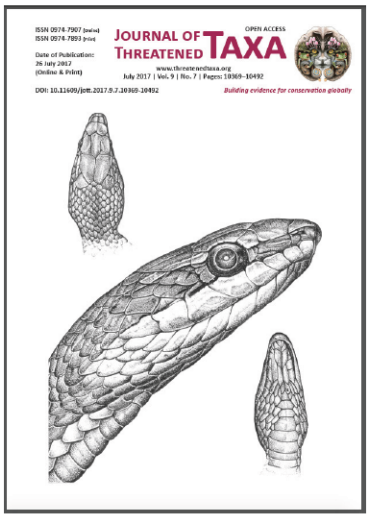

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Short Communication

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A new distribution record of the European Free-tailed Bat *Tadarida teniotis* (Chiroptera: Molossidae) from the western Himalaya, India

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Abstract: The distribution of the European Free-tailed Bat *Tadarida teniotis* extends from southern Europe and northern Africa to Myanmar. In India it is known only from Bihar, West Bengal and Kerala. This study records the species for the first time in the western Himalayan state of Uttarakhand. Echolocation calls were found to be higher in frequency and shorter in duration than reported in previous studies. Extensive acoustic surveys are recommended to assess the distribution of this species in India.

Keywords: echolocation call, India, *Tadarida teniotis*, Uttarakhand, western Himalaya.

The European Free-tailed Bat *Tadarida teniotis* (Rafinesque, 1814) is found in southern Europe, parts of northern Africa, Central Asia, India and Myanmar (Benda & Piraccini 2016). Hill (1963) reported *T. teniotis* in India based on a specimen collected at Kurseong (1,678m) in northern West Bengal. In the absence of subsequent sight records, *T. teniotis* was thought to be a "rare migrant" in India (Molur et al. 2002). During recent acoustic surveys, however, its echolocation calls were recorded at Bhagalpur in Bihar at a confirmed roost and Shendurney Wildlife Sanctuary (WS) in Kerala from free-flying individuals (Deshpande & Kelkar 2015). Here we report *T. teniotis* from Dehradun and Tehri-Garhwal districts of Uttarakhand in the western Himalaya, thus confirming that it may not be as uncommon in India as perceived earlier.

T. teniotis has been recorded up to an elevation of 3,000m in the Alps (Arlettaz et al. 2000; Benda & Piraccini 2016) and up to 1,698m in India (Hill 1963). It roosts in caves and rock crevices in high cliffs (Bates & Harrison 1997) in colonies that vary from 5–100 individuals (Benda & Piraccini 2016). These bats typically emerge late from their roost about an hour after sunset, and forage high over a variety of habitats such as beech woodlands, agricultural fields, illuminated urban areas (Russo & Jones 2003) and pine and cork oak woodlands in valleys and hills (Marques et al. 2004). *T. teniotis* is probably sedentary in Europe (Hutterer et al. 2005) and undergoes torpor (Arlettaz et al. 2000). Little is known of its habits in India.

During a series of bat surveys (February to June 2016), in March 2016, more than 30 individuals of *T. teniotis* were caught in one night in two ground-level mist nets

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Competing interests: The author declares no competing interests.

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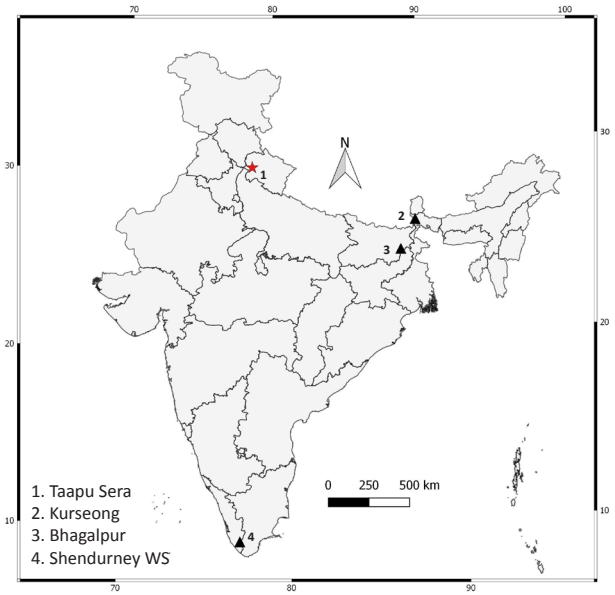

Figure 1. Known locations of *Tadarida teniotis* in India. The red star indicates the new location described in this study.

Image 1. Habitat at Taapu Sera.

