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Helminth fauna of Valentin's Lizard *Darevskia valentini* (Boettger, 1892) (Squamata: Lacertidae) collected from central and eastern Anatolia, Turkey

S. BİRLİK^{1*}, H. S. YILDIRIMHAN¹, Ç. ILGAZ^{2,3}, Y. KUMLUTAŞ^{2,3}

¹Uludağ University, Faculty of Arts and Sciences, Department of Biology, Nilüfer, Bursa, Turkey, E-mail: *sezen@uludag.edu.tr, yhikmet@uludag.edu.tr; ²Dokuz Eylül University, Faculty of Science, Department of Biology, 35160, Buca-İzmir, Turkey, E-mail: cetin.ilgaz@deu.edu.tr, yusuf.kumlutas@deu.edu.tr; ³Dokuz Eylül University Fauna and Flora Research Centre, 35610, Buca-İzmir, Turkey

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Summary

In this study, we assessed the helminth fauna of seventy two Valentin's Lizard, *Darevskia valentini* (32♂♂, 35♀♀, 5 subadult). Specimens collected from Kayseri, Ardahan and Van Provinces in Turkey. As a result of the present study, it was detected that forty one hosts are infected with one or more species of helminth. Two species of Cestoda, *Oochoristica tuberculata* and *Mesocestoides* spp., and 5 species of Nematoda, *Spauligodon aloisei*, *Skrjabinodon alcaraziensis*, *Skrjabinodon medinae*, *Skrjabinelazia hoffmanni* and *Strongyloides darevsky* were found in the hosts. *D. valentini* represents a new host record for all helminths recorded. *Skrjabinodon alcaraziensis* is recorded for the first time from Turkey. Van, Kayseri and Ardahan are new locality records for all helminths from *D. valentini*.

Keywords: *Darevskia valentini*; Cestode; Nematode; Turkey

Introduction

Darevskia valentini is present in west and central Anatolia, Turkey, southwestern Armenia and southwestern Georgia. Within the Caucasus it is found as isolated populations in Armenia, Azerbaijan, southern Georgia and eastern Turkey. The most extensive areas of the distribution range in the Caucasus are the high mountain areas of the Gegamsky range to the shores of Lake Sevan in the north, the high mountain area of the Aragaz Peak, and the high mountain plateau in the foothills of the Childyrsky and Javakhetsky ranges in the extreme north-west of Armenia and adjoining regions of southern Georgia. It is also found on the Ardenissky mountain range, and further east it inhabits the high-mountains of the Karabakh Upland within the limits of Nagorny Karabakh. The species is widely distributed in north-eastern, eastern and south-eastern Turkey. It is probably found in the high mountains adjacent Iran, although this needs to be confirmed. It might have been introduced to Ohio in the United States. In Turkey it has been recorded from

1,300 to 3,000m asl (Ananjeva *et al.*, 2006; Tok *et al.*, 2009; Baran *et al.*, 2012).

Helminths are parasites that infect internal and external organs of most invertebrate and vertebrate groups (Lima *et al.*, 2017). Knowledge of the lizard-associated helminth fauna has increased through research concerning (i) records of new hosts (Burse & Goldberg 2004; Bursey *et al.*, 2005; Ávila & Silva, 2010; McAllister *et al.*, 2011; Ávila *et al.*, 2012), (ii) descriptions of new parasite species (Burse *et al.*, 2003; Pereira *et al.*, 2012), and (iii) influence of biotic and abiotic variables on helminth diversity and abundance (Sharpilo *et al.*, 2001; Brito *et al.*, 2014a, b; Galdino *et al.*, 2014). In Turkey, 66 lizard species occur (Baran *et al.*, 2012; Uetz, 2015); of these 66 species, only 30 have been studied from a helminthological point of view. Among this wide diversification of hosts, there is still less information on endoparasites of lizards in some parts of Turkey which makes understanding of the relationship between these parasites and their hosts difficult.

The current study characterizes the helminth richness of parasitic

* – corresponding author

species and the parameters of parasitic infection (prevalence, mean intensity of infection and range) in specimens of lizard collected from Kayseri, Ardahan and Van Provinces in Turkey and the aim of the present work is to enrich the existing knowledge about helminth parasites associated with Lacertidae, Turkey by analyzing specimens of this family found in Turkey.

