

Distribution and new records of cave-dwelling bats in the Central Zagros Mountains, Lorestan province, Iran

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Data on distribution and fauna of cave-dwelling bat species from Iran is infrequent. Recent studies in certain parts of the country especially the western and southwestern regions demonstrated a high level of species richness for chiropteran fauna. Since Lorestan province is located in the middle of Zagros mountain ranges, and a considerable number of bat species are living in the adjacent provinces; it is expected that Lorestan also harbors a great number of bat species. In the present study, 49 caves were investigated of which 48 caves were found to be occupied by 1 to 3 bat species. Bats were identified using identification keys, measured, photographed, and then released. A total number of 68 records from 11 species was documented in this study. The identified species include *Rhinopoma hardwickii*, *R. muscatellum* and *R. microphyllum* from family Rhinopomatidae, *Rhinolophus ferrumequinum*, *Rb. hipposideros*, *Rb. euryale*, *Rb. mehelyi* and *Rb. blasii* from family Rhinolophidae, *Myotis blythii* and *M. capaccinii* from Vespertilionidae family, and *Miniopterus pallidus* from Miniopteridae family. *Rhinolophus ferrumequinum* with 19 observation records had the highest distributional range. Furthermore, the biggest colony comprising several thousands of individuals of *R. microphyllum* was observed in Khofash Cave. *Myotis capaccinii*, *Rhinopoma microphyllum*, *Rhinolophus blasii*, and *Rb. mehelyi* were observed for the first time in Lorestan province.

Key words: *Chiroptera, distribution, fauna, Lorestan Province, Zagros Range.*

INTRODUCTION

Caves are considered the most stable and persistent roosts of chiropterans. At various latitudes, caves can be utilized by bats as hibernacula, maternity, or mating roosts. However, several parameters including appropriate temperature, humidity, cavity size, rock type, and thermoregulatory should be met to make them a suitable roost for bats (Altringham, 2011). Data on bats from caves in Iran are scarce. In the review of all bat localities known for Iran, Benda *et al.* (2012) found that only about 15% of them are cave dwellers.

Lorestan is one of the western provinces of Iran where the presence of Zagros mountain ranges strongly influences the climatic conditions, topography, and fauna of the region. The mountain ranges in this province are generally oriented from northwest and southwest to southeast, forming high elevations, lowlands, narrow plains, and numerous valleys (Ahmadi *et al.*, 2009). The cold climate is dominant in the mountainous parts of the province, while in the southern parts

neighboring the broad border with Khuzestan, the climatic conditions are influenced by the high temperature of this southern neighbor province during the warm seasons. As a result of these conditions, three main climatic regions can be recognized in this province: the cold mountainous region, the central temperate region, and the western warm region (Poortulabi, 2009). This climatic categorization may have important effects on the distributional patterns of bat species in this province. Furthermore, since Lorestan province is encompassed by the Zagros mountain ranges, many natural caves can be found in almost all parts of this province. So far, no comprehensive effort has been made to study the distribution of cave-dwelling bat species in this region.

The latest data about chiropteran faunal assemblage of Iran demonstrates the occurrence of 51 bat species (Karami *et al.*, 2008, Benda *et al.*, 2012; Naderi *et al.*, 2017). Recent overviews of bat fauna for some provinces were published (Fathipour *et al.* 2016; Shahabi *et al.*, 2017a). Furthermore, new distributional records, phylogeographic and taxonomic researches about specific bat species or genera in this country have added valuable information to this mammalian group data inventory (Akmali *et al.*, 2011, 2014; Najafi *et al.*, 2018a, b; Shahabi *et al.*, 2017b, 2019; Mehdizadeh *et al.*, 2018). In Lorestan province, according to previous studies, 13 species including *Rhinopoma hardwickii*, *R. muscatellum*, *Rhinolophus ferrumequinum*, *Rh. hipposideros*, *Rh. euryale*, *Myotis blythii*, *Pipistrellus kublii*, *Miniopterus pallidus*, *Tadarida teniotis*, *Vespertilio murinus*, *Eptesicus anatolicus*, *P. pipistrellus*, and *Barbastella darjelingensis* have been reported so far (DeBlase, 1980; Benda *et al.*, 2012).

In the current study, we present new data on cave-dwelling bat species in the Lorestan province. Furthermore, all previous reports on the observation of bat species in the province are reviewed.

MATERIAL AND METHODS

During 2014-2016, several field trips were taken in Lorestan province in order to study the distributional patterns of cave-dwelling bat species. This province is located in the western part of Iran between 32°37' to 34°22' N and 46°51' to 50°3' E. Lorestan is topographically a mountainous region located in the middle of the Zagros Mountains. The climatic profile of this province ranges from cold in the north to warm in the southern parts. The altitude range of this region varies from 330 meters in Pole Zal region to 4050 meters in Oshtoran-Kuh Mountain.

In order to recognize the caves, different information sources such as relevant offices and organizations, the literature, websites, and local people were employed and inquired. Totally, 49 caves were listed and scheduled for visit (Table 1). During field trips taken to study the caves, several characteristics of them including dimensions, location, visibility and accessibility of cave entrance, vegetation, any sign of animals, humidity and temperature, above mean sea level, penetration of air and light, seasonal changes in water level as well as physical and mechanical affinities including rock type, internal structures such as crevices, chambers and passages, and destruction level were considered and documented.

