

ORIGINAL ARTICLE

New records of the Wroughton's Free-tailed Bat (*Otomops wroughtoni*) and its activity in the vicinity of wind turbines in western India

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ABSTRACT

Otomops wroughtoni is one of the rarest and most enigmatic species of bats in South and Southeast Asia. The species was first discovered from Barepede caves in Karnataka, India. In subsequent years a single individual was reported from Cambodia followed by discoveries of a few roosts in Northeast India. The species was initially classified as Critically Endangered but later it was moved to Data Deficient category in the IUCN status due to the lack of knowledge regarding its habitat, breeding, diet, distribution and population. The species is also listed in the schedule I of The Wildlife (Protection) Amendment Act, 2022 granting it the highest level of protection in India. We report a new distribution record of *Otomops wroughtoni* from the northern part of the Western Ghats, 250km north from its previously known distribution. We recorded 69 acoustic detections of the species over 54 nights while comparing bat activity in areas with and without wind turbines. The presence of this protected bat species within a wind farm raises critical concerns, as wind farms are a known global threat to open-space foraging bats. This study reinstates the value of acoustic surveys in identifying the distribution of data-deficient, high-altitude, open-space foraging bats. As the only recordings of individuals away from known roosts, our observations provide an understanding of the natural history and habitat of a poorly-known species.

INTRODUCTION

The Wroughton's Free-tailed Bat (*Otomops wroughtoni*), is one of the eight species within the *Otomops* genus, with its distribution restricted to only two Asian countries (Patel et al. 2024). This species is visually distinctive, characterized by an average forearm length of approximately 64 mm and is notably distinguished by its dark chocolate-brown dorsal coloration and a thin white border along each flank (Bates & Harrison 1997, Ruedi et al. 2014). The species was first described by Michael Rogers Oldfield Thomas in 1913 based on specimens collected by S.H Peter from the Barapede Caves in Karnataka, south-western India (Thomas 1913). For 88 years, *Otomops wroughtoni* was known only from this location until new records emerged when an individual was captured in Cambodia in 2001 (Walston & Bates 2001), and another was documented in the Shella Confederacy of Meghalaya in Northeast India in 2002 (Thabab & Bates 2002). These findings indicated that the species' distribution was more widespread than previously understood. In 2014, speleologists exploring and mapping caves in Jaintia Hills, Meghalaya, discovered three new roosts of *Otomops wroughtoni* (Ruedi et al. 2014), and in 2021 an additional roost was identified in the South Garo Hills of Meghalaya

(Patel et al. 2024). Initially classified as Critically Endangered by the International Union for Conservation of Nature (IUCN) due to its limited distribution, the species status was later revised to Data Deficient following the capture of individuals in Meghalaya and Cambodia (Prabhukhanolkar 2016). Furthermore, *Otomops wroughtoni* is listed under Schedule I of The Wildlife (Protection) Amendment Act, 2022, which provides it with the highest level of legal protection in India.

Out of all the previous records of this species, only the one from Cambodia is of a foraging individual, the remaining were roost observations. As free-tailed bats fly at high altitudes they are rarely captured in mistnets (Denzinger & Schnitzler 2013). Acoustic sampling presents tremendous opportunities in understanding the distribution and habitat use of high-flying bat species (Deshpande & Kelkar 2015). In 2015, the echolocation calls of *Otomops wroughtoni* were reported for the first time (Deshpande & Kelkar 2015). However, these reference recordings have hitherto not been used to survey this Data Deficient species. In this note, we report the occurrence of this rare and enigmatic species 250km away from the previously known roost through acoustic sampling, which we discovered while conducting a study on the effects of wind energy on bats.

