

## Original Research Article

# Urban Fauna: Amphibian Checklist of Shillong, Meghalaya

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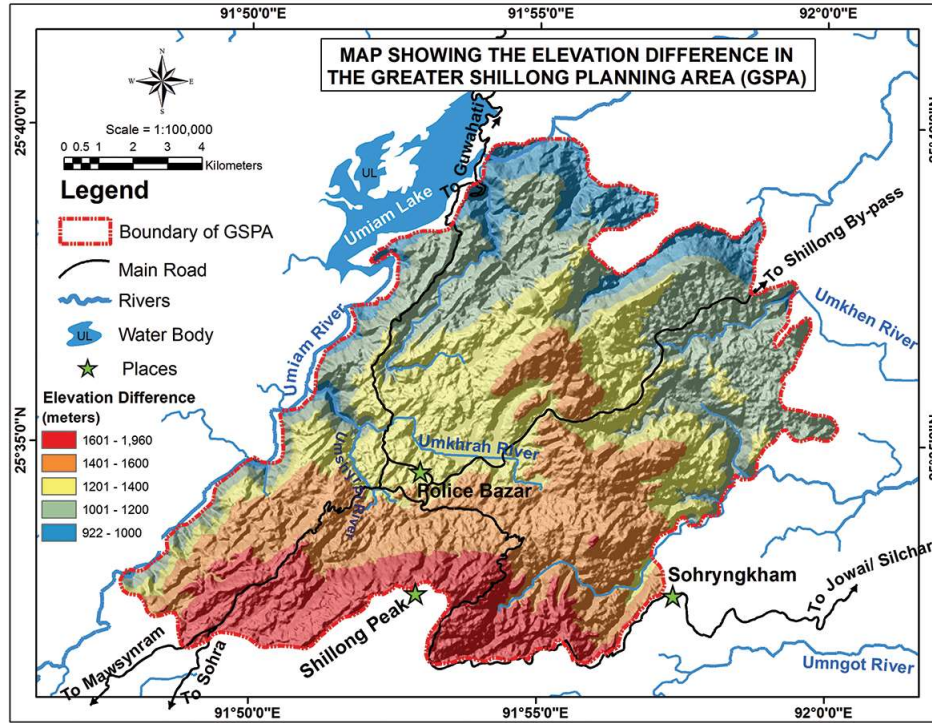
**Abstract:** We have far greater representation and documentation about the faunal diversity of a protected area than places undergoing fast urbanization. As such, little is known about the urban fauna of bustling cities within rich biodiversity hotspots. An attempt is made to prepare a consolidated checklist of the amphibian fauna of the Shillong City combining field based surveys and gleaning extensive relevant literatures and historical museum collection from this region. Shillong, the state capital of Meghalaya, which is one of the states of Northeast India lies within the Indo-Burma Biodiversity hotspots. With a largely hilly terrain which reaches up to 1960 m above sea level and large forest covers – including six protected and reserved forests – Shillong is home to diverse floral and faunal elements, which is yet to be properly documented. A total of 25 species of amphibians are reported to be occurring in the Greater Shillong Planning Area (GSPA), including a critically endangered species of bush frog, *Raorchestes shillongensis*, during the present survey conducted over a period between 2017 to 2019. Four species of highly endemic frogs with their respective type locality in East Khasi Hills, viz. *Xenophrys oropedion*, *R. shillongensis*, *Minervarya sengupti* and *Xenophrys flavipunctata* were also recorded during the present study including two additional new distributional records for two species extending their distributional range over considerable geographic space. A discussion on the threat perception to this faunal group in the study area is also made based on visual encounter during the field visits.

**Key words:** endangered fauna, faunal diversity, Greater Shillong Planning Area, Meghalaya.

## Introduction

A major hurdle for conservation and effective management of bio-resources is the preponderance of human settlement in areas of biodiversity hotspots (Burgess *et al.*, 2007). This makes conservation in urban areas where land is expensive and limited (Luck *et al.*, 2004), a challenging task. Thus, the urban faunal documentation is an important step towards understanding how rapid urbanization affects faunal elements and how the faunal elements interact and adapt to the changing habitats (Purkayastha *et al.*, 2011). Urban amphibian fauna is the least documented taxon despite the fact that the

urbanization induced habitat loss and habitat fragmentation are considered one of the leading forces of amphibian decline globally (Hamer and McDonnell, 2008). Amphibians, even though sensitive to environmental perturbations, are known to adapt to novel and anthropogenically altered habitats if the optimal conditions are available, and thus a proper understanding of the underlying potential factors in urban areas can lead to a holistic approach towards development without compromising conservation and will better equip the city planners for ecologically sustainable smart cities.



