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DISCOVERY OF NEW COLONIES OF THE RARE WROUGHTON'S FREE-TAILED BAT *OTOMOPS WROUGHTONI* (MAMMALIA: CHIROPTERA: MOLOSSIDAE) IN MEGHALAYA, NORTHEASTERN INDIA

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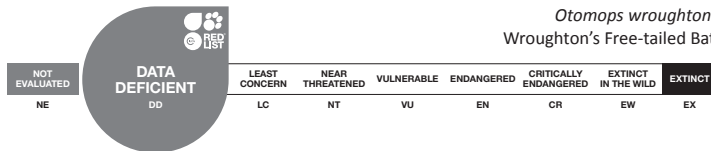
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Abstract: *Otomops wroughtoni* is an extremely rare molossid bat, known so far by a single breeding colony in southwestern India and two single individuals recorded in Meghalaya and Cambodia. We report here the discovery of three new roosts located in large karstic caves of the Jaintia Hills, in southeastern Meghalaya. Visual counts indicate that at least 90 individuals occupied these new roosts in February 2014, which doubles the known world population of this species. The new populations of Wroughton's Free-tailed Bats from the Jaintia Hills have considerable value for the conservation of this elusive species. Although these bats are protected under national

laws, their cave roosts and hunting habitats are subjected to severe and ongoing degradation. A protection plan that would include more extensive surveys and a strict conservation of these caves should be implemented rapidly to mitigate these threats.

Keywords: Breeding colony, conservation, Endangered species, Jaintia Hills, Molossidae, new roosts, *Otomops wroughtoni*.

Abbreviations: Fhi - highest frequency of call, expressed in kHz; Flw - lowest frequency of call; Fmx - frequency of call with most energy.



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Muzeul Național
de Istorie a României



Wroughton's Free-tailed Bat *Otomops wroughtoni* is a large, distinctive molossid known until recently by a single roosting colony located in a cave system in the Western Ghats of India (Thomas 1913; Prater 1914; Ramakrishna et al. 2003). Since its discovery by Thomas (1913), this roost was the only known locality occupied by that species (Bates & Harrison 1997), but recently single individuals captured in Meghalaya (Thabah & Bates 2002) and Cambodia (Walston & Bates 2001) suggest that its range might be much more extensive. However, as in other large molossids characterized by long and narrow wings (Fig. 1C; Fenton et al. 2004), *O. wroughtoni* is a powerful flyer that is certainly capable of covering large distances while foraging. Its distinctive external morphology (large size, huge ears projecting well beyond muzzle, bicolored, velvet fur; see Fig. 1A) make it easy to recognize and unlikely to be overlooked by previous bat researchers. In Barapede caves of the Western Ghats, visual observations indicate that Wroughton's Free-tailed Bats are present in the breeding colony throughout the year, although the total number of individuals present in the roost over the years fluctuate from 40 to over 75 (Ramakrishna et al. 2003). Both males and females occupy this roost and form small groups of 5–25 individuals. Reproduction was observed in December, with females carrying a single young. Given this apparent sedentary behavior, it is unclear whether the isolated bats found elsewhere are vagrants found far away from their breeding colonies, or whether they are part of yet unknown resident populations. Indeed, the single male caught with a harp trap placed at the entrance of Phlang Karuh Cave in the East Khasi Hills of Meghalaya in March 2001 (Thabah & Bates 2002) and the male captured by hand in a dipterocarp forest of Preah Vihear province in Cambodia in December 2000 (Walston & Bates 2001) might not have been roosting in the site of capture. Evidence for permanent populations living elsewhere than the Western Ghats is of considerable importance for the conservation of *O. wroughtoni*, which was initially classified as Critically Endangered due to its occurrence in a single area, but has now been placed in the category Data Deficient (Walston & Bates 2001; Francis et al. 2008).

During the long-term survey of caves of the limestone areas of Jaintia Hills, eastern Meghalaya, initiated by the Caving in the Abode of the Clouds Project (Harries et al. 2008; Arbenz 2013), we discovered new roosts of *O. wroughtoni*, doubling the number of known individuals of this species. We report here this discovery and describe the potential threats which should be mitigated to protect this rare bat (Image 1).

MATERIALS AND METHODS

In February 2014, a team of speleologists supported by the Meghalaya Adventurers Association began an expedition to identify new caves in the south-western parts of the Jaintia Hills. This initial survey included the localisation of caves known by local villagers, and by visual prospecting of karstic outcrops. Each located cave was explored and mapped, and its relevant biological fauna, such as the presence of bats or macro-invertebrates, recorded. To identify the species of bats occupying these potential roosts, they were captured with harp traps set near cave entrances or with a flap net (Borissenko & Kruskop 2003) if the roost was directly accessible. Upon capture bats were held temporarily in cotton bags, external measurements were taken with a dial calliper (to the nearest 0.1mm) and they were then released. Bats were handled carefully, following the standard guidelines for manipulating mammals (Sikes & Gannon 2011).

