Mesostigmatic mites associated with birds and mammals in Iran. A review

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Abstract

There are diverse relationships between mites and birds or mammals. These mites may play an important role in epizootics and in the perpetuation of some significant diseases. The purpose of this study is to revise the current knowledge of mesostigmatic mites occurring on birds, including their nests and mammals and their substrates, in Iran and to compare the results with other regions of the Palearctic ecozone. This study presents a revised list of 38 species of mesostigmatic mite occurring on birds (17 species) and mammals (24 species) or in their nests/substrates in Iran. *Dermanyssus gallinae*, *Ornithonyssus sylviarum* and *Parasitus hyalinus* were found on both birds and mammals. The species composition of mites reported in Iran was compared with other regions of the Palearctic ecozone. Parasites, specifically those from genera *Dermanyssus*, *Ornithonyssus* and *Liponyssoides*, may be hazardous to human health. Species from these genera were predominant among the reported mites.

Keywords Acari · Mites · Mesostigmata · Parasitology · Zoogeography · Iran

Introduction

The relationships formed between selected groups of invertebrates, especially mites and birds or mammals and their substrates, may be diverse. Relationships, for instance parasitic and phoretic associations, relating to the spread of arthropods that use vertebrates for this purpose have been analyzed frequently (de la Fuente et al. 2004; Gaglio et al. 2010; Gwiazdowicz et al. 2012; Haitlinger 1992; Haitlinger and Walter 1997; Oleaga et al. 2008). Specific microhabitats readily colonized by mites include the nests of birds (Bajerlein et al. 2006; Błoszyk et al. 2005, 2006, 2009; Gwiazdowicz

et al. 2005, 2006; Křištofik et al. 2007; Tryjanowski et al. 2001) and mammals (Krawczyk et al. 2015; Mašan and Stanko 2005; Mal'kova 2010; Napierała et al. 2016; Okulova 2003) and also animal dung (Cicolani 1992; Gwiazdowicz 2000, 2001; Haloti et al. 2005).

Kazemi and Rajaei (2013) recently included 348 species belonging to 128 genera and 39 families in the checklist of the Iranian mesostigmatic mites. Nonetheless, the reports of some species parasitic on birds and mammals species were neglected. A number of those species neglected by Kazemi and Rajaei (2013), and included in this catalogue, are free-living in soil and litter, while others are inhabitants of transient habitats, are associated with other arthropods, or a few are associated with birds, their nests, or with mammals. Since many rodents are reservoirs of diseases, mites occurring on different host species may play an important role in epizootics and in the perpetuation of diseases, such as tularemia, relapsing fever and rickettsial infections (Baumstark et al. 2007; Di Palma et al. 2012; George et al. 2015).

Information on the mesostigmatic mite fauna in Iran, especially those that are associated with birds and mammals, is very poor. Few taxonomic studies have been conducted on the fauna of parasitic mites in Iran and the understanding of this fauna, arises from the results of taxonomic studies on the ectoparasites of birds (Ardeshtir 2010; Moodi et al. 2014), rodents or some domestic animals (Motevalli-Haghi et al. 2000, 2002; Rafinejad

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et al. 2005; Rahdar and Vazirianzadeh 2009; Shayan and Rafinejad 2006) and bats (Vatandoost et al. 2010).

The purpose of this study is to summarize, organize and revise the current knowledge of mesostigmatic mites occurring on birds, their nests, and mammals in Iran. Data compiled will provide the possibility to assess the threat from harmful parasitic mites and contribute to other branches of research, for example zoogeography. Moreover, this study presents a comparison of the Iranian mesostigmatic fauna with other regions of the Palearctic allowing a greater insight into the relationships between mites and selected groups of vertebrates.

Materials and methods

Information concerning the species observed and their habitats or hosts was obtained from previous descriptions of the mite fauna of Iran in the literature. In addition, new data on the distribution of species previously recorded by authors of the present study are provided.

Materials were collected from different microhabitats and from different regions of Iran. The mesofauna from nests of birds and substrates of mammals was extracted by using Tullgren funnels. For parasitic species, rodents were captured alive in Khuzestan and Chaharmahal va Bakhtiari provinces using cage traps. Mice were euthanased in the laboratory using chloroform and mites were separated from the bodies by washing in hot water mixed with some drops of detergent. Mites were cleared in lactophenol, mounted in Hoyer's medium, and studied under a light microscope. The species list is sorted by genera and family and includes sampling data (date, locality, microhabitat or host). The coordinates presented describe the species distribution and do not refer to the sampling locations. Except for species previously reported by authors of this paper, we cannot confirm the correct identity of the species listed in the Tables 1 and 2.

Results and discussion

An organized inventory of the mesostigmatic mites occurring on birds, in their nests, or with mammals in Iran so far is presented. The inventory takes into account current species names and was prepared from the present literature. Seventeen of these mites are associated with birds and 24 with mammals. Three species, *Dermanyssus gallinae*, *Ornithonyssus sylviae* and *Parasitus hyalinus* were reported in nests of both birds and substrates of mammals (Tables 1 and 2).

The majority of the species reported are either facultative or obligatory (altogether 26 of 38 species respectively) parasites of birds or mammals. In contrast, mites belonging

to the genera *Gaeolaelaps*, *Parasitus*, *Stratiolaelaps*, and species such as *Eugamasus cavernicolus*, *Lasioseius penicilliger* and *Trachygamasus gracilis* are not parasitic. They usually prefer decaying plant matter, compost or manure with straw and a surface comprised of leaf-litter. However, they may be transferred into the nests via the gathering of nest lining materials. Moreover, they can hitchhike on bodies of insects and occasionally with vertebrates, a form of phoresy (Hyatt 1980; Karg 1993).

