



Ecto- and Endoparasites of the Rough-tailed Gecko *Cyrtopodion scabrum* (Heyden, 1827) (Squamata: Gekkonidae) from Eastern Turkey

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Abstract: A survey of parasites of the rough-tailed gecko *Cyrtopodion scabrum* was carried out in Turkey in order to determine the diversity of ecto- and endoparasites of this host species. The sample of 88 host specimens (36 females, 34 males and 18 juveniles) harboured endoparasites of three species: the cestode *Diplopylidium noelleri* and the nematodes *Physaloptera* sp. and *Physocephalus* sp. One ectoparasite species, *Geckobia* sp. (Acari), was also recorded. This report represents the first data on parasites of *C. scabrum* from Turkey. A species of the genus *Geckobia* sp. is recorded for the first time from Turkey. The present study provides the first parasite records for *C. scabrum* in its native geographical range.

Key words: *Cyrtopodion scabrum*, helminth, parasites, Nematoda, Cestoda, Acari

Introduction

Compared to other countries, the herpetofauna of Turkey is species-rich and includes 70 species of lizards (BARAN et al. 2012). The studies on their helminth fauna are still limited. Only 31 lizard species have been examined for parasitic worms in this country (SCHAD et al. 1960, TİNAR 1982, 1983, SAYGI & OLGUN 1993, YILDIRIMHAN et al. 2006, 2008, 2009, 2011, 2018, DÜŞEN et al. 2010, 2013, 2017, BİRLİK et al. 2015, 2016, 2017, ROCA et al. 2015a, 2015b, 2016).

The family Gekkonidae is represented by five genera and seven species in Turkey (BARAN et al. 2012). There are data on helminth parasites of only two gekkonid species in the country. In the Medi-

terranean house gecko *Hemidactylus turcicus* (L., 1758), known also as Turkish gecko, three helminth species have been recorded (TİNAR 1982, 1983, YILDIRIMHAN et al. 2008). Nine parasitic worm species have been found in the Werner's leaf-toed gecko *Asaccus elisae* (Werner, 1895) (YILDIRIMHAN et al. 2018). The data on the helminth parasites recorded in lizards of the family Gekkonidae in Turkey are summarised in Table 1.

The rougtail gecko *Cyrtopodion scabrum* (Heyden, 1827) is a small gekkonid lizard, with a native geographical range extending from Turkey, southwards to Egypt and the Sudan and eastwards to India (MARX 1968). We recently had the opportunity to examine specimens of *C. scabrum* from the region of the city of Şanlıurfa, south-eastern Turkey.

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The present study reports the helminth parasites recovered in this hosts species and provides data on their prevalence, intensity of infection and abundance. We also report an ectoparasite mite species found on *C. scabrum*.

Materials and Methods

Geckos were caught in 2000–2017 and preserved as museum specimens at the Biology Department, Science and Literature Faculty, Adıyaman University. Totally, 88 specimens of *C. scabrum* collected in April, May, June and September were examined. These included 36 females, 34 males and 18 juveniles. They had the mean snout-vent length (SVL) 36.3 ± 7.55 , with a range between 10 and 50 mm. They were sampled from ten locations in Şanlıurfa, Turkey. The host specimens were shipped to the Uludag University (Science and Literature Faculty, Parasitology Laboratory).

In the laboratory, the body cavity of each lizard was opened. The gastrointestinal tract from the oesophagus to rectum was removed, longitudinally cut and examined for the presence of helminth parasites. The stomach, small intestine and large intestines were examined separately for parasites under a dissecting microscope. Other organs, including the heart, lungs, liver, mesenteries and gonads, as well as the body cavity, were examined for encapsulated or free helminths. Nematodes were fixed in hot 4 % formalin, stored in 70 % ethanol, cleared in glycerol, placed on a glass slide in a drop of glycerol and examined using a compound light microscope.

Voucher specimens of *C. scabrum* have been deposited in Biology Department, Science and Literature Faculty, Adıyaman University. The helminth parasites have been deposited in the Parasitology Laboratory, Science and Literature Faculty, Uludag University.

Helminths were identified using descriptions and morphometric characteristics presented in the works by WARDLE & McLEOD (1952), YAMAGUTI (1959, 1961), SKRJABIN et al. 1967, SCHMIDT (1986), ANDERSON (1992), KHALIL et al. (1994) and ANDERSON et al. (2009).

Prevalence, mean intensity and mean abundance were calculated as described by BUSH et al. (1997).

