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Cover: Whale Shark *Rhincodon typus* and Reef - made with poster colours. © P. Kritika.

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COMMUNICATION

First occurrence record of Indian Roundleaf Bat *Hipposideros lankadiva* in Rajasthan, India

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Abstract: An erroneously cited text of Wason by subsequent authors has led to the assumption that *Hipposideros lankadiva* was first recorded in Rajasthan in the Bhim Bharak caves of Jodhpur. A careful review of Wason's note revealed that it in fact mentioned another species from the genus, *H. fulvus.* This erroneous citation has led to several research articles published on the ecological aspects of this species to be misinformed. The authors discovered a small population of *H. lankadiva* in eastern Rajasthan and have monitored this new population since 2010. Since the Bhim Bharak cave location is erroneous, Kased Cave (26.2209N, 77.1024E) is the only location of *H. lankadiva* for Rajasthan and is therefore the first record of the species from the state.

Keywords: Bhim Bharak caves, Chiroptera, Jodhpur, Kased Cave, occurrence, population.

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Author contributions: All authors have contributed equally to this paper.

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INTRODUCTION

The Indian Roundleaf Bat *Hipposideros lankadiva* is endemic to southern Asia, and has been recorded from many parts of India, as well as neighbouring nations like Sri Lanka, Bangladesh, and Myanmar (Bates et al. 2015; Saha et al. 2015). *Hipposideros lankadiva* Kelaart, 1850 was described from the city of Kandy in the central hills of Sri Lanka (Bates & Harrison 1997). Three subspecies have been reported for this species of bat. The subspecies described from Sri Lanka is *H. lankadiva lankadiva* (Kelaart, 1850) and the subspecies from India is referred to as *H. lankadiva indus* (Andersen, 1918). The latter is small in size relative to the former (Bates & Harrison 1997). Bates et al. (2015) described a new subspecies, *H. lankadiva gyi* from Myanmar with its distribution in northeastern India, which is morphometrically similar to the Sri Lankan subspecies.

Many taxonomic accounts have contributed to chiropteran studies in Rajasthan, such as Blanford (1891), Ryley (1914), Wroughton (1918), Ellerman & Morrison-Scott (1951), Prakash (1963a,b, 1973), Agrawal (1967), Biswas & Ghosh (1968), and Sinha (1973, 1975, 1976, 1977). The first detailed taxonomic exploration of bats in Rajasthan was conducted by the Zoological Survey of India (Sinha 1980) which documented detailed descriptions, illustrations, and zoogeography of 21 bat species in the state. Later on, various explorers described new occurrence records and ecology of bats in Rajasthan (Sinha 1981; Sharma 1986; Bhupathy 1987; Bohra 2011; Senacha & Dookia 2013).

On the occurrence of *H. lankadiva* in Rajasthan

Bates & Harrison (1997) quoted a published note by Wason (1978) on the occurrence of *H. lankadiva* in the Bhim Bharak caves of Jodhpur, Rajasthan. However, Sinha (1980, 1996) did not discuss this bat's presence in the state, and this led to doubts about the occurrence of *H. lankadiva* in the state. Bats have been studied in the Thar desert by various scientists, especially those based in Jodhpur such as Prakash (1963a,b, 1973), Agrawal (1967), Biswas & Ghosh (1968), Sinha (1973, 1975, 1976, 1977, 1981), Sharma (1986), and Senacha & Dookia (2013). Thus, no prior reports of this species lent credence to the idea that the observation by Bates & Harrison (1997) is incorrect.

A careful review of Wason's (1978) note revealed that it mentioned another species from the genus—*H. fulvus*—and the inclusion of *H. lankadiva* was due to an error by Bates & Harrison (1997).

Srinivasulu et al. (2013), examined published literature and compiled a list of 25 bat species from Rajasthan, including *H. lankadiva* from the Bhim Bharak caves of Jodhpur. Interestingly, without physically verifying the note by Wason (1978), Srinivasulu et al. (2013) quoted the same distribution area for *H. lankadiva* in Rajasthan. It seems that while they may have followed Bates & Harrison (1997), they cited Wason (1978) for the occurrence of *H. lankadiva* in Rajasthan. Afterwards, many documents have included *H. lankadiva* for the state of Rajasthan (Menon 2014; Bates et al. 2015).