(6x2.5 m and 9x2.5 m) placed along a shallow river at Taapu Sera (30.3829 N & 78.1758 E), Tehri-Garhwal District, at an elevation of 1,007m (Fig. 1; Image 1). The river was surrounded by dry, steep and scrub-covered hills on both sides. Handling methods followed standard procedures described in Kunz & Parsons (2009). Only six individuals were processed due to field constraints. Their age-class and sex were determined and forearm measurements were obtained using a dial caliper (0.1mm accuracy) (Images 2,3). No specimens were collected and all individuals were released at the site of capture. Echolocation calls were recorded on release in full spectrum (.wav file format) using an AnaBat Walkabout bat detector (Titley Scientific, Brendale, Australia) with a sampling rate of 500 kHz/s and a range of 10–250 kHz onto an SDHC card (Fig. 2). The recordings were analysed using BatSound Pro 3.31 (Pettersson Elektronik AB, Uppsala, Sweden). For recordings of hand-released bats, up to 10 clear pulses with highest signal to noise ratio were selected for each individual and the means for each call parameter were used for calculating the group mean (Wordley et al. 2014). Free-flying individuals were also recorded opportunistically. In these recordings, each pulse was treated independently as it could not be ascertained whether the pulse belonged to the same or different individuals. Start and end frequency and call duration were measured from a spectrogram with FFT size = 1024 and FFT overlap = 95% and a Hanning window. Call duration was measured (in ms) as the difference between start and end time of each pulse (Wordley et al. 2014). Inter-pulse Interval (IPI) was

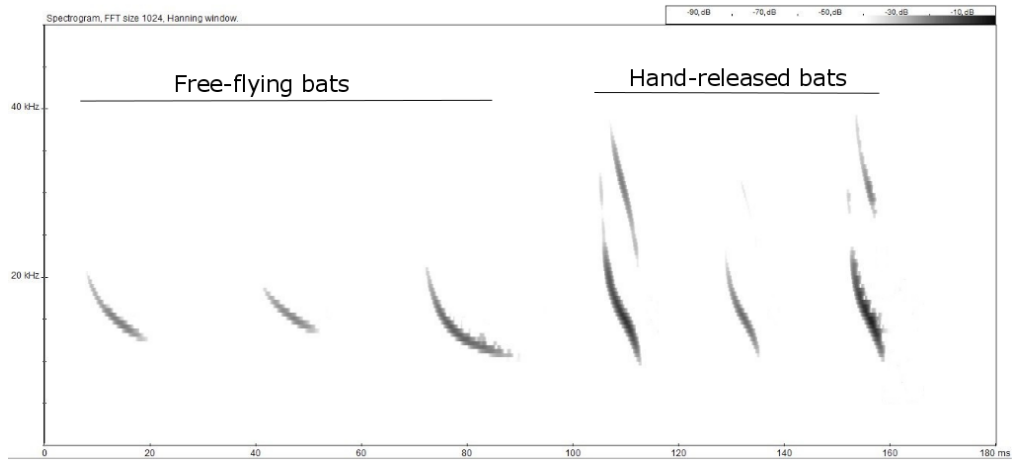

Figure 2. Representative calls of free-flying and hand-released individuals.

Images 2–3. *Tadarida teniotis*: whole body and close-up

measured from the oscillogram. Peak frequency or Frequency of Maximum Energy (FMaxE) was measured from the power spectrum (Russo & Jones 2002; Hughes et al. 2011; Wordley et al. 2014).

The sampled individuals were characterized by their large size (forearm, FA = 60.10–63.2 mm; Table 1). All other molossid species in the subcontinent have forearm length less than 58mm (Bates & Harrison 1997; Srinivasulu et al. 2010). Their ears were not joined over the forehead as seen in *Chaerephon plicatus* and *Otomops wroughtoni* (Bates & Harrison 1997; Srinivasulu et al. 2010). The ears, as measured from two individuals, (Ear length, EL = 26.50 and 33.31mm) were also markedly larger than those of *Tadarida aegyptiaca*

Table 1. Morphological characters of the six individuals of *T. teniotis* caught at Taapu Sera.

Individual no.	Sex	Age-class	FA (mm)	Ear length (mm)
1	M	Adult	62.75	26.5
2	M	Adult	61.19	-
3	M	Adult	60.10	-
4	M	Adult	62.91	-
5	M	Adult	63.00	-
6	M	Adult	63.20	33.31

Image 4. An individual roosting behind a pipe at FRI Campus

(in which the ears are not joined over the forehead; EL = 15.0–23.0mm) (Srinivasulu et al. 2010). Their pelage was pale brown above and mouse-grey below. Interestingly, all the individuals caught in our nets were males. The analysed call parameters (Table 2) indicate that free-flying bats recorded in this study called at higher start and peak frequencies and shorter durations than those reported in previous studies (Table 3).

About 15 free-tailed bats were seen roosting behind three vertical pipes along a corridor in the Forest Research Institute (FRI) Campus (30.3440 N & 77.9979 E, 670m) in Dehradun (Image 4). These individuals could not be examined as the roost was inaccessible, nor could their calls be recorded during emergence as visitors are not allowed to remain in the vicinity of the main campus building after dusk. Their large size and ears indicated that they were possibly *T. teniotis*.