Bats were identified based on differences in their morphological characteristics (DeBlase, 1980; Dietz & Von Helversen, 2004). Specimens were captured either by hand or with a hand-net. Before releasing, each specimen was photographed and three basic morphometric characters were measured in some samples of species (Table 2). The geographical position of each cave was recorded using a Garmin GPS unit (GPSMAP 60CSx; Garmin International, Inc., city, state, USA). Then the distribution map of each species was drawn by ArcGIS software using the data imported from GPS.

RESULTS AND DISCUSSION

A total number of 49 caves in Lorestan province were investigated, and 11 species of cavernicolous bats were identified (Table 1), from which seven species were reported in the previous literature and

four other species are reported for the first time. In one cave, no bat was observed but the remaining 48 caves were occupied by at least one species of bats. Two caves had a bat fauna of three species, 17 caves occupied by two species, and in 29 caves only one species was found (Table 1). The geographical location of each cave and their altitudinal range are shown in the Lorestan map displayed in Figure 1. As mentioned earlier, four species including *Myotis capaccinii*, *Rhinopoma microphyllum*, *Rhinolophus blasii*, and *Rb. mehelyi* are reported for the first time. Additionally, the alive specimens of *Rb. euryale* were observed and reported for the first time. DeBlase (1980) identified the latter species in this province, but just from four immature mummified individuals inhabiting in Eshkaft Dareze cave in Khurramabad.

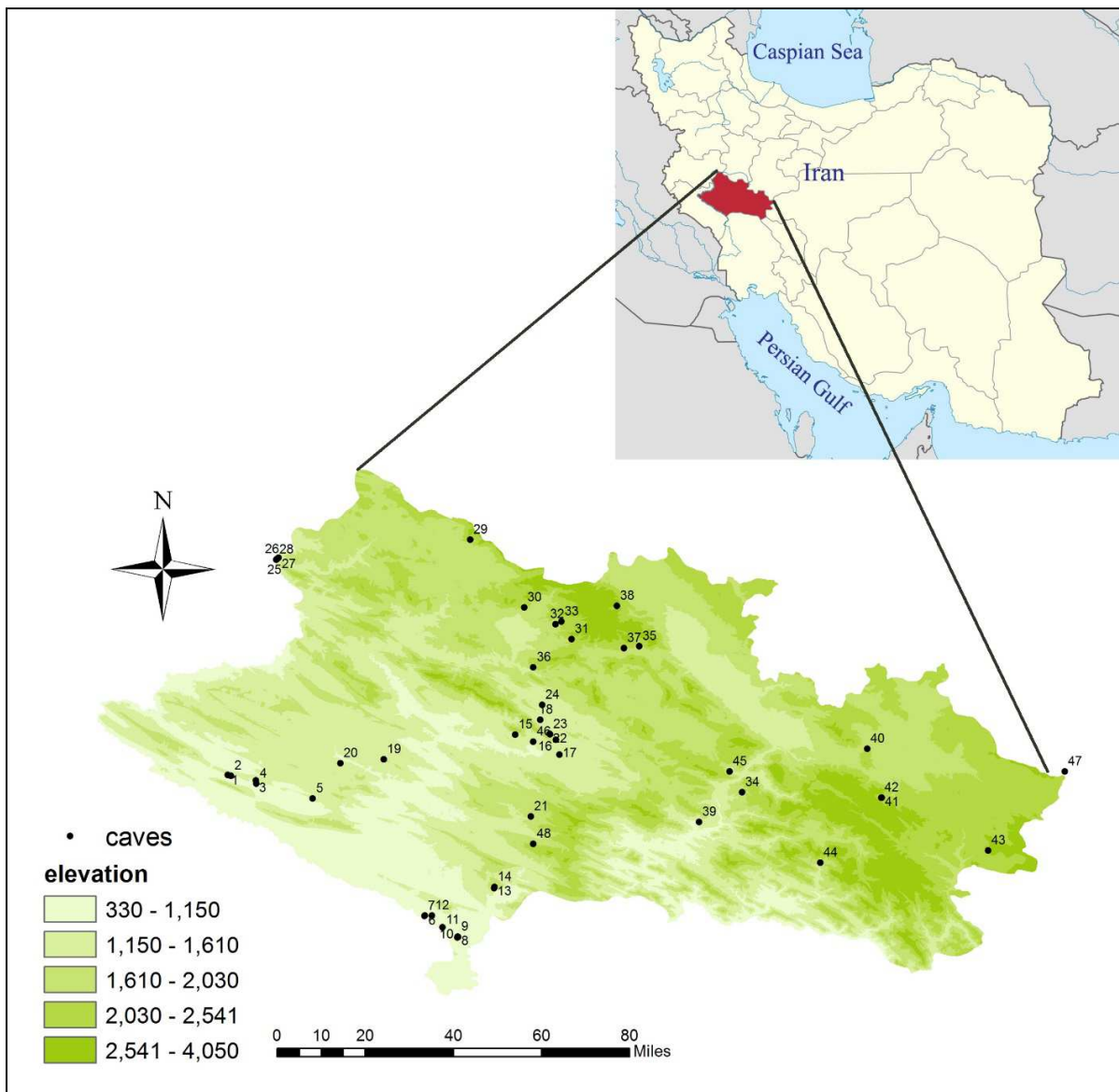


FIGURE 1. The geographical location of Lorestan Province in the west of Iran and 48 caves investigated in the study area. Numbers refer to caves as indicated in Table 1.

