

Original Article**Hedgehogs (*Erinaceus europaeus*) as a Source of Ectoparasites in Urban-suburban Areas of Northwest of Iran**

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Abstract

Background: Hedgehogs are small, nocturnal mammals which become popular in the world and have important role in transmission of zoonotic agents. Thus, the present study aimed to survey ectoparasite infestation from April 2010 to December 2011 in urban and suburban parts of Urmia and Tabriz Cities, Northwest of Iran.

Methods: A total number of 84 hedgehogs (40 females and 44 males) were examined. They have been carefully inspected for ectoparasites and collected arthropods were stored in 70% ethanol solution. The identification of arthropods was carried out using morphological diagnostic keys.

Results: The occurrence of ticks on hedgehogs was 23 (67.7%) with *Rhipicephalus turanicus* in Urmia and 11 (22%) as well as 1(2%) with *Rh. turanicus* and *Hyalomma anatolicum anatolicum* in Tabriz, respectively. One flea species, *Archaeopsylla erinacei*, was found with prevalence of 19 (55.9%) and 27 (54%) in Urmia and Tabriz Cities, respectively. Prevalence of infestation with *Rh. turanicus* and *A. erinacei* were not different ($P > 0.05$) between sexes of hedgehogs in two study areas. Highest prevalence of tick and flea infestation was in June in Urmia, whereas it was observed in August in Tabriz. Both tick and flea parasitizing hedgehogs showed seasonal difference in prevalence ($P < 0.05$) in Urmia, but it was not detected in Tabriz ($P > 0.05$).

Conclusion: The result showed the high occurrence of ectoparasites in hedgehog population and according to the zoonotic potential of these animals as vector of some agents further studies are needed to investigate in different parts of Iran.

Keywords: Ectoparasites, Hedgehog, *Erinaceus europeus*, Tick, Flea

Introduction

The European hedgehogs *Erinaceus europaeus* are widespread in rural, suburban and urban environment and have become popular as exotic pets. These animals belong to order Erinaceomorpha, family Erinaceidae and originally arrived from Europe, Asia and Africa (Rilley and Chomel 2005). Hedgehogs are considered as host of a wide variety of different parasites and pathogens (Keymer et al. 1991, Riley and Chomel 2005). Besides, these animals can be a reservoir host for leishmaniasis and trichinellosis in some parts of the world (Yaghoobi-Ershadi and Javadian 1996, Pozio 2007).

Hedgehogs can carry several tick and flea species (Beck 2007). Arthropod ectoparasites are a highly adapted group of invertebrates that live on the external body surfaces of animals and humans. Severe infestation with ectoparasites especially ticks can lead to anemia and weight loss (Pfaffle et al. 2009). Moreover, these arthropods can act as vectors of pathogenic agents, such as borreliosis, rickettsiasis and piroplasmiasis, which cause serious diseases in humans and animals (Skuballa et al. 2007, Skuballa et al. 2010, Marie et al. 2012). These mammals are pre-

sented with six species in three genera throughout parts of Iran (Etemad 1984).

Several studies have been conducted on parasites of hedgehogs from different part of the world that reveal the high occurrence of parasite including the ectoparasites and endoparasite helminthes (Dziemian et al. 2010, Gaglio et al. 2010, Foldvari et al. 2011, Pfaffle et al. 2011). Few studies have focused on prevalence of hedgehog infestation in the most parts of Iran (Youssefi et al. 2011). Consequently, the present work was performed in order to determine and compare prevalence and intensity of infestation on hedgehogs in Northwest of Iran.

Materials and Methods

The study was carried out in two cities in northwestern region in Iran. Urmia has semi-humid climate, yearly mean rainfall is of about 350 mm with the maximum mean temperature of 28.3 °C in August and the minimum mean temperature of -5 °C in January. Tabriz is arid, its mean rain fall is 330 mm, maximum temperature of 22 32.7 in July and the minimum mean temperature of -2.8 in December.

