

RESEARCH ARTICLE

Open Access

# Bats of Guilan, northern Iran: a review and uncovering novel discoveries, with comments on two key cave roosts

Zahra Malekpour-Fard and Vahid Akmalı

Department of Biology, Faculty of Science, Razi University, Kermanshah, Iran

(Received: 28 June 2023; Accepted: 10 October 2023)

## Abstract

Guilan province, located in northern Iran and surrounded by the Caspian Sea to the north and the Hyrcanian forests to the south, boasts the most diverse habitats in the country. However, there is a lack of information on bat fauna in the caves of Guilan province, with all existing records limited to artificial roosts, foraging individuals or echolocation calls. Despite this, available data suggests that 13 species of bats have been reported in the region. In this study, 12 caves throughout the province were observed, resulting in the identification of five bat species, namely *Miniopterus pallidus*, *Pipistrellus pipistrellus*, *Myotis blythii*, *Rhinolophus hipposideros*, and *R. ferrumequinum*. One colony and two individuals in separate localities were also identified at the generic level as *Rhinolophus* sp., while two cave roosts with large populations and considerable number of species were described in detail. Furthermore, this study encompasses data on five new sample records, comprising three from *Pipistrellus kuhlii*, one from *Rhinolophus* sp., and one from *Rhinolophus hipposideros*, from foraging individuals and artificial roosts. Overall, these findings contribute to our understanding of the diversity and distribution of bats in Guilan province, particularly within its caves.

**Keywords:** Chiroptera, Fauna, Hyrcanian Forests.

## INTRODUCTION

Caves are large subsurface habitats where peculiar, even ambivalent environmental conditions are experienced by their inhabitants. Compared to other subterranean habitats, caves are more easily accessible, making them a temporary or permanent residence for a diverse range of organisms. These organisms occupy caves for varying reasons and duration (Culver & Pipan, 2019).

Bats are considered as troglodyte mammals which partially depend on the surface environment to fulfill their biological demands (Culver & Pipan, 2019). They benefit from the caves for various reasons including mating, nursery, and hibernation, as well as daily, seasonal and transient roosts. Caves also provide a secure environment for bats to avoid outside temperature fluctuations, competitors and diurnal predators (Altringham, 2011).

The identification of 52 bat species from 9 different families in Iran highlights the country's diverse habitats and suitable climatic conditions for bats to exploit (Yusefi et al. 2019; Khajeh et al. 2020). The study was conducted in the political borders of Guilan province, a coastal province in the



north of the country that is surrounded by the western Hyrcanian Forests and divided into two main elevated areas: the Talesh mountain ranges in the west and the Alborz Mountain ranges in the east and south. Being surrounded by the Caspian Sea from the north and the mountains from the south, this region contains the most productive landscapes in the country, offering a wide variety of habitats for bats and other wildlife, including caves (Farid-Mojtahedi, 2013).

Compared to the well-studied caves in the Zagros Mountain ranges at the west and southwest of the Iran, the caves of the Talesh and Alborz Mountain ranges have been poorly studied. In recent years, a considerable number of caves in Zagros mountains have been investigated for their bat fauna, while data on chiropteran assemblage of caves in Talesh and Alborz Mountain ranges is scarce (Fathipour et al. 2016; Shahabi et al. 2017; Akmalı et al. 2019a, b, 2022). Over a hundred caves and natural rock shelters have been discovered in the western part of the Hyrcanian forests (Dehdar-Dargahi & Farid-Mojtahedi 2014; Jahani, 2017). This study represents the first attempt to collect information about the bat assemblage and their roosts in the caves of this area. Furthermore, all previous records of bats from this area are reviewed.

## **MATERIAL AND METHODS**

Field studies were conducted in 2019-2022, during which a total number of 17 caves were visited on a regular basis all-year-round, and investigated for their bat fauna. Only a few colonies were discovered in certain caves, while only one or two hanging or flying individuals were observed in the most caves. A few individuals were collected by hand, hand-net, or mist-net, photographed, and measured for their distinguishing characteristics, and then released at their roosts. Forearm measurements are provided in Table 3. Bats were identified using identification keys (DeBlase, 1980; Dietz & Von Helversen, 2004). The coordinates of each cave were recorded using a mobile GPS app. All new coordinates, as well as previous records of bats from the studied area, were imported to ArcGIS version 10.2, and a distribution map was prepared. We excluded previous records without coordinates or precise location addresses. Additionally, in six cases, estimated coordinates were assigned for records with accurate addresses using Google Earth Pro. This map illustrates all available record sites, including caves, artificial roosts, foraging individuals, and records of echolocation calls, separately. This study was conducted under the research ethics certificate, with approval ID: IR.RAZI.REC.1399.039.

### **Study area**

Guilan province is a unique area in term of topography, elevations and climatic conditions and diversity of ecosystems. The elevation range varies from -26 meters through the Caspian coastal areas to 3707 meters in Samamoos mountain. This altitude variation is one of the main causes of diverse climatic conditions in the province, where semi-arid climate in the southern plain to highly humid and cold weather at the foothills can be experienced. The main topographic features of the province are the Talesh mountain range in the west and the Alborz range in the south and east. The occurrence of Sefid-rud tectonic valley disconnects the continuity of elevations in the middle of the Guilan province, leading to distinct environmental conditions in the southern lowlands of the Rudbar area where a semi-arid climate is dominant. The Caspian Sea makes the northern margin of the province and has considerable impacts on its topographical and climatical conditions. Estuarine ecosystems are located in the wide and flat plains along the shores of the Caspian Sea. A continuous topographic transition is observed crossing from the lowlands of the coastal plains to high elevations in the mountainous regions of Alborz foothills. The Hyrcanian vegetation belt covers the northern slopes of the mountains throughout the province. The temperature follows a descending pattern southward; then increases at the southern lowlands (Farid-Mojtahedi, 2013; Farid-Mojtahedi et al. 2018).