Bats commonly occur in sexually-segregated colonies (see Altringham 2011) which are more pronounced

Table 2. Echolocation call parameters of *T. teniotis* from this study given as mean (SD).

Method of recording	Start frequency (kHz)	End frequency (kHz)	Peak frequency (FMaxE) (kHz)	Duration (ms)	Inter-pulse Interval (IPI) (ms)
Free-flying bats (n = 34 pulses)	23.84 (4.28)	12.70 (0.89)	14.89 (0.73)	12.79 (2.26)	-
Hand-released bats (n = 6 individuals)	31.58 (2.27)	9.94 (1.01)	15.58 (0.58)	8.44 (1.24)	79.30 (26.67)

Table 3. Echolocation call parameters of *T. teniotis* from various studies, reviewed in Deshpande & Kelkar (2015). Values are given as mean (SD).

Data source	Start frequency (kHz)	End frequency (kHz)	Peak frequency (FmaxE) (kHz)	Duration (ms)	Inter-pulse Interval (IPI) (ms)
Zbinden & Zingg (1986)	13 (1.5)	10.7 (0.8)	11.6 (1)	15 (3.7)	743 (185)
Russo & Jones (2002)	17 (4.56)	12.1 (1.19)	13 (1.47)	16.6 (3.52)	622 (192)
Ulanovsky et al. (2004)	-	-	11.25 (0.43)	18.3 (2.2)	540 (86)
Obrist et al. (2004)	15.3 (2.5)	8 (0.7)	11.4 (0.8)	16.8 (2.4)	-
Benda et al. (2006)	16.5 (2.5)	10.2 (1.2)	12.2 (1.4)	20.1 (2.3)	484.3 (135.3)
Pandourski & Karaivanov (2007)	12.75 (0.4)	10.25 (0.1)	11.2 (0.2)	13.93 (1.2)	406.5 (19.1)
Davy et al. (2007)	12.15	10.5	12.1	18.04	724.37
Papadatou et al. (2008)	15.4 (3.28)	11.1 (1.34)	13.2 (1.18)	18.4 (4.74)	764.6 (259.4)
Uhrin et al. (2009)	14.8 (1.84)	11.75 (0.07)	11.35 (0.64)	23.2 (2.54)	653
Georgiakakis et al. (2010)	-	-	13.05 (1.68)	-	-
Walters et al. (2012)	14.61 (4.95)	10.64 (1.51)	11.76 (2.28)	15.03 (3.47)	-
Deshpande & Kelkar (2015)	14.29 (3.39)	10.11 (1.29)	12.47 (1.28)	19.5 (12.92)	229.3 (157.6)

during spring and summer in temperate areas, as females form female-only maternity colonies (Safi & Kerth 2007). Group hunting by male molossids as a result of information transfer about the presence of insects has also been suggested as a reason for social behaviour of males (Dechmann et al. 2010; Safi & Kerth 2007). These empirical observations might explain why only males were caught in this study. As many individuals were foraging at the site, it is possible that some individuals were calling with higher start and peak frequencies and shorter durations as a jamming avoidance response (JAR), a common response of echolocating bats when they experience interference from neighbouring conspecifics. Avoiding sonar jamming by increasing call frequency and reducing duration is known in *T. teniotis* (Ulanovsky et al. 2004), *T. brasiliensis* (Gillam et al. 2007), *Lasiurus borealis* (Obrist 1995) and *Rhinopoma microphyllum* (Cvikel et al. 2014). Bats also use shorter pulses with higher frequencies when flying in restricted and cluttered spaces (Neuweiler et al. 1987), which in this case was a narrow river with hills on either side. The observed differences in call parameters could also be due to geographical variation (Bayefsky-Anand et al. 2008). Pulses of higher start frequencies and shorter duration are also typical of recordings made by hand-released bats as they try to settle into flight and avoid the recordist in front of them (see Russo & Jones 2002; Ruedi et al. 2014).

The present records of *T. teniotis* represent the first record of this species from the western Himalaya and the second record from the Indian Himalaya. The occurrence of this species in the western Himalaya is not unexpected; it has been recorded from Afghanistan through the eastern Himalaya to Myanmar (Benda & Piraccini 2016). However, due to its behaviour of roosting in inaccessible and often hilly areas, it is rarely observed at its roost. Besides, because of its high-flying nature, it may be missed while sampling with ground-level mist nets like other molossids. The capture success reported here was probably due to the relatively closed flight path available to the bats and the presence of water, which they might have descended to drink. Sampling in similar areas might help in capturing this species and other molossids. Extensive surveys aided by acoustic methods are also recommended to investigate the status and distribution of *T. teniotis* in India.

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