Caves as priority areas for the conservation of lesser known mammalian fauna in Meghalaya, North East India

Meghalaya in North East (NE) India falls under the Indo-Burma biodiversity hotspot[1]. Factors like geologic age, unique zoogeographic history and its location at the confluence of different biogeographic realms have been cited as reasons for the extraordinary opulence of life forms in NE India[2]. Meghalaya harbours 67 species of bats, the highest number of chiropteran species among all Indian states[3–5]. By virtue of rich limestone deposits, especially in the southern fringe of the Meghalaya plateau and high average annual precipitation, the state supports numerous caves and caverns, some of which are among the largest and most complex in the Indian subcontinent[6,7]. The Shillong Plateau hosts the richest type of karst phenomenon in India[8], and over 1700 caves have been documented from Meghalaya. Subterranean structures like caves serve as an important roosting ground for bats, as they provide permanency and relative stability of the microclimate and offer protection from natural elements[9,10]. Bats are known to occur in most of the caves in Meghalaya, and some caves harbour huge populations and several poorly known species[11,12]. Although bats are the predominant mammals in the caves of Meghalaya, other mammalian species have also been recorded, some of which could be accidental introductions.

Speleologists have been exploring the Meghalayan caves for several years. Based on direct sightings and skeletal remains recovered from inside the caves, several mammalian species other than bats have been recorded from the caves of Meghalaya, namely capped langur (*Trachypithecus pileatus*), large Indian civet (*Viverra zibetha*), Asiatic black bear (*Ursus thibetanus*), Himalayan field rat (*Rattus nitidus*), Edward's long-tailed giant rat (*Leopoldamys edwardsii*), Malayan porcupine (*Hystrix brachyura*), mouse (*Mus* sp.) and Asian grey shrew (*Crocidura attenuata*). However, as mentioned before, bats are the most numerically abundant mammals in the Meghalayan caves. In many habitats, they are considered to be limited more by roost availability than other factors[13]. Karstic region as a whole and caves in particular are important components to maintain the high diversity of bats in the tropics[14]. A large number of bat species are known to be associated with the karstic landscape in Southeast Asia[15,16]. In China, 101 out of 131 reported species are known to roost in caves and other subterranean habitats[17]. The abundance of underground shelters has been suggested to be the prime reason for high bat diversity in Meghalaya[3]. Although it is difficult to establish the level of dependency of bats on caves, at least 37 out of 67 reported species in Meghalaya are known to inhabit caves, at least temporarily[3]. Some of the globally threatened, data deficient or rare bat species have been recorded from the caves of Meghalaya. These include Wroughton's free-tailed bat (*Otomops wroughtoni*), a highly protected species under Indian laws and of which Meghalaya holds about 50% of the known global population[18]; tail-less leaf-nosed bat (*Coelops frithii*), great evening bat (*Ia io*), Rickett's big-footed bat (*Myotis pilosus*), Burmese whiskered bat (*Myotis montivagus*), etc.[4] (Figure 1). Besides, many of the caves harbour large populations of bats like *Eonycteris spelaea*, *Miniopterus magnater* and several species of *Rhinolophus* and *Hipposideros*. From an ecological point of view also, bats are crucial for maintaining the subterranean biodiversity, as bat guano is an important source of energy in these energy-impoverished ecosystems. Many guanophilic