Generally, the analyzed material was collected directly from bodies of mammals or birds, but also from places of their permanent presence e.g. nests. In the case of birds, numerous samples were collected from nests of unidentified bird species, while for mammals the material was collected from bodies of rodents living near humans such as *Rattus norvegicus*, *R. rattus*. *Mus musculus* and *Tatera indica* prevailed (Table 2).

The comparison of results obtained from Iran with other regions of the Palearctic revealed some similarities, but also differences in mite species compositions. Examples include the genus *Laelaps*, three species of which were reported from Iran, but, while *Laelaps agilis* and *L. hildae* which are very frequent and numerous in Europe, they were not present in this country. Similarly the species *Hirstionyssus butantanensis* was collected whereas the common species *H. isabellinus* or *H. sunci* were not recorded. It is also interesting that parasitic mites of genus *Haemogamasus*, up to this time numerous and common in Europe and North Asia, have not been reported (Haitlinger 1988). Moreover, *Eulaelaps stabularis*, a parasite encountered so far on bodies of over 30 species of mammals and in nests of over 30 species of birds, was recorded. This is a widespread species with a range covering nearly all Eurasia and North America (Bregetova 1956; Mařán and Fend'a 2010). *Steatonyssus periblepharus* is a parasite of bats thus far recorded in many countries of Eurasia and North Africa (Haitlinger and Walter 1997). Moreover, *Dermanyssus gallinae*, a common parasite encountered on breeding (e.g. chickens) and wild birds, was also reported on mammals (George et al. 2015). Its negative impact on human health has been known for several decades as its bites can cause skin irritation and also transmit viral diseases (Baumstark et al. 2007; Reeves et al. 2007). Additionally, *Ornithonyssus bacoti* is a species widespread in the Palearctic and parasitizes many mammalian species e.g. *Rattus* sp. It is frequently found on mammals associated with humans and therefore, as in the case of *D. gallinae*, it may pose a threat of transmission of viral diseases to people (Abdigoudarzi et al. 2014; Di Palma et al. 2012; George et al. 2015). For the reasons above, a detailed knowledge on the occurrence of mite species and of host species (especially birds) in Iran is required to help determine risks to humans and to take actions to limit them.

Analysis of the European bird nest acarofauna inhabiting perennial nests, for instance eagles or storks (Błoszyk et al. 2005,

Table 1 Inventory of the mesostigmatic mites associated with birds in Iran

Mite species	Host	Region of Iran	References
<i>Dermanyssus brevis</i> Ewing, 1936	<i>Galerida cristata</i> (L., 1758)	Ghayen (33° 43' N, 59° 43' E)	Moodi et al. 2014
<i>Dermanyssus chelidonis</i> Oudemans, 1939	Unidentified birds and their nests	Shahrekord (32° 19' N, 50° 51' E), Esfahan (32° 39' N, 51° 41' E)	Keivani et al. 2012
<i>Dermanyssus gallinae</i> (De Geer, 1778)	Unidentified birds and their nests, <i>Hirundo rustica</i> L., 1758, nests	Guilan (37°16'N, 49°35'E), Ghazvin (36°16'N, 49°59' E), Ghom (34°38' N, 50°52' E), Mazandaran (36° 33' N, 53° 03' E), Markazi (34° 05' N, 49° 42' E), Tehran (35° 42' N 51° 21E), Zanzan (36° 40' N 48° 30' E), Shahrekord (32° 19' N, 50° 51' E), Esfahan (32° 39' N, 51° 41' E), Urmia(37° 33' N 45° 04' E)	Keivani et al. 2012; Modarres-Awal 1994, 1997; Mohamadi Ghalehjoughi et al. 2017; Rafii and Rak 1974; Rahbari et al. 2009
<i>Eugamasus cavernicola</i> Trägårdh, 1912	Nest materials	Semnan (35° 34' N, 53° 23' E), Tehran (35° 42' N 51° 21E)	Kamali et al. 2001
<i>Eulaelaps stabularis</i> (C. L. Koch, 1839)	Unidentified birds and their nests	Shahrekord (32° 19' N, 50° 51' E), Esfahan (32° 39' N, 51° 41' E)	Keivani et al. 2012
<i>Gaeolaelaps kargi</i> (Costa, 1968)	Nest materials	Shahrekord (32° 19' N, 50° 51' E), Esfahan (32° 39' N, 51° 41' E)	Keivani et al. 2012
<i>Gaeolaelaps queenslandicus</i> (Womersley, 1956)	Nest materials	Shahrekord (32° 19' N, 50° 51' E), Esfahan (32° 39' N, 51° 41' E)	Keivani et al. 2012
<i>Lasioseius penicilliger</i> (Berlese, 1916)	<i>Passer domesticus</i> (L., 1758) <i>Columba livia</i> Gmelin, 1789	Tehran (35° 42' N 51° 21E)	Ardeshtir 2010
<i>Ornithonyssus sylviarum</i> Canestrini and Fanzago, 1877	<i>Oenanthe lugens</i> (Lichtenstein, 1823)	Tandoureh National Park (37°34' N, 58° 40' E)	Moodi et al. 2014
<i>Parasitus consanguineus</i> Oudemans et Voigts, 1904	Unidentified birds and their nests	Shahrekord (32° 19' N, 50° 51' E), Esfahan (32° 39' N, 51° 41' E)	Keivani et al. 2012
<i>Parasitus fimetorum</i> (Berlese, 1903)	Nest materials	Semnan (35° 34' N, 53° 23' E)	Kamali et al. 2001
<i>Parasitus hyalinus</i> (Willmann, 1949)	Bird nests	Semnan (35° 34' N, 53° 23' E), Tehran (35° 42' N 51° 21E)	Kamali et al. 2001; Modarres Awal 1997
<i>Parasitus noll</i> Karg, 1965	Nest materials	Semnan (35° 34' N, 53° 23' E), Tehran (35° 42' N 51° 21E)	Kamali et al. 2001
<i>Ptilonyssus hirsti</i> (Castro et Periera, 1947)	<i>Passer montanus</i> (L., 1758) and <i>P. domesticus</i> (L., 1758)	Kalat Nader (36°59' N, 59° 45' E), Bojnord (37°28' N, 57° 18' E)	Moodi et al. 2014
<i>Ptilonyssus icteridius</i> (Strandtmann et Furman, 1956)	<i>Emberiza bruniceps</i> Brandt, 1841	Tandoureh National Park (37°34' N, 58° 40' E)	Moodi et al. 2014
<i>Ptilonyssus pirangae</i> (Černý, 1969)	<i>Carduelis chloris</i> (L., 1758)	Shirvan (37°24' N, 57° 55' E)	Moodi et al. 2014
<i>Stratiolaelaps miles</i> (Berlese, 1892)	Nest materials	Ahvaz (31° 19' N, 48° 40' E)	Kamali et al. 2001