**Fig. 1.** An elevation map of Greater Shillong Planning Area showing the altitudinal gradients of the study area [Data Source: ALOS PALSAR DEM (12.5 m resolution)].

However, not much is known about the faunal diversity of Shillong, the capital city of Meghalaya, although the Greater Shillong Planning Area (GSPA) harbours three Reserved Forest (Riat Khwan RF, Rait Laban RF and Shyrwat RF) and three Protected Forests (Upper Shillong PF, Laitkor PF and Short Round PF) as well as many isolated patches of general forests (Green Block, Raid Laban Forest, etc.) totalling to approximately 12.96 km<sup>2</sup> (CCF Territorial, Meghalaya Forest, 2011-12). These forests harbour many groups of animals, particularly, lower vertebrates and invertebrates, including a critically endangered species of bush frog, *Raorchestes shillongensis* (Dutta et al., 2004).

*R. shillongensis* was described from Malki forest, Shillong by Pillai & Chanda (1973). In recent times, another species of frog was described, *Xenophrys oropedion*, from Risa Colony forest, Shillong by Mahony et al. (2013). These discoveries highlight the importance of a proper faunal investigation in Shillong which still harbour potential habitats in remnant forest fragments for a diverse group of frogs which warrants immediate

conservation action. In this paper, we are compiling a checklist of amphibians found in the Greater Shillong Planning Area that encompass an area of 174.64 km<sup>2</sup> (Mipun et al., 2015) combining efforts from extensive field surveys and review of literatures and verifying historical museum collections.

**Materials and methods**

Shillong is located in the Northeast Indian state of Meghalaya, and serves as the State capital as well as the district headquarters of East Khasi Hills. The city experiences very heavy monsoon rain in the summers while the winters are dry and bitterly cold. While carrying out multiple field visits (both diurnal and nocturnal) in and around Shillong, we have recorded the opportunistic sightings of amphibian species in the Greater Shillong Planning Area (Fig. 1) as demarcated in the work of Mipun et al. (2015) for a period of two years from 2017 to 2019. Field identification was carried out by comparative morphology and whenever possible the encountered individual was photo-documented. Published literatures were studied