**TABLE 1.** summarized information on studied caves.

No.	Name of cave	Elevation (meter)	Length of cave (meter)	Time of visits	Number of visits	Number of bat species
1	Divrash 2	314	30	All-year-round	5	3
2	Divrash 3	339	10	All-year-round	2	1
3	Darband Rashi	720	58	Summer, Autumn, Winter	4	1
4	Shoupar-Chal	137	70	All-year-round	4	2
5	Cheshmeh-Bad	1408	400	Summer	1	1
6	Kaslav	825	10	Summer, Autumn	2	1
7	Liyarud	503	12	Autumn	1	1
8	Shalash	1640	70	Autumn	1	1
9	Eqbal	495	20	Autumn	1	1
10	Diyarjan	1892	52	Summer	2	1
11	Koolak- Avar	293	500	Summer	1	1
12	Espahbodan	1681	24	Autumn	1	1

## RESULTS

### The review of previous studies

Totally, 18 bat species have been reported from Hyrcanian Forests so far from which 13 species have been observed in the western part of the forests. This number includes 23 site records that refer to echolocation calls, foraging bats, artificial roosts as well as a few records of bat remains in owl pellet. Here, we review the previous records on bats in this region (Benda et al. 2012; Tohidifar et al. 2016).

The sole record of *Rhinolophus ferrumequinum* dates back to 1774; and no recent observation is registered since then. *Pipistrellus nathusii* has been recently reported from Anzali Wetland by Naderi et al. (2017). This is the only record on this species in the country. Although, *Myotis blythii* have a wide distribution range in Iran, there have been no new observations of this species from Guilan Province since 1907. The records on *Rhinolophus hipposideros* from this region are limited to a few records including one museum specimen from Asalem, an artificial roost in Saghaleksar and foraging individuals in Anzali wetland (Benda et al. 2012; Naderi et al. 2017). Furthermore, Shahabi et al. (2019a) recorded the echolocation call of this species in Bandar Anzali. The only record on *Eptesicus serotinus* from Guilan province refers to the netting of two individuals in a clearing close to the forest edge in 1968 (Steiner & Gaisler, 1994). Similarly, from a sole record on *Hypsugo savii*, this bat was detected by its echolocation calls in a rocky valley near Rudsar. The observation records of *Pipistrellus pipistrellus* include a large colony in an attic, the remains in owl pellet and two separate foraging individuals. All reports on *P. pygmaeus* are limited to foraging individuals at the Caspian Sea coastal areas. Several records demonstrate the occurrence of *P. kuhli* in the province. These records include the observation of the bats in their roosts, netting foraging individuals, and their remnants in owl pellet. The records of the rare *Nyctalus noctule* from the province have been reviewed by DeBlase (1980). These records refer to two museum collections which were gathered by Thomas (1907) and Farhang Azad (1970) from their roosts. The single record on the *N. lasiopterus* for the whole country belongs to the western part of the Hyrcanian forests where Etemad (1970) detected a migratory individual. *Myotis mystacinus* morpho-group is another bat species which has been identified from Guilan, and has only one observation record.

The results of this study are based on several cave expeditions during 2019 to 2021 in the western parts of Hyrcanian forests. The results of the field trips are summarized in Table 1, and images of some of the specimens are shown in Figure 1. Totally, 12 caves were explored and four bat species were identified. The studied caves include Divrash complex caves (including three separate caves), Darband Rashi, Cheshmeh Bad, Shoupar-Chal, Liyarud, Shalash, Eqbal, Koolak-Avar, Diyarjan, Espahbodan and Keslav. The identified species are listed below with some details on their roosts. One addition colony was

identified at generic level and included in the results and analysis of this study. We represent these two taxa as *Rhinolophus* sp. from Divrash 3 cave. The single flying individuals in Diyarjan and Keslav caves weren't identified due to their high flight and immediate disappearance. In Espahbodan cave, only the remnants of a bat skeleton were found, but evidences from previous visitors demonstrate the existence of bats in this cave. Furthermore, two roosts bearing considerable population size were located, monitored all-year-round and depicted. We also present five new records from artificial roosts and foraging individuals. Here, we present the new bat records from the studied area.

#### **Family Miniopteridae Dobson, 1875**

##### ***Miniopterus pallidus* Thomas, 1907**

Pale bent-winged bat is a widespread bat in Iran (Akmali et al. 2015). There are some records on the occurrence of this species in the eastern parts of Hyrcanian forests. Shir-Abad cave is the only subterranean habitat in the Hyrcanian forests where this species has been reported. The two other records from the northern part of the country refer to its foraging habitats (Benda et al. 2012).

In this study, *Miniopterus pallidus* was observed in Divrash 2 and Shoupar-Chal caves, where it was observed to share its roost with lesser horseshoe bat. During a summer visit to Divrash 2 cave, four male individuals were collected by a mist-net at the entrance of the cave during their evening emergence. In Shoupar-Chal cave, a large colony of this species was observed, and a few individuals were captured by hand-difficulty net. A detailed description on these two roosts is discussed at the end of this section.

#### **Family Rhinolophidae Gray, 1825**

##### ***Rhinolophus* sp.**

Due to of collecting bats in some caves, we were unable to identify flying or hanging individuals at specific level. Although, visual observation and photography confirmed their affiliation to Rhinolophidae family. One colony in Divrash 3 cave, two individuals in Eqbal cave, and one in a manmade underground tunnel were assigned to *Rhinolophus* sp. Eqbal cave is a medium-sized single gallery that is partially separated into two rooms and requires crawling to enter. The bats were hanging separately from the walls of the cave, and no sign of accumulated bat guano was observed on the cave floor.