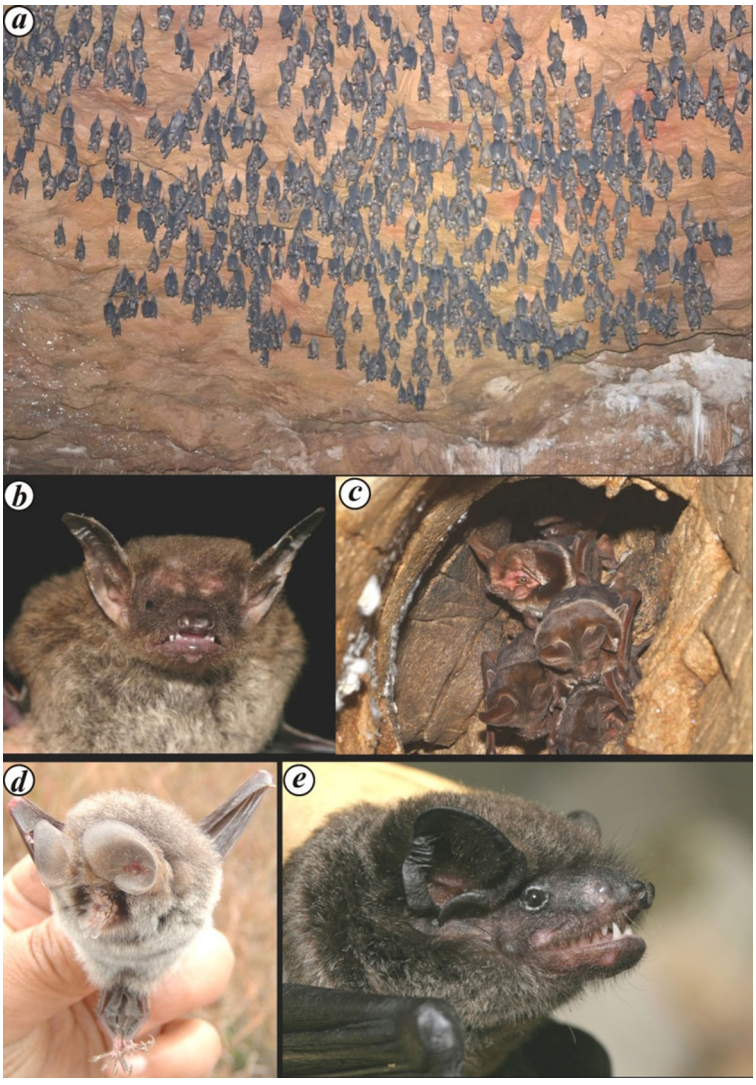

Figure 1 *a–e*. Some typical cave-dwelling bats of Meghalaya in North East India. ***a***, A large colony of horseshoe bats roosting in a cave. ***b***, Rickett's big-footed bat. ***c***, Wroughton's free-tailed bat. ***d***, Tail-less leaf-nosed bat. ***e***, Great evening bat.

beetles, cockroaches, mites, crickets and molluscs thrive on bat excreta, which in turn serve as prey for other predators.

The continued existence of the cave ecosystem in its natural state is crucial for the survival of a wide variety of cavernicolous fauna, including bats. Scientists continue to find new cave-adapted animal species from Meghalaya, including the world's largest cave fish[19]. Every cave system is potentially unique with its associated biota and needs to be protected. However, considering the limited resources at disposal, conservation prioritization is essential to minimize biodiversity loss. It has been documented that the epigeal environment is fundamental for the maintenance of a fragile hypogean troglomorphic fauna[20]. This calls for the protection of both the caves and the surrounding environment. However, it is a daunting task with several hurdles along the way. First is the incomplete biological inventory of cave systems in Meghalaya. Although about 1000 caves in the state have been explored and mapped[21–23], they have not been examined biospeleologically and not much is known about the biota living in these caves. Unless the biological values of these caves are documented, conservation prioritization is difficult. Secondly, there has been extensive mining of coal and limestone in the karstic areas of Meghalaya for a long time. This has resulted in a number of serious ecological problems like deterioration of water quality, diminishing plant cover, loss of aquatic biodiversity, degradation of soil productivity, etc.[24–28]. The issue of balancing economic benefits versus conservation has always been complex. While it is not our prerogative to deny the local people from reaping some economic benefits from the mineral resources in the state, the rampant and unmindful mining activities occurring in the karstic areas of Meghalaya are certainly detrimental to ecology. In several instances, cave systems have been physically damaged or wiped out of their biota. For example, Krem Umlawan, part of the mammoth Umlawan-Kotsati cave system in the East Jaintia Hills of Meghalaya, is now devoid of any original biota because of sludge deposits from limestone mining in nearby areas (pers. obs.). Likewise, Krem Mawmluh in the East Khasi Hills, a UNESCO geological heritage site of the state, witnessed a portion of a cave ceiling collapsing due to limestone mining in the nearby areas[29]. It may be mentioned that besides harbouring unique fauna, caves are also a geologist's treasure trove. For example, by studying a speleothem recovered from the Mawmluh cave, geologists have defined the latest geologic age, 'The Meghalayan Age', which is estimated to begin 4200 years BP (ref. 30).

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