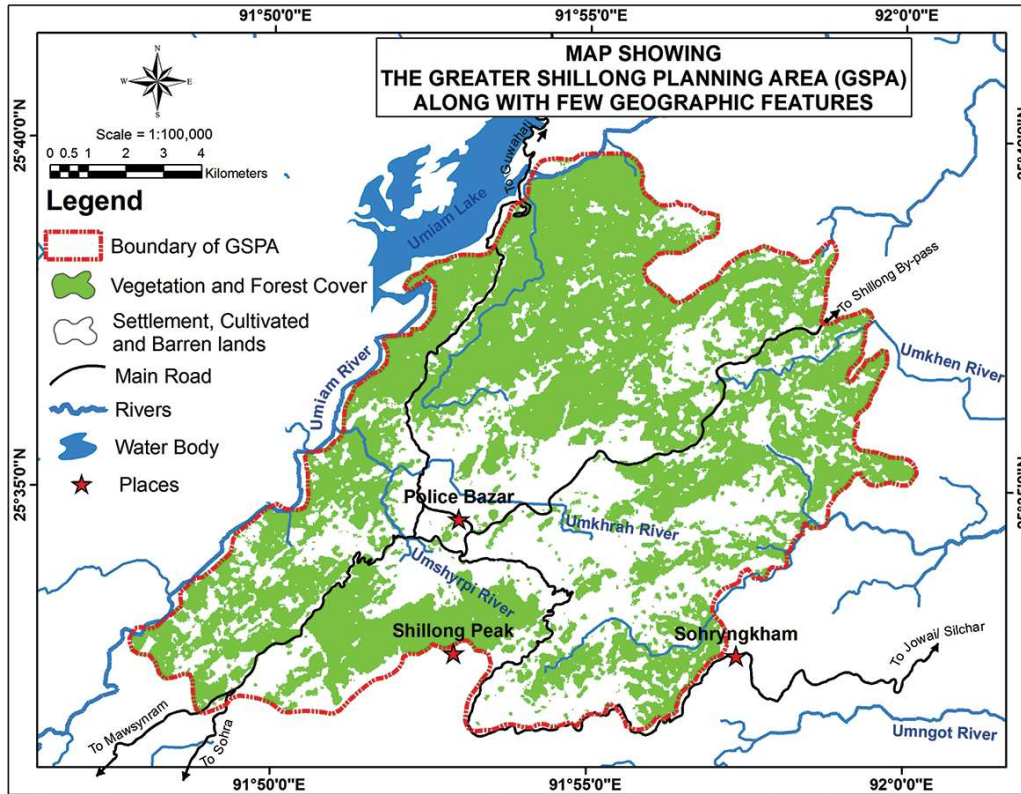


Fig. 2. A map of Greater Shillong Planning Area (GSPA) showing the forest covers of the study area (Data Source: Landsat Missions, USGS Earth Explorer)

pertaining to the amphibian fauna of this area while historical museum records available at the Zoological Survey of India (ZSI), Shillong with place of collection from East Khasi Hills were also consulted and cross validated for authentic identification and was georeferenced posteriorly to the nearest accuracy of 10 km. Classification followed was after Frost (2021). For the respective type locality details, Mahony *et al.* (2013) was followed pertaining for the species described from various localities of Khasi Hills, and for the rest, Frost (2021) was followed. IUCN status of the respective species was taken.

**Satellite imagery and its processing**

The border of the GSPA region is taken from the works of Mipun *et al.* (2015) and merged with the satellite’s digital elevation models (DEM) and multispectral bands. “ALOS PALSAR” DEM was downloaded from the Alaska Satellite Facility website (<https://search.asf.alaska.edu/>) with a spatial resolution of about 12.5 m and used to classify the GSPA region into five elevation categories for better visualization of

the regional topography (as shown in Fig. 1). “Landsat 7” was acquired from the U.S. Geological Survey Earth Explorer website (<https://earthexplorer.usgs.gov/>) with a spatial resolution of about 30 m and used to prepare a false colour composite (FCC) bands. FCC bands of 4, 3 and 2 were prepared to visualize and differentiate the vegetation cover against the barren land, settlement areas, etc., followed by its extraction and composing the map (as shown in Fig. 2). “ArcMap 10.2” software was used to process the above two satellite data. “Google Earth” imagery was also used to extract the water body boundary and validate the vegetation cover generated from the “Landsat 7” data above. Survey of India toposheet number 78 O/14 was further used to extract the geographic features such as streams/ river, roads and places.

**Geomorphology of the study site**

The altitudinal range of the study area varies from 922 m to 1960 m above the mean sea level. Shillong peak, about 1960m elevation, and being the highest peak in the Meghalaya State

lies just outside the GSPA in the southern part. Umiam lake, about 972 m elevation and 10 sq. km. area, is the lowest water body in the region that lies in the northern part just outside the GSPA boundary. A few rivers that drain in and around the GSPA area are namely Umkhrah, Umshyrpi, Umkhen and Umiam rivers. The regional topography of the GSPA and its adjoining areas has a NE-SW trending configuration which are geologically controlled (Fig. 1). Lithologically, the NE-SW ridges and valleys are composed of quartzites, phyllites, conglomerates, metavolcanics and amphibolites. Structurally, they are represented by mainly NE-SW fold hinges, fold axis and shear zones (Khonglah et al., 2008).

## Results

Our study has confirmed the presence of 25 species of amphibians belonging to 15 genera, 7 families and 1 order from the study area (Fig. 3 and 4). This study also recorded the range extension of two species which also serves their second sighting record following their description. The table 1 lists them along with their respective IUCN status and type locality detail.

Brief accounts of the species recorded with their respective natural history are given below:

***Duttaphrynus melanostictus* (Schneider, 1799):** A commonly occurring toad, which can be easily distinguished by its dorsum covered in dark tipped warts and dark cranial ridge and bulky, stout body. We found it to have a widespread distribution across the study area.