This erroneous citation has led to various research articles published on the ecological aspects of this species to be misinformed. For example, Dookia et al. (2017) expressed concern that *H. lankadiva* was not reported from the Thar desert since 1979. This erroneous location has also been used in spatial studies to predict new possible areas for the species (Venugopal 2020).

However, we recorded a small population of *H. lankadiva* in eastern Rajasthan and have monitored this new population since 2010, which was opportunistically discovered during a wildlife survey of the region. Since the Bhim Bharak cave location is erroneous, Kased Cave (26.2209N, 77.1024E) is the only location of *H. lankadiva* for Rajasthan and it is thus the first record of the species from the state.

Study Area

The population of *H. lankadiva* occurs in a natural cave between the Kailadevi Wildlife Sanctuary and National Chambal Gharial Sanctuary in Karauli, Rajasthan, India. The precise location is a Hindu religious site, known as the Kased Cave (26.2209N & 77.1024E) near the town of Karanpur (Figure 1). The cave is situated on a low hill close to the contiguous Vindhyan hill range of Kailadevi WS. Due to its holy status, no tree felling has occurred in its immediate vicinity although the local community has completely denuded its surrounding areas.

The cave is formed of sand stone. The main chamber of the cave is 12 x 12 m in size. This chamber is used by a "sadhu" (hermit) and other pilgrims alike to shelter, cook food, and perform devotional music. The height of the chamber is around 4.5–5.5 m from the centre, and form a dome shape. The surface is dark black in colour, as a result of exposure to smoke. In the main cave chamber, three narrow tube like tunnels further extend from it, one of them has a slow flowing stream and two of them are dry. When the pilgrims cook food for ritual offerings and create a disturbance, the bats move inside the narrow water tunnels. The water tunnel is 55–60 m long and a small stream flows through it year round. The main tunnel is 1–1.5 m high and 1–3 m wide. The temperature