Table 2 Inventory of the mesostigmatic mites associated with mammals in Iran

Mite species	Host	Region of Iran	References
<i>Androlaelaps casalis</i> (Berlese, 1887)	Unidentified rodents	Shahrekord (32° 19' N, 50° 51' E)	Babaeian et al. 2010
<i>Androlaelaps fahrenheitii</i> (Berlese, 1911)	<i>Rattus norvegicus</i> (Berkenhout, 1769), <i>R. rattus</i> (L., 1758), <i>Tatera indica</i> (Hardwicke, 1807), <i>Mus musculus</i> L., 1758, <i>Meriones persicus</i> (Blanford, 1875), <i>Apodemus sylvaticus</i> (L., 1758), <i>Microtus socialis</i> (Pallas, 1773), <i>Cricetulus migratorius</i> (Pallas, 1773), <i>Ellobius fuscicapillus</i> Blyth, 1843	Bandar Abbas (27° 10' N, 56° 15' E), Khorram-Abad (33° 27' N, 48° 20' E), Shahrekord (32° 19' N, 50° 51' E)	Babaeian et al. 2010; Hanafi-Bojd et al. 2007; Shayan and Rafinejad 2006
<i>Androlaelaps hermaphrodita</i> (Berlese, 1887)	<i>Tatera indica</i> (Hardwicke, 1807), <i>Meriones hurrianae</i> Jordon, 1867, <i>Meriones libycus</i> Lichtenstein, 1823 and <i>Gerbillus nanus</i> Blanford, 1875	Iranshahr (35° 42' N 51° 25' E), Qasre Qand (26° 13' N 60° 44' E), Nikshahr (26° 14' N 60° 13' E), Bam-poor (27° 11' N 60° 27' E)	Nateghpour et al. 2013
<i>Androlaelaps marshalli</i> (Berlese, 1911)	Unidentified rodents	Shahrekord (32° 19' N, 50° 51' E), Ahvaz (31° 19' N, 48° 40' E)	Nemati et al. 2008
<i>Dermanyssus americanus</i> Ewing, 1923	<i>Rattus norvegicus</i> (Berkenhout, 1769), <i>Tatera indica</i> (Hardwicke, 1807)	Bandar Abbas (27° 10' N, 56° 15' E)	Hanafi-Bojd et al. 2007
<i>Dermanyssus gallinae</i> (De Geer, 1778)	<i>Mus musculus</i> L., 1758, Human	Northwest of Iran, Tehran (35° 42' N 51° 21' E)	Abdougoudarzi et al. 2014; Allymehr et al. 2012
<i>Echinolaelaps echidninus</i> (Berlese, 1887)	<i>Rattus norvegicus</i> (Berkenhout, 1769), <i>R. rattus</i> (L., 1758), <i>Mus musculus</i> L., 1758, <i>Glis glis</i> (L., 1766), <i>Apodemus sylvaticus</i> (L., 1758), <i>Nesokia indica</i> (J.E. Gray, 1830), <i>Arvicola terrestris</i> (L., 1758), <i>Tatera indica</i> (Hardwicke, 1807), and undetermined species of rodents	Mazandaran (36° 33' N, 53° 03' E), Bandar Abbas (27° 10' N, 56° 15' E)	Hanafi-Bojd et al. 2007; Motevalli-Haghi et al. 2000; Motevalli-Haghi et al. 2002
<i>Gaeolaelaps aculeifer</i> (G. Canestrini, 1884)	Nest of small mammals	Ahvaz (31° 19' N, 48° 40' E)	Kamali et al. 2001; Nemati et al. 2000
<i>Hirstionyssus butantanensis</i> (Fonseca, 1932)	<i>Rattus</i> or <i>Mus</i> species and nest materials of unknown rodents	Shahrekord (32° 19' N, 50° 51' E)	Herrin 1974; Nemati et al. 2012
<i>Hirstionyssus meridianus</i> (Zemskaja, 1955)	<i>Meriones libycus</i> Lichtenstein, 1823	Mashhad (36° 18' N 59° 34' E)	Kazemi et al. 2015
<i>Laelaps acuminata</i> Furman, 1972	<i>Tatera indica</i> (Hardwicke, 1807), <i>Meriones hurrianae</i> Jordon, 1867, <i>Meriones libycus</i> Lichtenstein, 1823 and <i>Gerbillus nanus</i> Blanford, 1875	Iranshahr (35° 42' N 51° 25' E), Qasre Qand (26° 13' N 60° 44' E), Nikshahr (26° 14' N 60° 13' E), Bam-poor (27° 11' N 60° 27' E)	Nateghpour et al. 2013
<i>Laelaps algericus</i> Hirst, 1925	<i>Rattus rattus</i> (L., 1758), <i>Mus musculus</i> L., 1758	Ahvaz (31° 19' N, 48° 40' E), Mashhad (36° 18' N 59° 34' E)	Kazemi et al. 2015; Moravvej et al. 2016; Nemati et al. 2012
<i>Laelaspis astronomicus</i> (C.L. Koch, 1839)	<i>Rattus norvegicus</i> (Berkenhout, 1769), <i>R. rattus</i> (L., 1758), <i>Mus musculus</i> L., 1758	Hamedan (34° 49' N 48° 30' E)	Zendehfili et al. 2015
<i>Laelaps ekstremiti</i> Zachvatkin, 1948	Unidentified species of rodents	Shahrekord (32° 19' N, 50° 51' E)	Nemati et al. 2012
<i>Laelaps nuttali</i> (Hirst, 1955)	<i>Rattus norvegicus</i> (Berkenhout, 1769), <i>R. rattus</i> (L., 1758), <i>Tatera indica</i> (Hardwicke, 1807), <i>Mus musculus</i> L., 1758, <i>Meriones persicus</i> (Blanford, 1875), unidentified species of rodents	Ahvaz (31° 19' N, 48° 40' E), Bandar Abbas (27° 10' N, 56° 15' E), Sarpole-Zahab (34° 27' N 45° 51' E), Shahrekord (32° 19' N, 50° 51' E), Gomishan (37° 04' N 54° 04' E), Bandar Turkmen (36° 53' N 54° 04' E)	Gholipoury et al. 2016; Hanafi-Bojd et al. 2007; Kia et al. 2009; Nemati et al. 2000; Nemati et al. 2008; Telmadarraiy et al. 2007
<i>Liponyssoides sanguineus</i> (Hirst, 1914)	<i>Rattus norvegicus</i> (Berkenhout, 1769), <i>Mus musculus</i> L., 1758, <i>Meriones persicus</i> (Blanford, 1875), <i>Tatera</i>	Bandar-Abas (27° 10' N, 56° 15' E), Sarpole-Zahab (34° 27' N 45° 51' E), Shahrekord (32° 19' N, 50° 51' E),	Hanafi-Bojd et al. 2007; Nemati et al. 2008; Rahdar et al. 2015; Telmadarraiy et al. 2007

