This paper presents a part of the study conducted on cave fauna in Kohgiluyeh & Boyer-Ahmad and Fars provinces, South West and South of Iran. Eleven caves were investigated and seven species of bats were examined for identifying the ectoparasites. We found six species of ticks (Acari: Ixodidae) and four mites (Acari: Spinturnicidae and Macronyssidae), eight species of Nycteribiidae and two Strelibidae (Diptera: Insecta) as ectoparasites of bats. Two species of ticks and mites; Ixodes simplex (Ixodidae) and Macronyssus granulosus (Macronyssidae) were recorded for the first time from Iran. The threats from such ectoparasites have been discussed.

**Ectoparasites (Insecta and Acari) Associated with Bats in South and South-Western Caves of Iran**

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Study Area: Kohgiluyeh & Boyer-Ahmad province & Fars Province, Iran
Coordinates: 27°32' 44" N, 55°20' 21" to 31°17' 96" N, 50°35'13" E

Key words: Cavernicoles, Cave bats, Zagros Mountains.

**Abstract**

This paper presents a part of the study conducted on cave fauna in Kohgiluyeh & Boyer-Ahmad and Fars provinces, South West and South of Iran. Eleven caves were investigated and seven species of bats were examined for identifying the ectoparasites. We found six species of ticks (Acari: Ixodidae) and four mites (Acari: Spinturnicidae and Macronyssidae), eight species of Nycteribiidae and two Strelibidae (Diptera: Insecta) as ectoparasites of bats. Two species of ticks and mites; Ixodes simplex (Ixodidae) and Macronyssus granulosus (Macronyssidae) were recorded for the first time from Iran. The threats from such ectoparasites have been discussed.

**Introduction**

Zagros is a mountain range that extends from Turkey, Iraq to Iran, which is oriented from the northwest to the south Iran, and comprising nearly one fifth of the surface area of the country. Zagros, Elburz and central mountainous regions of Iran are mainly the karstic landscapes (Ghaderi & Karimi, 2014; Malek Hosseini et al., 2015a). This region harbors many caves, till date many of which remain unexplored. All such caves which have been surveyed for bioinventory works in the present study are located in the central and southern parts of the Zagros Mountains.

Microchiropteran bats are the major and most common biotic component for most of the caves. The ectoparasites in bats which includes ticks, mites, fleas, flies, bugs, and lice cause illness and reduced fecundity in bats (Krasnov et al., 2004).

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The body structure of the ectoparasites mostly depends on their host species, environments, bionomics, and habitat (Haitlinger & Lupicki, 2008). The most conspicuous bat ectoparasites are the bloodsucking Nycteribiid and Streblid flies, (Marshall, 1982). Some families of the ectoparasites have obligatory hematophagous species that only limited to bats (Krantz & Walter, 2009).

The present piece of work is an attempt to improve our knowledge regarding the ectoparasites associated with the microchiropteran bats abiding in the central Zagros caves.

**Material and Methods:**

**Study sites:** In the present study we targeted seven subterranean caves of Zagros mountain officially exist in two provinces.

**A: Kohgiluyeh & Boyer-Ahmad province:** four following caves were visited in Kohgiluyeh & Boyer-Ahmad province (an uneven and mountainous province at the middle of Zagros Mountain, south-west of Iran), in different months of the year:

i) Deh Sheikh (Pataveh) Cave, in the mountains that surround Deh Sheikh village, North West of Yasuj, (30°57’22” N, 51°14’17” E, 1735 m a. s. l., Sep. 27, 2011).


**B: Fars Province:** three caves in Fars province (south of Iran) were visited in different times of the year:

v) Shafagh Cave, about 75 km north-west of Jahrom city in Fars province (280 40’ 8” N, 520 56’ 34” E, 1506 m a. s. l., in July. 6, and Dec. 8, 2013).


vii) Charkhab Cave, south of Fars province. This cave is located in the Hormood protected area (270 32’ 44” N, 550 20’ 21” E. Altitude 639m., Dec. 30, 2013).

**Bats and ectoparasites sampling:** The bats were captured using an aerial net and then anesthetized with chloroform at the same place. After collecting the ectoparasites we released each bat in normal sense conditions. However, one specimen of each bat species was transferred to the laboratory for precise identification.

