Project Update: October 2020

About Project

Though, it is difficult by visual technique for the identification of nocturnal flying bats**,** their vocalisation analyses provide a great potential for bat biologists to study in their distribution, patterns of bat activity, habitat preferences and as a whole to monitor population trends specifically to those which are red listed or endangered species. Additionally, it also offers ways and means to engage professionals and amateurs alike in enjoying and studying echolocating bats (Limpens 2004). Due to lack of equipment, instrumentation had been a bottleneck in the development of research on echolocation or to work with sounds beyond the range of human hearing which is technically termed as 'ultrasound' (Fenton 2004). As of now, with the development of science and technology, innumerable techniques for identifying echolocating bats from their calls have been reputably documented and implemented by bat ecologists. However, due to factors such as degree of clutter in foraging habitat, sex, age, and geographical areas, call of the particular species varies (Jones *et al*. 2000; Fukai *et al.* 2004) which is proven to be another hindrance and challenges to study through echolocation. Therefore, a collection of reference call from known species is to be documented from the region for more reliable identification of the bat species.

Echolocation call

Echolocation – the sixth sense of bats (Schober and Grimmberger 1989), is produced by vocal cords which are mostly of an ultrasonic that are beyond the capacity of human hearing. Insectivorous bats are mostly echolocating bats for their commuting/navigation and in search of prey insects. When bats use their echolocation calls, they separate pulse and echo in time as they cannot tolerate overlap between the outgoing pulse and incoming echo. These bats produce with 'low duty cycle' with the signal about 10% of the time (Fenton 2004; Schnitzler and Kalko 2001). Bats with 'low duty cycle' use both broadband and narrowband component during foraging activity because, broadband signals provide more accurate information than narrowband signals, whereas narrowband can travel further (Fenton 2003). In some echolocating bats (e.g.: rhinolophids and hipposiderids spp.) produce signals about 40-80% of the time (high-duty cycle). Thus, these high duty cycle bats can tolerate the overlap between pulse and echo and able to make distinction between them in frequency (Fenton et al. 1995). Calls of high duty cycle bats dominate by constant frequency component (CF) whereas, low duty cycle dominates by frequency modulated component (FM) that may be cover a large range of frequency (broadband) or a smaller range of frequency (narrowband) (Fenton 2003).

Since many species have showed a great plasticity/intraspecific variation in their echolocation, referencing calls have to be documented from the habitat type and region where they will be used in the future (Fukai *et al.* 2004). Therefore, a large collection of echolocation calls must be recorded from known bat species by using ultrasound bat detector/s as reference call for the region. Call parameters that allow for the species identification from their echolocation calls include frequency-related, time-related and amplitude-related parameters (Limpens and McCracken 2004). Here we have reports based on their call types: frequency modulated (FM bats Fig. 1), constant frequency (CF bats, Fig. 2) and quasi-constant frequency (QCF bats, Fig. 3). In total, we have recorded four different FM bat species, five different species from CF bat and three species from QCF bats which totaled up 12 different species so far. The parameters for identification of species are recorded and measured from every captured species (not revealed in the report in consideration of data confidentiality). All the required data for repository will be disclosed in the final publication (in reliable journals).

Trapping methods and Recording echolocation call of captured species

For bat trapping, we deployed mist nets of 3 m x 14 m size (**Fig. 4**) and a harp trap which is of 1.4 m wide and 1.4 m high (**Fig. 5**) in different habitats: such as forests, river trails, and near agricultural lands. We also surveyed roosts specially caves and even captured few from human houses by using improvised sweep net. Morphological characteristics (e.g. mass, forearms length, ear length, tail length) of every captured bat was measured accordingly (**Fig. 6**) and recorded their calls for the documentations to establish reference call from the region. Based on the captured species, we recorded their calls with different ways and methods such as: in-hand recordings, free flying, in bag and confined net which may represent cluttered habitat.