##### ***Rhinolophus ferrumequinum* (Schreber, 1774)**

The greater horseshoe bat is one of the rhinolophid species whose distribution range and taxonomic status is well-studied from the Northwest to the Southwest and South of the country (Shahabi et al. 2017b, 2019b). Despite being observed in the studied area in the late 18th century, there have been no updated reports on the observation of this species since then. However, in the current study, we collected a dead bat in Shalash cave. In this cave, several hibernating bats were observed on the roof of the main corridor, and a dead individual of this species was found on the cave floor. This cave is a water cave and is known as a sacred place for the local people. The findings of this study provide updated observations on the presence of this species in the studied area and highlight the importance of continuing monitor and study bat populations in these caves.

##### ***Rhinolophus hipposideros* (Bechstein, 1800)**

The lesser horseshoe bat is a relatively common species in Iran, with a continuous distribution in the western half of the country and scattered records from eastern regions and southern coastal margins. However, there are no reports on this species from central deserts. Almost all records of *R. hipposideros* are limited to its roosts, mostly in caves. There are a few records of this species from the western part of Hyrcanian Forests, which refer to artificial shelters (Benda et al. 2012; Naderi et al. 2017). However, the occurrence of the lesser horseshoe bat has not been documented in Guilan caves until this study, which represents the first record of this bat in its subterranean roosts from the western parts of Hyrcanian Forests. In this study, three caves in the studied area were observed to have lesser horseshoe bats.

**TABLE 2.** Detailed information about new and previous bat records in Guilan province.

No.	Status	description	Altitude (meters)	Coordinates	Identified taxa	Reference
1	Artificial	Lisar, house crevices	0	N37 58 00.0 E48 55 00.0	<i>Pipistrellus kuhlii</i>	Benda et al. (2012)
2	Artificial	Rasht, roof of a house	-7	N37 17 00.0 E49 35 00.0	<i>Pipistrellus kuhlii</i>	Steiner and Gaisler (1994)
3	Artificial	Saqaleksar, near Rasht, attic of a mosque	50	N37 10 00.0 E49 34 00.0	<i>Rhinolophus hipposideros</i>	Benda et al. (2012)
4	Artificial	Saqaleksar, near Rasht, attic of a house	46	N37 09 46.8 E49 31 12.5	<i>Pipistrellus pipistrellus</i>	Benda et al. (2012)
5	Artificial	Anzali wetland, rural houses	-29	N37 24 55.0 E49 20 19.0	<i>Pipistrellus pygmaeus</i>	Naderi et al. (2017)
6	Artificial	Lisar, under a barn roof	-26	N37 22 51.6 E49 32 32.7	<i>Rhinolophus hipposideros</i>	Present study
7	Artificial	Golsarak tunnel, Emamzadeh Hashem	118	N37 01 49.9 E49 37 56.9	<i>Rhinolophus ferrumequinum</i>	Present study
8	Artificial	Near Rasht, under a barn roof	17	N37 57 43.1 E48 54 07.6	<i>Pipistrellus kuhlii</i>	Present study
9	Cave	Manjil, Cheshmeh-Bad cave	1408	N36 46 02.0 E49 29 10.0	<i>Myotis blythii</i>	Present study
10	Cave	Amlash, Liyarud cave	503	N37 00 31.9 E50 02 15.4	<i>Rhinolophus hipposideros</i>	Present study
11	Cave	Rezvanshahr, Shalash cave	1640	N37 27 02.2 E48 47 52.7	<i>Rhinolophus ferrumequinum</i>	Present study
12	Cave	Lahijan, Shoupar-Chal cave	137	N37 08 38.4 E50 04 56.8	<i>Miniopterus pallidus</i> , <i>Rhinolophus hipposideros</i>	Present study
13	Cave	Tutkabon, Darband Rashi cave	720	N36 50 02.0 E49 39 18.7	<i>Pipistrellus pipistrellus</i>	Present study
14	Cave	Tutkabon, Divrash 3 cave	339	N36 54 13.0 E49 35 27.8	<i>Rhinolophus</i> sp.	Present study
15	Cave	Tutkabon, Divrash 2 cave	314	N36 54 11.5 E49 35 25.0	<i>Miniopterus pallidus</i> , <i>Rhinolophus hipposideros</i> , <i>Myotis blythii</i>	Present study
16	Cave	Deylaman, Diyarjan cave	1892	N36 53 41.0 E50 01 10.0	Unidentified	Present study
17	Cave	Fuman, Eqbal cave	495	N37 17 21.4 E49 09 46.2	<i>Rhinolophus ferrumequinum</i>	Present study
18	Cave	Deylaman, Espahbodan cave	1681	N36 53 51.6 E49 46 21.9	Unidentified	Present study
19	Cave	Shaft, Keslav cave	825	N36 59 54.1 E49 13 39.2	Unidentified	Present study
20	Cave	Siyahkal, Koolak-Avar cave	293	N37 06 39.4 E49 52 59.9	<i>Myotis blythii</i>	Present study
21	Echolocation	In a rocky valley at Ziaz near Rudsar	854	N36 51 00.0 E50 14 00.0	<i>Hypsugo savii</i>	Benda et al. (2012)
22	Foraging	Above a river in a beech forest near Tutaki	406	N37 02 00.0 E49 54 00.0	<i>Pipistrellus pygmaeus</i>	Benda et al. (2012)
23	Foraging	Edge of small clearing in forest near Assalem	1278	N37 39 00.0 E48 49 00.0	<i>Eptesicus serotinus</i> , <i>Plecotus auritus</i>	Steiner and Gaisler, 1994
24	Foraging	Rudsar	-23	N37 08 00.0 E50 17 00.0	<i>Nyctalus lasiopterus</i>	Etemad (1970)
25	Foraging	Anzali wetland near Khomam	-27	N37 24 36.2 E49 33 52.2	<i>Rhinolophus hipposideros</i>	Naderi et al. (2017)
26	Foraging	Sorkhankol protected area, Anzali wetland	-27	N37 23 54.1 E49 27 15.5	<i>Pipistrellus kuhlii</i>	Naderi et al. (2017)
27	Foraging	Sorkhankol protected area, Anzali wetland	-28	N37 24 49.7 E49 27 20.0	<i>Pipistrellus nathusii</i>	Naderi et al. (2017)
28	Foraging	Anzali wetland	-24	N37 29 06.0 E49 19 27.0	<i>Pipistrellus pygmaeus</i>	Naderi et al. (2017)
29	Foraging	Anzali beach	-26	N37 29 40.1 E49 23 38.3	<i>Pipistrellus kuhlii</i>	Present study
30	Foraging	Sangachin road, near Anzali	-22	N37 31 08.4 E49 18 26.9	<i>Pipistrellus kuhlii</i>	Present study
31	Natural cavities	Tutkabon, near Divrash cave	352	N36 54 15.7 E49 35 35.4	<i>Rhinolophus hipposideros</i>	Present study