A total number of 84 hedgehogs (44 males and 40 females) were examined from April 2010 to December 2011 from Urmia (17 females and 17 males) and Tabriz (23 females and 27 males) Cities. For sampling, two study regions were divided to five parts (North, South, West, East and Center) and animals were searched by torchlight during night through parts of study regions especially in grassland, parks and garden areas. Then, animals were captured by hands and maintained in plastic baskets and transferred to Parasitology Laboratory, Faculty of Veterinary Medicine, Urmia University, Urmia. About 22 hedgehogs were found dead following road accidents and referred to Parasitology laboratory. All data about sex and weight were recorded. Each individual was

visually inspected for ectoparasites, then arthropods collected and stored in 70% ethanol solution. Fleas were cleared in 10% potassium hydroxide solution and mounted using routine technique. The ectoparasites morphologically were examined under the stereo microscope and identified using morphological taxonomic keys (Beaucournu and Launay 1999, Walker et al. 2007).

Statistics analysis

The following parasitological parameters were evaluated: percentage prevalence, the mean intensity and the mean abundance (Bush et al. 1997). Chi-square and Fisher's exact tests were used to test for differences in parasite prevalence in the hedgehog population. Statistical comparisons were carried out using SPSS 16.0 statistical software. Differences were considered significant at $P < 0.05$ level.

Results

A total number of 37 ticks (23 males and 14 females) and 241 fleas (127 males and 114 females) were collected from hedgehogs in Urmia and Tabriz Cities, respectively. The occurrence of ticks in Urmia on hedgehogs was 23 (67.7%) with *Rhipicephalus turanicus* and tick infestation in Tabriz was 11 (22%) and 1 (2%) with *Rh. turanicus* and *Hyalomma anatolicum anatolicum*, respectively. Other ectoparasite that found was *Archaeosylla erinacei* with prevalence of 19 (55.9%) and 27 (54%) in Urmia and Tabriz Cities, respectively. There were significant differences in female and male ticks and fleas ($P < 0.05$) that collected from Tabriz but significant differences was observed only in flea in Urmia. All information about number of infestation with ticks and fleas are shown in Table 1.

Prevalence with *Rh. turanicus* and *A. erinacei* were not different ($P > 0.05$) between sexes of animals in two study areas (Table 2).

Highest occurrence of infestation in both tick and flea was in June in Urmia. The significant variations were observed among seasons in both ectoparasite species ($P < 0.05$). In region two, highest prevalence of two parasite species was in August (Fig. 1).

The significant differences were not seen among season in flea and tick population ($P > 0.05$). Overall, the intensity of ectoparasite was higher in Urmia than Tabriz in hedgehog population.

Table 1. Prevalence and intensity of ectoparasite species on hedgehogs

| Study area | Parasite species | Prevalence (%) | Mean intensity (\pm SD) | Mean abundance (\pm SD) | Range | Sex ratio |
|------------|---------------------------------------|----------------|----------------------------|----------------------------|-------|-----------|
| Urmia | <i>Rhipicephalus turanicus</i> | 23(67.7) | 10.47(\pm 7) | 4.35(\pm 6.6) | 1–25 | 1/1.15 |
| | <i>Archaeosylla erinacei</i> | 19(55.9) | 7.78(\pm 7.2) | 7.08(\pm 7.6) | 2–34 | 1/ 2.52 |
| Tabriz | <i>Rhipicephalus turanicus</i> | 11(22) | 3.3(\pm 1.3) | 0.72(\pm 1.5) | 1–5 | 1/1.57 |
| | <i>Hyalomma anatolicum anatolicum</i> | 1(2) | 1(\pm 0) | 0.02(\pm 0.1) | 0–1 | - |
| | <i>Archaeosylla erinacei</i> | 27(54) | 3.6(\pm 1.7) | 2(\pm 0.2) | 1–8 | 1/7.6 |

Table 2. Prevalence of ectoparasite infestation in relation to sex of the hedgehogs (n= 84)

| City species | Sex of animals | | Significance |
|--------------------------------|----------------|----------|--------------|
| | Female | Male | |
| Urmia | (n=17) | (n=17) | |
| <i>Rhipicephalus turanicus</i> | 11(64.7) | 12(70.6) | $P > 0.05$ |
| <i>Archaeopsylla erinacei</i> | 10(58.8) | 9(52.9) | |
| Tabriz | (n=23) | (n=27) | |
| <i>Rhipicephalus turanicus</i> | 5(21.7) | 6(26.08) | |
| <i>Archaeopsylla erinacei</i> | 15(55.5) | 12(44.5) | $P > 0.05$ |