1. Bat with frequency modulated call (FM bats).

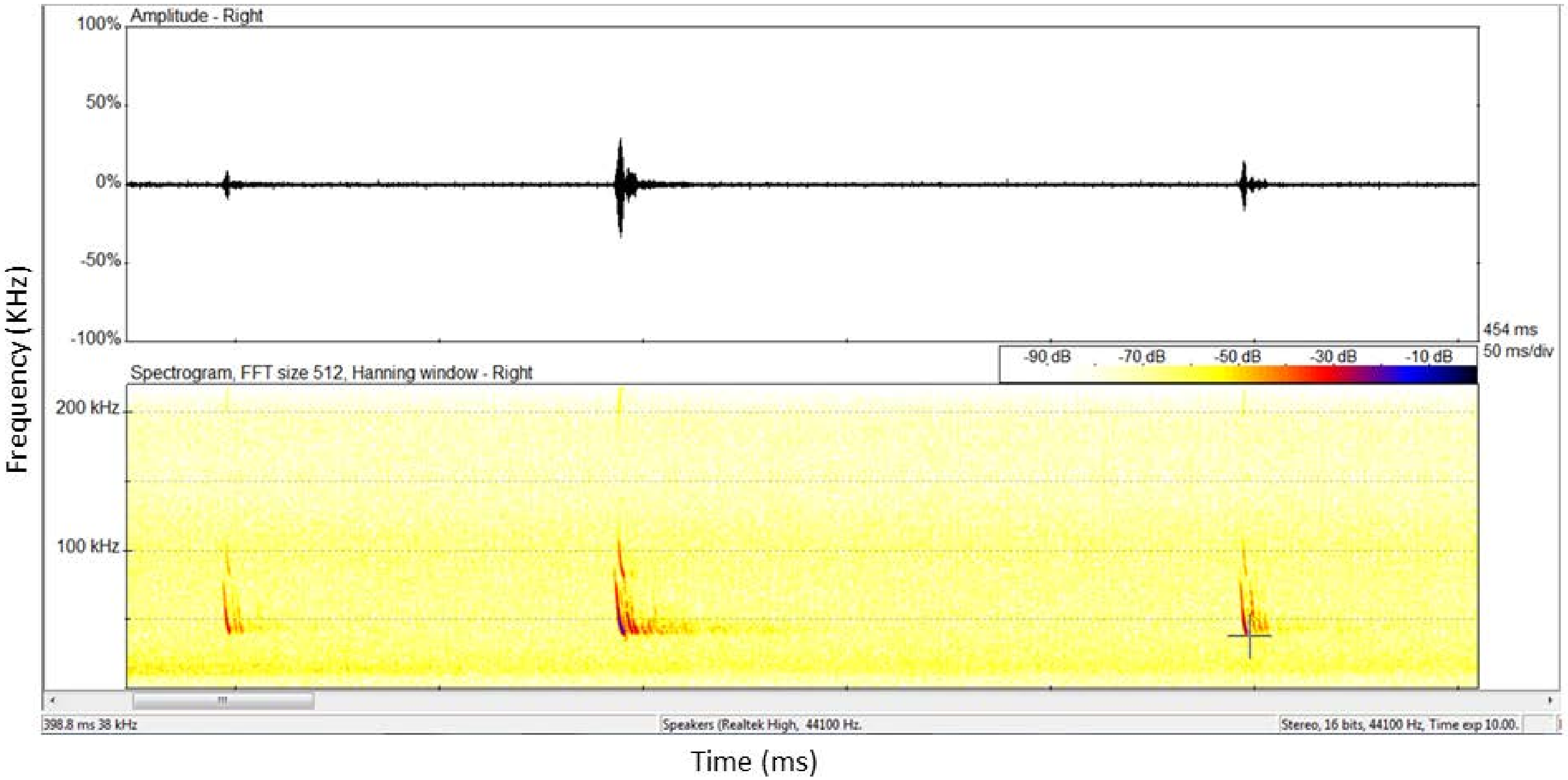


Fig. 1. Echolocation call of *Myotis sp.* (FM bats) in a spectrogram, showing FM-sweep call structure of free-flying bats shown in the figure depicting end frequency of 38.3 kHz. The species is captured by mist-net (see **Fig.4**) from the edge of the deciduous forest habitat.