***Euphlyctis cyanophlyctis* (Schneider, 1799):** The most common aquatic frog found in India, this species is seen in ponds and marshy areas. This microglossid frog is identifiable by its greyish or olive spotted/ marbled tuberculated dorsum. Fingers and toes clawed shaped; fingers free, toes fully webbed.

***Limnonectes khasianus* (Anderson, 1871):** This small sized digroglossid frog was previously widely reported as *L. laticeps* (now a junior synonym of the former *vides* Ohler and Deuti, 2013). We observed this species from Umshing, Umshyrpi locality of the city during April month in a small stagnant water puddle near a hill stream close to forested habitat.

***Minervarya pierrei* (Dubois, 1975):** This is another common microglossid frog, found widely across the city. The presence of wide mid-dorsal line is a distinguishing character.

***Minervarya sengupti* (Purkayastha and Matsui, 2012):** A slightly larger frog than *M. pierrei*, this species was spotted in the forests of Lumpariang and Risa Colony areas. Presence of red spots on the forelimbs and on the mid-dorsal line distinguishes it from congeners. This species is particularly active during the monsoon.

***Minervarya* sp.:** We have come across a tiny *Minervarya* species at NEHU campus, Umshing, which is not attributable to any of the known species from the region.

***Hyla annectans* (Jerdon, 1870):** It is one of the common tree frogs, which is found widely during the monsoon. This green coloured tree frog has a distinguished black lateral stripe from nostril to groin. Lateral sides to thighs with black spots.

***Xenophrys flavipunctata* (Mahony, Kamei, Teeling and Biju, 2018):** A large megophryid frog, it can be distinguished from its cryptic congener, *X. major* in that in the former, the anterior most tubercles are with dark brown blotches. Body colouration on dorsum greyish brown, dark triangular patch between the eyes. A Y-shaped dark mark on the occiput mid-dorsally with dorso-lateral dark strip on both sides. Dorso-lateral tubercles of a bright yellow colour. Ventrally, pale yellow in colour with scattered crimson dots and irregular dark blotches on the upper ventrum. We spotted a lone specimen of this species from Sohryngkham village, just outskirts of Shillong in July, 2018.

***Xenophrys major* (Boulenger, 1908):** We spotted a lone specimen of this species from Mawtawar and Mawlai-Mawroh area during peak monsoon season of June-July month.

***Xenophrys oropedion* (Mahony, Teeling and Biju, 2013):** A small sized megophryid frog, this is abundant in Risa Colony forest, which is the type locality of this species, and in Malki Forest. The dorsum is bright rich mid-brown, with tips of tubercles and granules, bright orange. Ventral side is speckled with bright orange dots. They are most active at night during monsoon. They occupy a canopy height of one meter and are spotted perched on shrubs, nearby water bodies.

**Table 1.** The checklist of amphibians of the Greater Shillong Planning Area (GSPA) along with their IUCN Status and type locality. Abbreviations used: CR-Critically Endangered, LC-Least Concern, DD- Data Deficient, NE–Not Evaluated, EKH-East Khasi Hills, AP- Arunachal Pradesh, WB-West Bengal, NEHU-North-Eastern Hill University.

