AN OVERVIEW OF THE HERPETOFAUNA OF SIKKIM WITH EMPHASIS ON THE ELEVATIONAL DISTRIBUTION PATTERN AND THREATS AND CONSERVATION ISSUES

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ABSTRACT

Herpetofauna that comprises amphibians and reptiles are the most important component of the ecosystem. They are threatened worldwide and are declining rapidly, mostly due to anthropogenic pressures. While conservation of these faunal groups has become priority, the study concerning them is scanty. Sikkim occupies a unique location in the eastern Himalaya and harbors high biodiversity including herpetofauna. Here we have complied the scattered available information on herpetofauna of Sikkim supported with our extensive field studies during 2003-2010. We also evaluated elevational distribution pattern, range size distribution and threats and conservation needs of herpetofauna. We prepared the checklist of herpetofauna which contains 50 species of amphibians and 88 species of reptiles that are found in Sikkim. During our study we observed 23 and 42 species of amphibians and reptiles respectively from Sikkim. Along the elevation gradient, amphibian species richness showed mid-elevation (1500-2000m) peak, whereas reptilian richness peaked at 500-1000m elevation. Amphibian distributions are influenced by both temperature and precipitation, whereas temperature alone determined reptile richness pattern along the elevation gradient. Most species of herpetofauna depicted narrow elevational range size. We found that most of the high altitude species extends their range towards low altitude but reverse is not true. Major threat for amphibian species is observed as collection by local communities and for reptiles it is rampant killing (especially snakes). Considering high richness at low elevation, narrow elevation range of many species and unique diversity, conservation of all habitats along the entire elevation gradient is necessary for conservation of herpetofauna in Sikkim. Raising awareness among people at various levels is one of the major conservation needs in Sikkim.

KEYWORDS: *Amphibian, conservation, elevational pattern, herpetofauna, range size, reptiles, species richness, threats.*

Philautus annandalii – Smallest amphibian of Sikkim. The croaking sound of this species is widely heard in our gardens during monsoon

Common Spectacled Cobra *(Naja naja)* a venomous snake, photographed in the Sal Forests of Sikkim

INTRODUCTION

Herpetofauna comprises both amphibians and reptiles. Amphibians are represented by frogs, toads, caecilians and salamanders, whereas reptiles include crocodiles, turtles, tortoises, snakes and lizards. They are the first vertebrates who conquered the terrestrial ecosystem successfully. These fascinating creatures have invaded varieties of habitats ranging from the hot lowland to the cold mountain summit and from scorching desert to cool forest. Though they are highly diverse and play a significant role in the ecosystem, the studies concerning these fauna are very scanty. Their cryptic nature, low conspicuousness and high seasonal activity have resulted in limited study.

Most of the herpetofauna are threatened and are declining more rapidly than birds and mammals (Stuart et al., 2004). Habitat loss, pollution and direct intervention by humans are thought to be the prime reasons for their decline. Conservation strategies are based mostly on glamorous taxa such as birds and mammals, which may neglect smaller and less conspicuous vertebrates such as herpetofauna (Vasudevan et al., 2006). The inclusion of minor vertebrates in management plan for any particular region is necessary for overall conservation of biodiversity at local as well as landscape level (Pawar et al., 2007). But such programmes are hampered by absence of ecological studies and non-availability of scientific data on herpetofauna.

The eastern Himalayas, including Sikkim and north-eastern states of India, is one of the biodiversity hotspots of the world (Mittermeier et al., 2005), and is located at the cross road of many Biogeographic realms (Palaearctic, Oriental) and regions (Indo Malayan, Indo Chinese). Sikkim (27° 5' - 28° 9' N and 87° 59' - 88° 56' E), a part of the Himalayan Biogeographic Zone of India (Rodgers and Panwar, 1988), harbors rich and unique biodiversity in the world. Rich faunal diversity of Sikkim is mainly accounted for its geographical location, altitudinal range (300 - 8580m asl) and varied climatic regime (hot tropics-cold arctic). The recent description of species from Northeast India indicates that the chances of documentation of new species with further scientific exploration are high in this region (Chanda and Ghosh, 1989; Mathew and Sen, 2007).