2. **Bat with constant frequency call structure (CF bat).**

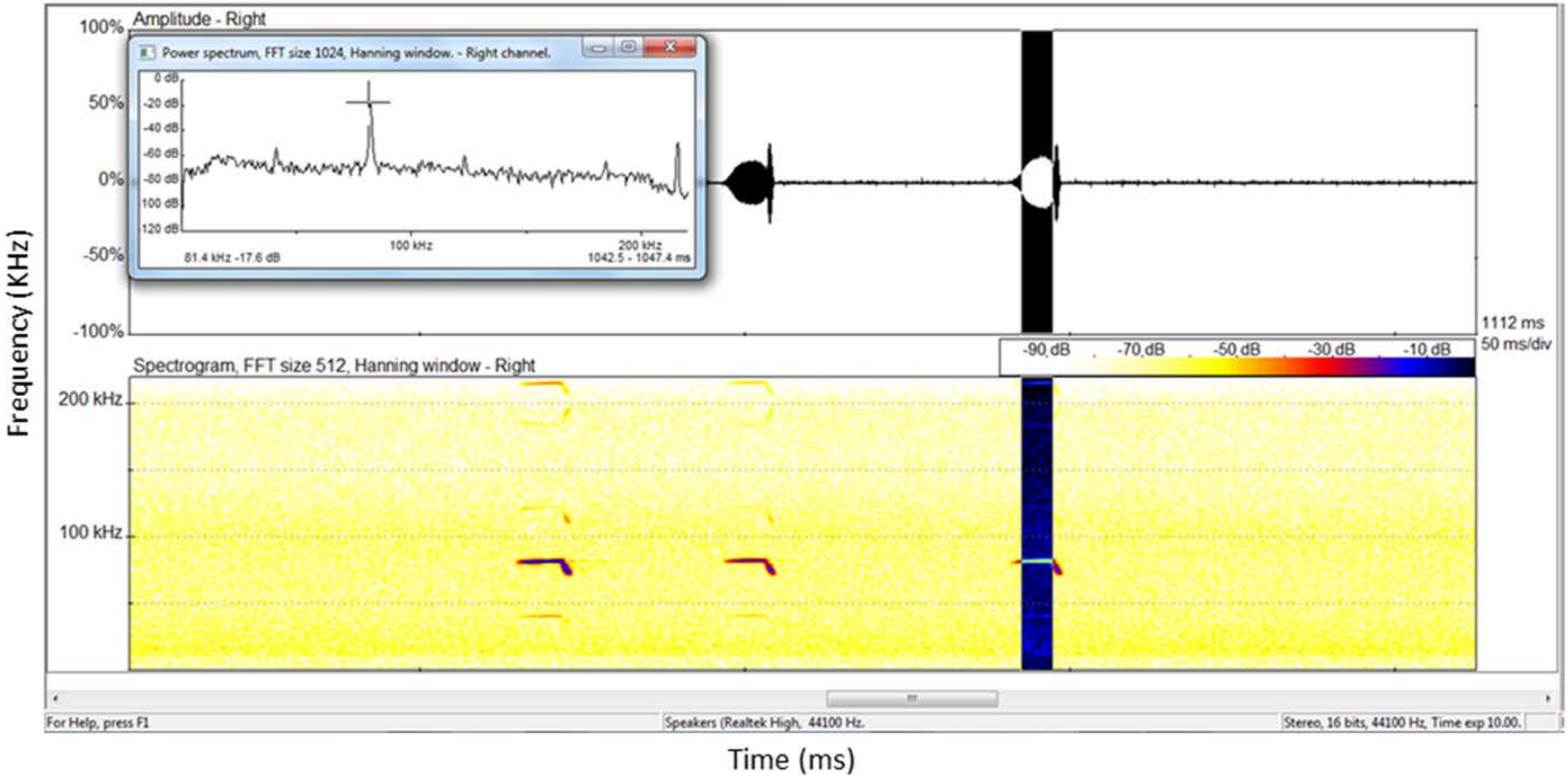


Fig. 2. Echolocation call of *Hipossideros sp.* (CF bat) in a spectrogram with CF call structure recorded in-hand and its Fmax Energy of 81.4 KHz. The species was captured by harp trap in cluttered habitat over stream water trail (see **Fig. 5** to view harp trap set up).