S/No	Species	Recorded Localities in GSPA	IUCN Status	Type Locality
<b>Class AMPHIBIA Gray, 1825</b>				
<b>Order ANURA Fisher von Waldheim, 1813</b>				
<b>Family BUFONIDAE Gray, 1825</b>				
1	<i>Duttaphrynus himalayanus</i> (Günther, 1864)	Purkayastha (2015)	LC	The Himalayas (Sikkim & Nepal)
2	<i>Duttaphrynus melanostictus</i> (Schneider, 1799)	Widely distributed	LC	India orientali
<b>Family DICROGLOSSIDAE Anderson, 1871</b>				
3	<i>Euphlyctis cyanophlyctis</i> (Schneider, 1799)	Widely distributed	LC	India orientali
4	<i>Limnonectes khasianus</i> (Anderson, 1871)	Umshing, Umshyrypi	DD	Khasi Hills
5	<i>Minervarya pierrei</i> (Dubois, 1975)	Widely distributed	LC	Nepal
6	<i>Minervarya sengupti</i> (Purkayastha and Matsui, 2012)	Lumpariang, Risa Colony	NE	Mawphlang, EKH
7	<i>Minervarya</i> sp.	NEHU campus, Umshing	—	—
<b>Family HYLIDAE Rafinesque, 1815</b>				
8	<i>Hyla annectans</i> (Jerdon, 1870)	Widely distributed	LC	Khasi Hills
<b>Family MEGOPHRYIDAE Bonaparte, 1850</b>				
9	<i>Xenophrys flavipunctata</i> (Mahony et al., 2018)	Sohryngkham	NE	Mawphlang, EKH
10	<i>Xenophrys major</i> (Boulenger, 1908)	Mawtawar, Mawlai-Mawroh	LC	Khasi Hills
11	<i>Xenophrys oropedion</i> (Mahony et al., 2013)	Risa Colony, Malki, Mawlai	NE	Shillong
<b>Family MICROHYLIDAE Günther, 1858 (1843)</b>				
12	<i>Microhyla berdmorei</i> (Blyth, 1856)	Purkayastha (2015)	LC	Myanmar
13	<i>Microhyla</i> sp.	Purkayastha (2015)	—	—
<b>Family RANIDAE Batsch, 1796</b>				
14	<i>Amolops cf. gerbillus</i> (Annandale, 1912)	NEHU campus, Umshing	LC	Abor Hills, AP
15	<i>Hydrophylax leptoglossa</i> (Cope, 1868)	NEHU campus, Umshing, Mawtawar, Mawlai-Mawroh	LC	Myanmar
16	<i>Clinotarsus alticola</i> (Boulenger, 1882)	Risa Colony, Malki	LC	Shillong
17	<i>Hylarana tytleri</i> Theobald, 1868	NEHU campus, Umshing, Mawlai-Mawroh	LC	Bangladesh
18	<i>Odorrana chloronota</i> (Günther, 1876)	Risa Colony, Malki	LC	Darjeeling, WB
19	<i>Odorrana livida</i> (Blyth, 1856)	Six Mile, Upper Shillong	DD	Myanmar
20	<i>Odorrana mawphlangensis</i> (Pillai and Chanda, 1977)	Risa Colony, Malki	DD	Mawphlang, EKH
<b>Family RHACOPHORIDAE Hoffman, 1932 (1858)</b>				
21	<i>Polypedates teraiensis</i> (Dubois, 1987)	Widely distributed	NE	Nepal
22	<i>Polypedates</i> sp.	Risa Colony, Malki	—	—
23	<i>Raorchestes shillongensis</i> (Pillai and Chanda, 1973)	Widely distributed	CR	Shillong
24	<i>Rhacophorus bipunctatus</i> Ahl, 1927	Widely distributed	LC	Khasi Hills
25	<i>Zhangixalus smaragdinus</i> (Blyth, 1852)	Risa Colony	LC	Naga Hills, Nagaland

***Amolops cf. gerbillus* (Annandale, 1912):** A small sized cascade frog, its dorsum is finely granulated. We have spotted this species at NEHU campus, Umshing during June month in the vicinity of an undisturbed waterfall.

***Clinotarsus alticola* (Boulenger, 1882):** Another species with its type locality at Shillong, this frog has a slender, compressed trunk. The dorsum is smooth and orangish in colour. They are found in Malki-Risa forests patch.

***Hydrophylax leptoglossa* (Cope, 1868):** A relatively common ranid frog, this species is distinguished by its brown

dorsum, with some dark spots, distinct dorso-lateral folds and darker flanks. The limbs are banded. We observed this species at NEHU campus, Umshing, and Mawtawar, Mawlai-Mawroh localities. It is quite common and can also be seen in clearings of thickets with small running streams.

***Hylarana tytleri* Theobald, 1868:** A bright green coloured frog, it has a distinct whitish dorso-lateral glandular folds. They are generally found in shrubs near water bodies. We have observed this species at NEHU campus, Umshing, and Mawtawar, Mawlai-Mawroh localities. Sighting of this species





**Fig. 3.** Anuran amphibians of Shillong. A- *Limnonectes khasianus*, B- *Minervarya sengupti*, C- *Xenophrys flavipunctata*; D- *X. Major*, E- *M. oropedion*; F- *Hydrophylax leptoglossa*; G- *Hylarana tytleri*; and H- *Clinotarsus alticola*





**Fig. 4.** Anuran amphibians of Shillong. I- *Odorrana chloronota*; J- *O. livida*; K- *O. mawphlangensis*, L- *Polypedates teraiensis* M- *Polypedates* sp.; N- *Raorchestes shillongensis*, O- *Rhacophorus bipunctatus*, and P- *Zhangixalus smaragdinus*.

was successful only during retreating monsoon and was seen only once at these localities during the entire study period.