Table 2 (continued)

Mite species	Host	Region of Iran	References
<i>Myonyssus gigas</i> (Oudemans, 1912)	<i>indica</i> (Hardwicke, 1807), unidentified rodents	Ahvaz (31° 19' N, 48° 40' E), Hovizeh (35° 44' N 51° 26' E)	Kazemi and Mohammad-Dustar-Sharaf 2015
<i>Ornithonyssus bacoti</i> (Hirst, 1913)	From soil and litter near an unknown small mammal nest	East Azerbaijan (38° 05' N, 46° 16' E)	Allymehri et al. 2012;
	On the body of <i>Rattus norvegicus</i> (Berkenhout, 1769), <i>R. rattus</i> (L., 1758), <i>Tatera indica</i> (Hardwicke, 1807), <i>Mus musculus</i> L., 1758, <i>Meriones persicus</i> Blanford, 1875), <i>Rhombomys opimus</i> (Lichtenstein, 1823) and also on the body of Human	Different parts of Iran, Ahvaz (31° 19' N, 48° 40' E), Meshkinshahr (38° 23' N 47° 39' E), Lorestan (33° 34' N, 48° 23' E), Bandar Abbas (27° 10' N, 56° 15' E), Sarpole-Zahab (34° 27' N 45° 51' E), Shahrekord (32° 19' N, 50° 51' E), Esfarayen (37° 04' N 57° 29' E), Shirvan (37° 29' N 57° 53' E), Damghan (36° 09' N 54° 21' E), Shahrood (36° 24' N 55° 00' E), Northwest of Iran, Tehran (35° 42' N 51° 21' E)	Hanafi-Bojd et al. 2007; Modarres-Awal 1994, 1997; Mohebali et al. 1997; Nemati et al. 2000, 2008; Pakdad et al. 2012; Rafii and Rak 1974; Rafinejad et al. 2005; Rahdar and Vazirianzadeh 2009; Telmadarraiy et al. 2007; Tajedin et al. 2009
<i>Ornithonyssus bursa</i> (Berlese, 1888)	On the body of breeder flock <i>Gallus gallus domesticus</i> (L., 1758)	Mazandaran (36° 33' N, 53° 03' E)	Rahbari et al. 2009
<i>Ornithonyssus sylviarum</i> (Canestrini & Fanzago, 1887)	On the body of <i>Rattus rattus</i> (L., 1758) and undetermined species of rodents	Lorestan (33° 34' N, 48° 23' E), Khorram Abbad (33° 27' N, 48° 20' E)	Rafinejad et al. 2005; Shayan and Rafinejad 2006
<i>Parasitus hyalinus</i> (Willmann, 1949)	On the rat carcass	Esfahan (32° 39' N, 51° 41' E), Semnan (35° 34' N, 53° 23' E), Tehran (35° 42' N 51° 21' E)	Kamali et al. 2001
<i>Parasitus mycophilus</i> (Karg, 1971)	Rodent nest	Khorasan Razavi Province (36° 18' N, 59° 34' E)	Kazemi et al. 2013
<i>Steatonyssus periblepharus</i> Kolenati, 1858	On unidentified bats	Ahvaz (31° 19' N, 48° 40' E)	Kavianpour et al. 2012
<i>Trachygamasus gracilis</i> (Karg, 1965)	On the rat carcass	Semnan (35° 34' N, 53° 23' E), Tehran (35° 42' N 51° 21' E)	Kamali et al. 2001