The frequency modulated calls were recorded from a distance of about 15m from the released bat with a Pettersson D240x bat detector (Pettersson Elektronik AB, Uppsala, Sweden). The 10x time-expanded calls were then transferred to an Edirol R05 recorder (Roland AG, Itingen, Switzerland) and analysed with BatSound Pro 3.31 (Pettersson Elektronik AB, Uppsala, Sweden) based on spectrograms with Hanning window at a sampling rate of 44,100 Hz and fast Fourier transformation size of 512. Call duration (in ms), pulse interval (in ms), lowest (Flw) and highest (Fhi) frequencies and the frequency with most energy (Fmax) were determined following Fenton et al. (2004).

Study area

The study area lies partly in the Amlarem Block (Kharkhana, Amsohrhong and Thangseh) and partly in the Khliehriat Block (Lama, Umlatdoh and Pynurkba) of the Jaintia Hills District, Meghalaya. It covers the central plateau and southern escarpment area comprised between 25°09'–25°16'N & 92°11'–92°18'E. The elevation ranges from 50m (near Kharkhana) to 890m (near Pynurkba). The two blocks are separated by the deep canyon of the large Myntdu River (Fig. 1). This river drains the waters coming from the Shillong plateau, which are highly polluted by the effluents from the intense coal mining activities occurring in this area (Blahwar et al. 2012).

The vegetation in the study area is also adversely affected by this unregulated mining activity and dominated by cultivated plants such as Areca Palm *Areca catechu*, Betel *Piper betel* and Broom Grass



Image 1. Portrait of an adult male *Otomops wroughtoni* captured in the Jaintia Hills (A), and details of its chest gland (B), pilosity of hindfoot (C) and shape of the wing (D).

Thysanachaena maxima, interspersed with isolated patches of semi-evergreen forest.

The Jaintia Hills District experiences a tropical monsoon climate (Sarma 2005). The rainy season occurs from mid-May to September with about 80% of the total annual rain falling during this period of the year. The annual rainfall is very variable depending on orographic situations, but ranges from 3797 to 7912 mm per year. October to November, and March to May are transition periods between the rainy and the dry seasons. The dry season coincides with the winter period (December–February) that is characterized by cold (about 8°C minimal temperatures in January) and dry weather conditions (61% relative humidity in December). The summer months are warmer (maximum mean temperature 24.5°C in August) and more humid (85% relative humidity in July).

RESULTS AND DISCUSSION

Thirty caves large enough to be potential bat roosts (i.e., >15m deep) were located in the general area comprising part of the southern escarpment of the

southwestern Jaintia Hills, i.e., within ca. 15km radius around the village of Lakadong (Fig. 1). Nearly 13km of underground habitats were explored and mapped. Bats were detected in 13 of them mostly as single lethargic individuals belonging to the genera *Rhinolophus* or *Hipposideros*. Larger numbers of bats were seen in three places and belonged to active colonies of *Eonycteris*, *Hipposideros* or *Miniopterus*, but the presence of recent guano and skeletal deposits in several other cavities suggested that other bat colonies occupied these roosts, at least temporarily.

We found *Otomops* in two distinct caves located near the villages of Pynurkba (cave 1; 25°15'N & 92°17'E; 860m) and Umlatdoh (cave 2; 25°12'N & 92°16'E; 730m). In a third cave near Thangseh (cave 3; 25°11'N & 92°12'E; 420m), we heard only the characteristic loud and audible screams emitted intermittently by alarmed Wroughton's Free-tailed Bats (Prater 1914) from deep inside a narrow crevice, but we were unable to see the bats. All three caves were large, collapsed doline cavities, with very wide (up to 15m) and high entrances (up to 15m) and situated in gullies covered