TABLE 1. Distribution of cave-dwelling bats in 48 caves investigated in Lorestan Province as well as geographic coordinates of the caves and their localities. Species names are shown by numbers as follows: 1 - *Rhinopoma microphyllum*, 2 - *Rhinopoma hardwickii*, 3 - *Rhinopoma muscatellum*, 4 - *Rhinolophus ferrumequinum*, 5 - *Rhinolophus hipposideros*, 6 - *Rhinolophus blasii*, 7 - *Rhinolophus euryale*, 8 - *Rhinolophus mehelyi*, 9 - *Myotis blythii*, 10 - *Myotis capaccinii* and 11 - *Miniopterus pallidus*. Total number of species present in each cave is also indicated in the last column.

No.	Cave name	Locality (town)	Lat/ N	Lon/ E	1	2	3	4	5	6	7	8	9	10	11	Total
1	Alinabad	Kuhdasht	33°22'	47°16'	+	+										2
2	Bar- Aftab (Horataou)	Kuhdasht	33°22'	47°16'	+	+										2
3	Posht-kooch Qaterchi	Romeshgan	33°21'	47°21'			+	+								2
4	Khoshil	Pol-e Dokhtar	33°20'	47°21'							+					1
5	Serah-e bazvand	Romeshgan	33°17'	47°32'	+	+										2
6	Dareh khazine namaki	Pol-e Dokhtar	32°54'	47°54'				+								1
7	Dareh khazine abi	Pol-e Dokhtar	32°54'	47°54'	+	+										2
8	Jadeh pa-alam (1 st cave)	Pol-e Dokhtar	32°50'	48°01'	+	+										2
9	Jadeh pa-alam (2 nd cave=Water cave)	Pol-e Dokhtar	32°50'	48°01'	+	+										2
10	Pa-alam above river	Pol-e Dokhtar	32°50'	48°01'	+	+	+									3
11	Khofash	Pol-e Dokhtar	32°52'	47°58'	+	+	+									3
12	Tooneli Pa-alam	Pol-e Dokhtar	32°54'	47°56'			+									1
13	Koorkie	Pol-e Dokhtar	33°00'	48°08'	+	+										2
14	Gandom-kar	Khurramabad	33°00'	48°08'	+	+										2
15	Yafteh	Khurramabad	33°30'	48°12'	+											1
16	Qamarie	Khurramabad	33°29'	48°20'	+	+										2
17	Konjie	Khurramabad	33°26'	48°21'	+											1
18	Kaldar	Khurramabad	33°33'	48°17'	+	+										2
19	Botkhane	Kuhdasht	33°25'	47°46'									+			1
20	Darmaran Zarooni	Kuhdasht	33°24'	47°38'				+								1
21	Koogan	Pol-e Dokhtar	33°14'	48°15'							+					1
22	Falakien 1	Khurramabad	33°30'	48°19'				+					+			2
23	Falakien 2	Khurramabad	33°30'	48°19'									+			1
24	Robat	Khurramabad	33°39'	48°18'				+								1
25	Garmabe 1 (Miyan Tange)	Noor-Abad	34°05'	47°25'					+							1
26	Garmabe 2	Noor-Abad	34°05'	47°25'				+	+							2
27	Garmabe 3	Noor-Abad	34°05'	47°26'								+				1
28	Garmabe tabaqati	Noor-Abad	34°05'	47°25'				+	+							2
29	Kafraj	Noor-Abad	34°08'	48°03'				+								1
30	Semsa	Alashtar	33°55'	48°14'				+								1
31	Eshkaft-Kove	Alashtar	33°49'	48°23'				+								1
32	Do poul	Alashtar	33°52'	48°20'				+								1
33	Tarikdor (Khargooshnab)	Alashtar	33°52'	48°21'									+			1
34	Chehartaq Kahman	Alashtar	33°19'	48°57'				+	+							2
35	Tang lour	Brujerd	33°47'	48°37'					+							1
36	Piermorad	Brujerd	33°43'	48°16'						+				+		2
37	Senobar	Brujerd	33°47'	48°34'				+								1
38	Venayi	Brujerd	33°55'	48°32'				+								1
39	Vareshkaft	Brujerd	33°13'	48°48'				+								1
40	Dare chapie	Azna	33°27'	49°22'				+								1
41	Kamandan	Azna	33°18'	49°25'				+								1
42	Kenar roudkhane	Azna	33°18'	49°24'				+								1
43	Gerdakonak	Aligoodarz	33°07'	49°45'				+								1
44	Shahrood	Aligoodarz	33°05'	49°12'				+								1
45	Mano	Dorud	33°23'	48°54'									+		+	2
46	Eshkaft Nesar	Azna	33°29'	48°16'											+	1
47	Dermine	Aligoodarz	33°23'	50°01'											+	1
48	Pieremam (Eshkaft Gorbe)	Aligoodarz	33°09'	48°16'					+							1

A total of 11 species were collected in the study area comprising 4 genera and 4 families. Geographic location, number of specimens and some ecological notes for each species are as follows and their relevant photos are presented in figures 2-4.

