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New Distributional Records of the Mediterranean Horseshoe Bat *Rhinolophus euryale* Blasius, 1853 (Chiroptera: Rhinolophidae) in Iran

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Abstract: We present a review of earlier records of the Mediterranean horseshoe bat *Rhinolophus euryale* Blasius, 1853 in Iran together with new distributional data obtained during a recent period (2014–2016). Until 2012, *Rhinolophus euryale* had been recorded from 18 localities in Iran. The present study describes 11 further localities, thus increasing the known geographical range of this species mainly over Zagros and Elburz Ranges at elevations between 900–2500 m above sea level.

Key words: *Rhinolophus euryale*, new records, Zagros Mountains.

Introduction

The family Rhinolophidae Gray, 1825 includes only one extant genus, *Rhinolophus* Lacépéde, 1799, occurring widely in temperate regions of the African, Australian, Indomalayan, Oceania and Palaearctic bioregions (Csorba et al. 2003). In addition to the single living genus, one extinct genus, *Palaeonycteris* Pomel, 1854, has been recognised (Wilson & Reeder 2005).

The Mediterranean horseshoe bat *Rhinolophus euryale* Blasius, 1853 is one of the six rhinolophid species occurring in Iran (DeBlase 1980, Benda et al. 2012). *Rhinolophus euryale* is mainly distributed in North Africa (Morocco, Algeria, Tunisia, possibly Egypt) and, through the Middle East, its geographical range extends to Turkmenistan. This species occurs also in the Mediterranean parts of the Middle East (DeBlase 1972, Benda & Horáček 1998), being recorded in Turkey, Iran and Levant. It inhabits both Mediterranean and Oceanic climatic regions, preying predominantly and selectively on moths; seasonally, other prey species may play important roles in its diet (Goiti et al. 2008, Russo et al. 2005). In Iran, *R. euryale* occurs in habitats of Mediterranean type, mostly those in the Zagros and Elburz Mountains (Sharifi et al. 2000, Benda et al. 2012). Published data on its distribution in Iran have been presented by Lay (1967), Etemad (1967), Felten et al. (1977), DeBlase (1972, 1980) Farhang-Azad (1970, 1971), Karami et al. (2008), Akmali et al. (2011a), Benda et al. (2012), Sharifi et al. (2000), Sharifi & Hemmati (2004), Fathipour et al. (2016) and Shahabi et al. (2017).

Rhinolophus euryale has experienced a dramatic decline in the Oceanic parts of its distribution (Aihartza 2004). Based on IUCN criteria, many states in its geographical range have reported declining populations and disappearing colonies. It has been inferred that overall population decline of this species has approached the 30% loss and, based on this estimate, the species is assessed as Near Threatened (NT) (Juste & Alcalde 2016). Roost disturbances and excessive visits of caves as well aw degradation and loss of foraging habitats are considered the main reasons for the declining trends of this species (Juste & Alcalde 2016, Petrov et al. 2014, Goiti & Aihartza 2008, Russo et al. 2002, 2005). The first attempt to evaluate

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the conservation status of *R. euryale* in Iran has been carried out by Sharifi et al. (2000). This assessment designated *R. euryale* as rare in a conservation evaluation system consisting of common, rare, very rare and extremely rare (Sharifi et al. 2000).

In this article, we present a review of earlier records of occurrence of *Rhinolophus euryale* in Iran and report new distributional records for this species.

Materials and Methods

The present survey was carried out from May 2014 to September 2016. The study targeted caves and crevices in the areas in western, northern and eastern Iran. Twelve caves representing different habitats were visited on 20 May 2014, 11 September 2014, 5 May 2015, 15 June 2015, 16 June 2015, 20 June 2015, 11 August 2015, 30 September 2015, 2 October 2015, 4 October 2015, 24 May 2016, 2 June 2016, 9 September 2016. All records were mapped and are presented in Appendix 1. The geographical position for each cave was recorded using a Garmin GPS unit (GPSMAP 60CSx; Garmin International, Inc., USA). Bats were netted with mist nets (6 × 3 m) placed on caves entrances or were collected using hand nets. In addition, air temperature and humidity were measured in the field and inside the caves using a digital thermo-hydrometer.