Materials and Method

Mean snout-vent length of lizard specimens is = 62.31 ± 10.41 mm, with a range from 37.28 to 77.1 mm. All lizards were not in full sexual maturity (35 ♀♀, 32 ♂♂ and 5 subadults). We conducted the study in July and August in 2015 and 2016 at several localities of Kayseri, Ardahan and Van provinces, Turkey (Fig. 1). The hosts were dissected under a stereomicroscope and their body cavity, lung, stomach, small intestine and large intestine was analyzed in search of helminths. They were placed in separate petri dishes with 9 % saline solution and carefully dissected further under a stereomicroscope. The body cavity was also inspected for parasites. Helminths were removed from the gastrointestinal tract, counted, rinsed in saline and fixed with different hot solutions, depending on the type of parasite: nematodes were fixed in 70 % ethanol and cestodes were fixed in 70 % ethanol or acetic acid. All fixed worms were stored in 70 % ethanol until identified. For taxonomic identification, nematodes were cleared with glycerine: ethanol (2:1); cestodes were stained with acetocarmine. Prevalence, mean intensity and abundance of infection of each helminth species were calculated as suggested by Bush *et al.* (1997). All helminths were identified under a light microscope according to

the figures and descriptions given by Anderson (2000), Anderson *et al.* (2009), Yorke and Maplestone (1926), Schad *et al.* (1960), Yamaguti (1961), Schmidt (1986), Petter and Quantin (1976), Hughes (1940), Skryabin (1991) and Wittenberg (1934). Finally, representative helminth specimens were deposited in the helminth collection of Uludağ University Museum of Zoology, Bursa, Turkey. Lizard specimens were deposited in the Dokuz Eylül University Fauna and Flora Research Centre, İzmir, Turkey.

Ethical Approval and/or Informed Consent

The research related to animals use has been complied with all the relevant national regulations and institutional policies for the care and use of animals. The study protocol no. 2013-04/08 was approved by Republic of Turkey, Uludağ University Experimental Animals Local Ethics Committee.

Results

Seventy two lizards were captured and studied: *Darevskia valentini*. A total of seven species of helminths were recovered comprising two species of cestodes and five species of nematodes. The cestodes recovered include; *Oochoristica tuberculata* and *Mesocestoides* sp. The nematodes recovered were *Skryabinelazia hoffmanni*, *Skryabinodon medinae*, *Skryabinodon aloisei*, *Spauligodon aloisei* and *Strongyloides darevsky* with prevalence of 58.33 %. The helminths recovered from lizards examined from Kayseri, Van, Ardahan provinces and their prevalences, mean abundance and intensity are given in Table. 1.