Family Rhinopomatidae Bonaparte, 1838

Rhinopoma microphyllum (Brünnich, 1782)

The Greater Mouse-tailed Bat, *Rhinopoma microphyllum* is reported from two caves in Pol-e Dokhtar, a town in the south-west of the province. It is the first report of this species from Lorestan. In addition to Pa-alam cave (above the river) where the presence of *R. microphyllum* is documented, a large colony of this species including several thousands of individuals was observed in Khofash cave. In both caves, members of the three species of the genus *Rhinopoma* were observed sympatrically. Previously, *R. microphyllum* was reported from adjacent provinces including Ilam, Kermanshah and Khuzestan.

Rhinopoma hardwickii Gray, 1831

The lesser mouse-tailed bat, *Rhinopoma hardwickii* was observed in 14 caves in Khurramabad, Kuhdasht, Romeshgan, and Pol-e Dokhtar. This species is usually observed in colonies mixed with *R. muscatellum*. This species was observed only once in the province in a small colony in the Simareh river valley at Jelugir (Benda, 1998).

TABLE 2. Number of caves and other sites recorded for each species, as well as altitudinal ranges (Meter), observation time, and three basic biometric data provided from alive specimens collected in Lorestan caves. Abbreviations: NC (Number of caves), AI (altitudinal ranges in meters), OT (Observation time), N (Number of measured individuals), HB (Head and body length), FA (Forearm length), HF (Length of hind foot), M±SD (Mean ± standard deviation). Mean ± standard deviation values are given, in millimeters.

No.	Species	NC	AI	OT	HB		FA	HF
					N	M±SD	M±SD	M±SD
1	<i>Rhinopoma microphyllum</i>	2	345-450	Spring and Summer	8	76.0±1.7	64.3±0.7	15.8±0.2
2	<i>R. hardwickii</i>	14	332-1321	Spring and Summer	13	63.1±4.7	57.6±1.8	13±1.1
3	<i>R. muscatellum</i>	15	332-1321	Spring and Summer	11	56.6±1.1	49.1±0.6	11.9±0.4
4	<i>Rhinolophus ferrumequinum</i>	19	1151-2732	Spring and Summer	4	58.5±2.1	56.0±0.8	11.1±0.6
5	<i>Rh. hipposideros</i>	5	1138-1930	Spring and Summer	5	42.3± 1.7	38.8±0.9	7.4±0.5
6	<i>Rh. blasii</i>	1	1849	Spring and Summer	1	57	46	11
7	<i>Rh. euryale</i>	2	1170-1620	Spring and Summer	3	46.2±2.1	48.1±1.1	11.1±0.9
8	<i>Rh. mehelyi</i>	1	1122	Spring and Summer	1	51.4	52.3	10
9	<i>Myotis blythii</i>	5	1374-1948	Spring and Summer	14	70.7±1.9	61.4±1.4	14.2±0.9
10	<i>M. capaccinii</i>	1	1849	Spring and Summer	7	54.1±3.2	42.3±0.6	13.1±0.6
11	<i>Miniopterus pallidus</i>	3	1882-2517	Spring and Summer	21	61.0±1.8	45.0±0.6	11.0±0.4

Rhinopoma muscatellum Thomas, 1903

Found in 15 caves, the small mouse-tailed bat, *Rhinopoma muscatellum*, is the most widespread bat species in the western parts of the province (Khurramabad, Kuhdasht, Romeshgan, and Pol-e Dokhtar). This species follows an ascending pattern in its distribution from north to south of the province. In almost all caves, the co-existence of this species with at least one other species of the genus *Rhinopoma* is evident. In the largest colony, all three species of the genus *Rhinopoma* occur together. In spite of its wide distributional range, there is just one previous report on this species until now in Pol-e Tang located near Pol-e Dokhtar (Benda *et al.*, 2012).



FIGURE 2. Bat species of Rhinopomatidae family recorded in this study.

Family Rhinolophidae Gray, 1825

Rhinolophus ferrumequinum (Schreber 1774)

The greater horseshoe bat was observed in seven caves of western (Romesghan, Kuhdasht, Khurramabad, and Noor-Abad) and 12 caves of eastern localities (Aligoodarz, Azna, Brujerd and Alashtar). This species has the largest distribution in Lorestan. In almost all caves in the western part of the province, only a few to several individuals could be counted, but up to 90 bats were observed in some colonies in eastern caves. Previously, DeBlase (1980) had reported about 12 individuals observed in a cave 3.2 Km. away from north of Khurramabad. Furthermore, a record of the echolocation calls of a foraging individual had been obtained in the valley of the Dez River near Lenje Abad (Benda *et al.*, 2012).

Rhinolophus hipposideros (Borkhausen, 1797)

The lesser horseshoe bat was documented in small populations including two to six individuals from three caves (Garmabe 1, Garmabe 2 and Tabaqati) in the coldest western part of the province (Noor Abad). In eastern localities, the situation is slightly different; as in Chehartaq cave from Alashtar, a colony of 20 individuals including *Rb. hipposideros* mixed with *Rb. ferrumequinum* was observed when flying at the cave entrance. Furthermore, in two other caves (Tang Lour in Brujerd and Pier Morad in Aligoodarz) the number of counted individuals was similar to those found in western caves. The only previous report of this species in the province is the record of the echolocation of a foraging individual in Lenje Abad (Benda, 2012).

Rhinolophus blasii Peters, 1866

It is the first report of the Blasius's horseshoe bat observed in Lorestan. From an extremely inaccessible roosting site in Piermorad cave in Brujerd where a very cold climate and high humidity dominates, one colony of *Rb. blasii* along with another colony of vespertilionid bats (*Myotis capaccinii*) was registered.

