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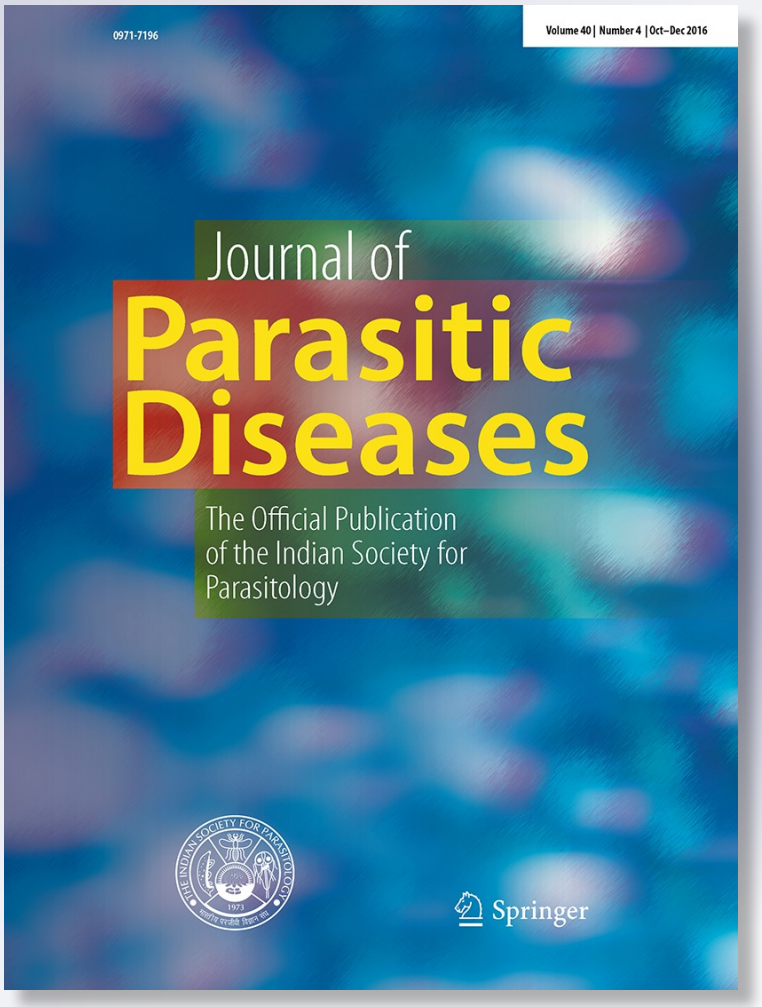

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ORIGINAL ARTICLE

A survey on parasites of long-eared hedgehog (*Hemiechinus auritus)* in northeast of Iran

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Abstract As there appeared to be no data available on parasite infection of Hedgehogs in the region and considering the potential threat of Hedgehogs for animal and public health, the present study was carried out using biological samples and necropsy findings collected from long-eared hedgehog captured in Mashhad city in the northeast of Iran. During the study 23 dead hedgehogs were collected randomly from different regions of Mashhad County. Following autopsy of these animals, observation for enteric parasites was carefully done. At the same time, 38 live hedgehogs were captured at this region and after anesthetizing of them, their ectoparasites were removed. The captured animals were released after recovery. All of studied animals were found to be infected with at least one of the parasites. The endoparasites removed from dead hedgehogs were: *Oliganthorhynchus erinacei*, *Nephridiorhynchus major*, *Hymenolepis erinacei* and *Crenosoma striatum*. The ectoparasites found on live studied animals according to their abundance were *Rhipicephalus turanicus, Haemaphysalis erinacei* and *Echidnophaga gallinacea.* The results of this study will contribute to our understanding of the parasites infecting *Hemiechinus auritus* in Iran. These results also suggest that pet owners especially those keep hedgehog should be aware about hazards that may pose by these animals.

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Introduction

Hedgehogs are small, nocturnal and spiny-coated mammals which are found in synanthropic environments and they are kept as pets by some people (Mizgajska-Wiktor et al. 2010; Silaghi et al. 2012). As Hedgehogs feed on insects, worms, centipedes, snails, mice, frogs, lizards and snakes, they are considered as useful animals for natural ecosystems and are in the protected species list (Mizgajska-Wiktor et al. 2010). They are ideal hosts for ecto and enoparasites, because they have active foraging behavior and do not groom themselves (Foldvari et al. 2011).