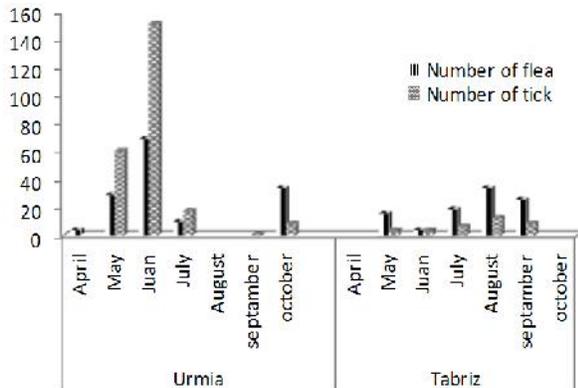


Fig. 1. Infestation rate of hedgehog fleas and ticks collected from Urmia and Tabriz Cities, Iran

Discussion

In the present study, the ectoparasite prevalence was observed in European hedgehogs

(*Erinaceus europaeus*) in Northwest of Iran. A total number of 37 ticks with the species of *Rh. turanicus* (67.7%) were identified from Urmia. Of the hedgehogs sampled in Tabriz, 22% and 2% were infested with *Rh. turanicus* and *H. anatolicum anatolicum*, respectively. The result revealed that infestation rate with ticks was higher than in Urmia. Youssefi et al. (2011) found prevalence of 75% for *Rh. turanicus* in hedgehogs (*Erinaceus concolor*) in north of Iran. At the investigation on identification of tick species, the presence of *Rh. turanicus* among ruminants confirmed in two ecologic regions in Iran (Rahbari et al. 2008). Besides in another study *Rh. turanicus* was found in West and East Azerbaijan (Nabian and Rahbari 2008).

Seasonal variation was observed in hedgehog population in Urmia, but not in Tabriz. The possible reason could be associated with climatic conditions. Rainfall was considered as the most important climatic factor that influenced the seasonal variation in parasite population. According to previous study by Nabian and Rahbari (2008), seasonal activity of ticks has been during the hot and humid months in the Western and Northwestern regions of Iran, which is resulted from several factors including increase of rainfall, temperatures and relative humidity. The results of this study are similar to study carried out by Pfaffle et al. (2011) on tick populations in hedgehogs. Moreover, seasonal variation in tick infestation on hedgehog had been shown in urban ecosystem of the city of Poznan, Poland (Dziemian et al. 2010). We observed no significant differences in the abundance of any arthropod between hedgehog sexes. The findings of other studies were in accordance with our study (Gaglio et al. 2010, Pfaffle et al. 2011). Different molecular investigations were conducted on hedgehog ectoparasites which suggested the possibility of transmission of rickettsial agents by arthropods (Matsumoto et al. 2005, Harrus et al. 2010). Marie et al. (2011) showed that European hedgehogs (*Erinaceus europaeus*) were infested with *Rh. sanguineus* and *Rickettsia massiliae* was identified from ticks. This pathogen is a causative agent of spotted fever disease in humans. In addition, similar study on African hedgehog (*Atelerix algirus*) and desert hedgehog (*Paraechinus aethiopicus*) in Algeria indicated that examined ticks including *Rh. sanguineus* and *Haemaphysalis erinacei* were positive for *R. massiliae* (Khaldi et al. 2012). Therefore, it was concluded that horizontal transmission of *Rickettsia* between hedgehog and tick results in hedgehog become potential reservoir host for these emergent pathogens and at this point of view, in environments which there are close communication between human and

these animals, the risk factor of infection will increased for humans. Furthermore, *Rh. turanicus* can act as a vector for *Rickettsia*, *Anaplasma*, *Theileria*, *Babesia*, and Arboviruses (Psaroulaki et al. 2006).