Rhinolophus euryale Blasius, 1853

A few individuals of the Mediterranean horseshoe bat were documented in two caves, Dare Khoshil, and Koogan, in the western part of Pol-e Dokhtar. There is no prior report on the observation of alive individuals in this province, but DeBlase (1980) has documented some pieces of evidence including a large quantity of guano and four mummified immature individuals in Eshkaft Dareze cave at the west of Khurramabad suggesting that this locality is definitely a nursery site for *Rb. euryale*.

***Rhinolophus mehelyi* Matschie, 1901**

The Mehely's horseshoe bat, *Rhinolophus mehelyi*, is an uncommon bat species in Iran (Benda *et al.*, 2012). In this study, this species is reported for the first time from Lorestan according to the observation of one individual in one cave (Garmabe 3 cave) at the western part of the province (Noor-Abad).



FIGURE 3. Bat species of Rhinolophidae family recorded in this study.

Family Vespertilionidae Gray, 1821***Myotis blythii* (Tomes, 1857)**

The lesser mouse-eared bat, *Myotis blythii*, was observed in four caves. A big colony including several hundred bats in Botkhane cave in Kuhdasht and a few individuals in the Falakien 1 cave in Khurramabad from western localities were reported. Additionally, a small colony of 50 individuals in Tarikdar cave from Alashtar, and a large colony of 500 bats a mix of *Myotis blythii* and *Miniopterus pallidus* in Meno cave near Dorud were documented from eastern parts of the province.

There are some reports of the occurrence of this species in Lorestan. One report was released by DeBlase (1980) in which he has recorded one mummified individual as well as the roost of this species in the Eshkaf Dareze cave in Khurramabad. In another report from a cave at the same locality, DeBlase (1980) has observed two large colonies of *M. blythii* with several hundred members in each colony. Furthermore, bone remains of *M. blythii* were found in pellets of some owl species in Lenje Abad and Gholaman from Lorestan.

***Myotis capaccinii* (Bonaparte, 1837)**

The long-fingered bat, *Myotis capaccinii*, was reported from Lorestan for the first time. One colony of this species was observed in Piermorad cave in a cold and mountainous region from Brujerd. Furthermore, the co-occurrence of this colony with a colony of *Rhinolophus blasii* is evident.

Family Miniopteridae Dobson, 1875***Miniopterus pallidus* Thomas, 1907**

Several populous colonies of the pale bent-wing bat, *Miniopterus pallidus*, were observed in three caves from three different localities in eastern part of the province. A large colony of 500 individuals was documented in Eshkaft Nesar cave (in Azna). Furthermore, two colonies comprising 1000 individuals were found together in Darmineh cave (in Aligoodarz), and one with 500 members including *M. pallidus* and *Myotis blythii* was observed in Meno cave (in Dorud). Previously, just one individual had been captured in Lenje Abad near Dorud (Benda, 1998). Another report documented the echolocation calls of a foraging individual in the valley of the Dez river south of Dorud (Benda *et al.*, 2012).



FIGURE 4. Bat species of Vespertilionidae and Miniopteridae families recorded in this study.

From north to south and west to east of Lorestan, a remarkable climatic variation is registered. Since Lorestan is located in the middle of the Zagros mountain ranges, a vast area of this province is covered with mountainous regions with considerable precipitation and rich vegetation and forests. As altitude increases from west to eastern and northern parts of the province, the temperature level drops sharply. Also, humidity follows an ascending rate from west and southwest to east, north, and northeast. These distinguishable differences in climatic parameters and the effect of altitude level in different parts of the province lead to the formation of three distinct climatic regions. At the north, northeast, and east, the elevation level is more than 1400 meters. In these regions, the day and night temperature difference is noticeable. Furthermore, precipitation rate and humidity are higher than in other parts of the province. Six localities (towns) including Noor-Abad and Selsele (Alashtar) in the north, Brujerd, and Azna in the northeast, and Aligoodarz and Dorud in the east are located in the mountainous part of the province where the very cold and semi-arid climatic conditions dominate. Summer is temperate and winter is very cold in these parts of Lorestan. The central region including Khurramabad and some parts of Kuhdasht represents a temperate and semi-arid climatic condition. The altitude level is lower than the cold northern parts. In these localities, summer is warm and winter is cold. Pol-e Dokhtar and some parts of Kuhdasht are located in the southern and southwestern parts where the semi-hot and arid conditions dominate. High annual average temperature level, little precipitation, and permanent evaporation are the climatic characteristics of this part of the province. The lowest altitude level is also another feature of these regions. With a few exceptions, such climatic partitioning of the province has strongly influenced the distribution

patterns of bat fauna in Lorestan. In other words, for nearly all species, the occurrence range directly reflects the climatic status of the habitats exploited by different bat species.

In this study, 11 species from four microchiropteran families including Rhinopomatidae, Rhinolophidae, Vespertilionidae, and Miniopteridae were identified. The distribution maps for each species based on new records in the present study are shown in Figure 5. Occurring in 19 caves from nine localities (towns), *Rhinolophus ferrumequinum* is the most widespread species in Lorestan. Three species including *Myotis capaccinii*, *Rb. Blasii*, and *Rb. mehelyi* were observed in only one cave; so, they have the lowest distributional range in the province. Also, *Rb. mehelyi* seems to be a rare species in the province, as only one individual was recorded in one cave. The biggest colony belongs to *Rhinopoma microphyllum* with thousands of individuals mixed with two other congeners found in the Khofash cave. Five species of the genus *Rhinolophus*, including *Rb. ferrumequinum*, *Rb. hipposideros*, *Rb. euryale*, *Rb. Blasii*, and *Rb. mehelyi* were recorded in Lorestan; so *Rhinolophus* is registered as the most specious genus in the province.