**TABLE 3.** Forearm measurements of bat species.

No.	Bat species	Number of measured specimens	Mean forearm length (mm)
1	<i>Miniopterus pallidus</i>	7	46.46
2	<i>Rhinolophus hipposideros</i>	6	37.1
2	<i>Rhinolophus ferrumequinum</i>	1	55.5
4	<i>Pipistrellus pipistrellus</i>	2	32.12
5	<i>Pipistrellus kuhlii</i>	7	32.62



*Miniopterus pallidus* from  
Shoupar-Chal cave



*Rhinolophus hipposideros* from  
Liyarud cave



*Rhinolophus* sp. from Eqbal cave  
(photo by Pooya Safari)



*Rhinolophus hipposideros* from  
Divrash2 cave



*Pipistrellus pipistrellus* from  
Darband Rashi cave



*Myotis blythii* from Cheshmeh-  
bad cave (photo by Masoud Zare)



Corpse of *Rhinolophus ferrumequinum*  
from Shalash cave



*Pipistrellus kuhlii* from  
Anzali beach



*Miniopterus pallidus* from  
Divrash2 cave

**FIGURE 1.** The images of identified bat species in the present study.





**FIGURE 2.** A) The roof of the barn in Lisar, roost of the lesser horseshoe bat; B) Unidentified horseshoe bat in the underground tunnel near Emamzadeh-Hashem; C) the passage of the tunnel.

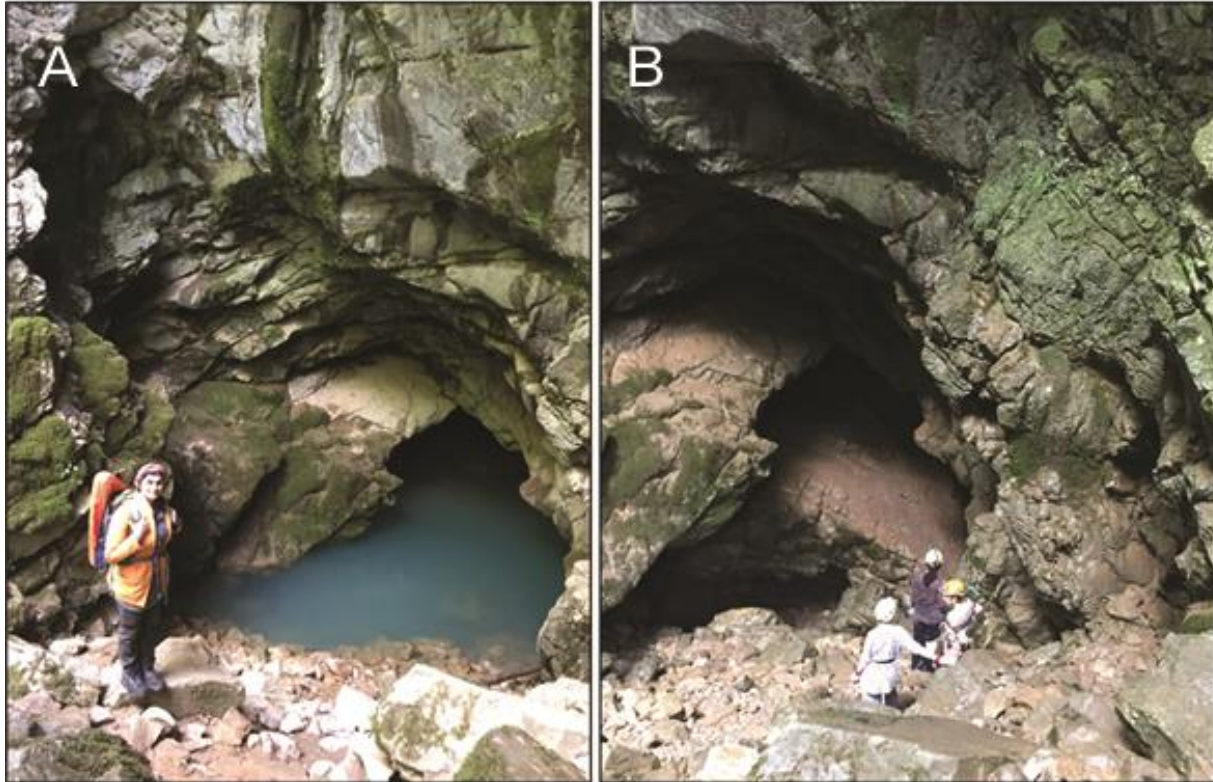
Divrash 2 cave is a permanent and all-year-round roost for *R. hipposideros*. We observed less than ten immotile individuals hanging separately from the ceiling and walls of the cave near the floor during mid-autumn and early spring visits. During the mid-summer visit, one specimen was collected by a mist-net set up at the cave entrance as it emerged in the evening. Another individual was collected from a small cavity along the valley near Divrash complex caves during the mid-autumn visit. Shoupar-Chal cave, located in a small relict forest in the middle of a tea farm, was observed to have a big mixed colony of about 500 individuals of *Miniopterus pallidus* and *R. hipposideros* during the mid-summer visit. One flying individual of the lesser horseshoe bat was collected by a hand net. During the early spring visit, only a few flying bats were observed. Liyarud cave, located on a steep slope with dense forest coverage, was observed to have two individuals hanging from the low ceiling of the cave. These observations provide valuable insights into the distribution and roosting behavior of the lesser horseshoe bat in the western parts of Hyrcanian Forests, highlighting the importance of monitoring and studying bat populations in this area.

