis* (Schrank)], *Felicola* Ewing [two species: *F. subrostratus* (Burmeister), *F. vulpis* (Denny)], *Trichodectes* Nitzsch [three species: *T. canis* (de Geer, 1778), *T. melis* (Fabricius, 1805), *T. pinguis* Burmeister] of this family have been reported in Turkey (Dik 2020; Eren et al. 2021). The majority of the aforementioned species of trichodectid lice were reported from domestic animals (cattle, sheep, goats,

donkeys, horses, cats, and dogs), but only three species of lice (*F. vulpis*, *T. melis* and *T. pinguis*) were collected from wild mammals (red fox, Caucasian badger, and Brown bear) in Turkey (Dik and Orunc Kilinc 2016; Taşçı et al. 2017; Eren et al. 2021).

The trichodectid genus *Stachiella* Kéler is currently represented by only 13 species all over the world. The members of this genus are mainly parasitized on mustelids (*Galictis*, *Mustela*, and *Martes*) (Carnivora: Mustelidae), but some species are a parasite of some Procyonids (*Procyon* and *Potos*) (Carnivora: Procyonidae) (Werneck 1948; Price et al. 2003; Smith et al. 2022). In the present study, we reported the genus *Stachiella* Kéler in Turkey for the first time, based on two specimens (1 male and 1 nymph) (Fig. 2A, B) of *Stachiella retusa* (Burmeister) collected on *M. foina* from Tokat province.

Consequently, we provide some new ectoparasite-host associations for Turkey in the present study. In addition, *S. retusa* was discovered for the first time, which comprises the first record of the genus *Stachiella* in Turkey. We believe that many new ectoparasite–host associations for Turkey will be reported in the future when more detailed studies on ectoparasite infestation on wild mammals in Turkey are performed.

Declarations

Funding

There is no fund for the present study.

Conflict of interest

The author declares that there is no conflict of interest regarding the publication of this paper.

Author contributions

Adem Keskin: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Visualization, Writing - original draft, Writing - review & editing.

Bilal Dik: Data curation, Formal analysis, Investigation, Methodology, Resources, Writing - review & editing.

Statement of ethics approval

Studies requiring the capturing of small mammals and their ectoparasites were conducted after obtaining legal permissions from the Republic of Turkey, Ministry of Forestry and Water Affairs, General Directorate of Nature Conservation, and National Parks (21264211-288.04-E.72185).

Availability of data and material

All data generated or analyzed during this study are included in this published article.

Consent to participate and consent for publication

Not applicable.

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Figures

Figure 1

Locality of ectoparasite specimens collected from stone marten, *Martes foina*, in the present study.

Figure 2

Stachiella retusa (Burmeister), **A.** male (ventral view), **B.** nymph (ventral view).