Other arthropod species found in our study was *A. erinacei* with infestation rate of 55.8% and 54% in Urmia and Tabriz Cities, respectively. Highest prevalence was in May to June in Urmia but it was from August to September in Tabriz. There was no data about flea infestation on hedgehogs in Iran. In the Northern white-breasted hedgehog (*Erinaceus roumanicus*) in urban park of central Budapest, Hungary, 99.4% were infected with *A. erinacei* flea (Foldvari et al. 2011). In an epidemiological survey, which was done on European hedgehogs (*Erinaceus europaeus*) in Britain, two ectoparasites species *A. erinacei* (8%) and *Ixodes hexagonus* (59%) were reported (Gaglio et al. 2010). According to Thamm et al. (2009), investigated hedgehogs had infestation with *A. erinacei* and *I. hexagonus* which suggested there were association between ectoparasite infestation and urban environment. Mixed Infestation with *A. erinacei* and dog flea reported from pet animals and hedgehog in Germany (Visser et al. 2001). Similar to tick that mentioned above, flea have the ability of transmission of Rickettsial agents (Bitam et al. 2006). There was one report about human infestation with *A. erinacei* in the world (Pomykal et al. 1985).

Based on the results, it was concluded that the occurrence of ectoparasites in hedgehog population was high in Urmia and Tabriz Cities and their ability in transmission of infectious agents should be noted. For these reasons, further studies are needed to investigate hedgehog ectoparasites in other parts of Iran.

Conclusion

The result of this investigation showed the

high prevalence ectoparasites in hedgehog population and according to the zoonotic potential of these animals as vector of some agents further studies are needed to investigate in different parts of Iran.

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References

- Beck W (2007) Endoparasitism beim Igel. Wien Klin Wochenschr. 119(3): 40–44.
- Beaucournu JC, Launay F (1999) Fleas (Siphonaptera) of France and Western Mediterranean. Paris Federation of Companies Sciences, France.
- Bitam I, Parola P, Dela-Cruz KD, Matsumoto K, Baziz B, Rolin JM, Belkaid M, Raoult D (2006) First molecular detection of *Rickettsia felis* in fleas from Algeria. Am J Trop Med Hyg. 74(4): 532–535.
- Bush AO, Lafferty KD, Lotz JM, Shostak AW (1997) Parasitology meets ecology on its own terms: Margolis et al. revisited. J Parasitol. 83: 45–52.
- Dziemian S, Pilacinska B, Bogawski P, Michalik J (2010) Infestation of the Northern white-breasted hedgehog (*Erinaceus roumanicus*) with *Ixodes* ticks in urban ecosystems of the city of Poznan. Wiad Parazytol. 56(5): 41–47.
- Etemad E (1984) The Mammals of Iran. Chiroptera and Insectivore. Department of the Environment Press, Iran.
- Foldvari G, Rigo K, Jablonszky M, Biro G, Molnar V, Toth M (2011) Ticks and the city: Ectoparasite of the northern white-breasted hedgehog (*Erinaceus roumanicus*) in an urban park. Ticks Tick Borne Dis. 2(4): 231–234.
- Gaglio G, Allen S, Bowden L, Bryant M, Morgan ER (2010) Parasites of European hedgehogs (*Erinaceus europaeus*) in Britain: epidemiological study and coprological test evaluation. Eur J Wild Res. 56: 839–844.
- Gilles J, Silaghi C, Just FT, Pradel I, Pfister K (2009) Polymerase chain reaction of *Rickettsia felis*-like organism in *Archaeopsylla erinacei* (Siphonaptera: Pulicidae) from Bavaria, Germany. J Med Entomol. 46(3): 703–707.
- Harrus S, Perlman A, Muncuoglu KY, Morick D, Baneth G (2010) Molecular detection of *Rickettsia massiliae*, *Rickettsia sibirica mongolitimonae* and *Rickettsia conorii israelensis* in ticks from Israel. Clin Microbiol Infect. 17(2): 176–179.
- Keymer IF, Gibson EA, Reynolds DJ (1991) Zoonoses and other findings in hedgehogs (*Erinaceus europaeus*): a survey of mortality and review of the literature. Vet Rec. 128(11): 245–249.
- Khalidi M, Socolovschi C, Benyettou M, Barech G, Biche M, Kernif T, Raoult D, Parola P (2012) Rickettsiae in arthropods collected from the north African hedgehog (*Atelerix lagurus*) and the desert hedgehog (*Paraechinus aethiopicus*) in Algeria. Comp Immunol Microbiol Infect Dis. 35(2): 117–122.
- Marie JL, Davoust B, Socolovschi C, Raoult D, Parola P (2012) Molecular detection of rickettsial agents in ticks and fleas collected from a European hedgehog (*Erinaceus europaeus*) in Marseille, France. Comp Immunol Microbiol Infect Dis. 35(1): 77–79.
- Matsumoto K, Ogawa M, Brouqui P, Raoult D, Parola P (2005) Transmission of *Rickettsia massiliae* in the tick, *Rhipicephalus turanicus*. Med Vet Entomol. 19: 263–270.