The occurrence range of the mouse-tailed bats is limited to central, south, and southwest climatic regions of the province. *Rhinopoma muscatellum* and *R. hardwickii* were observed in 15 and 14 caves of Khurramabad, Kuhdasht, Pol-e Dokhtar, and Romeshgan, respectively. Such a distribution pattern is normally expected because the members of Rhinopomatidae are well adapted to arid and semi-arid climatic conditions and lowlands. *R. microphyllum* was only observed in two caves from Pol-e Dokhtar in the southernmost part of the province marked with the highest temperature level.

The distribution of *Rhinolophus ferrumequinum* shows the highest geographical variation. This species was observed in 9 of 10 studied localities (towns). Due to its adaptive features, the occurrence of the greater horseshoe bat is expected in cold mountainous regions including Selsele, Brujerd, Azna, Aligoodarz, Dorud, and Noor-Abad. *Rb. ferrumequinum* was also observed in some caves of Khurramabad, Romeshgan, and even in Kuhdasht with very hot summers. Such occurrence is far from our previous assumptions. Similar to its widespread congener, *Rb. hipposideros* tends to live in cold regions, but in Lorestan it occurs in a lower density and extensity comparing with *Rb. ferrumequinum*. The lesser horseshoe bat was observed in six caves from Noor-Abad, Brujerd, and Aligoodarz.

In Pirmorad cave, at the coldest part of Brujerd, two sympatric colonies of *Myotis capaccinii* and *Rhinolophus blasii* were identified. Additionally, *Rb. mehelyi* was observed in Garmabe 3 cave from Noor-Abad in the northernmost part of the province with cold mountainous climatic conditions. This indicates that all three species are highly adapted to very cold conditions.

The other species displaying high geographical variation is *Myotis blythii* which was observed in Kuhdasht and Khurramabad with a temperate and rather warm climate, at the temperate parts of Selsele, and in Dorud where the cold and mountainous climate dominates.

The co-existence of different chiropterans is evident in many caves. In some cases, two different species from two separate families occur together. *Rhinolophus blasii* and *Myotis capaccinii* in Pirmorad cave, *Rhinopoma muscatellum* and *Rhinolophus ferrumequinum* in Ghaterchi cave, *Myotis blythii* and *Miniopterus pallidus* in Meno cave, and, *Myotis blythii* and *Rhinolophus ferrumequinum* in Falakien 1 cave are the representatives of separate families occurring together. In three caves namely Garmabeh 2 cave, Tabaghati, and Chehar Tagh, the co-occurrence of *Rhinolophus ferrumequinum* and *Rb. hipposideros* is documented. In almost all caves inhabited by *R. muscatellum*, the presence of *R. hardwickii* is also confirmed. Furthermore, in two caves of Pol-e Dokhtar (Pa-alam and Khofash), all three species of rhinopomatid bats were observed in the same location.