3. Bat with Quasi-constant frequency call structure (QCF bat).

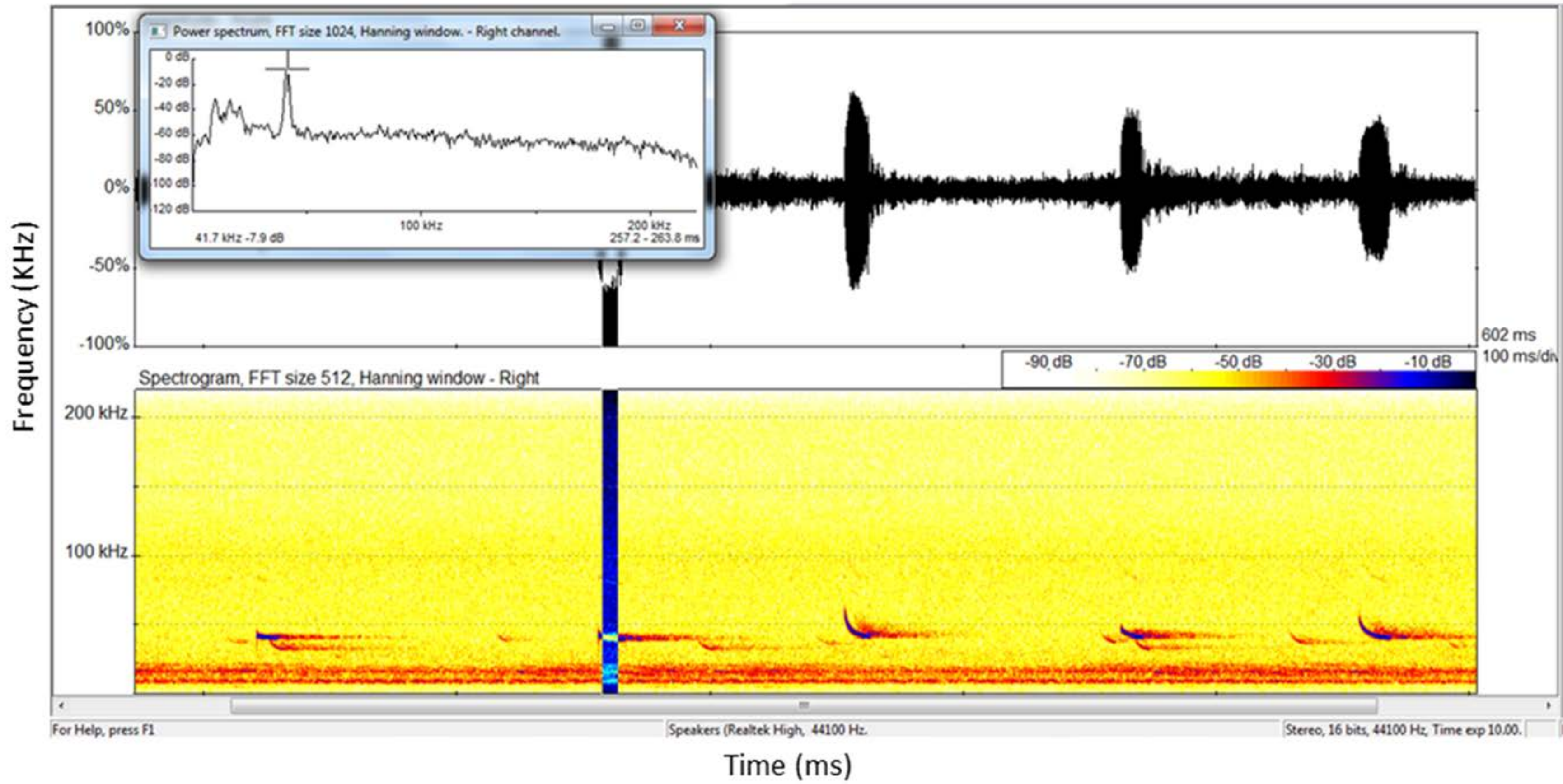


Fig. 3. Echolocation call of unidentified sp. (QCF bat) in spectrogram, showing QCF call structure recorded in confined net with Fmax Energy of 41.7 KHz. The species was captured from riverine forest.

Fig.4. Mist netting at the edge of forest habitat under Samdrup Choling Sub district, Southern Bhutan. The mist net was set up from 1800 till 2000 (Bhutan Time, GMT/UTC + 6hrs). We captured one known species (Myotis sp./FM bat, see Fig. 1 to view its call structure) and another unidentified species from the site.

Fig.5. Harp trap set up over water trial (stream) in the deciduous broadleaved forest from 1800 till 2100 (Bhutan Time, GMT/UTC + 6hrs). We captured at least one species of CF bat (see Fig. 2 to view its call structure). My field assistants: Mr. Dorji Wangchuck (Left) and Mr. Tashi Tshering (Right).