The host bats were precisely searched for ectoparasites and then both bats as well as their parasites were preserved in 75% ethanol. The isolated mites were prepared in 15% KOH solution and stored in “Liquido de Swan” then processed for permanent slide preparation according to Ref. The bat flies (Nycteribiidae and Strelibidae) were identified under stereo microscope using taxonomical keys including Theodor & Mosconam (1954) and Theodor (1967). The voucher parasite specimens of each species were deposited in Zoology Museum of...
Biology Department in Shiraz University (ZM-CBSU), and also in personal collection of the Dr. Martin Ševčík, from Charles University in Prague (Faculty of Science, Department of Zoology).

The taxa were arranged alphabetically and species data were represented in the following format: synonyms, published data, and material examined (number of specimens, locality, date, and number of host, previous records, and distribution).

**Results and Discussion:**

**Ectoparasites:** two families of mites ( Macronyssidae and Spinturnicidae), one family of ticks (Ixodidae) and two families of insects (Nycteribiidae and Strelibidae) were collected from the bats belonging to the families of Rhinopomatidae, Rhinolophidae, Vespertilionidae, and Pteropodidae found in seven caves of the studied area.

**Family: Nycteribiidae** Samouelle, 1819

**Nycteribia latreillii** (Leach, 1817)

<table>
<thead>
<tr>
<th>Material examined</th>
<th>Previous records from Iran</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2♂ from 1 ind.</td>
<td>Bazangan (Khorasan-e Razavi Province) (Benda et al., 2012)</td>
<td>Europe, Asia, North Africa.</td>
</tr>
</tbody>
</table>

**Nycteribia pedicularia** Latreille, 1805

<table>
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<tr>
<th>New records</th>
<th>Distribution</th>
</tr>
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<tbody>
<tr>
<td>2♂, 2 female from 1 inds.</td>
<td>Europe, Asia, Turkey, Israel, Iran; North Africa, Tunisia, Algeria.</td>
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</tbody>
</table>

**Nycteribia schmidlii** Schiner, 1853

<table>
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<tr>
<th>New records</th>
<th>Previous records</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>5♂ 2♀ from 1 ind.</td>
<td>Mozduran Cave, Khorassan [Khorasan-e Razavi Province] (Kock, 1983), North of Iran (Hürka, 1984), Tadovan cave (Fars Province), (Benda et al., 2012).</td>
<td>Europe, Asia, North Africa.</td>
</tr>
</tbody>
</table>

**Nycteribia vexata** Westwood, 1835

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<tr>
<th>Previous records</th>
<th>New records</th>
<th>Distribution</th>
</tr>
</thead>
</table>

**Penicillidia conspicua** Speiser, 1901

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<tr>
<th>New records</th>
<th>Previous records</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1♂ from 1 ind.</td>
<td>North of Iran (Kock, 1983) , Tadovan cave (Fars Province), Dashkasain, Dashkahal cave (Ardabil Province), Mozduran Cave, Khorassan [Khorasan-e Razavi Province] (Benda et al., 2012)</td>
<td>Europe, Asia, North Africa.</td>
</tr>
</tbody>
</table>

**Penicillidia dufourii** (Westwood, 1835)

<table>
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<tr>
<th>New records</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2♂, 1♀ from 1 ind.</td>
<td>Europe, Asia, North Africa.</td>
</tr>
</tbody>
</table>
2012, local \[2\]; 1♀, from 1 ind. *Myotis* sp., May. 17, 2012, Local \[4\]; 2♂, 1♀, from 6 inds. *Miniopterus schreibersii*, July. 6, 2013, local \[5\].