Results

There were four parasite species in our samples of *C. scabrum*. However, no individual host harboured

more than two parasite species. Of the infected lizards, 40 harboured one parasite species and six harboured two parasite species. Totally, 42 gecko specimens were not infected by parasites. There were 6.39 ± 0.88 ($x \pm SE$) parasite specimens per infected lizard. Parasite infection prevalence, abundance and mean intensity in *C. scabrum* are presented in Table 2.

Cestoda

Family Dipylidiidae Stiles, 1896

Genus *Diplopylidium* Beddard, 1913

Diplopylidium noelleri (Skrjabin, 1924) Lopez-Neyra, 1927, metacestodes (Fig. 1)

Synonyms: *Progynopylidium noelleri* Skrjabin, 1924; *Diplopylidium monoophoroides* (Lopez-Neyra, 1927)

Prevalence and intensity: 42 infected of 88 studied (47.73 %); mean intensity 11.4.

Temporal distribution: September 2005, 4 hosts with 3, 5, 10 and 90 parasites; May 2006, 1 host with 1 parasite; June 2006, 3 hosts with 2, 5 and 5 parasites; April 2009, 1 host with 10 parasites; September 2011, 26 hosts with 1, 1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 6, 6, 6, 7, 9, 10, 10, 12, 20, 28, 28 and 35 parasites; June 2010, 1 host with 5 parasites; May 2017, 2 hosts with 12 and 30 parasites.

Localities: Şey Maksat District, Şuayip City Harran; Tebedibi Village, Akşemsettin, Devtesti, Osmanlı District; Eyyübiye, Sınırgören Akçakale, Birecik, Şanlıurfa.

Site of infection: Body cavity.

Nematoda

Family Physalopteridae Railliet, 1893

Genus *Physaloptera* Rudolphi, 1819

Physaloptera sp., larvae (Fig. 2)

Prevalence and intensity: 7 infected of 88 studied (7.95%); mean intensity 1.7.

Temporal distribution: September 2005, 2 hosts with 1 and 2 parasites; September 2011, 5 hosts with 1, 1, 1, 3 and 3 parasites.

Localities: Şey Maksat District; Devtesti, Osmanlı District; Eyyübiye, Şanlıurfa.

Site of infection: Intestinal wall.

Family Spirocercidae Chitwood & Wehr, 1932

Genus *Physocephalus* Diesing, 1861

Physocephalus sp., larva (Fig. 3)

Prevalence and intensity: 1 infected of 88 studied (1.14 %); mean intensity 1.

Temporal distribution: May 2006, 1 host with 1 parasite.

Locality: Şuayip City, Harran, Şanlıurfa.

Site of infection: Intestinal wall.

Table 1. Species of the the family Gekkonidae known as hosts of helminth parasites from Turkey

Host	Locality	Helminth species	References
<i>Hemidactylus turcicus</i>	South Region of Turkey	Nematoda: <i>Spauligodon laevicauda</i> (Seurat, 1914)	TINAR (1982)
	South Region of Turkey	Nematoda: <i>Spauligodon laevicauda</i>	TINAR (1983)
		Cestoda: <i>Joyeuxiella pasqualei</i> (Diamare, 1893), larvae	
	Hatay	Nematoda: <i>Spauligodon laevicauda</i> Acanthocephala: <i>Macracanthorhynchus catulinus</i> Kostylev, 1927, larvae	YILDIRIMHAN et al. (2008)
<i>Asaccus barani</i>	Şanlıurfa	Digenea: <i>Plagiorchis molini</i> Lent & Freitas, 1940	YILDIRIMHAN et al. (2018)
		Cestoda: <i>Diplopylidium noelleri</i> (Skrjabin, 1924), larvae	
		Nematoda: <i>Atractis dactyluris</i> (Rudolphi, 1819); <i>Spauligodon azerbaijanicus</i> Sharpilo, 1974; <i>S. tarentolae</i> (Spaul, 1826); <i>S. eremiasi</i> Markov & Bogdanov, 1961; <i>Spauligodon</i> sp.; <i>Acuariidae</i> gen. sp. (larvae)	
		Acanthocephala: <i>Centrorhynchus aluconis</i> (Müller, 1780), larvae	

Table 2. Prevalence, intensity and abundance of helminth parasites in *Cyrtopodion scabrum* from Eastern Turkey

Helminth species	Number of hosts infected	Prevalence (%)	Intensity (Range)	Mean intensity	Mean abundance
Nematoda					
<i>Physaloptera</i> sp.	7	7.95	1-3	1.7	0.14
<i>Physocephalus</i> sp.	1	1.14	1	1.0	0.01
Cestoda					
<i>Diplopylidium noelleri</i>	42	47.73	1-90	11.4	5.44



Fig. 1. Metacestode of *Diplopylidium noelleri* (Skrjabin, 1924) from *Cyrtopodion scabrum* in Şanlıurfa.