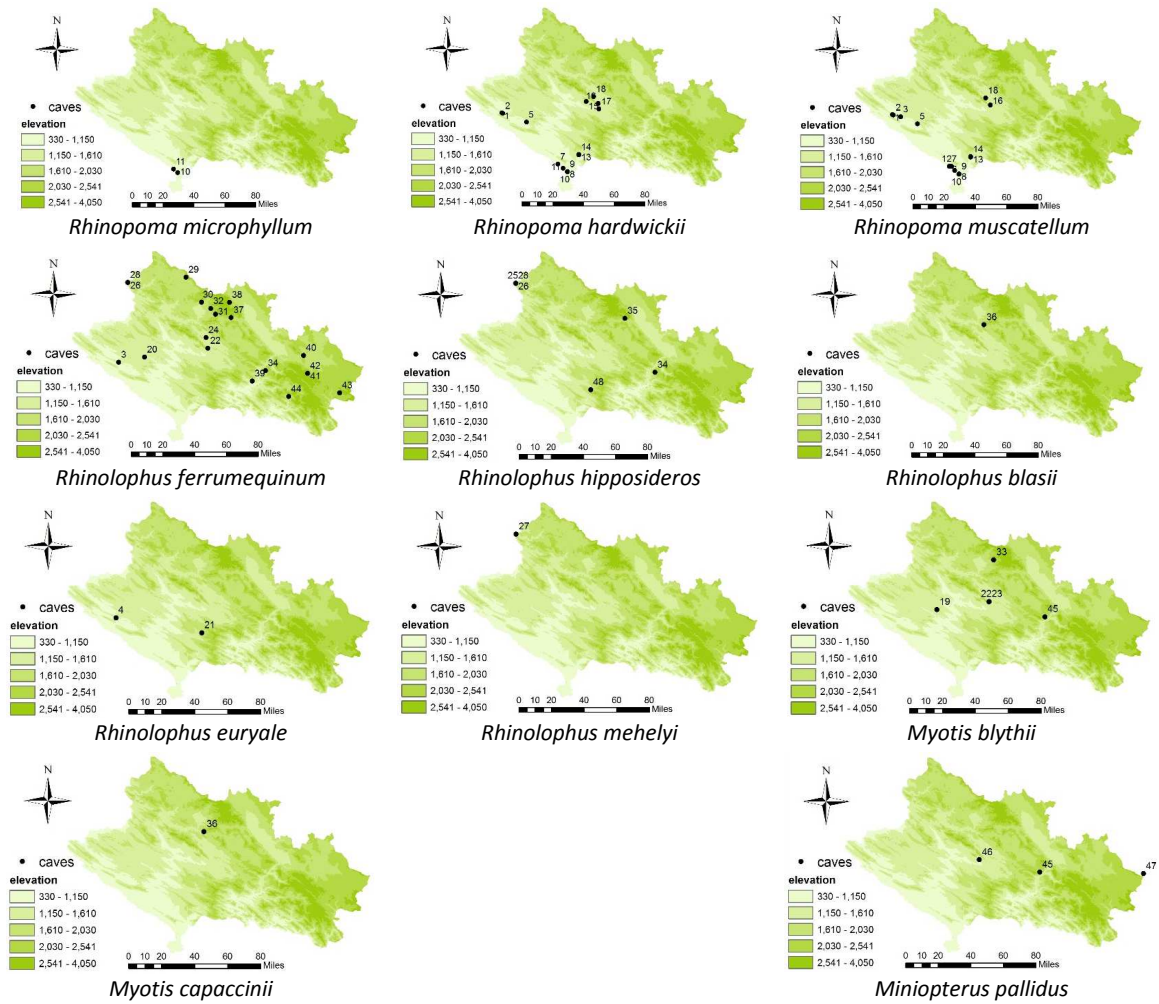


FIGURE 5. Separate maps of bat records for each species.

TABLE 3. Composition of the bat fauna of Lorestan province and the number of records for each species based on Benda *et al.* (2012) compared with the new records from the current study.

family	species	Benda <i>et al.</i> (2012)	The current study	Total records for Lorestan	Total records for Iran
Rhinopomatidae	<i>Rhinopoma microphyllum</i>	0	2	2	72
	<i>Rhinopoma muscatellum</i>	1	15	16	68
	<i>Rhinopoma hardwickii</i>	1	14	15	19
Rhinolophidae	<i>Rhinolophus ferrumequinum</i>	2	19	21	79
	<i>Rhinolophus hipposideros</i>	1	5	6	43
	<i>Rhinolophus euryale</i>	1	2	3	21
	<i>Rhinolophus mehelyi</i>	0	1	1	17
	<i>Rhinolophus blasii</i>	0	1	1	31
Vespertilionidae	<i>Myotis blythii</i>	3	5	8	116
	<i>Myotis capaccinii</i>	0	1	1	14
	<i>Pipistrellus kublii</i>	2	0	2	108
	<i>Pipistrellus pipistrellus</i>	4	0	4	64
	<i>Vespertilio murinus</i>	1	0	1	7
	<i>Eptesicus anatolicus</i>	1	0	1	10
	<i>Barbastella darjelingensis</i>	1	0	1	6
Molossidae	<i>Tadarida teniotis</i>	1	0	1	26
Miniopteridae	<i>Miniopterus pallidus</i>	2	3	5	63
total		21	68	89	764

Considering the 68 new records from the present study, a total number of 89 records of 17 bat species from five families have been documented in Lorestan province so far. The latest data based on a review by Benda *et al.* (2012) included 21 records from this province (Table 3). This indicates a considerable increase in the number of species records for this province as shown in Figure 6. This is the third study in Iran which focuses on the bat fauna of particular provinces. Previously, Fathipour *et al.* (2016) have studied the distribution of cavernicolous bat species in Ilam province, the western neighbor of Lorestan. In another research, Shahabi *et al.* (2017a) have listed 143 new records of bat species in Fars province. Due to extensive sampling in such studies, valuable faunistic information is provided for separate regions. Furthermore, such studies confirm that the number of bat species in Iran may be much higher than what has been reported in the literature. The present study in addition to the new records from Ilam and Fars provinces raise the number of bat records of Iran from 902 to 1152 total records reviewed by Benda *et al.* (2012). Figure 7 compares the record number for each species in Lorestan province with total number of the species recorded in Iran.

Lorestan and Ilam are two adjacent provinces with a high level of similarity in climatic conditions. Cold and mountainous climate in the north and the warm climate in the south dominates both provinces. Therefore, it is not surprising that the bat fauna of two provinces shows some degrees of uniformity. Indeed, from five families that form the chiropteran fauna structure of each province, four families including Rhinopomatidae, Rhinolophidae, Vespertilionidae, and Miniopteridae are common. The fifth family is Molossidae in Lorestan and Hipposideridae in Ilam. Furthermore, at lower taxonomic ranks, the similarity is also remarkable. Lorestan with 17 and Ilam with 11 identified bat species represent a uniformity of 47 percent. *Rhinopoma microphyllum*, *R. muscatellum*, *R. hardwickii*, *Rhinolophus ferrumequinum*, *Rh. hipposideros*, *Rh. euryale*, *Rh. blasii*, *Myotis blythii*, and *Miniopterus pallidus* are the species that have been recorded in both provinces.