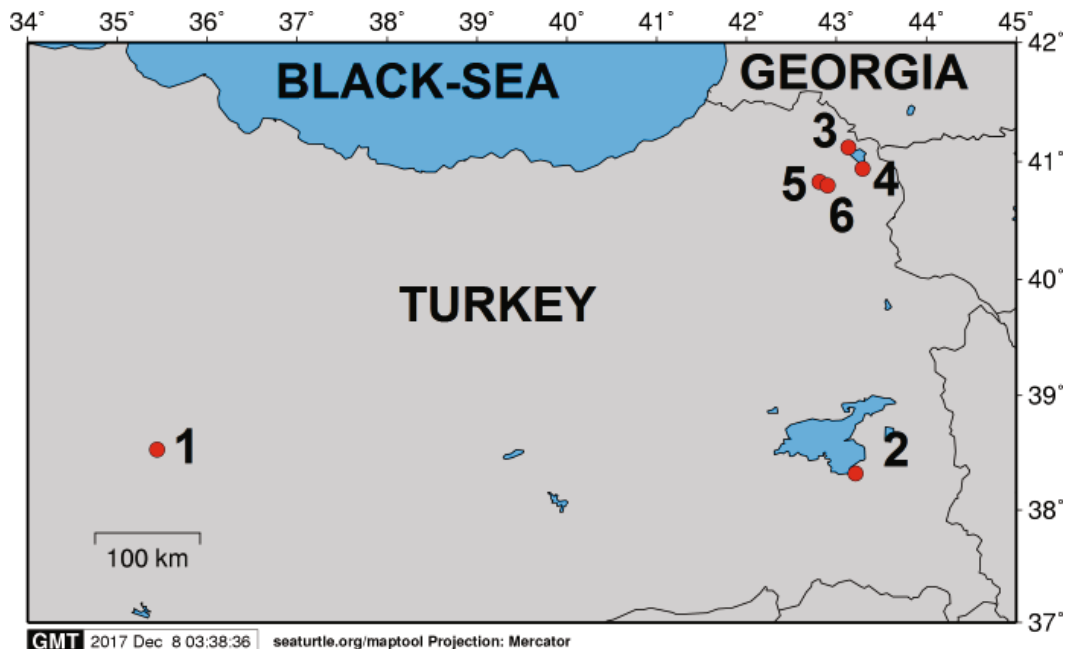


Fig. 1. The localities of host populations of *Darevskia valentini* (1. Erciyes Mountain, Kayseri; 2. Between Van-Bahçesaray 79. km; 3. Between Göle-Susuz 17. km Ardahan 4. Çıldır Lake, Ardahan 5. Çıldır-Taşbaşı Village, Ardahan; 6. Between Susuz-Göle 35. km Ardahan).

Table 1. Prevalence, mean intensity and mean abundance.

Helmint Species	Site of infection	Prevalence (%)	Mean intensity	Mean abundance
Cestoda				
<i>Mesocestoides</i> sp.	Intestine	5.55	too numerous to count	too numerous to count
<i>Oochoristica tuberculata</i>	Intestine	2.77	9	0.25
Nematoda				
<i>Skrjabinodon medinae</i>	Small intestine	15.27	3.9	0.59
<i>Skrjabinodon alcaraziensis</i>	Small intestine	1.38	1	0.013
<i>Spauligodon aloisei</i>	Small intestine	30.55	5.27	1.61
<i>Strongyloides darevsky</i>	Small intestine	2.77	1	0.027
<i>Skrjabinelazia hoffmanni</i>	Small intestine	9.72	3.14	0.3

Fifty-seven percent of hosts were parasitized by at least 1 species of helminth. In total 202 individuals of seven parasites species were collected from 42 of the 72 Valentin's Lizards examined. Of all the lizards analyzed, thirty were not parasitized. Of the infected lizards, 33 harbored one species of helminth, 4 harbored two species, 2 harbored three species and 2 harbored four species.

Discussion

Helminth species recorded in this study primarily infect lizards through host diet, which coherent with previous studies.

In the present study, we recorded the first occurrence of all species parasitizing *D. valentini*. All species recorded here except one were reported in other studies carried out in Turkey. This suggests that these parasites have wide range in geographical distribution and especially Oxyuroid family members of Nematoda frequently found in Lacertid lizards.

The genus *Oochoristica* was established by Luhe (1898) for unarmed cestodes with irregularly alternating genital openings and a uterus that transmutes quickly in a way that eggs can be found embedded in the parenchyma of gravid segments. It comprises cestodes parasitizing reptiles and is cosmopolitan in its distribution. Within this group, which includes about 88 species (Burse et al., 2010) and more species have been added recently (Mašová et al., 2010; Schuster, 2011; Bursey & Goldberg, 2011; Mašová et al., 2012; McAllister & Bursey, 2017) about 17 species are known from Palearctic. *Oochoristica tuberculata* (Rudolphi, 1819) was chosen as type species. This is the fifth record of *O. tuberculata* in Turkey, other reports are from *Paralaudakia caucasia* (Yıldırımhan et al., 2006), *Chalcides ocellatus* (İncedogan et al., 2014), *Eremias suphani* (Düşen et al., 2015) *Apathya cappadocica* (Birlik et al., 2015) and *Acanthodactylus harranensis* (Düşen et al., 2016). The total number of cestodes was 18.

Mesocestoides spp., this group of cestodes has unique and distinct characteristics among cyclophyllidean cestodes such as the median ventral position of the genital atrium and bipartite vitelline gland. It is found in different hosts (birds and carnivore mammals) in different geographic regions (Gallas & Silveria, 2011). In our

study, we analysed of the gastrointestinal contents of lizards and found this species. These data suggest that reptiles could be the possible intermediate hosts of *Mesocestoides* spp. This is the sixth record of *Mesocestoides* spp. from Turkey. Other reports are from *Anatalocerta danfordi* (Gürelli et al., 2007), *L. trilineata* (Yıldırımhan et al., 2011), *A. cappadocica* (Birlik et al., 2015), *P. laevis* (Birlik et al., 2016) and *D. rudis* (Birlik et al., 2018). *D. valentini* is a new host record for tetrahyridia of *Mesocestoides* spp.