On the other hand, these animals can serve as reservoir for some zoonotic pathogens. Hedgehogs acquire some pathogens through tick or flea bites and are involved in the endemic cycle of these pathogens. Keeping in mind that Hedgehogs are known as potential host for some variants of *Anaplasma phagocytophilum*, tick–born encephalitis virus (TBEV), *Rickettsia felis, Eucoleus aerophilus*, causative agent of pulmonary infection which resembled a bronchial carcinoma and at least four species of Lyme spirochetes (Foldvari et al. 2011; McCarthy and Moore 2000; Silaghi et al. 2012).

The hedgehogs have become popular in recent years among pet owners and these animals have benefits and potential hazards for their owners. Some studies have been conducted on ecto and endoparasites and some other on zoonotic pathogens in hedgehogs around the world (Foldvari et al. 2011; Silaghi et al. 2012). In Iran, despite of having four hedgehog species (*Hemiechinus auritus*, *Hemiechinus hypomelas*, *Hemiechinus aethiopicus* and

Erinaceous concolor), little attention has been paid to their microbial, fungal and parasitological infections threatening public health (Hajipour et al. 2015; Youssefi et al. 2013). Therefore, the present study was conducted to investigate ecto and endoparasites of long-eared hedgehog (*Hemiechinus auritus*) in North East of Iran.

Materials and methods

From April 2010 to September 2014, 23 dead hedgehogs were collected randomly from different regions of Mashhad County. The animals' collected were mostly road casualties or humanely euthanatized by chloroform in the course of study with permission from appropriate authorities from the Iranian Environmental Health Organization.

Following autopsy of the animals, observation for enteric parasites was carefully done. The cranial end of the esophagus and the end of the rectum were tied off for removing the entire gastrointestinal tract. The gastrointestinal tract was opened for a thorough examination. Contents were flushed out with saline solution, and the resulting solution was observed. Macroscopical and microscopical analysis of the mucosa was done, examining the digestive content and scrapings of the mucosa. Recovered helminths were fixed in alcohol and the cestodes were stained with carmine. The parasites were identified according to the keys and guideline given by Yamaguti (1961).

At the same time, 38 live hedgehogs were captured at Ferdowsi University campus (predominantly April–October of each year). After weighting animals, anesthesia was performed with a combination of Xylazine (Xyla®, Interchemie Co. Venray, Holand) 1 mg/kg and Ketamine (Rotexmedica Co., Trittau, Germany) 5 mg/kg body weight applied intramuscularly. During the anesthesia ectoparasites were removed and transferred to tubes containing 70 % ethanol. The captured animals were released after recovery. Collected ticks and fleas were brought to parasitology laboratory and identified under stereomicroscope or light microscope (in the case of fleas) using the relevant standard identification keys.

Results

In total of 23 *Hemiechinus auritus*, four helminths including two acanthocephalans, one nematode and one cestode were found. The most prevalent species was *Oliganthorhynchus erinacei* (23/23, 100 %), followed by *Nephridiorhynchus major* (7/23, 30.4 %), *Hymenolepis erinacei* (3/23, 13.04 %) *and Crenosoma striatum* (1/23, 4.34 %). All of studied animals were found to be infected with one or more helminth species. The infection intensity varied greatly between species; in particular, the infection intensity of *O. erinacei* was considerably greater than those of any other species. Furthermore, the highest abundance was also observed with *O. erinacei*, whereas the lowest was recorded for *C. striatum.*

Of 38 hedgehogs captured and examined for ectoparasites, all of them showed infestation with ixodid ticks. Only one of them had mixed infestation with ticks and fleas. A total of 226 ixodid ticks and four fleas were collected from examined hedgehogs. Parasitological studies revealed that collected ticks were *Rhipicephalus turanicus* and *Haemaphysalis erinacei*. *R. turanicus* was the predominant tick species. The collected fleas were identified as *Echidnophaga gallinacea.* The detailed data for ectoparasies removed from studied hedgehogs in this study has been presented in Table 1.