The herpetofauna of Sikkim is the least studied group among all the land vertebrates. Barring sporadic collections, reporting by the Zoological Survey of India, a few taxonomic studies and anecdotal notes (Boulenger, 1890; Smith, 1931, 1935, 1943; Ganguli-Lachungpa, 1998), information on the herpetofauna of Sikkim is scanty. Compilation on the herpetofauna of Sikkim (Jha and Thapa, 2002) is largely based on published literatures (Smith, 1935, 1943; Ganguli-Lachungpa, 1998). Primary data on the herpetofauna resulting from field studies is lacking for Sikkim. Recently we have undertaken the extensive studies on herpetofauna of Teesta Valley and Maenam Wildlife Sanctuary (Chettri, 2007, 2010; Chettri et al., 2010). In this paper, we have compiled the scattered published information on herpetofauna of Sikkim supported with the extensive field studies conducted during 2003 to 2010. At first we updated the checklist of both amphibians and reptiles of Sikkim. Then, based on our studies in the state, we analysed altitudinal pattern and range size distribution of herpetofauna. The analysis of distribution pattern along elevation gradient is proved to be comprehensive assessment tool for rapid identification of hotspot areas. At the end, we also discuss threats and conservation initiatives of these vertebrates in Sikkim.

MATERIALS AND METHODS

Compilation

We referred all the published literatures dealing with the herpetofauna of Sikkim and surrounding regions to gather information on species occurrence in the state. Available baseline information on habitat details and altitudinal

range of the species were also obtained. These information were verified with our observation during the field studies. Hence, we prepared an updated checklist of the reptiles and amphibians for the Sikkim state.

Data collection

We conducted field study in the Teesta Valley and Maenam Wildlife Sanctuary in Sikkim. For the herpetofaunal study, we categorized study area into seven zones based on elevation (500m interval). Altitude zones and major vegetation types are presented in Table 1. We followed time constraint visual encounter survey (VES) method (Heyer et al., 1994) for sampling amphibians and reptiles. In this method, rigorous search is conducted in all probable microhabitats such as boulders, logs and mosses looking for the animals. The search was conducted during day (09:00 to 14:00) and evening (18:00 to 20:00) hours. On locating animals, data on species, number of individuals, altitude, vegetation and microhabitat types were recorded. For amphibian study, VES was supplemented with night stream surveys in various locations. Streams were identified and measured at the initial stage of the study. Amphibians (especially frogs) were searched along the stream with the help of search light during dusk to early night hours (18:30 to 20:30). On encountering a species, we collected all the details as mentioned above for VES. During stream surveys, only the animals observed above ground were recorded without disturbing the microhabitats.

Data Analysis

We estimated species richness and abundance of reptiles and amphibians in total and for each zone separately. Number of species was obtained as cumulative number of species observed and abundance as total number of individuals observed during the study. Based on these data, we estimated distribution pattern along the elevation gradient. We also estimated elevational range size of all the species encountered during our study. Relative abundance of each species was obtained as n_i / N * 100 (number of observations of a species / total observations of all species) * 100. Anthropogenic threat on amphibians was analysed based on data on extraction of amphibians to figure out the total amphibian extraction per site, preferred species, purpose of extraction, and time of collection.