Skrjabinodon alcaraziensis is recorded for the first time from Ardahan, Turkey. This species was identified first time from *Algyroides marchi* (Sauria: Lacertidae), Spain (Lafuente & Roca, 1995). We found one male specimen of this species (prevalence 1.38 %). Hornero and Roca (1992) stated that this species exhibits an unpaired papilla between the postcloacal pair.

Skrjabinodon medinae; This species was described by Garcia-Calvente (1948) as *Pharyngodon medinae*. It lacks caudal alae and possesses a single pair of sessile pre-cloacal papillae. According to Petter and Quentin (1976), in the Oxyuroid family Pharyngodonidae Travassos, 1919, the presence or the absence of caudal alae in the males, in conjunction with other characteristics, such as a sclerotised tri-valvulate oesophageal bulb and the position of the vulva, permit four genera to be distinguished: *Pharyngodon*, *Spauligodon*, *Skrjabinodon* and *Parathelandros* (Hornero and Roca, 1992). These species which belongs these genera are frequently found in lizards of family Lacertidae. This is the fifth report of *Sk. medinae* from our country. Others: *Lacerta trilineata* (Yıldırımhan et al., 2011), *Apatyha cappadocica* (Birlik et al., 2015), *Phoenicolacerta laevis* (Birlik et al., 2016) and *Darevskia rudis* (Birlik et al., 2018).

Spauligodon aloisei; previously, it was reported from *Iranolacerta brandthii* (Birlik et al., 2017) and *Darevskia rudis* (Birlik et al., 2018). This study is the third record of the species in Turkey. This species was identified first time from *Podarcis siculus* (Lacertidae) from Italy. It has spined tail both males and females and absence of a spicule in males. Genital pore and vulva are above the level of the oesophageal bulb.

Skrjabinelazia Sypliaxov, 1930 (Seuratoidea) parasitizes some families of saurians, mainly Gekkonidae and Lacertidae, and

has world-wide distribution. Several species are present in the Palearctic region. They are described from restricted geographic areas. Worms are reported from the stomach as well as from the small and large intestine. Males are rare probably short-lived, since several species are known only by the females (Lhermitte *et al.*, 2008). *Skrjabinelazia hoffmanni*; we have already found 20 female and 2 male specimens of this species from Erciyes Mountain, Kayseri. This is the fourth record of this species in Turkey, other reports are from *Anatololacerta danfordi* (Gürelli *et al.*, 2007), *D. rudis* (Roca *et al.*, 2015a; Birlık *et al.*, 2018).

Strongyloides darevsky, the genus *Strongyloides* Grassi, 1879 includes a great number of species parasitizing different amphibians, reptiles, birds and mammals (Roca and Hornero, 1992). Roca *et al.* (2016) stated that *Strongyloides darevsky* is in fact a true *Darevskia* specialist since it has been recorded only from species of this genus. This is the fourth record of *S. darevsky* in Turkey, other reports are from *D. rudis* (Roca *et al.*, 2015a; Birlık *et al.*, 2018), *D. armeniaca* (Roca *et al.*, 2016). We found only two female specimens from Ardahan (prevalence 2.77 %).

Normally, larger individuals depend on higher quantities of food, which results in bigger home ranges (Watve and Sukumar, 1995) and host size has also been associated with increasing parasite intensity in other vertebrates but we did not find a significant association between host length and endohelminth abundance in *D. valentini*. The sex of the host had no influence on the overall prevalence of helminth infections in the lizard *D. valentini* examined in this study, as both sexes have the same prevalence of infection. This may be due to the fact that both sexes ingest similar diet. Amo *et al.* 2005 stated that both sexes seem to be susceptible to parasite infections as the prevalence and intensity of infection were similar but there are studies which have a significant difference in the overall intensity of helminth infection and the sex of the lizard. This can be correlate with number of studied specimens. More host specimens will be studied in terms of helminthological examination. Therefore, additional studies are necessary in the different biomes to determine the true helminth diversity of this family of lizards.

In summary, one new helminth record, seven new host records and new geographic locality records are documented in this study. The data presented here serve to increase the knowledge of the fauna of gastrointestinal parasites of *D. valentini* for the first time. However, further studies need to be conducted with a larger sample to better understand the infection patterns of this lizard in Turkey.

Conflict of Interest

Authors state no conflict of interest.

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