Discussion

Despite the large geographical extent of Iran and presence of four hedgehog species in this country, there is few published data on parasites infesting these animals. The results of this study revealed that *R. turanicus* was the predominant ectoparasite species on *Hemiechinus auritus* in the study area. There is no published data about parasites of this species in Iran and other part of the world. *R. turanicus* has already been reported from *Erinaceus europaeus* in Northwestern Iran (Hajipour et al. 2015). Although the presence of *Erinaceus europaeus* in Iran is controversial, the report of high frequency of *R. turanicus* is in agreement with our results. Moreover, *R. turanicus* has been reported from *Erinaceus concolor* in North of Iran (Youssefi et al. 2011). Usually collected tick species and their abundance from a host in a certain area is correspondent with tick fauna in that region. The finding of large number of adult *R. turanicus* on examined hedgehogs in current study is in accordance with tick faunestic studies in this region (Razmi et al. 2011).

The other ectoparasite that we identified on studied hedgehogs was *H. erinacei.* We found this tick mostly on the ears of hedgehogs that is in accordance with results of Hoogstraal (Hoogstraal 1955). *H. erinacei* has been recorded on hedgehogs from Tehran, Mashhad and eastern Kurdistan in Iran (Abbasian-Lintzen 1960). Moreover; Khaldi et al. (2012) reported *H. erinacei* and *Rhipicephalus sanguineus* from *Paraechinus aethiopicus* and *Atelerix algirus* hedgehogs in Algeria. Interestingly, they found a new *Rickettsia* species of the spotted fever group in 77 % of *H. erinacei* ticks.

Echidnophaga gallinacea was the only flea species identified on examined hedgehogs in the current study. In

Table 1 Detailed data for ectoparasites found on examined hedgehogs in the current study

Ectoparasite	Male	Female	Nymph	Larva*	Total
Rhipicephalus turanicus	159	32	3	2	196
Haemaphysalis erinacei	24	4	–	2	30
Echidnophaga gallinacea	–	4	–	–	4

* Not identified to species level

the similar studies on other hedgehog species in Iran and other part of the world *Archaeopsylla erinacei* have been reported as the main flea species infesting studied animals (Foldvari et al. 2011; Hajipour et al. 2015). Dog flea (*Ctenocephalides canis*) has been also found on the Northern white-breasted hedgehog (*Erinaceus roumanicus*) in Hungary (Foldvari et al. 2011). Since fleas are not host-specific insects, we can expect to find different species of this insect on different animals as well as hedgehogs.

In this study, all of *H. auritus* were infected with *O. erinacei* which requires arthropod as intermediate hosts. Hedgehogs eat almost any animal substance, including arthropods, vegetation, slugs, snails and meat (Ozen 2006). As a result of these dietary habits, it seems likely that they are frequently exposed to infective stages of the heteroxen parasites that were ultimately found to be the most prevalent species hosted by hedgehogs.

Furthermore, only few long-eared hedgehogs were infected with *N. major*, *H. erinacei* and *C. striatum.* There is very limited published data on the prevalence of helminth parasites in *H. auritus* in Iran, and there is only one published data on the helminth prevalence of *Erinaceus concolor* in Northern Iran (Youssefi et al. 2013). Some of species composition in our study was already reported in *E. concolor,* however, it is the first time that *O. erinacei* has been reported from Iran. Globally, our post-mortem examination of *H. auritus* revealed the same parasites to those reported for *E. concolor* from turkey and *E. europaeus* from European countries (Boag and Fowler 1988; Ciraka et al. 2010; Poglayen et al. 2003).

This is worthwhile to clarify that age-related differences have been reported in helminth infections of hedgehogs, where higher infection rates were observed with increasing age (Majeed et al. 1989). Since the age of the animals used in this study could not be definitively determined, we were unable to analyze the impact of age on helminth parasite burden.

Hedgehogs may act as reservoir hosts for some parasites in rural and urban environments (Poglayen et al. 2003; Visser et al. 2001). For instance, *Dicrocoelium dendriticum* and *Haemonchus contortus* were found in *E. europaeus* and in *Atelerix albiventris* (Poglayen et al. 2003; Kaikabo et al. 2007). Although it is clear that hedgehogs are susceptible to these helminths, their role as a reservoir host in the epizootiology of these parasites requires further study.

Conclusion

Our results suggest that pet owners especially those keep hedgehog should be aware about hazards that may pose by these animals. Therefore, taking care including washing hands after handling them and using pesticides for eliminating ectoparasies will reduce the risk of catching zoonotic diseases from their hedgehogs.

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