2006, 2009; Bajerlein et al. 2006; Gwiazdowicz et al. 2005, 2006; Philips 2000) and also annual nests (Ambros et al. 1992; Krištofik et al. 2007, 2013; Fend'a and Schniererová 2004; Tryjanowski et al. 2001), revealed that the list of mesostigmatic mites solely includes over 100 species. Of course, most of these species are sporadic species accidentally transferred to nests along with nest building material or by phoresy with insects. However, based on the fact that the wealth of the avifauna in Iran and in other parts of the Palearctic is similar (Clements 2000) we may assume that possible species diversity of acarofauna inhabiting bird nests in Iran is much higher than currently recorded.

These results indicate that the knowledge of parasitic acarofauna, both on birds, in their nests, and mammals in Iran is relatively poor. This in turn leads to a conclusion that there is a need to develop this type of acarological research in Iran.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The authors declare that no institutional or national guidelines for the care and use of animals need to be followed in this study. All appropriate permissions from museums authorities for the use of specimens included in the study have been obtained.

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References

- Abdigoudarzi M, Mirafzali MS, Belgehszadeh H (2014) Human infestation with *Dermanyssus gallinae* (Acari: Dermanyssidae) in a family referred with pruritus and skin lesions. *J Arthropod Borne Dis* 8: 119–123
- Allymehr M, Tavassoli M, Manoochehri MH, Ardavan D (2012) Ectoparasites and gastrointestinal helminths of house mice (*Mus musculus*) from poultry houses in Northwest Iran. *Comp Parasitol* 79:283–287. <https://doi.org/10.1654/4534.1>
- Ambros M, Krištofik J, Šustek Z (1992) The mites (Acari, Mesostigmata) in the birds' nests in Slovakia. *Biologia* 47:369–381
- Ardeshir F (2010) A preliminary study on mite fauna of bird nests in Iran. *Podoces* 5:112–115
- Babaeian E, Seraj AA, Nemati A, Kazemi S (2010) Mites of the family Laelapidae (Acari: Mesostigmata) in Shahrekord region. In: *Proceedings of the 19th Iranian Plant Protection Congress*, 31 Jul – 3 Aug, 2010, Tehran, Iran, 1, p 328
- Bajerlein D, Błoszyk J, Gwiazdowicz DJ, Ptaszyk J, Halliday RB (2006) Community structure and dispersal of mites mites (Acari: Mesostigmata) in nests of the white stork (*Ciconia ciconia*). *Biologia* 61:525–530. <https://doi.org/10.2478/s11756-006-0086-9>
- Baumstark J, Beck W, Hofmann H (2007) Outbreak of tropical rat mite (*Ornithonyssus bacoti*) dermatitis in a home for disabled persons. *Dermatology* 215:66–68. <https://doi.org/10.1159/000102037>
- Błoszyk J, Bajerlein D, Gwiazdowicz DJ, Halliday RB (2005) Nests of the white stork *Ciconia ciconia* (L.) as habitat for mesostigmatic mites (Acari: Mesostigmata). *Acta Parasitol* 50:171–175
- Błoszyk J, Bajerlein D, Gwiazdowicz DJ, Halliday RB, Dylewska M (2006) Uropodine mite communities (Acari: Mesostigmata) in birds' nests in Poland. *Belg J Zool* 136:145–153
- Błoszyk J, Gwiazdowicz DJ, Halliday RB, Dolata PT, Goldyn B (2009) Nest of the black stork *Ciconia nigra* as a habitat for mesostigmatid mites (Acari: Mesostigmata). *Biologia* 64:962–968. <https://doi.org/10.2478/s11756-009-0146-z>
- Bregetova NG (1956) Gamasid mites (Gamasoidea). A short key. *Academy of Sciences of U.S.S.R., Moscow. Opred. Faune SSSR* 61:1–247 [in Russian]
- Cicolani B (1992) Macrochelid mites (Acari: Mesostigmata) occurring in animal droppings in the pasture ecosystem in Central Italy. *Agric Ecosyst Environ* 40:47–60. <https://doi.org/10.1016/b978-0-444-89390-1.50007-x>
- Clements JF (2000) *Birds of the world: a checklist*. Cornell University Press, Ithaca
- De La Fuente J, Naranjo V, Ruiz-Fons F, Vicente J, Estrada-Peña A, Almazán C, Kocan KM, Martín MP, Gortázar C (2004) Prevalence of tick-borne pathogens in ixodid ticks (Acari: Ixodidae) collected from European wild boar (*Sus scrofa*) and Iberian red deer (*Cervus elaphus hispanicus*) in Central Spain. *Eur J Wildl Res* 50:187–196. <https://doi.org/10.1007/s10344-004-0060-1>
- Di Palma A, Giangaspero A, Cafiero MA, Germinara GS (2012) A gallery of the key characters to ease identification of *Dermanyssus gallinae* (Acari: Gamasida: Dermanyssidae) and allow differentiation from *Ornithonyssus sylvianus* (Acari: Gamasida: Macronyssidae). *Parasit Vectors* 5:104. <https://doi.org/10.1186/1756-3305-5-104>