### Family Vespertilionidae Gray, 1821

#### *Myotis blythii* (Tomes, 1857)

*Myotis blythii* is one of the most common bat species in Iran, with a widespread distribution from northeast to northwest and southwest. While there are a few records of *M. blythii* from the southeast, no records of this species have been documented in the central deserts and eastern areas of Iran. Most records of *M. blythii* refer to its roosts, especially in caves located in mountainous and humid areas above 1500 meters above sea level. Sheikh-Jabbari (2008) identified *M. blythii* in 12 localities in the closest region to the studied area, Ardabil Province, of which four records refer to caves. There are also several records of this species throughout the Alborz Mountain Ranges. Thomas (1907) collected one male individual from the Alborz Mountains near Rasht, although no further details were given on this record. In the current study, we observed *M. blythii* roosting in the caves. One individual was observed in a torpor state in a small cavity on the ceiling of Divrash 2 cave. This observation was made during the early spring visit when no flying bats were observed in the cave space. Another cave where *M. blythii* was observed in this study is Cheshmeh-Bad. This cave is an aquatic cave with a water flow through the main passage that connects to a pool at the first gallery. A few individuals of *M. blythii* were observed hanging on the walls of the first gallery. Additionally, a flying individual of this species was observed around the entrance of Koolak-Avar cave, during which it unexpectedly landed on the shoulder of a team member. However, due to the cave's impassable passages, the team was unable to explore the cave further, and no bat colony was found. These observations enhanced our understanding of the distribution and roosting behavior of *M.*

*blythii* in Iran, highlighting the importance of studying and monitoring bat populations in caves located in mountainous and humid areas. Despite being one of the most frequent species in the country, there are still gaps in our knowledge of this species' distribution in certain regions, such as the central deserts and eastern areas, which require further investigation.



**FIGURE 3.** A) The level of water in early spring is going down after the flood; B) The water level is back to its normal conditions inside the cave.



**FIGURE 4.** A) The entrance of Divrash 3 (white arrow); B) Installing mist-net at the entrance of Divrash 2.



### ***Pipistrellus pipistrellus* (Schreber, 1774)**

Out of the four *Pipistrellus* species that are known from Iran, only *Pipistrellus pipistrellus* has been observed to roost in caves. *P. pipistrellus* and *P. kuhlii* are both very common species in Iran's bat fauna, while *P. pygmaeus* and *P. nathussi* are rather rare with limited distribution ranges. *P. pipistrellus* has a contiguous distribution in northern regions of the country, while *P. kuhlii* is more frequent in south-west and southern parts (Benda et al. 2012). In the current study, two individuals of this species were netted inside a cave at their emergence time. These two individuals were members of a rather large colony, but due to its inaccessible and high location, the bat assemblage remained unknown. The colony was estimated to comprise around 500 bats hanging from the cave ceiling at a height of 30 meters. During the early winter visit to the cave, no individuals were observed, possibly due to their hiding in invisible and deep crevices during the hibernation interval.

In addition to cave roosts, this study presents five new records of foraging individuals and artificial roosts. Two foraging *Pipistrellus kuhlii* were collected in separate captures, with one individual caught by mist-net at Anzali beach and another accidentally flying into a moving car on Sangachin road. Three more records were attributed to artificial roosts. A group of five *Rhinolophus hipposideros* individuals was observed below the roof of a barn near Lisar (Figure 2-1). Another record refers to the observation of a hibernating *R. ferrumequinum* in a manmade underground tunnel near Emamzadeh-Hashem (Figure 2-2 & 2-3). Furthermore, seven *P. kuhlii* individuals were detected under the roof of a small warehouse in a rural house next to a river bank of Anzali wetland near Rasht. All of these records have been included in the distribution map of bat records in Guilan province.

### **Divrash complex caves**

The Divrash complex caves are located at the end of Divrash valley and comprise three separate caves, each with an independent entrance, although their possible connectivity has yet to be discovered. The caves are referred to as Divrash 1, 2, and 3. To reach the caves, one must begin at the end of Divrash village and continue through the forest along the Khereshk-Rood River. After approximately one hour of navigating and crossing the river, one arrives at the end of the valley. The large entrance of Divrash 1 is visible in front of you, and to enter the cave gallery, you must descend on unstable and loose rocks. The gallery features a permanent underground lake that encompasses the entire area. Discovering the unknown part of the cave requires special equipment and experience in cave diving. As the level of underground water rises during winter, the permanent underground lake in the cave becomes the source of a stream that flows out of the cave through its way at the bottom of the valley to join the Sefidab river.