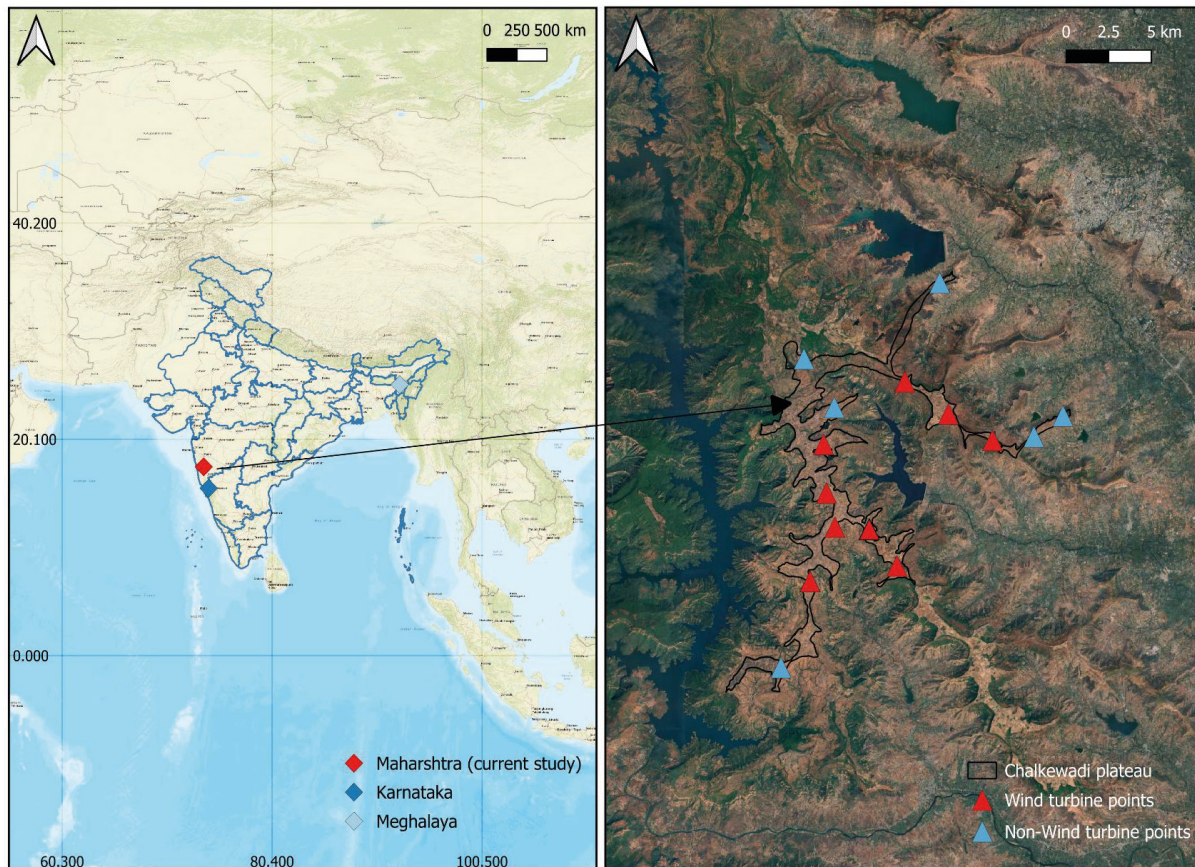


Fig. 1 - Map of the study area with states from which the species was previously known and sampling points where it was detected.

MATERIALS AND METHODS

We were conducting a study on the impacts of wind energy on bats in Chalkewadi plateau (17.544139°, 73.842584°) of Satara district in the state of Maharashtra, India during the months of February, March, September, October and November 2024, when we opportunistically detected *Otomops wroughtoni* using bat detector (see Supplementary Material 1 (SM1) for geographic coordinates of sampling points where *Otomops wroughtoni* was detected). The plateau extends 30 km in length, has an average width of 3.6 km and is situated at an average elevation of 1137 m above sea level (a.s.l) in the Western Ghats biodiversity hotspot. It is bordered by dams and rivers on all sides and the Sahyadri Tiger Reserve to the west (Fig. 1). It is also home to one of India's oldest wind farms. The main habitats seen in the plateau area are rocky outcrops, grasslands, shrub clusters, dense tree clusters, perennial ponds and seasonal streams. Their unique topographical features, such as high elevation and the absence of large woody vegetation, make them suitable for wind farms, resulting in the establishment of approximately 1000 wind turbines along with supporting infrastructure since around 2002 (Karandikar et al. 2015).

