RESEARCH ARTICLE

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, 50° 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 & Łupicki, 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).
- ii) Gakal Cave, East of Gachsaran (30°18'44" N, 51°09'28" E, 1100 m a. s. l., May 18, 2012 and Oct. 2, 2012).
- iii) Kiler Cave, in the northwest of Yasuj (31°17'96" N, 50°35'13" E, 1610 m a. s. l., Oct. 27, 2011 and 11 July 2012).
- iv) Neyneh Cave, in the southwest of Dehdasht (30°40'18" N, 50°21'71" E, 770 m a. s. l., May 17, 2012).

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 (28°40'8" N, 52°56'34" E, 1506 m a. s. l., in July. 6, and Dec. 8, 2013).
- vi) Tadovan Cave, Khafr Jahrom road (28°50'48" N, 53°19'46" E, 1200 m a. s. l., Oct. 7, 2013).
- vii) Charkhab Cave, south of Fars province. This cave is located in the Hormood protected area (27°32'44" N, 55°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 Streblidae) 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)

Material examined: 2♂ from 1 ind. *Miniopterus schreibersii*, Oct. 27, 2011; 1♀ from 1 ind. *Miniopterus schreibersii*, July. 11, 2012, local. [3]; 2♂ from 1 ind. *Myotis* sp., May. 17, 2012, [4]; 1♀ from 1 ind. *Myotis blythii*, May. 18, 2012, local. [2].

Previous records from Iran: Bazangan (Khorasan-e Razawi Province.) (Benda *et al.*, 2012)

Distribution: Europe, Asia, North Africa.

Nycteribia pedicularia Latreille, 1805

New records: 2♂, 2 female from 1 inds. *Rhinopoma muscatellum*, May. 17, 2012, local. [4]. 7 specimens from 6 inds. *Miniopterus schreibersii* (4♂ and 3♀), 6 July, local. [5].

Previous records: Fars Province (Maa, 1968 ; Kock, 1983).

Distribution: Europe, Asia- Turkey, Israel, Iran; North Africa, Tunisia, Algeria.

Nycteribia schmidlii Schiner, 1853

New records: 5♂ 2♀ from 1 ind. *Miniopterus schreibersii*, Oct. 27, 2011, local. [3]; 2♂ from 1 ind. *Myotis blythii*, July. 11, 2012, local. [4]. 1♂, May. 18, 2012) local [2], from 1 ind. *Myotis blythii* and (2♂ 1 ♀ : Oct. 2, 2012) from 1 ind *Miniopterus schreibersii*, local [2]

(1♀ : May. 17, 2012) local [4], host: 1 ind *Myotis* sp.; 3♂, 3 ♀ from 5 inds. *Miniopterus schreibersii*, Nov. 7, 2013, local [6]. ; 1♀ from 6 inds. *Miniopterus schreibersii*, July. 6, 2013, local. [5]. 5♂, 2 ♀ from 3 inds. *Miniopterus schreibersii*, Dec. 8, 2013, local [5].

Previous records: Mozduran Cave, Khorassan [Khorasan-e Razawi Province] (Kock, 1983), North of Iran (Hürka, 1984), Tadovan cave (Fars Province), (Benda *et al.*, 2012).

Distribution: Europe; Asia, North Africa.

Nycteribia vexata Westwood, 1835

Previous records: Alborz Mts. (Maa, 1968) North of Iran (Kock, 1983). Alburz Mountains (Theodor, 1967),

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

Distribution: Europe, Asia, North Africa.

Penicillidia conspicua Speiser, 1901

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

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

Distribution: Europe, Asia, North Africa.

Penicillidia dufourii (Westwood, 1835)

New records: 2♂, 1♀ from 1 ind. *Myotis blythii*, Oct. 27, 2011, local [3]; 1♀ from 1 ind. *Myotis blythii*, May. 18,

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 hyrtlai Kolenati, 1856

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

Previous records: North of Iran (Kock, 1983), Kuhhayeh Genu Mts (Hormozgan province) (Hürka, 1984).

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

Phthiridium biarticulatum Hermann, 1804

New records: 2♂ 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 Razawi Province] (Kock, 1983), Dashkasan, Dashkasan cave (Ardabil Province) (Benda *et al.*, 2012)

Distribution: Circum-Mediterranean and reaches Tajikistan and Kyrgyzstan.

Family: Strelibidae Kolenati, 1863

Brachytarsina alluaudi minor Falcoz, 1923

New records: 5♂, 8♀ from 14 inds *Rhinopoma muscatellum*, Jan. 9, 2014, local [7].

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

Distribution: Mediterranean zone, Middle East Africa, Afghanistan.

Brachytarsina flavipennis Macquart 1851

New records: 1 ♀ from 2 inds. *Rhinolophus hipposideros*, Nov. 7, 2013, local [6]

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

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 Palearctic, 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 larvae from 7 inds. *Rhinopoma muscatellum*, Nov. 7, 2013, local [6].

Previous records: North of Iran (Pomerantzev, 1959), Kermanshah province (Vatandoost *et al.*, 2010), Meymand (Kohgiluyeh 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)

New records: 2♂, 2 ♀ from 3 inds. *Miniopterus schreibersii*, Oct. 27, 2011, local

[3]; 1♂, 1 female from 1 ind. *Myotis blythii*, July. 11, 2012, local [3]; (1♀ from 1 ind *Rhinopoma microphyllum*, Oct.

2, 2012, local [2], 1♂ from 6 inds. *Miniopterus schreibersii*, July. 6, 2013, local [5]. 3♂, 1♀ 1 nymphal stage from 3 inds. *Miniopterus schreibersii*, Dec. 8, 2013, local [5].

Previous records: Tadovan cave and Hesar (Fars Province), Mina (Khorasan-e Razawi Province.), Meymand (Kohgiluyeh va 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♀ 1♂ from 1 ind. *Miniopterus schreibersii*, Oct. 27, 2011, local [3].

Remarks: New for Iranian fauna.

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♀); Tadovan cave (2♂)

Family: Vespertilionidae:

Miniopterus schreibersii (Kuhl, 1817)

Locality: Kiler cave (2♂, 2♀), Gakal cave (1♂). Shafagh cave (4♂, 2♀ July 6, 2013 and 2♂, 1♀, Dec. 8, 2013), Tadovan cave (3♂, 2♀).

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♀); Tadovan 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* Kolenati, 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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