Divrash 2 is located on the rocky wall of the valley to the right of Divrash 1. After passing through a low entrance passage, a single large gallery is present. There is a platform on the left with a high ceiling, where bats roost. However, due to the accumulation of fresh mud and guano on this platform, it is impossible to ascend it. Additionally, the height of the ceiling makes it difficult to visually identify the bat species. However, there is a colony in a relatively hidden cavity on the ceiling, which can be spotted by observing the movements of bats. Furthermore, bat individuals can be observed singly or in small groups around the ceiling of this area. A few individuals can also be seen hanging from the walls and low ceilings around the large gallery of the cave. These individuals can be easily caught by hand or hand nets and identified as lesser horseshoe bats.

During a mid-summer visit, we set a mist net at the cave entrance and waited outside for their evening emergence. Five individuals were captured, of which four adult pale bent-winged bats were identified, as well as one lesser horseshoe bat. During another visit in late winter, we observed a hibernating individual of a mouse-eared bat in one of the small cavities on the low ceiling at the deepest part of the cave. This was the only record of this species during our visits to this cave. There are some evidences on the connectivity of this cave and Divrash 1. During the wet season, a temporary water stream flows into the cave from inside the crevices in the cave wall at the deepest part of the cave, then goes downward through the crevices on the opposite wall and disappears into the hidden voids. It seems this water flow originates from the same spring that the pond in Divrash 1 emanates from.



**FIGURE 5.** A) The entrance of Shoupar-Chal from inside the cave; B) The entrance from outside.

The third cave that we assign it as Divrash 3, is located on the outer walls of the Divrash 1, approximately 20 meters above its entrance (Figure 4-1). Two cavities are located above a steep slope next to each other, with the right one being a dead-end. The left cavity is a 10-meter narrow passage that leads to a small room. In this room, a population of 50 horseshoe bats occupied the low ceiling. At the right corner of the room, there is a fairly narrow passage that slopes down sharply to the undiscovered part of the cave that is coated with sticky mud. The connectivity between this passage and Divrash 1 needs to be examined. Several flying bats were also observed in this passage.

We visited this cave several times from 2019 to 2022, covering all seasons. During all visits, we observed a permanent population of bats in Divrash 2 and Divrash 3. Although we did not record any pup or pregnant individuals during our visits, given the continuous presence of bats in these caves, they may serve as maternity roosts as well as hibernacula.

### **Shoupar-Chal cave**

This cave is located in the midst of tea farms within a small relict forest, situated on a karstic outcrop. The entrance of the cave is W-shaped and is quite large, leading to a wide inclined passage that opens up into the main gallery of the cave. Although there is no water source within the cave, the walls in the entrance area are damp, causing water droplets to form. Additionally, a small opening can be observed on the right side of the entrance area in the ceiling. The cave contains a large elevated platform that partially divides the space into two rooms. The highest point of the cave roof reaches 20 meters. Several small cavities can be found within the inner space of the cave.

A deep cavity in the ceiling at the deepest part of the cave was home to a large population of about 500 bats. We applied a visual counting method to estimate the population size as the bats flew out of their roost space. Furthermore, a few lesser horseshoe bats were found hanging from the walls around the cave entrance area. To identify the bat species, we captured a few individuals using a hand-net, and identified *Miniopterus pallidus* and *Rhinolophus hipposideros* in this cave. We observed this population during three visits to the cave in mid and late summer, as well as mid-autumn. The cave is relatively easy to explore, with no special equipment necessary. There are no impassable passages or obstacles in the cave area, and only simple rock climbing is required in certain parts of the cave. The cave is situated on personal property, which provides some protection from human disturbances.