Identification of *R. euryale* was based on forearm length and presence of the complex noseleaf as described by DeBlase (1980). However, considering that *R. euryale* can be easily confused with *R. mehelyi* (Mucedda et al. 2009, Puechmaille et al. 2012), our identification procedure followed the following characters: the lancet of *R. mehelyi* is abruptly narrowed above the middle to a distinctly linear tip, allowing distinction from *R. euryale* that has a lancet narrowing gradually to its tip, with only a slight constriction (Dietz & von Helversen 2004). Also, *R. euryale* has its eyes partially covered by the margin of the noseleaf (more specifically the skin of the lancet) while, in *R. mehelyi*, the eyes are distant from the noseleaf (Mucedda et al. 2009). Although the presence of darker hair around the eyes may be useful to recognise *M. mehelyi*, it is not effective for

Table 1. External measurements of the Mediterranean horseshoe bats from the Kerend Cave, Kermanshah Province, western Iran. Data include number of individuals (n=10), mean (X) and standard deviation (SD).

Characters	X	±SD
Head and body length (HB)	46.78	4.26
Tail length (TL)	28	1.91
Forearm length (FA)	48.57	0.78
Ear length (E)	21.42	0.53
Length of hind foot (HF)	11.08	1.59
Tibia length (TBL)	21.28	0.56
Fourth digit length (D4)	61.16	1.91
Third digit length (D3)	68.17	1.28
Body mass (weight)	11.65	0.87

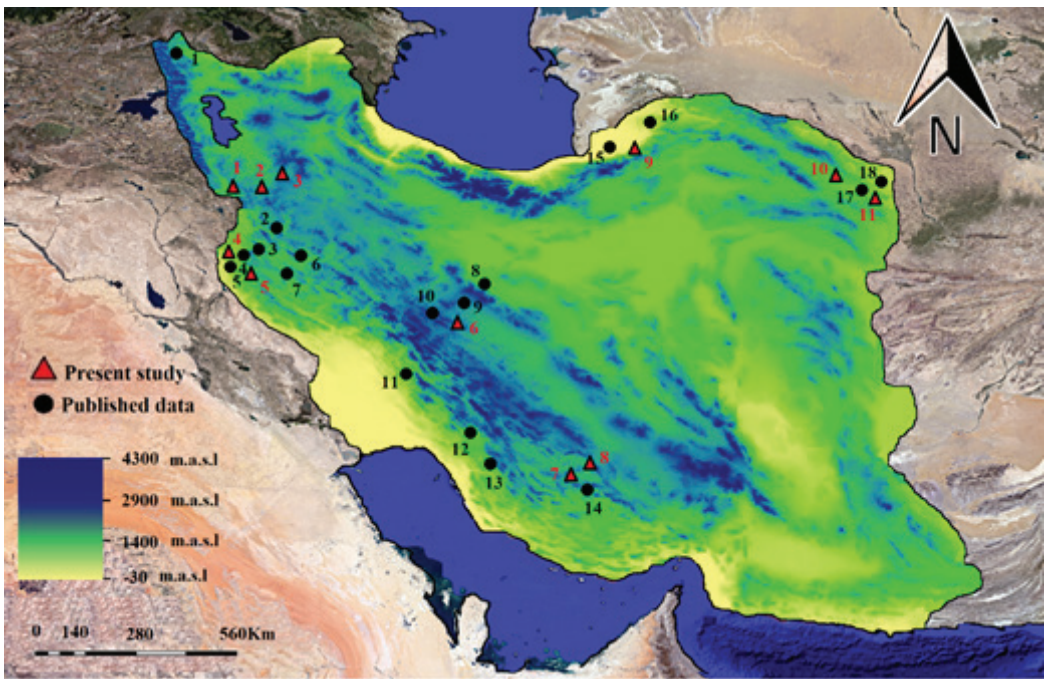

Fig. 1. Geographical distribution of the *Rhinolophus euryale* in Iran, including the records presented in this study (Triangle, Geographical coordinates of caves are summarised in Appendix 1) and earlier locality records provided from published data (circles, geographical coordinates of caves are summarised in Appendix 2).