***Odorrana chloronota* (Günther, 1876):** A small sized green dorsum odorous ranid frog, quite common at Risa Colony and Malki forest during monsoon. The green dorsum is spotted with black, round dots, mid-dorsally. The limbs are faintly banded.

***Odorrana livida* (Blyth, 1856):** A large sized, smooth skinned uniformly green dorsum frog, we spotted this species at Six Mile (= Laimer) locality in Upper Shillong. They are active during May to June period, and are often observed sitting over a boulder near a forested stream. Thighs with distinct yellow blotches with dark marbling, is a distinguishing character from its congeners.

***Odorrana mawphlangensis* (Pillai and Chanda, 1977):** A large sized frog, the dorsum is brownish with green patches. Body is stout and thighs are meaty. This is a commonly occurring frog around Risa-Malki forest patch. They breed around slow flowing water bodies. Largely nocturnal, mating takes place in water and the amplexus can last up to many hours.

***Polypedates teraiensis* (Dubois, 1987):** A widely distributed tree frog species, the light brown coloured dorsum contains 4-6 rows of darker longitudinal stripes. Skin on the head is ossified. The habit is nocturnal and active during monsoon and sympatric with *Rhacophorus bipunctatus*.

***Polypedates* sp.:** This *Polypedates* species was not agreeing to any of the congeners found from the region, although slightly agreeing to the species *P. assamensis* described by Mathew and Sen (2009) from Dhemaji, Assam. We have observed this from Risa-Malki forest patch.

***Raorchestes shillongensis* (Pillai and Chanda, 1973):** This is the only bush frog known to occur in Shillong. Described from Malki Forest of the City (Pillai and Chanda, 1973), the males of this species make a characteristic *tik-tik-tik* call that resonates all across the city during the monsoon period. In the dry season, they hibernate in soil and fallen logs. They are polymorphic and we have observed six morphs during our study period.

***Rhacophorus bipunctatus* Ahl, 1927:** A medium sized, light green dorsum tree frog, this is distinguished by the presence

of black/dark blue spots on the flanks. The spots can be between 1-3, but mostly one on each flank. Sometimes, the green dorsum is with minute black dots. Ventrums are bright yellowish. The webbings are bright red. This was described from Khasi Hills.

***Zhangixalus smaragdinus* (Blyth, 1852):** A large sized tree frog, a lone individual was spotted from Risa Colony in August, 2017. The dorsum is green and smooth while the ventrum is creamy yellowish/whitish and granulated. Webbings colour similar with ventrum.

## Discussion

Shillong city has type locality of three species of frogs. *R. shillongensis* and *M. oropedion* were described from Risa Colony forest and Malki forest of the city, respectively (Pillai and Chanda, 1973; Mahony et al., 2013) and are quite common in the forested areas. In fact, *R. shillongensis* can even be seen in the heart of urban dwellings during the monsoons. However, this species is restricted to the city and its suburbs, and is endemic to East Khasi Hills district of the State (Baruah et al., 2017; 2018). Another species, *Clinotarsus alticola* has its type locality in Shillong as well (Chanda et al., 2001) and was found to be common in Malki-Risa forest patch.

*Minervarya sengupti* and *Xenophrys flavipunctata*, both described from Mawphlang, which is about 25 km away from the city (Purkayastha and Matsui, 2012; Mahony et al., 2018), are also reported from Shillong that constitutes their respective second report post their descriptions as well as also extending their known geographical range. While many individuals of *M. sengupti* were spotted at Risa Colony and Lumparing forests of the city, a lone individual of *M. flavipunctata* was spotted just outskirts of Shillong at Sohryngkham village.

Among the other frogs found in the city, *Limnonectes khasianus*, *Hyla annectans*, *Xenophrys major* and *Rhacophorus bipunctatus* have their respective type localities in unspecified areas of the Khasi Hills (Mahony et al., 2013) of the State.