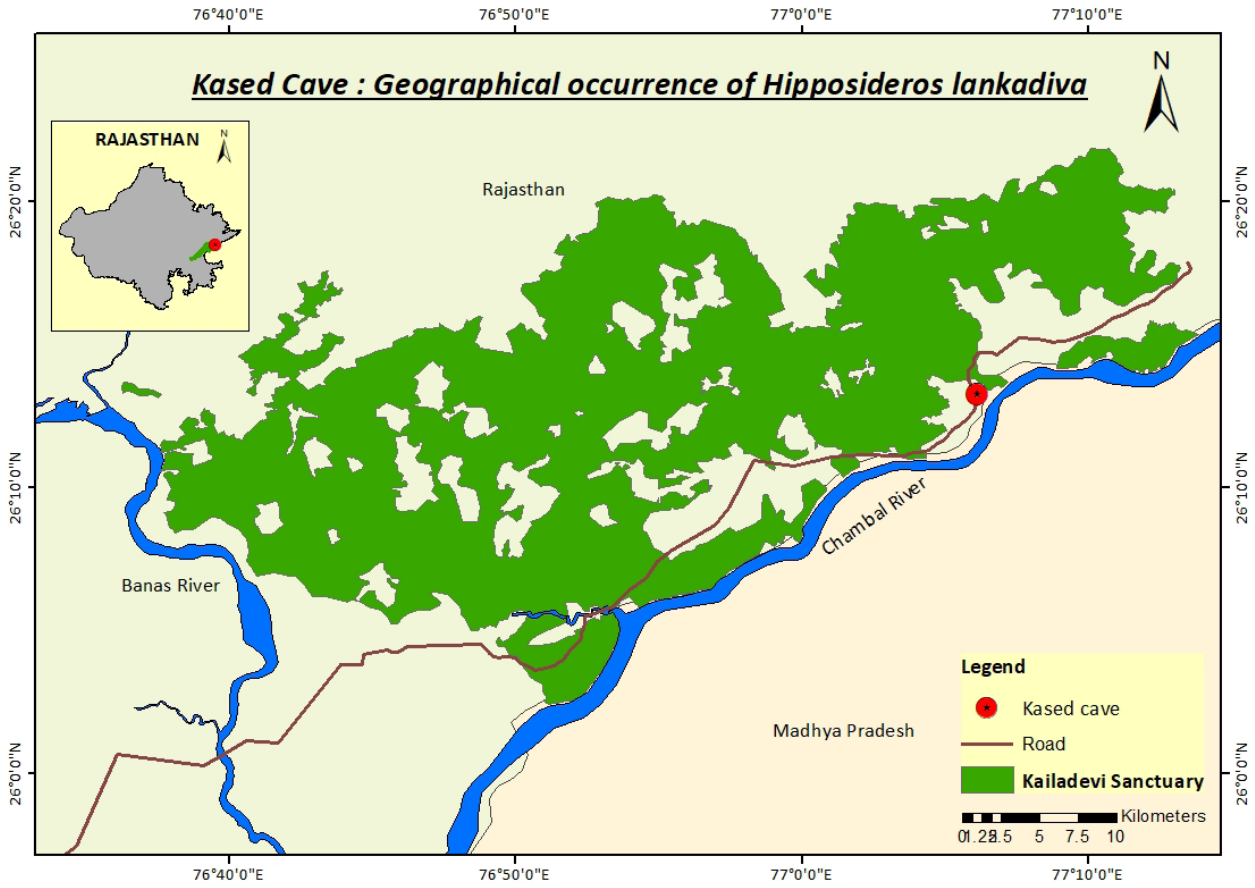

Figure 1. New distribution localities for Indian Roundleaf Bat *Hipposideros lankadiva* in Rajasthan, India

in this water tunnel stays the same year round, because it is underground and not affected by surface weather patterns. The temperature of the cave is usually close to the average annual temperature. During the study we found two other species of bats, *Lyroderma lyra* and *H. fulvus,* along with *H. lankadiva* at the same site.

The tree species found on the hill are *Anogeissus pendula, Mitragyna parvifolia, Crateva adansonii, Butea monosperma,* and exotic trees & herbaceous plants recently planted in the area by the guardians of the temple. A seasonal water stream forms a waterfall nearby. The surrounding area is high and the cave opening is in a depressed area, which makes it moist and cool. The nearby areas are comprised of a mosaic of agriculture fields and scrubland. The Chambal river 1.2km away from the cave site. An undulating landscape consisting of ravines exists between the Chambal river and Kased Cave.

MATERIAL AND METHOD

Basic data of habitat and the surroundings has been collected like measurements of the cave and vegetation species. Five individuals of the species were captured in hand nets at Kased Cave, Karanpur, and Karauli (Figure 1). Specimen and habitat photographs were taken with the help of Nikon D850 DSLR with 300 mm, 17–35 mm lens. Morphological data was taken by manual examination in which measurements were taken with a digital calliper and compared with earlier findings (Srinivasalu et al. 2010; Bates et al. 2015; Saha 2015). The captured bats have been released after taking morphometric measurements. All data was compared with available literature to conclude a final result. Lux meter was used to observe the intensity of light in the cave (Lacoeuilhe et al. 2014). To detect if light intensity influenced roost selection in bats, lux values were observed at places where the bats roost. MS6610 high accuracy 0~50,000 LUX digital luxmeters illuminometer was used to measure the value of light.

RESULTS

We captured 5 individuals of bats (three males and two females) for morphometric analysis. (Table 1). The morphometric data revealed that the bat matches with the subspecies *H. lankadiva indus*. The pelage of the bats varied from yellowish-brown to dark brown (Image 1). They were darker on the head & shoulders and paler on the underside. For species identification we compare morphometric analysis from Srinivasalu et al.(2010), Saha (2015), and Bates et al. (2015). The average value of FA (mm) in three male samples was found to be 85.99 ± 2.12 and in two females to be 83.70 ± 0.65, respectively. Similarly (Saha 2015) the mean value of FA (mm) was 87.64 ± 3.62.

In the study of Srinivasulu (2010) the HBL (mm) range was 87.0–106.0 in males and females as well. In this study we have also rendered the range and mean value of HBL (mm) reported in (78.11–98.57) 89.62 ± 10.47 males and (91.28–92.81) 92.05 ± 1.08 females.