Table 2. Bats co-occurring with *Rhinolophus eurayle*. Species names are abbreviated as follows.

No	Cave	Lat/N	Lon/E	*R.. eurayle*	*R.. ferrumequinum*	*R.. blasii*	*R.. mehelyi*	*Rhinopoma muscatellum*	*Myotis emarginatus*	*Myotis blythii*	*Miniopterus pallidus*	*Rousettus aegyptiacus*
1	Bezangan Cave	36°17′	60°26′	+		+					+	
2	Davazdahemam Cave	34°22′	45°58′	+	+			+	+	+		
3	Gara Tarik Cave	36°07′	47°55′	+								
4	Kamtaran Cave	36°01′	47°34′	+			+			+		
5	Palangan Cave	30°03′	52°44′	+								
6	Sarab Cave	32°18′	50°24′	+	+					+	+	
7	Shabpare Cave	30°16′	53°10′	+	+			+		+		+
8	Shoei Cave	36°00′	45°53′	+			+			+		
9	Taghdanlu Cave	37°27′	56°12′	+	+							
10	Tange rad Cave	33°53′	47°03′	+								
11	Zookenan Cave	36°38′	46°24′	+								

all samples. Pale colouration has been used cautiously to differentiate between the two species, as *R. mehelyi* are darker than *R. euryale*. Echolocation calls in *R. mehelyi* are expected to be lower than those of *R. mehelyi*, knowing that call frequency may overlap between the two species (Dietz 2007, Russo et al. 2005, Salsamendi et al. 2005).

Measurements were taken using a digital calliper to the nearest 0.01 mm. Seven external measurements were taken from live bats: head and body length (HB), tail length (TL), forearm length (FA), ear length (E), third digit length (D3), fourth digit length (D4), tibia length (TBL), length of hind foot (HF) as wells as body mass (weight), also taken from live bats (Sharifi & Akmali 2006).

Results

The occurrence points of *R. euryale* reported since 2014 are shown in Fig. 1 and Appendix 1. From 29 localities of *R. euryale* reported here, 11 are reported for the first time. Of these new localities, only three records are from the Elburz Mountain.Nine records are known from the Zagros Mountains. No specimens are presented from large biogeographical units in the country, such as deserts in the Iranian basin, Persian Gulf coastal area and the Mesopotamian Plain, east and south-east terrains and southern Caspian Sea coast. We also reviewed the available literature and found 18 previously published records of the species in different regions of Iran (Fig. 1, Appendix 2). *R. euryale* was reported in mountain areas ranging from 932 m a.s.l. in the Bezangan Cave (Khorasan Razavi Province) up to 2447 m a.s.l. in the Sarab Cave (Chahar-Mahal-e Bakhtiari Province). Over 75% of the localities reported for *R. euryale* were in the Zagros Mountains.

Two of the new localities are nursery colonies: the Kerend Cave (Kermanshah Province) in western Iran and the Zookenan Cave in north-eastern Iran (Khorasan Razavi Province). The most important biometric data obtained from the examined in this study *R. euryale* are shown in Table 1.

The summer aggregations in caves often included two or more bat species (*R. mehelyi, R. ferrumequinum* and *R. hipposideros*; Table 2). *Rhinolophus euryale* was also found to be associated with *Myotis emarginatus*, *Miniopterus pallidus* and *Myotis blythii*. Five bat species were found to share a roost with *R. euryale* in Dehbid, Ghaderabad (Fars Province) caves, including *R. ferrumequinum*, *M. blythii*, *Rhinopoma muscatellum*, *Rhinolophus mehelyi* and *Rousettus aegyptiacus*. Three bat species were found to share the roost with *R. euryale* in the Sarab caves (Chahar-Mahal-e Bakhtiari Province). These included *R. ferrumequinum*, *M. blythii* and *M. pallidus*. In the Davazdah Emam Cave (Kurdistan Province), we reported *M. emarginatus*, *M. blythii* and *Rhinopoma muscatellum* along with *R. euryale* (Table 2).