Acari

Family Pterygosomatidae Oudemans, 1910

Genus *Geckobia* Mégnin, 1878

Geckobia sp. (Fig. 4)

Prevalence and intensity: 2 infected of 88 studied (2.27 %); mean intensity 6.5.

Temporal distribution: June 2010, 2 hosts with 4 and 9 parasites.

Locality: Birecik, Şanlıurfa.

Site of infection: Ectoparasite.

Discussion

Forty-six of the 88 specimens of *C. scabrum* examined for parasites were infected with one or more endo- or ectoparasites. In total, 505 specimens of multicellular parasites belonging to four species were collected: 479 specimens of *D. noelleri*, 12 specimens of *Physaloptera* sp., 1 specimen of *Physocephalus* sp. and 13 specimens of acari of the genus *Geckobia*. The total prevalence of multicellular parasite infection of *C. scabrum* was 52.3 %. Six specimens (6.8 %) of *C. scabrum* had multiple infections. These were five specimens (5.7 %) with *Dipylidium noelleri* and *Physaloptera* sp. and one specimen (1.1 %) with *D. noelleri* and *Physocephalus* sp. Forty host specimens (45.4 %) harboured



Fig. 2. Larva of *Physaloptera* sp. from *Cyrtopodion scabrum* in Şanlıurfa.



Fig. 3. Larva of *Physocephalus* sp. from *Cyrtopodion scabrum* in Birecik, Şanlıurfa.

only one multicellular parasite species. *Diplopylidium noelleri* was the most prevalent and the most abundant species in the rough-tailed geckos, found in 47.7 % of the studied geckos (Table 2). More than 94 % of the total helminth specimens belonged to this species. It was followed by *Physaloptera* sp. –

2.3 %. *C. scabrum* is a new host record for a species of the genus *Physocephalus* sp. In this study, the two nematode species recovered in *C. scabrum* had low infection rates. All the recorded helminth species were represented by larval forms, which are not specific parasites of the studied host species.

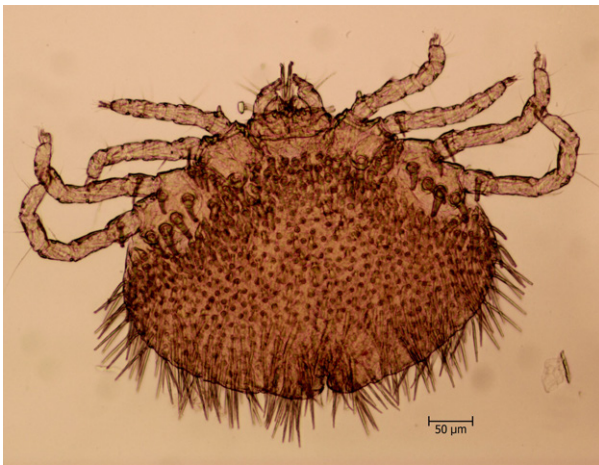


Fig. 4. *Geckobia* sp. from *Cyrtopodion scabrum* in Birecik, Şanlıurfa.

In Turkey, metacestodes of *D. noelleri* have been reported from *Asaccus barani* (YILDIRIMHAN et al. 2018). The geographical range of *D. noelleri* includes the Middle East, southern Europe, Central Asia and North Africa (WITENBERG 1932, SHARPILO 1976, HARALAMPIDES 1977, EL-SHABRAWY & IMAM 1978, BURGU et al. 1985, GADALE et al. 1989, ABDUL-SALAM & BAKER 1990, SCHUSTER 2020). A recent review of the geographical range and the known hosts was provided by SCHUSTER (2020) – domestic cats, red foxes and dogs are considered as the main definitive hosts and 24 species of reptiles (lizards and snakes) have been recorded as hosts of metacestodes of this species. *Diplopylidium noelleri* is a very prevalent parasite in cats in areas where this parasite occurs. In Greece, HARALAMPIDES (1977) reported in 71 out of 123 cats examined. In Egypt, EL-SHABRAWY & IMAM (1978) recorded it in 24 out of 66 cats.