Fig.6. Every captured specie was measured their morphological features for repository data documentation. The species, *Megaderma* sp. was captured from one of the human houses by sweep net, village Phuntshothang under Samdrup Choling Sub-district where we have observed more than 15 individuals sharing the ground floor as their roost. The very house is looking after by caretaker, Mr. Suk Bdr. Subba. According to him, the house has been used as their roost for more than 5 yrs. (personal communication, Sept 27, 2020).

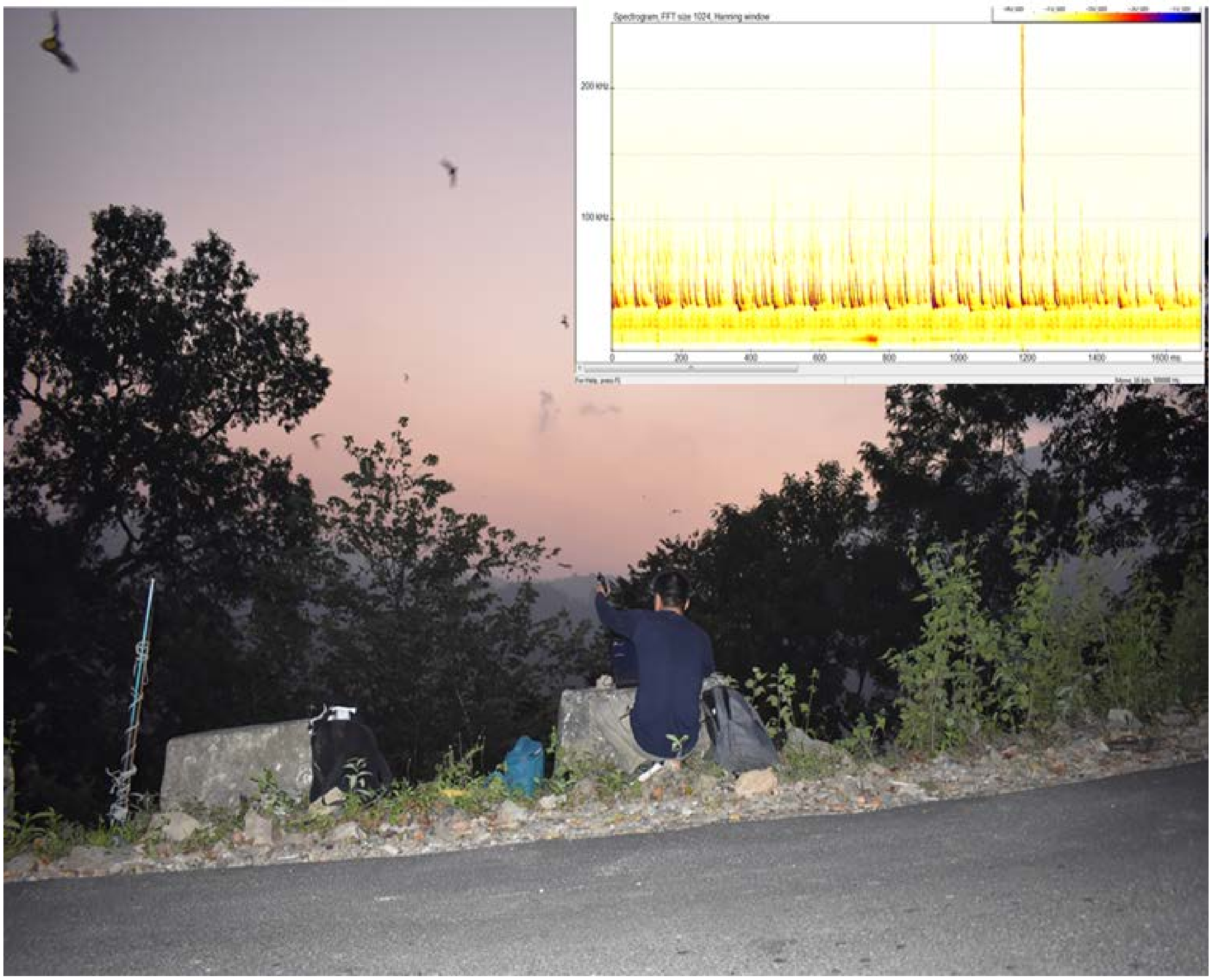
Opportunistic foragers are triggered by the availability of prey insects.