On the comparison of tail length, our observation is supported by Srinivasulu et al. (2010) and Bates et al. (2015). According to Bates et al. (2015), the tail length was found to be 35.0–47.0 (mm) in males and 40.0–45.0 (mm) in females. According to Srinivasulu et al. (2010) the vast range length of the tail (mm) was 35.0–58.0. The mean TL (mm) recorded in this study is 33.36 ± 2.24 in males and 37.80 ± 0.48 in females.

Morphologically, there is no extraneous character variation from different species ranges in males and

Table 1. Morphological Characters of *Hipposideros lankadiva* (Kelaart, 1850).

Body characters	Srinivasulu et al. 2010	Saha 2015	Bates et al. 2015		Present study						
					Male				Female		
			Male	Female	Male 1	Male 2	Male 3	AVG	Female 1	Female 2	AVG
Forearm Length FA (mm)	75.0–99.0	87.64±3.62	80.1–87.0	75.0–89.0	86.76	83.59	87.62	85.99±2.12	83.24	84.16	83.70±0.65
Head Body Length HBL (mm)	87.0–106.0	98.1±4.24	NA	NA	78.11	98.57	92.17	89.62±10.47	92.81	91.28	92.05±1.08
Tail Length TL (mm)	35.0–58.0	51.45±2.34	35.0–47.0	40.0–45.0	30.84	35.12	34.12	33.36±2.24	38.14	37.46	37.80±0.48
Hind Foot Length HFL (mm)	12.0–20.0	19.35±1.0	12.0–16.0	13.0–16.0	15.77	19.29	17.53	17.53±1.76	14.52	13.88	14.20±0.45
Ear Length EAR (mm)	19.5–30.0	27.6±2.05	22.0–26.0	19.5–27.0	23.19	26.93	27.11	25.74±2.21	26.39	28.63	27.51±1.58
Length of Tibia TIB (mm)		35.55±2.48			35.02	33.89	34.46	34.46±0.57	33.15	34.09	33.62±0.66
No. of Supplementary Leaflets	4	NA	NA	NA	4	4	4	-	4	4	-
Narial Lappets	Well-developed	NA	NA	NA	Well-developed	Well-developed	Well-developed	-	Well-developed	Well-developed	-
Length of Third Metacarpal 3MT (mm)	NA	67.71±0.79	57.2–63.7	57.0–65.0	56.7	62.18	60.41	59.76±2.80	58.49	58.43	58.46±0.04
Length of Fourth Metacarpal 4MT (mm)	NA	NA	57.2–61.8	55.3–63.6	58.26	55.59	62.31	58.72±3.38	60.18	58.93	59.56±0.88
Length of Fifth Metacarpal 5MT (mm)	NA	NA	50.7–56.9	49.7–58.6	49.73	51.14	50.19	50.35±0.72	47.78	50.12	48.95±1.65
First Phalanx of the Third Digit 3D1P	NA	31.60±1.17	25.4–28.5	26.0–30.0	26.14	25.82	26.15	26.04±0.19	28.43	28.07	28.25±0.25
Second Phalanx of the Third Digit, 3D2P (mm)	NA	34.34±1.23	24.4–28.4	24.5–28.8	28.39	28.79	29.88	29.02±0.77	27.12	27.86	27.49±0.52
First Phalanx of the Fourth Digit 4D1P (mm)	NA	NA	19.0–21.8	19.4–21.1	20.11	21.23	20.44	20.59±0.58	21.16	20.78	20.97±0.27
Second Phalanx of the Fourth Digit 4D2P (mm)	NA	NA	11.2–14.0	12.5–14.1	9.96	11.49	12.23	11.23±1.16	11.56	11.93	11.75±0.26
Nose-leaf	NA	11.17±0.09	NA	NA	9.92	10.19	10.06	10.06±0.14	10.56	10.89	10.73±0.23

Image 1. Portrait of Indian Roundleaf Bat *Hipposideros lankadiva*.