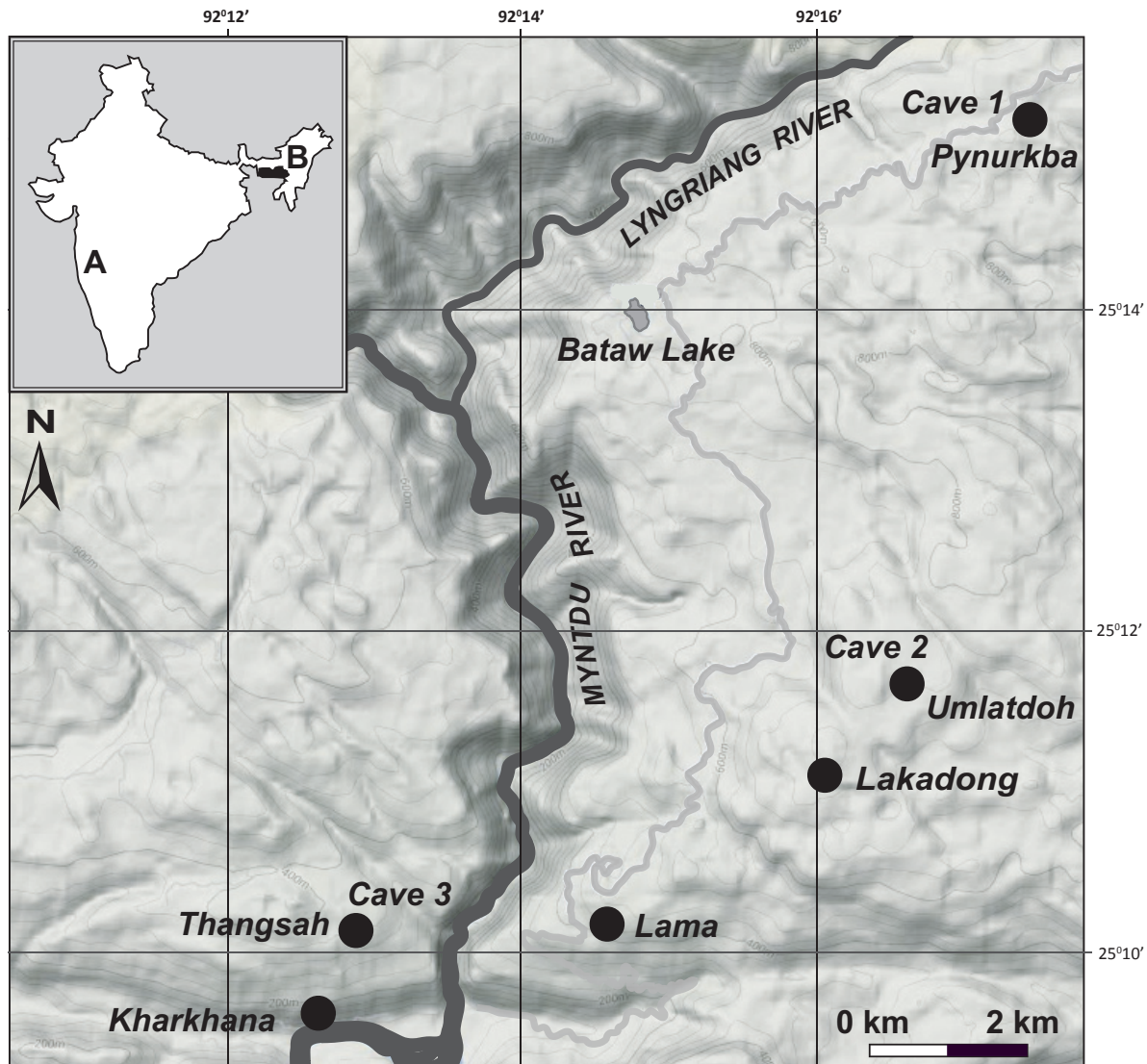


Figure 1. Location of the three new roosts of *Otomops wroughtoni* found in 2014 in the SE Jaintia Hills, in the oriental parts of Meghalaya. The inset is a general map of India showing the location of the historic roost at Karnataka, in the Western Ghats (A), and highlights the province of Meghalaya (B).

with secondary, semi-evergreen forests. The general topography of the region around these caves is hilly (Fig. 1), with relatively flat areas being covered by grassland or cultivated fields, interspersed with patches of forests. Small, temporary streams flowing into the gullies bring additional moisture to these patches of vegetation.

In the first two caves, larger aggregations (12–70 individuals) of Wroughton's Free-tailed Bats were found in relatively large cupola (avens) in the ceiling, while smaller groups (3–8 individuals) were roosting in narrower crevices of the ceiling. In all situations, the bats were roosting within 20–75 m of the cave entrance, at a height of 3–15 m. These cave characteristics are probably linked to the need of these large molossids to

gain speed by dropping from their roost before flapping flight (Norberg & Rayner 1987). Light from the outside was dim but still perceptible near most roosts occupied by *Otomops*. A small cluster of about 20 *Miniopterus magnater* was also observed in the first cave (cave 1), while caves 2 and 3 harboured few *Hipposideros larvatus* and *Rhinolophus* spp., but all these bats were roosting further inside the cavities, in areas of total darkness.