**Previous records:** Alborz Mts (Theodor, 1967), North of Iran (Kock, 1983), (Benda et al., 2012)

**Distribution:** Europe, Asia, India, North Africa.

Eucampsipoda hyrtlii Kolenati, 1856

**New records:** 1 from 1 ind. *Rousettus aegyptiacus*, July. 6, 2013, local \[5\].

**Previous records:** North of Iran (Kock, 1983), Kuhhaye Genu Mts (Hormozgan province) (Hùrka, 1984).

**Distribution:** Europe and the Mediterranean region, Asia - Iran.

Phthiridium biarticulatum Hermann, 1804


**Previous records:** North of Iran, Mozduran Cave, Khorassan [Khorasan-e Razavi Province] (Kock, 1983), Dashkasan, Dashkasan cave (Ardabil Province) (Benda et al., 2012)

**Distribution:** Circum-Mediterranean and reaches Tajikistan and Kyrgyzstan.

Kolenati, 1856

**New records:** 8♀ from 14 inds *Rhinopoma muscatellum*, Jan. 9, 2014, local \[7\]. 1♀ from 2 inds. *Rhinolophus hipposideros*, Nov. 7, 2013, local \[6\]. 2♂, 2♀ from 7 inds *Rhinopoma muscatellum*, Nov. 7, 2013, local \[6\].

**Previous records:** North of Iran, Mozduran Cave, Khorassan [Khorasan-e Razavi Province] (Kock, 1983), Dashkasan, Dashkasan cave (Ardabil Province) (Benda et al., 2012)

**Distribution:** Mediterranean zone, Middle East Africa, Afghanistan.

Macquart 1851

**New records:** 1♂, 1♀ from 1 ind. *Miniopterus schreibersii*, Oct. 27, 2011, local \[3\]; 2 larvae from 5 inds. *Miniopterus schreibersii*, Nov. 7, 2013, local \[6\].

**Previous records:** Estahbanat (Fars Province) (Maa, 1968)

**Distribution:** Mediterranean zone, Middle East Africa, Afghanistan.

Order: Ixodida Leach, 1815

Family: Ixodidae Koch, 1844

**Ixodes simplex** Neumann, 1906

**New records:** 1 nymph from 1 ind. *Miniopterus schreibersii*, Oct. 27, 2011, local \[3\]; 2 larvae from 5 inds. *Miniopterus schreibersii*, Nov. 7, 2013, local \[6\].

**Distribution:** Europe, Asia, Africa, New Guinea, Australia. Distribution of this species is also reported from the Palaearctic, Afrotropical, Oriental and Australian regions.

**Remarks:** New for fauna of Iran.

**Ixodes vespertilionis** Koch, 1844

**New records:** 1 larva from 1 ind. *Rhinolophus hipposideros*, sep. 27, 2011, local \[1\]. 1 larva from 7 inds. *Rhinopoma muscatellum*, Nov. 7, 2013, local \[6\].

**Previous records:** North of Iran, Mozduran Cave, Khorassan [Khorasan-e Razavi Province], (Kock, 1983), Meymand (Kohgiluye va Boyer Ahmad Province), (Benda et al., 2012)

**Distribution:** Europe, Africa, Middle East and Southeast Asia, Pacific Islands, China and Japan.

Order: Mesostigmata

**Family: Spinturnicidae Oudemans, 1902**

**Spinturnix myoti** (Kolenati, 1856)

**New records:** 1♂, from 1 ind. *Myotis blythii*, July. 11, 2012, local \[3\]; 1♂, 1♀, from 1 ind. *Myotis blythii*, May. 18, 2012, local \[2\].

**Previous records:** Ali Abad (Golestan Prov.), Tadovan, Tadovan cave (Fars Prov.), (Benda et al., 2012)

**Distribution:** Turkey, Transcaucasia, and West Turkestan.

**Spinturnix psi** (Kolenati, 1856)

Previous records: Tadovane cave and Hesar (Fars Province), Mina (Khorasan-e Razawi Province.), Meymand (Kohgiluyeva Boyer Ahmad Province), Mormori (Ilam Province), (Benda et al., 2012).

Distribution: Eastern Europe, North Africa, and Middle Eastern Countries.

Meristaspis lateralis (Kolenati, 1856)

New records: 1 ♂ from 6 inds. Miniopterus schreibersii, July. 16, 2013, local [5]; 1 ♂, 2 ♀, 10 nymphal stage from 1 ind. Rousettus aegyptiacus, July. 6, 2013, local [5]., 1♂ from 1 ind. Myotis blythii, July. 6, 2013, local [5].

Previous records: Bishapur cave (Fars Province), Bongaru, Hazarmani Mts. Podonu, Chahar Dahaneh, Zangard (Hormozgan Province), (Benda et al., 2012).