Discussion

In the present study, we have recorded *R. euryale* from twenty nine localities in Iran; 11 records are reported for the first time (Fig. 1, Appendix 1). We also have reviewed the literature data citing published records of the species in various regions of Iran (Fig.1, Appendices 1, 2). In order to avoid misidentification of *R. euryale* with two medium-sized rhinolophid species (*R. blasii* and *R. mehelyi*) that are morphologically similar and their differences can appear very subtle, we considered morphometric measurements and echolocation when identifying every species. The occurrence data for *R. euryale* show that this species is mainly distributed in various localities along the Zagros and Elburz Mountains (Fig. 1). The lowlands of the central deserts and the coastal areas along the Persian Gulf appear to be the natural limit of distribution of this species.

Rhinolophus euryale was found to share several roosts with other bat species, such as *R. blasii*, *R. ferrumequinum*, *R. hipposiderous, Myotis capaccinii, Myotis blythii* and members of *Rhinopoma*. In the Tadovan Cave (Fars), DeBlase (1980) has recorded five additional species: *Rhinopoma microphyllum, R. muscatellum, Rhinolophus hipposideros, R. blasii* and *Myotis capaccinii.* Benda et al. (2012) have recorded *Rhinopoma microphyllum, R. muscatellum, Rhinolophus ferrumequinum* and *Miniopterus pallidus* in the same cave. Akmali et al. (2011a) have also reported numerous co-occurring species in roosts of *R. euryale,* including *Rhinopoma microphyllum, R. muscatellum, Rhinolophus hipposideros, R. mehelyi, R. blasii, Myotis blythii* and *Miniopterus pallidus* in the Tadovan Cave, while in the present study only tree species have been documented in the Tadovan Cave (*R. euryale*, *Miniopterus pallidus* and *Rhinolophus hipposideros*).

There is evidence that bat population may have experienced a significant decline in caves visited in the course of the present study. E. g., in several caves that have been visited before such as the Moghan Cave (Khorasan Province) and the Bishapur Cave (Fars Province) by Benda et al. (2012), we have found no trace of bats. In some caves, comparison between old and fresh guano indicates a lower population size in recent years. It is very difficult to establish a firm basis for a quantitative assessment of population changes in bats of Iran due to the lack of information on the abundance of the population in the past.

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Appendix 1. Distribution records of *Rhinolophus eurayle* in the present study. The locality numbers correspond to the numbers shown in the distribution map of Iranian Mediterranean horseshoe bats in Fig. 1. Abbreviations: Alt = Altitude (meter), T = Temperature (Centigrade), H = Humidity.

Present data: Locality 1- Shoei Cave near Baneh, Kurdistan Prov., Lat: 36°00′N 45°53′E, Alt: 1893, T = 21° C, H = 56%; **Locality 2**- Kamtaran Cave, Kudistan Prov., 36°01′N 47°34′E, Alt:1782; **Locality 3:** Gara Tarik, Kurdistan Prov, N Qareh., Lat: 13, 36°07′N, 47°55′E, Alt: 2300, T = 23° C, H = 58%; **Locality 4**- Davazdah Emam Cave, Sar Pole Zahab, Kermanshah Prov. Lat: 34°22′N 45°58′E, Alt: 981,T = 27° C, H = 60%; **Locality 5**- Tange rad Cave, Aseman Abad, Ilam Prov., Lat: 33°53′N 46°24′E, Alt: 1521, **Locality 6**- Sarab Cave, Babaheydar, Chahar-Mahal-e Bakhtiari Prov., Lat: 32°18′N 50°24′E Alt: 2447, T = 18° C, H = 34%; **Locality 7**- Palanghan Cave, Fars Prov., Lat: 30°03′N 52°44′E, Alt: 1589; **Locality 8**- Shabpareh Cave, Ghaderabad, Gehbid. Fars Prov., Lat: 30°16′N 53°10′E, Alt: 1987, T = 32° C, H = 19.5%; **Locality 9**- Taghdanlu Cave, Khorasan-e Shomali, Prov., Lat: 37°27′N 56°12′E, Alt: 1165, T = 31.8° C, H = 55%; **Locality 10**- Zookenan Cave, Kenan, Khorasan-e Razavi Prov., Lat: 36°38′N 59°07′E, Alt: 1418, T = 13° C, H = 87%; **Locality 11**- Bezanghan Cave, Khorasan-e Razavi Prov, Lat: 36°17′N 60°26′E, Alt (932) T = 21° C, H = 55%.