RESULTS AND DISCUSSION

A. AMPHIBIANS

Background

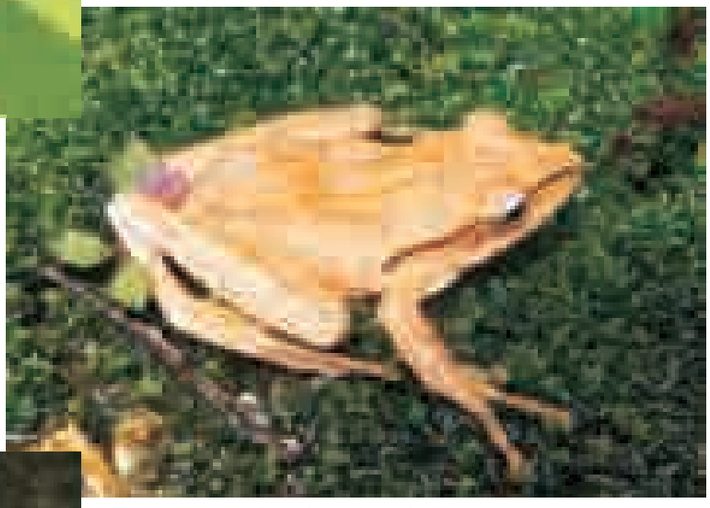
Number of amphibian species reported to occur in Sikkim varies from author to author. Boulenger (1890) reported 17 species, whereas Gammie (1928) records 16 species of amphibians from Sikkim. Inger and Dutta (1986) summarized amphibian distribution based on the literature and reported 56 species from Northeast India, 15 specific to Sikkim. Waltner (1973) reported 53 species of amphibians from the entire range of Himalayas including 30 from Sikkim. Swan (1993) reported 41 amphibians from plains and mountains of both Sikkim and Darjeeling area, but reduced the species confined to hills to 32. Ganguli-Lachungpa (1998) highlighted the paucity of information regarding amphibians and reported 13 species including two unidentified ones. Chanda (2002) documented Indian amphibians, which included 21 species found in Sikkim. Jha and Thapa (2002) reported 27 species of amphibians from Sikkim Himalayas of which 20 are specific to Sikkim but their reporting is based on published literatures. Schleich and Kastle (2002) included 52 species of amphibians from Sikkim and Darjeeling. We observed 23 species including two unidentified ones in our study in the Teesta Valley and Maenam Wildlife Sanctuary in Sikkim. After compilation of all these information supported with our study, checklist of amphibians of Sikkim now contains 50 species (Appendix 1). These species are represented by three orders and seven amphibian families. Among 50 species, three (*Xenophrys robusta, Amolops monticola*, *Ichthyophis sikkimensis*) are endemic to Darjeeling, Sikkim and Eastern Nepal region (Schleich and Kastle, 2002).

Species richness and relative abundance

Intensive survey in the Teesta Valley and Maenam Wildlife Sanctuary yielded 1346 amphibians representing 23 species that includes two unidentified ones (some of the observed amphibians are shown in Plate 1 & 2). These species

Plate 1: Amphibian species observed in Sikkim

Xenophrys sp



Polypedates himalayanus

Paa ercepeae

Amolops monticola

Plate 2: Amphibian species observed in Sikkim

Scutiger sikkimensis

Polypedates megacephalus

Duttaphrynus melanostictus

Amolops formosus

belonged to six families and two amphibian orders. Order Apoda was represented by single family and species, whereas order Anura comprised of five families and twenty-two species. Of the total amphibian species, nine were observed specifically in Teesta Valley and three species in Maenam Wildlife Sanctuary with 11 species common to both the sites.

These 23 species of amphibians from Teesta Valley and Maenam Wildlife Sanctuary constituted approximately 46% of the species found in Sikkim and 42% in Northeast India (Inger and Dutta, 1986). Representing such high diversity, the study area serves as potential habitat for amphibians. The high diversity in comparison to small area is attributed to varied microhabitats and ecological niches suitable for the existence of amphibians (Plate 3).

Relative abundance of amphibian species in Sikkim shows sparse distribution. Barring a few species, relative abundance of most species was low. Most species were observed only once or twice during the entire course of our study. Of the 23 species, ten species contributed less than 1% population. Almost half of the total abundance was contributed by single species i.e. *Duttaphrynus himalayanus* (44.28%). This result supports well established community pattern (a few common and most rare species i.e. a community is dominated by few common species; Heatwole, 1982; Magurran, 1988).

Distribution pattern along elevation gradient

Distribution of amphibian species along the elevation gradient showed unimodel pattern with peak at mid-elevation zone (Fig. 1). Maximum of 15 species were observed in zone IV (1500-2000m) and minimum of four species were found in highest elevation zone (>3000m). Hence, mid-elevation region should be prioritized for amphibian conservation.

Though the species richness declined towards both the ends, decline was sharper towards higher elevation. There was four-fold decrease in species richness from mid-elevation band to highest elevation band. Abundance followed slightly different pattern although a peak was observed at 2000-2500m (Fig.1). High abundance towards higher elevation was due to the clumped distribution of one species (*Duttaphrynus himalayanus*).

The elevational pattern of amphibians in Sikkim is in accordance with birds and plants (Acharya, 2008; Acharya et al., 2011) but slightly different from reptiles of this region (species richness peaked at 1000m for reptiles in Sikkim; Chettri et al., 2010). Although reptiles and amphibians are reported to follow monotonic decline (Heatwole, 1982), mid-elevation peak in amphibian species richness is also not uncommon (Fu et al., 2006).