Image 2. Close of an Indian Roundleaf Bat *Hipposideros lankadiva* face.

females between our five samples and the reference value (Bates et al. 2015). *H. lankadiva* (Kelaart 1850) is a Large Leaf-nosed Bat having four (additional) supplementary leaflets on the nose-leaf with the 4th leaflet reduced, which is a key character of the species are present in all specimens (Image 1). The length of the ear is also an important parameter by which we can see the account of the species. According to Bates et al. (2015) the range of ear length (mm) in females was found to be 19.5–27.0, but in our study, the maximum value of female ear (mm) was found to be 28.63 and the average value was recorded as 27.51 ± 1.58. In the same cave, we found 89 *L. lyra* and four *H. fulvus* bats along with *H. lankadiva.*

We also surveyed the Bhima Bharak cave site at Jodhpur. No specimens of *H. lankadiva* were found in the main part of the cave (Shiva Temple) and in the lower part of the cave. We found 39 individuals of *Taphozous perforatus* and four *Rhinopoma hardwickii* at the cave. During this study, we personally communicated with Anil Wason to investigate if the species had ever been reported by him in the past, but Wason categorically denied ever observing or reporting *H. lankadiva*.

There was a considerable difference between the internal climate and light intensity inside Kased Cave and outer area of the cave, where the value of light intensity was measured to be 62 lux on the opening of the cave. By comparison, the internal light intensity at the site in Karauli was measured at zero lux. The bats prefer zero lux intensity area of the cave. Humidity of the Kased Cave in Karauli was also recorded at more than 50% with water source availability.

DISCUSSION

The species *H. lankadiva* has been observed for the first time in 2010 by the authors in Rajasthan, but it has been first reported now in 2022. This delay in reporting is because of the species already being listed on the bat checklist of Rajasthan, which was the consequence of the erroneous inclusion. Bates & Harrison (1997) erroneously included the bat in Rajasthan and some other reports strengthened this erroneous record

like Srinivasalu et al. (2013) and Bates et al. (2015). Srinivasalu et al. (2013) and Bates et al. (2015), have not only erroneously included the bat, but also cited a wrong reference for Wason (1978), i.e., Srinivasalu et al. (2013) mentioned "44(5): 305–306"; whereas Bates et al. (2015) mentioned "46(5): 331–332", while the correct reference is 43(5): 305–306. It seems like they mixed Wason (1978) with another reference, Wason & Misra (1981) and it is important to note that neither mentioned *H. lankadiva*. The erroneous report perpetuated and impacted many other studies like Venugopal (2020).

Venugopal (2020) used a habitat modelling approach (MaxEnt) based on known locations, to predict new possible geographic presence of *H. lankadiva*. The study also included the erroneous Bhim Bharak location, which misinformed the study and, in all likelihood, must have had an adverse impact on the results, which may have expanded the predicted distribution area of the species. Since this erroneous location is far from the other known locations and lies in a new biogeographic zone, the magnitude of the error could be substantial. The majority of the predicted suitable areas were in and around known localities which are in the Western Ghats and central India (Venugopal 2020). The predicted areas around western Gujarat and Rajasthan, may be due to inclusion of sites where this species has been incorrectly identified. The Jodhpur lies in totally different biogeographic zone.

It is proved that the report of *H. lankadiva* from the Bhim Bharak caves, Jodhpur, Rajasthan is erroneous, and must be omitted from the list of bats occurring in that particular part of Rajasthan, so that it does not continue to perpetuate and impact any further studies.

The newly reported site has a very small population and shows a decline in numbers. The Kased Cave location is under observation by the authors since December 2010 and at that time the number of bats was 150–200 as per personal records. At present, the number shows that the bats are declining in the area and their numbers are five times lower. In the most recent survey (October 2021) we recorded only 32–35 bats. The anthropogenic disturbance level in the cave has also increased. The conservation status of *H. lankadiva* is listed by the IUCN Red List as 'Least Concern' (Molur et al. 2008). Rajasthan is geographically the most largest state in India and only Sinha (1980) conducted comprehensive chiropteran species exploration work throughout the state. Most other studies are sporadic and opportunistic. There is still an immense opportunity for greater chiropteran exploration in the state.

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