For our study we randomly selected 10 sampling points each in wind turbine and non-wind turbine areas (at least 1 km away from the nearest wind turbine) using Google Earth, ensuring a minimum distance of 2 km between points. We recorded bats using an Echo Meter Touch 2 (Wildlife Acoustics, Maynard, USA) paired with an Android device, capable of recording frequencies up to 128 kHz during the summer season and Echo Meter Touch 2 Pro capable of

recording up to 192kHz in the post-monsoon season. At each sampling point, we conducted point counts by recording for 15 minutes at any time between sunset and 12:00 am. Multiple points were sampled in a given night but each individual point was resampled on eight separate nights. The entire study was conducted over 82 nights amassing a total sampling effort of 4,800 recording minutes (2,400 minutes each in wind turbine and non-wind turbine areas combining both seasons). We analysed all the recordings using Raven Pro 1.6 software (Cornell Lab of Ornithology, Ithaca, USA) and identification of *Otomops wroughtoni* relied on echolocation calls, with spectral structure and frequency parameters examined in the software's spectrogram and cross-referenced with published data on Indian bat calls (Deshpande & Kelkar 2015, Chakravarty et al. 2020, Shah & Srinivasulu 2020, Raman & Hughes 2021). Each 15-minute recording was broken down into one-minute segments in which we marked the presence of each bat species. We hereby refer to the species presence with at least 2 clear pulses in a one-minute interval as a "detection". Call parameters such as Begin time (BT), End time (ET), End Frequency (EF), Start Frequency (SF), Duration (D), Frequency with maximum Energy (FmaxE) and Bandwidth (BW) were extracted for all clear echolocation pulses in each 1-minute interval and very faint pulses were avoided. The analysis was done in Hanning window with a Fast Fourier Transform (FFT) size of 512 in the software. Given the slight overlap in call frequencies of *Otomops wroughtoni* and *Tadarida aegyptiaca*, we compared the means of EF and FmaxE of calls identified as *Otomops wroughtoni* and *Tadarida aegyptiaca* using a Wilcoxon Rank Sum Test. The statistical analysis was conducted using R software (version 4.4.2).

RESULTS AND DISCUSSION

The presence of *Otomops wroughtoni* was confirmed using the acoustic key published by [Deshpande and Kelkar \(2015\)](#). The calls of *Otomops wroughtoni* ([Fig. 2](#)) which we recorded had a start frequency of 18.17 ± 1.60 kHz, end frequency of 14.91 ± 0.44 kHz, and FmaxE of 16.63 ± 0.79 kHz (see [Table 1](#)) in the first harmonic. In total, we recorded 69 detections of *Otomops wroughtoni* with 44 detections during dry season and 25 during wet season, in which 49 detections occurred in areas without wind turbines and 20 detections occurred in areas with wind turbines, in a total of 54 nights out of 82 sampling nights.

Acoustic surveys are particularly effective for studying species in the Molossidae family, as these bats typically fly at high altitudes, making them difficult to capture using harp nets and mist nets ([Vaughan 1966](#), [Schnitzler & Kalko 2001](#), [Voigt & Holderied 2011](#), [Deshpande & Kelkar 2015](#)). The calls we recorded were consistent with the acoustic characteristics of *Otomops wroughtoni* as confirmed by the acoustic key published by [Deshpande and Kelkar \(2015\)](#). According to this key, bat calls with an EF below 15.5 kHz and FmaxE above 14.5 kHz are indicative of *Otomops wroughtoni*. All the calls we analysed fell within an EF range of 13.4–15.4 kHz and an FmaxE range of 15.1–18.7 kHz, aligning well with

the established criteria. We also compared our recorded calls to the mean $\pm$ standard deviation of call measurements reported in previous literature ([Table 1](#)). While our recordings showed slight variations, they remained within the range defined by the acoustic key. Variability in bat calls, even within the same species, has been documented and can result from factors such as weather conditions and local ambient noise. Changes in weather, for example can influence echolocation call frequencies by affecting atmospheric attenuation and the bats physiological state ([Wu et al. 2021](#)). Slight differences may also emerge due to recording devices. For example, [Deshpande and Kelkar \(2015\)](#) used Pettersson D240x Ultrasound detector while we used Echometer Touch 2 and Echometer Touch 2 Pro detectors. Although these effects have not been specifically studied in *Otomops wroughtoni*, they may explain the minor differences in call frequencies observed in our recordings compared to previous studies. Among the species detected in the study area, *Tadarida aegyptiaca* is the only one with calls that could potentially overlap with those of *Otomops wroughtoni*. According to the acoustic key, calls with an EF above 15.5 kHz and a FmaxE below 21.2 kHz are classified as Egyptian free-tailed bat (*Tadarida aegyptiaca*). Both species exhibit a shallow frequency-modulated (FM) call structure, typical of free-tailed bats ([Deshpande & Kelkar 2015](#)). However, the calls we recorded were distinct enough