Scotophilus heathii Horsfield, 1831 has huge distribution in Asian countries from Afghanistan to South China, South to Sri Lanka, Burma, Cambodia, Thailand and Vietnam (Bates and Harrison, 1997). According to Rahman et al. (2015), they forage above the water bodies at a greater height and in the open environment. However, this species is found to be a great opportunistic forager in semi-cluttered habitats over the swarming of termite colony (T. dendup. pers. obs., Nov. 01. 2020 – Nov. 05.2020) (Fig. 7) in three different spots. During the 2nd day of my observation, mist netting was successful and captured 10 individuals of same species (*S. heathii*) (Fig. 8) and recorded its call after the morphological measurement (would be disclosed its measurements in publication).

Mist netting over the swarming of termite colony

Scotophilus heathii captured by mist-net on 03.11.2020

Acoustic assessment at the time of foraging over the swarming of termite colony.
During 3rd nights dated 03.11.2020, we assessed at the time of their foraging over the swarming of alates acoustically (Fig. 9). Spectrogram, FFT size 512 on Hanning window revealed that most of the foragers are dominated by *Scotophilus heathii* with reference to the collected call library during 2nd nights from different spot. The spots of swarming alates between 2nd and 3rd nights is more than 1000 m apart. The wonderous thing is, how these species are able to locate the exact spot of alates swarming in different spot? Do they communicate each other, exchange bio-signal or do termites produce hormonal secretion during the time of swarming, so as to detect by their predators, specifically by the bat? Therefore, this would be another interesting topic to explore further in scientific research work.



Acoustic monitoring over swarming Alates, 3rd nights.

A view of opportunistic foragers (probably more of *S heathii* with reference to our collected call library) over Termite swarmers on 3rd monitoring nights. **Location:** Samdrup Choling, Sub-district, Samdrup Jongkhar, Southern Bhutan.

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References

Bates, P. and D. Harrison (1997). Bats of the Indian Sub- continent. Harrison Zoological Museum, Harrison, UK. 123-258.

Fenton, M. B. 2003. Eavesdropping on the echolocation and social calls of bats. Mammalian Review 33: 193-204.

Fenton, M.B., 2004. Bat natural history and echolocation. *Bat Echolocation Research: tools, techniques and analysis*, p.2.

Fenton, M.B., Audet, D., Orbrist, M.K. and Rydell, J., 1995. Signal strength, timing, and self-deafening: the evolution of echolocation in bats. *Paleobiology*, pp.229-242.

Fukui, D., Argetsuma, N. and Hill, D. 2004. Identification of eight species of bats (Mammalia: Chiroptera) inhibiting forest of southern Hokkaido, Japan: potential for conservation monitoring. Zoological Science 21: 947-955.

Jones, G., Vaughan, N. and Parsons, S. 2000. Acoustic identification of bats from direct sampled and time expanded recordings of vocalization. Acta Chiropterologica 2: 155-170.

Limpens, H.J.G.A. and McCracken, G.F., 2004. Choosing a bat detector: theoretical and practical aspects. *Bat Echolocation Research: tools, techniques and analysis. Bat Conservation International, Austin, Texas*, pp.28-37.

Limpens, H.J.G.A., 2004. Field identification: using bat detectors to identify species. *Bat Echolocation Research: tools, techniques and analysis*, p.46.

Rahman, F.U., Perveen, F., Rauf, T., Salim, M., Ali, Z., Khan, S. and Kamal, Z., 2015. HABITAT ANALYSIS OF Scotophilus heathiiHorsfield, 1831 IN NORTHWESTERN PARTS OF PAKISTAN. *JOURNAL OF ANIMAL AND PLANT SCIENCES*, *25*(3), pp.731-734.

Schnitzler, H.U. and Kalko, E.K., 2001. Echolocation by Insect-Eating Bats: We define four distinct functional groups of bats and find differences in signal structure that correlate with the typical echolocation tasks faced by each group. *Bioscience*, *51*(7), pp.557-569.

Schober, W. and Grimmberger, E., 1989. *A guide to bats of Britain and Europe*. Hamlyn.