- Fend'a P, Schniererová E (2004) Mites (Acarina: Mesostigmata) in the nests of *Acrocephalus* spp. and in neighbouring reeds. *Biologia* 59: 41–47
- 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 Wildl Res* 56: 839–844. <https://doi.org/10.1007/s10344-010-0381-1>
- George DR, Finn RD, Graham KM, Mul MF, Maurer V, Moro CV, Sparagano OA (2015) Should the poultry red mite *Dermanyssus gallinae* be of wider concern for veterinary and medical science? *Parasit Vectors* 8:178. <https://doi.org/10.1186/s13071-015-0768-7>
- Gholipoury M, Rezai HR, Namroodi S, Arab-Khazaeli F (2016) Zoonotic and non-zoonotic parasites of wild rodents in Turk-man Sahra, north-eastern Iran. *Iran J Parasitol* 11:350–357
- Gwiazdowicz DJ (2000) Mites (Acari, Gamasida) associated with insects in the Białowieża National Park. *Acta Parasitol* 45:43–47
- Gwiazdowicz DJ (2001) *Sapropsecans bialoviensis* sp. n. (Acari, Halolaelapidae) from Poland. *Biologia* 56:149–153
- Gwiazdowicz DJ, Coulson SJ, Grytnes JA, Pilskog HE (2012) The bird ectoparasite *Dermanyssus hirundinis* (Acari, Mesostigmata) in the high Arctic: a new parasitic mite to Spitsbergen, Svalbard. *Acta Parasitol* 57:378–384. <https://doi.org/10.2478/s11686-012-0050-5>
- Gwiazdowicz DJ, Błoszyk J, Mizera T, Tryjanowski P (2005) Mesostigmatic mites (Acari: Mesostigmata) in White-Tailed Sea eagle nests (*Haliaeetus albicilla*). *J Raptor Res* 39:60–65
- Gwiazdowicz DJ, Błoszyk J, Bajerlein D, Halliday RB, Mizera T (2006) Mites (Acari: Mesostigmata) inhabiting nests of the white-tailed sea eagle *Haliaeetus albicilla* (L.) in Poland. *Entomol Fenn* 17:366–372
- Haitlinger R (1988) Haemogamasidae Oudemans, 1926 (Acari, Mesostigmata) of Poland. *Pol Pismo Entomol* 58:635–661 [in Polish]
- Haitlinger R (1992) Parasitic arthropods (Siphonaptera, Diptera, Acari) of bats from western part of the Białowieża Primeval Forest. *Nyctalus* 4:315–319
- Haitlinger R, Walter G (1997) Data relating to the distribution and host-specificity of bat-infesting mites (Acari, Mesostigmata, Prostigmata, Astigmata) in Germany. *Drosra* 2:95–112
- Haloti S, Glida H, Niogret J, Janati-Idrissi A, Bertrand M, Lumaret JP (2005) Phoretic macrochelids (Acari: Mesostigmata) from Africa. *Coprophilous macrochelidae* from Morocco. *Acarologia* 45:155–159
- Hanafi-Bojd AA, Shahi M, Baghaei M, Shayeghi M, Razmand N, Pakari A (2007) A study on rodent ectoparasites in Bandar-abbas: the main economic southern seaport of Iran. *Iran J Environ Health Sci Engin* 4:173–176
- Herrin CS (1974) The taxonomy status of *Hirstionyssus butantanensis* (Fonseca, 1932) (Acari, Mesostigmata). *J Med Entomol* 11:341–346. <https://doi.org/10.1093/jmedent/11.3.341>
- Hyatt KH (1980) Mites of the subfamily Parasitinae (Mesostigmata: Parasitidae) in the British Isles. *Bull Br Mus Nat Hist (Zool)* 38: 237–378
- Kamali K, Ostovan H, Atamehr A (2001) A catalog of mites and ticks (Acari) of Iran. Islamic Azad University Scientific Publication Center, Tehran
- Karg W (1993) Acari (Acarina), Milben Parasitiformes (Anactinochaeta), Cohors Gamasina Leach. *Raubmilben. Die Tierwelt Deutschlands*, 59 Teil. Gustav Fischer Verlag, Jena
- Kavianpour MR, Nemati A, Hasanzade H (2012) Introducing a new genus and a new species of Macronyssidae (Acari: Mesostigmata) for Iran's mite fauna. In: *1st International and 8th National Congress of Parasitology and Parasitic Diseases in Iran*, 16–18 October 2012, Kerman, p 41
- Kazemi S, Rajaei A (2013) An annotated checklist of Iranian Mesostigmata (Acari), excluding the family Phytoseiidae. *Persian J Acarol* 2:63–158
- Kazemi S, Arjomandi E, Ahangaran Y (2013) A review of the Iranian Parasitidae (Acari: Mesostigmata). *Persian J Acarol* 2:159–180
- Kazemi S, Mohammad-Dustar-Sharaf M (2015) First report of the sub-family Myonyssinae (Acari: Mesostigmata: Laelapidae) from Iran. *Persian J Acarol* 4:437–439
- Kazemi S, Moravvej G, Hamidi K, Nourani L (2015) Mesostigmatic mites (Acari: Mesostigmata) associated with rodents in Khorasan Razavi Province. *Iran J Entomol Soc Iran* 35:95–97
- Keivani F, Nemati A, Nematollahi M, Riahi E (2012) Some mites of Mesostigmata in birds' nests in Chaharmahal va Bakhtiari and Esfahan. In: *Proceedings of the 20th Iranian Plant Protection Congress*, August 2012, Shiraz, p 420