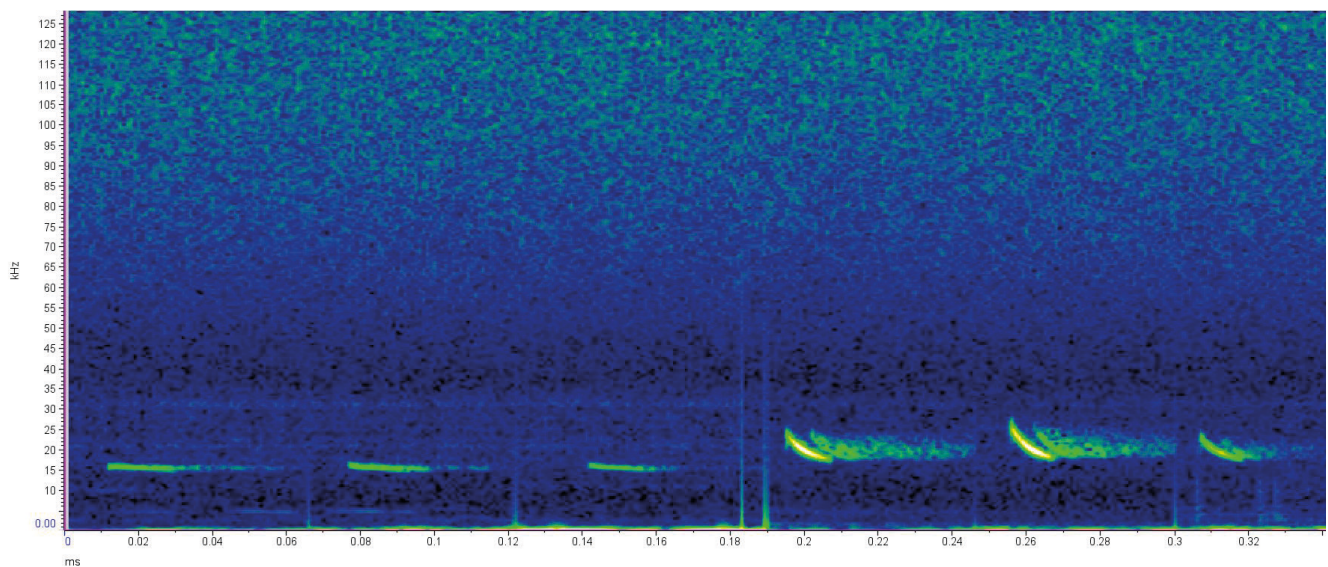


Fig. 2 - Acoustic calls of *Otomops wroughtoni* and *Tadarida aegyptiaca*

Table 1 - Call parameters of *Otomops wroughtoni* compared with other literature

Species	Category	Start Frequency(kHz)	End frequency(kHz)	FmaxE (kHz)	Data source
<i>Otomops wroughtoni</i>	Release calls	18.5	12.4	15.3	Ruedi et al. 2014
	Calls emitted in open space (n=46)	21.5 ± 3.05	12.76 ± 0.99	15.12 ± 0.65	Deshpande & Kelkar 2015
	Calls emitted in clutter (n=310)	24.9 ± 2.31	13.00 ± 0.98	16.15 ± 0.93	
	Calls emitted in open space(n=69)	18.17 ± 1.60	14.91 ± 0.44	16.63 ± 0.79	Current study

to allow clear differentiation between *Otomops wroughtoni* and *Tadarida aegyptiaca* using the acoustic key (Fig. 2 and SM2). We also found significant differences between the means of EF ($W = 0$, $p < 0.001$), and means of FmaxE ($W = 262.5$, $p < 0.001$) of both species. Despite the significant differences between the two species, there is a chance that the calls overlapping in the upper and lower quantiles of the violin plot may have been misidentified (SM2). However, these were very few recordings that would only slightly reduce the number of *Otomops wroughtoni* detections.