When we observed and counted the Wroughton's Free-tailed Bats in the early afternoon with head lamps, individuals were mostly torpid and reluctant to move to more concealed parts of their roost. None of these bats attempted to take flight, which made them particularly vulnerable to capture. At cave 1, we counted a total

of 82 visible individuals in two separate clusters (72 and 10 individuals, respectively), while at cave 2, there were a minimum of 15 *Otomops* located in three distinct crevices. At cave 3, bats could not be counted as they were concealed deeper in a narrow crevice. Although the gender of roosting individuals could not be determined, these bats appeared to be adults, with no smaller or young animals present at the time of visit. The two captured males had no signs of reproductive activity, such as enlarged testes. Hence, unlike animals in the Western Ghats (Prater 1914), the Jaintia Wroughton's free-tailed bats did not appear to reproduce at this time of the year (February), but this observation would need closer examination of more individuals, and at different times of the year, to be substantiated. Otherwise, the habitat settings and roost characteristics, as well as the aggregation behaviour of individuals in these caves of the Jaintia Hills correspond in all respects to observations made in the historic roosts of the Western Ghats (Prater 1914; Bates & Harrison 1997; Ramakrishna et al. 2003).

The following external morphological characteristics of two captured adult males were recorded: both animals had the very typical large ears and parti-coloured fur of Wroughton's Free-tailed Bats (Image 1), conspicuous chest glands (Image 1B), unusual pilosity on the upper surface of the forewings (Image 1D) and comb-like hairs along the toes (Image 1C). Head and body length was 92 and 85 mm; ear length was 34.3 and 26.9 mm; forearm length was 67.0 and 67.4 mm; tail measured from the anus to the tip was 49mm in both individuals; hindfoot length, including claw was 13.5 and 12.3 mm; and tibia length was 20.3 and 20.0 mm. Measurements of ear length or head and body length may be less accurate than other features because they were taken quickly on the live animals prior to release in order to minimize disturbances. Judging from the measurements listed in Walston & Bates (2001) for the various known Asian *Otomops* taxa, the general size of the two males from the Jaintia Hills corresponded well to that of other Indian specimens, while the Cambodian *O. wroughtoni* or *O. formosus* from Java are slightly smaller.

The echolocation calls of the two males recorded upon release were brief (about 3 ms) and emitted with relatively short inter-pulse intervals (48–60 ms); frequency-modulated sweep calls (F_{hi} = 18.5kHz; F_{lw} = 12.4kHz) and with most energy emitted at about 15.3kHz. As noted for the similar-sized *O. martiensseni* (Fenton et al. 2004), these echolocation call characteristics taken from hand-released bats may not correspond to normal search calls, which are usually less modulated, longer and with larger pulse intervals. These potential

differences should be checked with animals flying free near the roost entrances.

Conservation

Wroughton's Free-tailed Bats are currently considered as Data Deficient (Francis et al. 2008) owing to the scarcity of records (a single breeding colony and two widely disjunct individual records; Walston & Bates 2001; Thabah & Bates 2002) and the very small number of known individuals. The discovery of three new roosts in Jaintia Hills, with at least 97 additional individuals is thus a significant improvement in the global status of *O. wroughtoni* and confirms the existence of undetected populations, 2100km away from the historical roosts in Karnataka (Fig. 1). However, nothing is known about the population fluctuation or pattern of occupancy of this species in the limestone caves of Jaintia Hills, nor whether *O. wroughtoni* is breeding in this northernmost region. The exact numbers roosting in these caves are also unknown but they are certainly higher than the visual estimates made in February. Visual roost emergence counts together with bat detector recordings at different times of the year may help understand these aspects (Fenton et al. 2004). Knowledge of the foraging habitats of this rare bat is also urgently needed (Fenton et al. 2002). This urgency in Jaintia Hills is due to the ongoing and severe destruction of native habitats induced by unregulated limestone and coal mining (Blahwar et al. 2012; Arbenz 2013) or by logging activities that can quickly alter the vegetation (Sarma 2005). Areca nut and broom production are the main sources of income for the local people, and plantations of *A. catechu* and *T. maxima* are still being expanded, which again adversely affects potential foraging habitats of the bats.

CONCLUSION

The discovery of several new cave roosts of *O. wroughtoni* in Jaintia Hills of Meghalaya increases the number of known individuals in this rare species to close to 200, and considerably extends the geographic range occupied by significant populations. However, the extrinsic factors linked to habitat degradation combined with the intrinsic factors such as relatively small colony size, slow population growth, docile nature and their naturally rare occurrence, make it particularly vulnerable and at a high risk of local extinction (Racey & Entwistle 2000, 2003). Although Wroughton's Free-tailed Bats are classified as strictly protected species under the Indian Wildlife (Protection) Act 1972 (as amended in 2002), the caves in which they roost and the habitats in which they

forage in the Jaintia Hills are not. The extreme roost fidelity displayed by these bats over more than a century in the Western Ghats is also likely to be a characteristic of the Meghalayan populations of *O. wroughtoni*. Hence, it is imperative that these newly discovered cave roosts are fully protected as they are in great danger of not only being disturbed but also mined. Furthermore targeted education and awareness campaigns could prevent local bats from being destroyed, as indigenous people from the surrounding villages commonly hunt bats within caves for food.

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