During our field visits, we have come across two species of frogs which were not identified up to the species level. While *Minervarya* sp. is a small sized dicroglossid frog and is not attributable to any of the known *Minervarya* species



from the region; a dark coloured *Polypedates* sp. was also found, with loose cephalic skin but not agreeing with *Polypedates maculatus*. Nevertheless, we have included them in this report.

The report of Himalayan Salamander, *Tylotriton verrucosus* from Upper Shillong by Das (1984) was not supported by any voucher specimen; however, our unsuccessful hunt for this species in and around Shillong has led us to believe that locals in Umlyngka, Umtyngar and Sohra localities have encountered a “salamander” species agreeing with the morphological characters of this species. Nevertheless, until any confirmed report of its occurrence is established, we are not keeping this species in this checklist.

Purkayastha (2015) briefly reported 14 species of amphibians from Shillong, including reports of two microhylid frogs, *Microhyla berdmorei* and *M. ornata*. However, we did not encounter any microhylid frog during our field work nor we could find any such museum specimens in ZSI Shillong collected from Shillong. Recently, a major taxonomic revision on the distribution of *M. ornata* was carried out and as it has been restricted to South India, the erstwhile population of “*M. ornata*” from North-east India has been split into *M. mymensinghensis*, *M. nilphamariensis* and *M. mukhlesuri* (Garg et al., 2018). Since none of *Microhyla* species reported by Purkayastha (2015) was supported by vouchers or photographs, we are not inclined to include them in this checklist; however, as microhylids of this genus is quite common in Khasi Hills, hence, we are retaining them.

Although there is a lack of documentation of urban fauna from the region, we can compare our findings of Shillong with that of its neighbouring metropolis of Guwahati in Assam. In terms of amphibian species richness, Shillong fare better *vis-à-vis* Guwahati, which has an area of 216.779 km<sup>2</sup>, and is reported to harbour 14 species of anuran amphibians (Purkayastha et al., 2011), which was later revised up to 17 amphibian species (Purkayastha, 2015).

### Threats to these amphibians

Understanding the risks faced by the fauna of an area is a critical prerequisite for effective management of biodiversity.

Of the 25 species recorded in the study area, the assessment of their conservation status (IUCN) revealed one critically endangered (CR) species, while a considerable fraction (~30%) are Data Deficient (DD) and Not Evaluated (NE) yet. The high population density of Shillong, has led to rapid urbanization pressure, due to which forest patches are coming under increased encroachment pressure. Although, the government protected forest (12.96 km<sup>2</sup>) areas provide a safe haven for the fauna of the city, but that is miniscule to the total forest cover (of about 80 km<sup>2</sup>) currently available in the GSPA that has no legal protection (Fig. 2). Thus, the smart-city planners should give utmost importance of maintaining habitat connectivity for the remaining forest patches during their project implementation phase. They can also think of creating ponds in close proximity to forested habitats which can act as “fall back refugia” during breeding times.

Another emerging threat is the landscaping and maintenance of residential and commercial areas typically involving removal of shrubs, leaf litter and an increase in grasses and herbs which can invariably impact various perianthropoc amphibian species (McKinney, 2008). One such species in Shillong is the critically endangered *R. shillongensis* which thrives in this human dominated landscape.

Other additional threats observed in our study area includes the rising pollution level of the main rivers of the city (Umkhrah river at Polo area and Umshyrpi river at Rilbong area); besides, the littering of pristine forest habitats commonly being used as picnic spots, can also adversely affect amphibians specially those which undergoes direct development avoiding the free swimming tadpole stage (like bush frogs). Besides, amphibians mainly depend on acoustic calls to lure potential females which are species specific. The spurt of urbanization in Shillong area can severely impede this vital process through light and noise pollution in their breeding habitats.

It is evident from our study that even though urban habitats are markedly different from their natural counterparts; they still have the potential to provide habitats for numerous amphibian species. Under the current scenario of exponential

increase of human population and constrained land resources for biodiversity conservation, the role of various stakeholders in town planning becomes pivotal in the implementation of “smart city” in Shillong giving due consideration and importance to its amazing amphibian diversity that has been documented here.

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