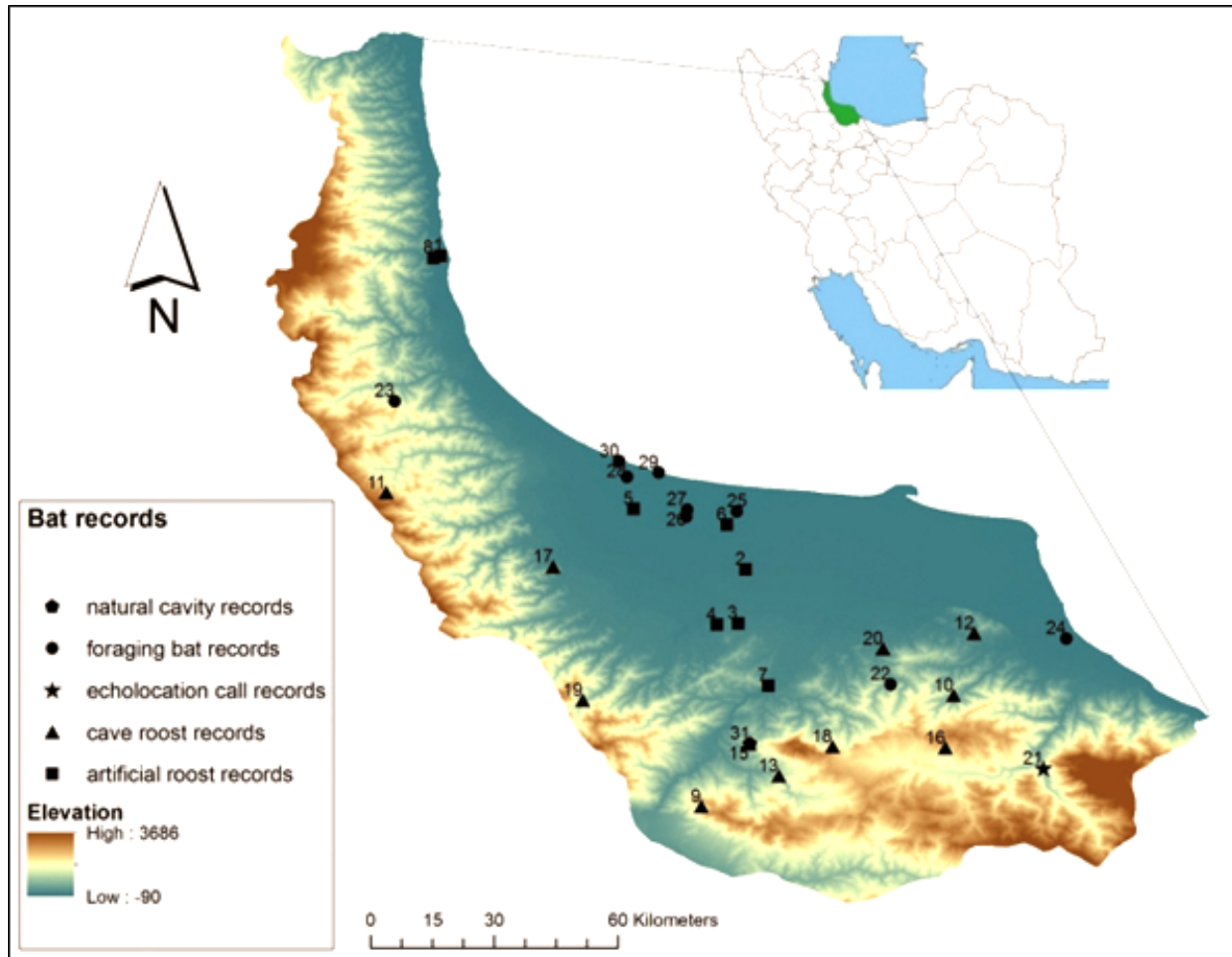


FIGURE 6. Distribution map of all bat records in Guilan province with available coordinates.

## DISCUSSION

The caves in Guilan province have not been well studied in terms of their biodiversity, particularly with respect to their bat fauna. In this study, we conducted several exploration efforts to locate bat colonies in the Hyrcanian forests of this area. As a result, we detected two large aggregations of bats in the Divrash complex caves and Shoupar-Chal cave, and monitored them throughout the year. Although we did not directly observe any maternity roosts, the presence of bats in all seasons indicates that these caves are important habitats. The Shoupar-Chal cave is located in the middle of a private tea farm, which has helped to protect it from disturbances by visitors. While we did find evidence of occasional human visitation, such as garbage and waste, our observations demonstrate the persistence presence of bats in this cave.

The conditions in Divrash complex caves are vastly different. This cave is renowned for its picturesque surroundings, and during warm seasons, an average of 1000 visitors from nature-traveler communities and mountaineering clubs visit the cave each week. Their presence inevitably results in disturbance and devastating impacts on the cave's fauna. Unfortunately, this cave is not supervised by any relevant organizations. According to local people, the number of bats in this cave has been declining since the arrival of visitors. The current study has shown that at least three bat species use this cave as their permanent roost, making it imperative to protect the cave.

This study has contributed new records of cave roosts to supplement existing records, which previously only included artificial roosts, foraging individuals, and echolocation calls. We combined our new findings with previous records to gain a comprehensive understanding of the distribution patterns of

bats based on the type of record. We used a total of 31 records, including 12 cave roost records, eight artificial roost records, nine foraging individual records, and one record each for echolocation calls and natural cavities, utilizing their available coordinates to create a distribution map. Detailed information on all records can be found in Table 2, which provides a comprehensive review of the data.

The altitudes of each locality were extracted from the Digital Elevation Model (DEM) of Guilan province. The resulting map revealed a regular pattern of distribution for bat records based on their altitudes (Figure 6). All 12 cave roosts, with the exception of Shoupar-Chal, were situated between 300 meters to approximately 2000 meters above sea level, whereas artificial roosts, including barns and attics, were less than 120 meters in height. Around 80 percent of the foraging bats were recorded in the Caspian lowlands, at least 22 meters below sea level. Two foraging records refer to the higher elevations. A few individuals of *Pipistrellus pygmaeus* were netted at an altitude of 406 meters above sea level. The other record was the capture of two individuals of *Eptesicus serotinus* in a wooded area in the Talesh mountains at an altitude of 1278 meters, dating back to 1968.

## CONCLUSION

This study represents the first attempt to investigate cave-dwelling bats in the western part of the Hyrcanian forests within the political boundaries of the Guilan province. A total of five species, including *Miniopterus pallidus*, *Myotis blythii*, *Pipistrellus pipistrellus*, *Rhinolophus hipposideros*, and *R. ferrumequinum*, as well as one generic level identification, *Rhinolophus* sp., were recorded from the caves of Guilan. *M. pallidus* was reported for the first time in the studied area, observed in two caves in rather large colonies. Furthermore, *R. hipposideros* was documented for the first time in cave roosts in this region, and the occurrence of *R. ferrumequinum* was confirmed after more than 100 years without any records of observations. Two key cave roosts were monitored throughout the year and described in detail, emphasizing the necessity of continuous monitoring to obtain accurate information about bat colonies. Additionally, *Pipistrellus kuhlii* was reported from non-cave habitats. Although this study has improved the data on caves and their bat fauna in Guilan province, there is still much work to be done. Also, accurate data is crucial for any conservation program, and persistent and regular field studies utilizing the latest technologies and equipment should not be overlooked.

## ACKNOWLEDGMENTS

We kindly thank Helaleh Nategheh and Sharareh Shafiei for their invaluable accompanying in all field studies and cave explorations. Also, we are greatly thankful to Majid Tajvar, Saman Alinejad, Davood Shahnazari, and Nima Farid-Mojtahedi for either accompanying in field trips or providing sources and guidance.