The wing morphology helps *Otomops wroughtoni* forage effectively at high altitudes (Norberg 1990, Fenton & Griffin 1997, Norberg & Rainer 1997). They produce narrow band shallow FM calls, which makes their calls travel long distances indicating that they are open-space foragers (Barclay & Brigham 1991, Denzinger & Schnitzler 2013). This foraging behaviour, characterized by flying in open areas at considerable heights, makes the species susceptible to wind turbine-related mortality. Even if these bats successfully avoid physical contact with the blades, they remain vulnerable to barotrauma, a condition caused by rapid pressure changes near the turbine blades, which can lead to fatal tissue damage in air-filled structures (Baerwald et al. 2008, Grodsky et al. 2011, Rollins et al. 2012). There have been reports of *Otomops harrisoni* mortality in wind energy facilities in Kenya (M.T. O'Mara pers.comm., 12 August 2024) and wind farms have also been reported as an emerging threat to *Otomops martiensseni* in Sub-Saharan Africa (Richards et al. 2016). The morphology and foraging characteristics of these species are very similar which makes *Otomops wroughtoni* also a potentially threatened species due to wind farm mortality in India (Thomas 1913, Long 1995). *Otomops wroughtoni* is currently classified as Data Deficient by the IUCN, indicating a significant lack of information regarding its breeding ecology, diet, distribution range, population trends and habitat preferences.

The area where we detected this species has not been previously surveyed for bats. It may also be noted that all previous records of *Otomops wroughtoni* from India are observations made at roosts and little knowledge exists on its foraging habitats. Although 250 km from its known roost in Barapede Cave, north Karnataka, the habitat in both sites is rather similar. Both areas have similar elevation, consist of lateritic plateaus and have moist deciduous forests in their vicinity (Prabhukhanolkar 2016). Similar habitats are prevalent across the northern Western Ghats (Jithin et al. 2023) and may represent suitable roosting and foraging habitats for *Otomops wroughtoni*. Morphological and genetic evidence by Kock et al. 2005 and Lamb et al. 2006 support the likelihood of seasonal migration in the African species *Otomops martiensseni*, which may be plausible in *Otomops wroughtoni* as well. All detections of the species in this study occurred within rocky outcrops with some areas having grasslands and patches of shrubs, some points also had steep cliffs nearby. Given that *Otomops wroughtoni* is known to roost in narrow crevices and requires elevated ground to take flight, these cliff faces may also represent potential roosting habitats. During the post-monsoon sampling, we observed increased water availability within the wind farm, which may partly explain why the species was detected in more sampling points within the wind

farm compared to summer, even though the number of detections was similar. An interesting recent observation is the report of a single *Otomops wroughtoni* individual from a biodiversity park in Delhi-NCR, capital region of India (Gandhiok 2024). If the species distribution is widespread and the reasons behind its sporadic occurrence in multiple places is unknown, then this study proves its point of acoustic surveys being very effective in helping find more populations and understanding their habitat choice better.

Our novel observations underscore the necessity for a comprehensive investigation and implementation of a rigorous population monitoring program across seasons, using acoustics for assessing the current status of *Otomops wroughtoni*, understanding its habitat use and identifying potential new locations where the species may occur. The species is granted the highest level of protection in India, therefore thorough surveys must be conducted before siting any developmental projects in its possible habitat. We also recommend intensive carcass searches in wind farms across the species potential range to investigate if wind energy is a significant threat to the species or not.

LIMITATIONS

Our study identified *Otomops wroughtoni* solely based on the published acoustic key by Deshpande and Kelkar (2015). Although the call of the species is very distinctive, our identification was not validated through direct capture or visual confirmation. Even though we conducted roost searches in the vicinity of the study area, these efforts ended up being unsuccessful. In India, biogeographical, behavioural variation in echolocation calls of bats remain undocumented therefore unrecorded variation can exist within a species. Additionally, the use of different detector models across seasons may have contributed to variation in detection probability and call quality. Microphone sensitivity, signal to noise ratio, and orientation can all effect detection probability and recording quality (Fenton 2000, Britzke et al. 2010, Adams et al. 2012, Turgeon et al. 2017, Darras et al. 2020). Due to differences in detecting algorithms and microphone sensitivity, data sets from various detectors may differ. Even when comparing detectors of the same model, the microphones need to be calibrated to provide comparable performance (Larson & Hayes 2000, Adams et al. 2012). The use of correction factors as discussed by Goodwin et al. 2024 is also recommendable while using different detectors.

Given these limitations, we adopted a conservative approach and assigned the identification of *Otomops wroughtoni* only to those detections that matched the described acoustic key both visually and statistically. We recommend that future surveys capture the variation in the frequencies of rare and data deficient species such as *Otomops wroughtoni*. In our study area, we recommend that future efforts include more intensive roost surveys to further ascertain the occurrence and status of *Otomops wroughtoni*.

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