Distribution: Philippines.

Family: Macronyssidae Oudemans, 1936

Macronyssus granulosus (Kolenati, 1856)

New records: 1♀ from 1 ind. Miniopterus schreibersii, Oct. 27, 2011, local [3].


Distribution: Europe, Asia.

Hosts: seven bat species (hosts) from Rhinolophidae (1 sp.), Vespertilionidae (3 sp.), Rhinopomatidae (2 sp.), and Pteropodidae (1 sp.) were captured in the caves. All were 50 specimens:

Family: Rhinolophidae:

Rhinolophus hipposideros (Bechstein, 1800)

Locality: Deh Sheikh cave (1♀); Tadovane cave (2♂).

Family: Vespertilionidae:

Miniopterus schreibersii (Kuhl, 1817)


Myotis blythii (Tomes, 1857),

Locality: Kiler cave: (1♂), Gakal cave: (1♂) and Shafagh cave (1♂) July 6, 2013.

Myotis sp.

Locality: Neyneh cave (1♀).

Family: Rhinopomatidae:

Rhinopoma muscatellum, Thomas, 1903

Locality: Neyneh cave (1♂); Charkhab cave (9♀, 5♀).

Rhinopoma microphyllum (Brunnich, 1792)

Locality: Gakal cave (1♀); Tadovane cave (3♂, 4♀).

Family: Pteropodidae

Rousettus aegyptiacus Geoffroy 1810

Locality: Shafagh cave (1♂).
Conclusion:
Till date very limited studies have been done on ectoparasites of bats in Iran (Benda et al., 2012). Thus, a gap in our knowledge on the subject is existed even if Iran is a vast country with diverse climates having many mountain chains holding caves. The knowledge regarding Bats’ ectoparasites help us for understanding the biological, systematic, and phylogenetic aspects of the hosts. In addition, it also helps to clarify the epidemiological aspects of disease transmission among bats. The arthropod ectoparasites of bats usually belongs to the Siphonaptera, Diptera, Hemiptera, Dermaptera, and Acari (ticks and mites) orders, aside from being Nycteribiidae and streblid flies are exclusive to bats (Bertola et al., 2005) and Spinturnicidae, a family of mites (Acari: Mesostigmata) with very high specificity.

Earlier, the investigation of the fauna of the caves of Kohgiluyeh & Boyer-Ahmad and Fars, in the south-west and south of Iran have ceded us various new and interesting information about different groups of animals such as bats, reptiles, crustaceans, myriapods, spiders, acari and insects (Kashani et al., 2013; Christophoryová et al., 2013; Dashan 2014, Dashan et al., 2014 a&b, Malek Hosseini et al., 2015 a&b, Reboleira et al., 2015, Malek Hosseini et al., 2016). In the current study we collected 108 specimens of ectoparasites from seven captured species of bats. Sixteen species of bat ectoparasites were separated and identified. A total of 50 host bats were collected and identified which belonged to 7 species, 5 genera and 4 families. These parasites consisted of 8 species of Nycteribiidae (Diptera), 2 Strelibidae and 6 species of Acari, 2 Ixodidae, 3 Spinturnicidae, and 1 Macronyssidae. Two species of acari are reported as new for the Iranian fauna; *Ixodes simplex* Neumann, 1906 and *Macronyssus granulosus* Kolouhi, 1856.

In now a days, unfortunately due to high anthropogenic disturbances, the above studied caves have partly been destroyed. Thus, some unique cavernicoles abiding in these habitats could be considered as endangered species. Though, the ceded bat ectoparasites could be enough to big bulk to the subject, but how far it is threatening to the bat populations of the studied caves are yet to be studied.

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The authors are thankful to the Dr. Martin Ševčík, from the Department of Zoology, Charles University in Prague, Czech Republic (Slovak Society for Parasitology at Slovak Academy of Sciences, Slovakia), who helped in identification and species confirmation. We would also like to thank Dr. Vahid Akmal, University of Razi, Kermanshah-Iran, and Mr. Alamdar Shafie and his colleagues from Pardis caving club, who helped us in caving. We are also grateful to the Iranian National Science Foundation (INSF), for the financial support of this study.

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