The genus *Physaloptera* sp. includes parasites essentially of birds of prey and carnivore mammals. In Turkey, larvae of *Physaloptera* were reported from the lizards *Lacerta viridis* (SCHAD et al. 1960) and *Eremias suphani* (DÜŞEN et al. 2013). Several species of these stomach nematodes parasitic in dogs, cats and other mammals (mostly carnivores) have been recorded throughout the World (ANDERSON et al. 2009). Larvae of this nematode genus recorded from lizards and snakes on the territory of East Europe and the Caucasus (e.g., Ukraine, Armenia and Georgia) are believed to belong to *Physaloptera clausa* (Rudolphi, 1819), a widespread stomach nematode of hedgehogs (*Erinaceus* spp.) (SHARPILO 1976). Reptiles are paratenic hosts of the nematodes of the genus *Physaloptera* (SHARPILO 1976).

The available single specimen of the genus *Physocephalus* cannot be identified at the species

level based on its morphology. According to Fauna Europaea, the only species of this genus occurring in Europe is *Physocephalus sexalatus* (Molin, 1860) (GIBSON et al. 2015), a cosmopolitan stomach parasite of wild and domestic pigs, with numerous records of its third-stage larvae in reptiles being its paratenic hosts (SHARPILO 1976, MCALLISTER et al. 2004). In Turkey, *P. sexalatus* has been recorded from wild boars by SENLIK et al. (2011). Another parasite of the same genus, *Physocephalus dromedarii* Schuster, Wibbelt & Kinne, 2014, an abomasal parasite of dromedaries (*Camelus dromedarius*), is widespread in Middle East and Central Asia (SCHUSTER et al. 2014). The species identification of the nematode species of the genus *Physocephalus* occurring in the rough-tailed gecko in eastern Turkey needs further studies when more numerous specimens are available.

The obligatory ectoparasitic mites of the genus *Geckobia* Megnin, 1878 (Acari: Pterygosomatidae) are restricted exclusively to the geckos (Lacertilia: Gekkonoidea) (HIRST 1917, 1926, LAWRENCE 1953). This genus is the largest one in the family and includes about 65 species; they are divided into four groups differing by their geographical distribution and host range. Group 1 is widely distributed (Africa, Asia and Europe) and includes parasites of geckos of the families Gekkonidae, Pygopodidae and Eublepharidae. The remaining three groups are more restricted in both their host-associations and geographical distribution – Group 2 is associated exclusively with representatives of Diplodactylinae (Gekkonoidea: Pygopodidae) from New Zealand; Group 3 is distributed on South African Gekkonidae, and Group 4 occurs on Asian geckos of the families Gekkonidae and Eublepharidae (BOCKHOV & MIRONOV 2000). In this study, we found specimens of *Geckobia* on two host specimens only, with totally 13 parasites. This is the first report of a species of the genus *Geckobia* from Turkey as well as from *Cyrtopodion scabrum* in its native geographical range. The species identification of the specimens of the genus *Geckobia* parasitising *Cyrtopodion scabrum* requires further studies.

Cyrtopodion scabrum has been introduced to North America (Texas and Arizona), where it has been studied for parasites in Galveston County, Texas (MCALLISTER et al. 1991). Except *Geckobia* sp., which might be identical with the undescribed species recorded by us, they recorded also the intestinal oxyurid nematode *Parapharyngodon cubensis* Barus & Coy Otero, 1969, known to occur in a wide range of native lizards of the families Iguanidae, Gekkonidae and Teiidae in America (MCALLISTER et

al. 1991). No oxyurid nematodes were found in our study, which is the first detailed helminthological study of this host species in its native geographical range in the Palaearctic. In the same time, McALLISTER et al. (1991) did not record any of the helminth species recorded by us from the native range in the hosts in Turkey.

In summary, the first detailed parasitological survey of populations of the rougtail gecko *Cryptopodion scabrum* in its native geographical range revealed an ectoparasitic mite species of the genus *Geckobia*, which might be an undescribed new species. This gecko species also participates in the circulation of helminth species of the genera *Diplopylidium*, *Physaloptera* and *Physocephalus* parasitic in mammals and (or) birds. We suggest further studies on the parasite fauna of reptiles in Turkey in order to reveal completely the diversity of parasites and the role of the host group for the transmission parasitic diseases of other animal groups in Turkey.

Ethical approval: The research related to animal use has been complied with all the relevant national regulations and institutional policies for the care and use of animals. The study protocol no B.30.2.HRÜ.0.05.07.00/85 was approved by Republic of Turkey, Harran University Experimental Animals Local Ethics Committee and the protocol no B.18.0.DMP.0.02-510.02-48387 was approved by Republic of Turkey, Ministry of Environment and Urbanisation.

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