- Kia EB, Moghddas-Sani H, Hassanpoor H, Vatandoost H, Zahabiun F, Akhavan AA, Hanafi-Bojd AA, Telmadarraiy Z (2009) Ectoparasites of rodents captured in Bandar Abbas, Southern Iran. *Iran J Arthropod Borne Dis* 3:44–49
- Krawczyk AJ, Augustiničová G, Gwiazdowicz DJ, Konwerski S, Kucharczyk H, Olejniczak I, Rutkowski T, Skubała P, Solarz K, Zdrojewska Z, Tryjanowski P (2015) Nests of the harvest mouse (*Micromys minutus*) as habitat for invertebrates. *Biologia* 70:1637–1647. <https://doi.org/10.1515/biolog-2015-0186>
- Krištofik J, Mašan P, Šustek Z (2007) Arthropods (Pseudoscorpionidea, Acarina, Coleoptera, Siphonaptera) in nests of the bearded tit (*Panurus biarmicus*). *Biologia* 62:749–755. <https://doi.org/10.2478/s11756-007-0142-0>
- Krištofik J, Mašan P, Šustek Z, Nuhličková S (2013) Arthropods (Acarina, Coleoptera, Siphonaptera) in nests of hoopoe (*Upupa epops*) in Central Europe. *Biologia* 68:155–161. <https://doi.org/10.2478/s11756-012-0135-5>
- Mal'kova MG (2010) Characteristics of zonal distribution of the gamasid mites connected with small mammals and their nests in Western Siberia. *Parazitologia* 44:297–309
- Mašan P, Fend'a P (2010) A review of the laelapid mites associated with terrestrial mammals in Slovakia, with a key to the European species (Acar: Mesostigmata: Dermanyssoidea). Institute of Zoology Slovak Academy of Sciences, Bratislava
- Mašan P, Stanko M (2005) Mesostigmatic mites (Acarina) and fleas (Siphonaptera) associated with nests of mound-building mouse, *Mus spicilegus* Petényi, 1882 (Mammalia, Rodentia). *Acta Parasitol* 50:228–234
- Modarres Awal M (1997) List of agricultural pests and their natural enemies in Iran, revised edn. Ferdowsi University, Mashhad
- Modarres-Awal M (1994) List of agricultural pests and their natural enemies in Iran. Ferdowsi University Publication, Mashhad
- Mohamadi Ghalehjoughi E, Tavassoli M, Naem S (2017) Dermanyssus gallinae (Acarina, Mesostigmata) in the barn swallow (*Hirundo rustica*) nests in Urmia suburb, North West of Iran. *Persian J Acarol* 6(2): 95–102
- Mohebbali M, Rezaie H, Farahnak A, Nootash A (1997) A survey on parasitic fauna (helminths and ectoparasites) of the rodents in Meshkinshahr district North West Iran. *J Fac Vet Med Univ Tehran* 25:23–25
- Moodi B, Aliabadian M, Moshaverinia A, Mirshamsi Kakhki O, Faraji F (2014) Mites associated with passerine birds in eastern Iran. *Int J Acarol* 40:133–137. <https://doi.org/10.1080/01647954.2014.888094>
- Moravvej G, Hamidi K, Nourani L (2016) Relationship between the sex and age of *Mus musculus* (Rodentia: Muridae) with ectoparasites prevalence in northeast of Iran. *Persian J Acarol* 5:51–62
- Motevalli-Haghi F, Gholami S, Sharif M, Sedaghat MM, Parsi B (2000) Study of rodents ectoparasites in Sari city and central regions of Mazandaran province. *Iran J Mazandaran Univ Med Sci* 27:1–7
- Motevalli-Haghi F, Gholami S, Sharif M, Moabedi I, Sobhani Z, Sedaghat MM, Najafpour AA (2002) Study of rodents ectoparasites in urban areas of Mazandaran province. *Iran J Mazandaran Univ Med Sci* 36:72–77
- Napierała A, Mądra A, Leszczyńska-Deja K, Gwiazdowicz DJ, Goldyn B, Błoszyk J (2016) Community structure variability of Uropodina mites (Acar: Mesostigmata) in nests of the common mole, *Talpa europaea*, in Central Europe. *Exp Appl Acarol* 68:429–440. <https://doi.org/10.1007/s10493-016-0017-6>
- Nateghpour M, Akhavan AA, Hanafi-Bojd AA, Telmadarraiy Z, Ayazian Mavi S, Hosseini-Vasoukolaei N, Metvalli-Haghi A, Akbarzadeh K (2013) Wild rodents and their ectoparasites in Baluchistan area, southeast of Iran. *Trop Biomed* 30:72–77
- Nemati A, Babaeian E, Kamali K (2008) Mites associated with some small mammals in Shahrekord. In: Proceedings of the 18th Iranian Plant Protection Congress, University of Bu-Ali Sina, Iran 24–27 August 2008, Hamedan, p 236