Appendix 2. Distribution of the records that have been published earlier. The locality numbers correspond to the numbers shown in the distribution map of the Mediterranean horseshoe bats in Iran in Fig. 1. Abbreviations: Alt = Altitude (meter).

Review data: Locality 1- Maku Cave, in the mountain south of Zangmar River, 27 September, 2 and 6 October 1962, Lat: 39°18′N 44°31′E; **Locality 2**- 30 km NE of Bijar, shrine, 20 September 1969, Lat: 35°52′N 47°36′E (DeBlase 1972, 1980); **Locality 3**-Sanandaj, 11 September 1998, Lat: 35° 19' N, 47° 00' E, Alt: 1503 (Benda 2012); **Locality 4-** Kerend Cave , 5 km W Kerend-e Gharb, Lat: 34°17′N 46°13′E (Akmali et al. 2011a); **Locality 5**- Telesm-e Dobiran Cave Ilam, Lat: 33°50′N46°18′ E (Fathipoor et al. 2015); **Locality 6**- Khorazan Cave [= Tafrijan, Khorzeneh Cave] near Hamedan, Summer 1965: 34°46′N 48°35′E (Etemad 1967, 1984, DeBlase 1980); **Locality 7**- Eshkaf Dareze Cave, W edge of Khurramabad , 6 September 1968, Lat: 33°28′N 48°21′E (DeBlase 1972, 1980); **Locality 8**- Deh Zireh, 35 km SE of Kashan, 27 April 1996, Lat: 33°45′N 51°45′E; **Locality 9-**

Alavice [= Alavijeh] , 15 September 1998: 33°03′N 51°05′E; **Locality 10**- Shah Abbas Caves, Kuh Rang, cave, 1965, Lat: 32°18′N 50°13′E (Lay 1967, DeBlase 1972, 1980); **Locality 11**- Behbahan, Lat: 30°36′N 50°14′E (Etemad 1967, DeBlase 1980); **Locality 12**- Dashtak, 32 km SSW of Yasuj, 3 May 1996: 30°23′N 51°30′E; **Locality 13**- Bishapur, 19 km NW of Kazerun, large cave above the Sasan spring, Lat: 29°48′N 51°37′E; **Locality 14**- Tadovan Cave, 44 km NW of Jahrom, Lat: 28°51′N 53°20′E; **Locality 15**- Shir Abad Cave , 20 km NE Ali Abad, water cave, April 1998, Lat: 36°57′N 55°02′E (H. Zohoori 2008); **Locality 16-** Mohamed Reza Shah National Park, scrub forest, 14 August 1970, Lat: 37°32′N 56°22′E (DeBlase 1980); **Locality 17-** 71 km. SE Meshad, 30 July 1969, Lat: 36° 18' N, 59° 37' E, Alt: 983 1 m, IPHR (Farhang-Azad 1970a ex DeBlase 1980); **Locality 18-** Mozduran, Lat: 36°17′N 60°31′E (Felten et al. 1977, DeBlase 1980, Kock 1983, Benda et al. 2006).