## LITERATURE CITED

Akmali, V., Mehdizadeh, R., Chaghamirza, K., Moradi, M., Sharifi, M., 2015. Taxonomic evaluation of the bent-winged bat (*Miniopterus*) populations occurring in Iran inferred from mitochondrial cytochrome-b sequences. *Mammalia* 79(4), 449-455.

Akmali, V., Abbasian, M., Parsatabar, H., Malekpour Fard, Z., 2019a. Distribution and new records of cave-dwelling bats in the Central Zagros Mountains, Lorestan province, Iran. *Iranian Journal of Animal Biosystematics* 15(2), 157-170.

Akmali, V., Shahabi, S., Zagmajster, M., 2019b. Bats of Tadovan Cave in southern Iran: their occurrence in the cave, and conservation issues. *Cave and Karst Science* 46, 1-8.

Akmali, V., Abedini, S., Malekpour Fard, Z., 2022. Bat fauna and conservation assessment of Kurdistan caves, Iran. *Subterranean Biology* 18(42), 79-95.



- Altringham, J. D., 2011. Bats: from evolution to conservation. Oxford University Press.
- Benda, P., Faizolahi, K., Andreas, M., et al., 2012. Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 10. Bat fauna of Iran. *Acta Societatis Zoologicae Bohemicae* 76(1–4), 163–582.
- Culver, D. C., Pipan, T., 2019. The biology of caves and other subterranean habitats. Oxford University Press.
- DeBlase AF (1980) The bats of Iran: systematics, distribution, ecology. *Fieldiana Zoology*, 424 pp. <https://doi.org/10.5962/bhl.title.3206>
- Dehdar-Dargahi, M., Farid-Mojtahedi, N., 2014. Natural attraction of Guilan (geology and geomorphology). Farhang-e Ilia press. (In Persian)
- Dietz C, Von Helversen O (2004) Illustrated identification key to the bats of Europe. Tuebingen and Erlangen, Germany, 72 pp.
- Etemad, E., 1970. A note on the occurrence of the giant noctule, *Nyctalus lasiopterus* Schreber, 1780, in Iran (Chiroptera: Vespertilionidae). *Mammalia* 34, 547.
- Farhang-azad, A., 1970. Report on the 1969 Survey of Small-mammal-borne Diseases in Iran. Part I. Unpublished report. Tehran: Iran-WHO International Epidemiological Research Centre, Institute of Public Health Research, University of Tehran.
- Farid-Mojtahedi, N., 2013. The mountains of Guilan. Farhang-e Ilia Press. Iran, 143 pp. (In Persian).
- Farid-Mojtahedi, N., Abed, H., Negah, S., Owji, R., Hadinejad-Saboori, S., Momenpoor, F., 2018. The climate of Guilan. Farhang-e Ilia Press. Iran, 812 pp. (In Persian)
- Fathipour, F., Sharifi, M., Akmal, V., 2016. Distribution of cavernicolous bat fauna in Ilam Province, Western and Southwestern of the Iranian Plateau. *Iranian Journal of Animal Biosystematics* 12(1), 97–110.
- Jahani, V., 2017. Archaeological caves of Guilan. Farhang-e Ilia Press. Iran, 134 pp. (In Persian).
- Khajeh, A., Mohammadi, Z., Ghorbani, F., Jahantigh, H., 2021. Molecular and morphometric characterization of fruit bats of the genus *Rousettus* Gray, 1821 (Chiroptera: Pteropodidae) in Iran. *Zoology in the Middle East* 67(1), 1-11.
- Naderi, S., Mirzajani, A., Rajabi Maham, H., Hadipour, E., 2017. The mammals of Anzali Wetland in the Southern Caspian Sea. *Caspian Journal of Environmental Science* 15(3), 223-235.
- Shahabi, S., Akmal, V., Sharifi, M., 2017a. Distribution and new records of cave dwelling bats from Fars province in south west of Iran. *History* 18(59), 91–116.
- Shahabi, S., Akmal, V., Sharifi, M., 2017b. Taxonomic evaluation of the greater horseshoe bat *Rhinolophus ferrumequinum* (Chiroptera: Rhinolophidae) in Iran inferred from the mitochondrial D-loop gene. *Zoological Science* 34(4), 361-367.

- Shahabi, S., Sharifi, M., Akmal, V., 2019a. Echolocation call frequency and mitochondrial control region variation in the closely related bat species of the genus *Rhinolophus* (Chiroptera: Rhinolophidae) occurring in Iran: implications for taxonomy and intraspecific phylogeny. *Mammal Research* 64, 485-501.
- Shahabi, S., Sharifi, M., Akmal, V., 2019b. Potential geographic distribution and habitat suitability of the Greater horseshoe bat, *Rhinolophus ferrumequinum* (Chiroptera: Rhinolophidae) in Iran. *Journal of Wildlife and Biodiversity* 3(2), 40-51.
- Steiner, H. M., Gaisler, J., 1994. On a collection of bats (Chiroptera) from NE Turkey and N Iran. *Acta Scientiarum Naturalium Academiae Scientiarum Bohemicae Brno*, n.s 28(1), 1–37.
- Thomas, O., 1907. On mammals from northern Persia, presented to the National Museum by Col. A. C. Bailward. *Annals and Magazine of Natural History, Seventh Series* 20, 88–92.
- Tohidifar, M., Moser, M., Zehzad, B., Ghadirian, T., 2016. Biodiversity of the hyrcanian forests. A synthesis report. UNDP/GEF/FRWO Caspian Hyrcanian Forest Project.
- Yusefi, GH., Faizolahi, K., Darvish, J., Safi, K., Brito, J. C., 2019. The species diversity, distribution, and conservation status of the terrestrial mammals of Iran. *Journal of Mammalogy* 100(1), 55–71