- Nemati A, Mossadegh MS, Kamali K, Ostovan H (2000) The external parasitic mites of *Rattus* spp. and *Mus musculus* mice in Ahvaz region. In: Proceedings of 14th Iranian Plant Protection Congress, 5–8 Sep, 2000, Isfahan University of Technology, Iran, p 334
- Nemati A, Mohseni M, Gwiazdowicz DJ, Kavianpour M (2012) Fauna diversity of some mites of Mesostigmata (Acarina) in Chaharmahal va Bakhtiari and Khuzestan provinces. In: 1st International and 8th National Congress of Parasitology and Parasitic Diseases in Iran, 16–18 October 2012, Kerman, p 47
- Okulova NM (2003) A burrow of a little ground squirrel as a consortium. *Parazitologia* 37:361–380
- Oleaga A, Balseiro A, Gortázar C (2008) Sarcoptic mange in two roe deer (*Capreolus capreolus*) from northern Spain. *Eur J Wildl Res* 54: 134–137. <https://doi.org/10.1007/s10344-007-0105-3>
- Pakdad K, Ahmadi NA, Amini-roaya R, Piazak N, Shahmehri M (2012) A study on rodent Ectoparasites in the north district of Tehran, Iran during 2007–2009. *J Paramed Sci* 3:42–46
- Philips JR (2000) A review and checklist of the parasitic mites (Acarina) of the Falconiformes and Strigiformes. *J Raptor Res* 34:210–231
- Rafii A, Rak H (1974) Parasitology of Arthropoda (entomology). Veterinary Publication, Tehran No. 264
- Rafinejad J, Shayan A, Tirgari S, Basseri HR, Nikpour F (2005) Parasitic arthropods of rodents in Khoram-Abad, Lorestan, Iran. In: Proceedings of the fifth international conference on urban pests, Iran, pp 363–369
- Rahbari S, Nabian S, Ronaghi H (2009) Haematophagus mites in poultry farms of Iran. *Iran J Arthropod Borne Dis* 3:18–21
- Rahdar M, Vazirianzadeh B (2009) A case report of tropical rat mite infestation *Ornithonyssus bacoti* (Dermanyssidae: Acarina) in Ahvaz, SW Iran. *Jundishapur J Microbiol* 2:78–80
- Rahdar M, Vazirianzadeh B, Rointan ES, Amraei K (2015) Identification of collected ectoparasites of rodents in the west of Khuzestan Province (Ahvaz and Hovizeh), southwest of Iran. *Asian Pac J Trop Dis* 5:627–631. [https://doi.org/10.1016/s2222-1808\(15\)60902-1](https://doi.org/10.1016/s2222-1808(15)60902-1)
- Reeves WK, Loftis AD, Szumlas DE, Abbassy MM, Helmy IH, Hanafi HA, Dasch GA (2007) Rickettsial pathogens in the tropical rat mite *Ornithonyssus bacoti* (Acarina: Macronyssidae) from Egyptian rats (*Rattus* spp.). *Exp Appl Acarol* 41:101–107. <https://doi.org/10.1007/s10493-006-9040-3>
- Shayan A, Rafinejad J (2006) Arthropod parasites of rodents in Khorram Abad district, Lorestan province of Iran. *Iran J Public Health* 35: 70–76
- Tajedin L, Rassi Y, Oshaghi MA, Telmadarraiy Z, Akhavan AA, Abai MR, Arandian MH (2009) Study on ectoparasites of *Rhombomys opimus*, the main reservoir of zoonotic cutaneous leishmaniasis in endemic foci in Iran. *Iran J Arthropod Borne Dis* 3:41–45
- Telmadarraiy Z, Vatandoost H, Mohammadi S, Akhavan AA, Abai MR, Rafinejad J, Kia EB, Faghhi Naini F, Jedari M, Aboulhasani M (2007) Determination of rodent ectoparasite fauna in Sarpole-Zahab District, Kermanshah Province, Iran, 2004–2005. *Iran J Arthropod Borne Dis* 1:58–62
- Tryjanowski P, Baraniak E, Bajczyk R, Gwiazdowicz DJ, Konwerski S, Olszanowski Z, Szymkowiak P (2001) Arthropods in nests of the red-backed shrike (*Lanius collurio*) in Poland. *Belg. J Zool* 131:69–74
- Vatandoost H, Telmadarraiy Z, Sharifi M, Moradi A, Kamali M, Taran M (2010) Ectoparasites of lesser mouse eared bat, *Myotis blythii* from Kermanshah Iran. *Asian Pac J Trop Med* 3:371–373. [https://doi.org/10.1016/s1995-7645\(10\)60090-9](https://doi.org/10.1016/s1995-7645(10)60090-9)
- Zendehfili H, Zahimia AH, Maghsood AH, Khanjani M, Fallah M (2015) Ectoparasites of rodents captured in Hamedan, Western Iran. *J Arthropod Borne Dis* 9:267–273