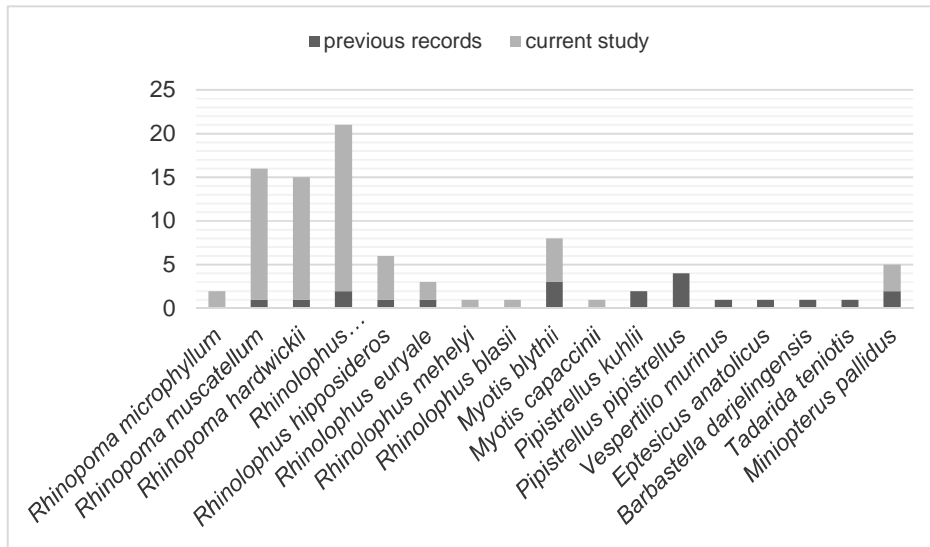


FIGURE 6. Total records number of each bat species from Lorestan Province including the previous records and records from the current study.

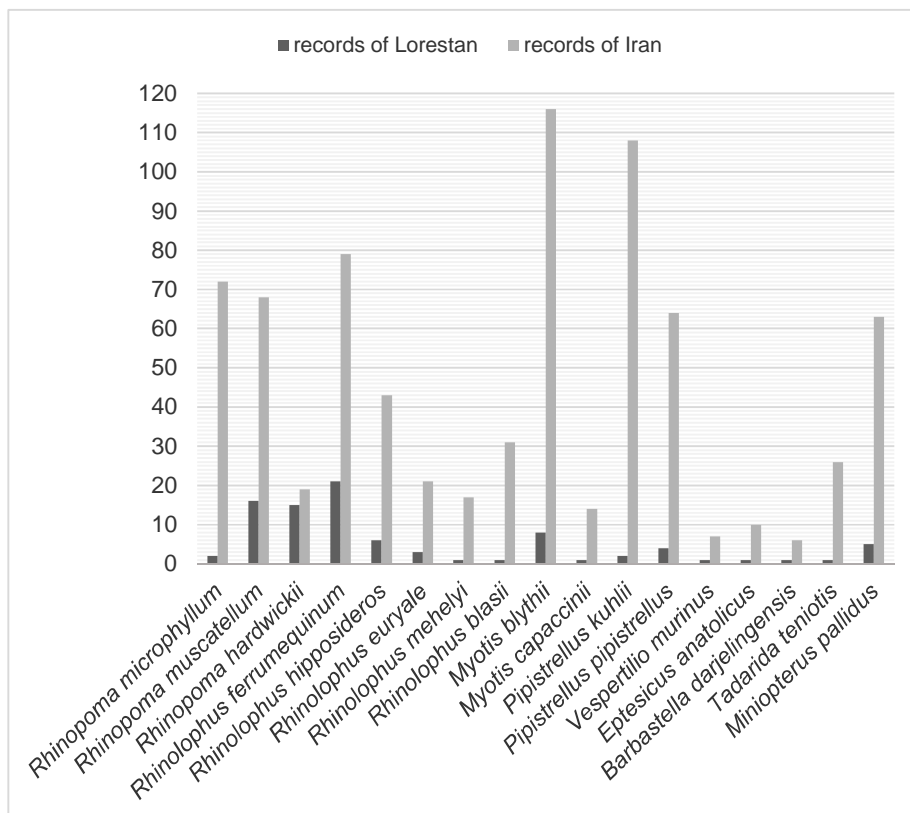


FIGURE 7. The records number of each bat species from Lorestan Province and whole Iran.

From a comparative point of view, Lorestan with 17 bat species, covers almost one third of whole Iran bat fauna (51 species). Lorestan province with only 1.7% (about 28000 Km²) of the country's area (about 1648000 Km²), shows a high species richness for bat fauna. However, the density (or population size) in each record is relatively low. It is partly due to the low reproduction rate of these mammals, so, any threat has a direct influence on their population size. There are some major threats against karst caves, consequently threatening cave inhabitants including bats. Increase in seasonal flood levels caused by the change of vegetation and its destruction may accumulate the deposits on the cave floor and change the cave structure. In addition, repurposing lands for agriculture or other purposes may cause the obstruction of the entrance of the caves. Additionally, in some cases, caves are used as a site for keeping the cattle. All forms of human disturbance can make irreparable changes in the structure and life of the caves, leading cavernicolous animals to extinction. Therefore, it seems necessary to provide applicable rules in order to conserve caves and their ecosystems.

In the current study, a total number of 48 caves occupied by bats in Lorestan province were investigated and 11 cavernicolous species were identified. Considering previous reports on six other species, the total number of bat species residing in the province reaches to 17. This number covers 89 total records of the observed species in the province, 68 of which are new and documented for the first time in the present study.

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