- Nabian S, Rahbari S (2008) Occurrence of soft and hard ticks on ruminants in Zagros Mountainous areas of Iran. Iran J Arthropod-Borne Dis. 2(1): 16–20.
- Pfäffle M, Petney T, Elgas M, Skuballa Jb, Taraschewski H (2009) Tick induced blood loss leads to regenerative anaemia in the European hedgehog (*Erinaceus europaeus*). J Parasitol. 136: 443–452.
- Pfäffle M, Petney T, Skuballa J, Taraschewski H (2011) Comparative population dynamics of a generalist (*Ixodes ricinus*) and specialist tick (*I. hexagonus*) species from European hedgehogs. Exp Appl Acarol. 54: 151–164.
- Pfäffle MP (2011) Influence of parasites on fitness parameters of the European hedgehog (*Erinaceus europaeus*). [PhD dissertation]. Berlin University, Germany.
- Pomykal J (1985) A case of infestation of humans with fleas *Archaeopsylla erinacei* (Siphonaptera, Pulicidae). Folia Parasitol. 32(4): 348.
- Pozio E (2007) World distribution of *Trichinella* spp. infections in animals and humans. Vet Parasitol. 149: 3–21.
- Psaroulaki A, Ragiadakou D, Kouris G, Papadopoulos B, Chaniotis B, Tselentis Y (2006) Ticks, tick-borne Rickettsiae, and *Coxiella burnetii* in the Greek Island of Cephalonia. Ann NY Acad Sci. 1078: 389–399.
- Rahbari S, Nabian S, Shayan P, Seddighian M (2008) Detection of different species of *Rhipicephalus* ticks in some parts of Iran. J Vet Res. 63(4): 195–198.
- Riley PY, Chomel BB (2005) Hedgehog Zoonoses. Emerg Infect Dis. 11(1): 1–5.
- Skuballa J, Oehme R, Hartelt K, Petney T, Bucher T, Kimmig P, Taraschewski H (2007) European hedgehogs as hosts for *Borrelia* spp., Germany. Emerg Infect Dis. 13(6): 952–953.
- Skuballa J, Petney T, Pfäffle M, Taraschewski H (2010) Molecular Detection of *Anaplasma phagocytophilum* in the European hedgehog (*Erinaceus europaeus*) and its Ticks. Vector-Borne Zoonot. 10(10): 1055–1057.
- Thamm S, Kalko EKV, Wells K (2009) Ectoparasite infestations of hedgehogs (*Erinaceus europaeus*) are associated with small-scale landscape structures in an urban–suburban environment. Eco Health. 6: 404–413.
- Visser M, Rehbein S, Wiedemann C (2001) Species of flea (Siphonaptera) infesting pets and hedgehogs in Germany. J Vet Med. 48: 197–202.
- Walker AR, Bouattour A, Camicas JL, Estrada-Pena A, Horak IG, Latif AA, Pegram RG, Preston PM (2007) Ticks of Domestic Animals in Africa: a Guide to Identification of Species. Bioscience Reports Scotland, UK.
- Yaghoobi-Ershadi MR, Javadian E (1996) Epidemiological study of reservoir hosts in an endemic area of zoonotic cutaneous leishmaniasis in Iran. Bull World Health Organ. 74(6): 587–590.
- Yakhchali M, Hosseini A (2006) Prevalence and ectoparasites fauna of sheep and goats flocks in Urmia suburb, Iran. Veterinarski Arhiv. 76 (5): 431–442.
- Youssefi MR, Rahimi MT, Hosseini SM, Darvishi MM (2011) First report of *Rhipicephalus turanicus* from hedgehog (*Erinaceus concolor*) in north of Iran. World J Zool. 6(4): 401–403.