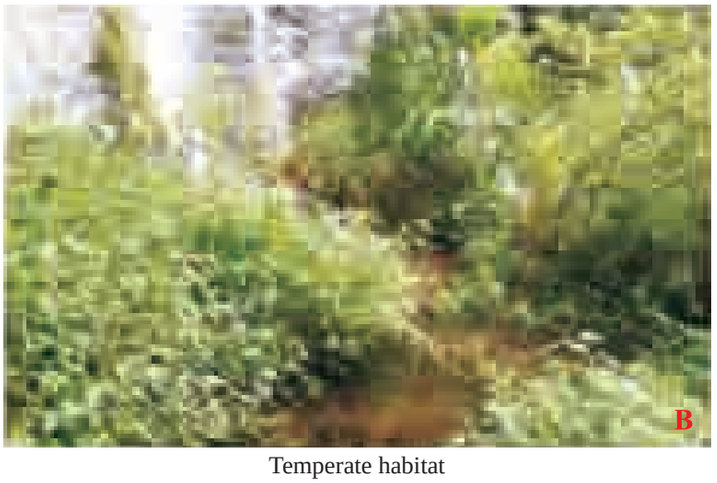
The peak of species richness and abundance at 1500-2000m zone coincides with vegetation and climatic ecotones, where sub-tropical type is replaced by temperate one. The peak in species richness at ecotone might be due to the invasion of species from the adjacent elevation sites. Hofer et al. (2000) reported ecotone as factors for declining amphibian richness along the altitude gradient in Mount Kupe, Cameroon. The climatic factors such as temperature, precipitation and potential evapo-transpiration are found to be significant variables in explaining the elevational pattern of amphibian species richness in Sikkim (Chettri, 2010). Due to their unique body physiology, amphibians are readily affected by both temperature and moisture related variables.

Elevational Range Size

The elevational range size of the 23 amphibian species recorded during the study is depicted in Figure 2. Around 10 species showed very narrow elevational width (<500m) and single species i.e. *Duttaphrynus himalayanus* showed the

Plate 3: Typical amphibian habitat in tropical (A), temperate (B) and alpine vegetation (C) in Sikkim

Tropical habitat



Temperate habitat

Alpine habitat

maximum elevation range (2500m). The narrow elevational range of most amphibian species reflects their sensitivity towards various environmental factors which changes at a faster rate along the elevation gradient. The range sizes have been used as a predictor of extinctions; narrow range species have greater risk of extinctions (Harris and Pimm, 2008). These species needs high conservation attention. It indicates that the conservation of habitats along the entire gradient is necessary as many species are restricted within narrow elevation range.

Threats and conservation issues

In addition to climatic changes and natural calamities, the amphibians and their habitat is threatened mostly due to anthropogenic pressures. Data on anthropogenic threats to amphibians and their habitat were gathered during our study. Based on surveys in different places in Sikkim, we observed that local people collect amphibians from various streams. The collection is used as meat supplement as well as for some medicinal purposes after smoke dried (Plate 4). Amphibian collection is done during monsoon season (June – September) at dusk to early night hours (19:00-21:30). Occasionally, collections during day hours are also observed.

The most preferred species are *Amolops* spp., *Nanorana* spp. and *Xenophrys* spp., although all kinds of frogs are hunted. Interviews with the collectors revealed that they are unaware of the impact of collection on amphibian population. They believe that frogs are nature's gift to them like fruits and die out after some span of time even if not collected. Hence, extraction is one way of harvest before the natural resources are wasted or rotten. The perception is that if they collect more, the number of amphibians will increase in the subsequent years. In some cases, it was found that most collectors pretend to be ignorant about rules and regulations of the government and legal action against such extraction. We educated the local people about significance of amphibians and their conservation importance through various formal programs and informal talks.

Habitat of amphibians is also disturbed during fishing as collectors divert water from the stream to other side. In this process, large number of eggs and tadpoles present there gets dehydrated and die. This activity has posed serious threat to amphibian population as well as their habitat (especially breeding) causing population decline. Anthropogenic disturbance to breeding habitats of amphibians is considered as the most serious threat for population decline worldwide (MacNally et al., 2009). Another significant threat to amphibian habitat is mining at different scale from smaller streams to rivers. It possesses great threat to the diversity of amphibians and other aquatic fauna in Sikkim. Rampant extraction of sand, gravel and boulders affect the amphibian microhabitat.

Although much awareness has been raised and forest department has stringent rules and actions, more awareness programme targeting local people is necessary to control such extraction and other anthropogenic threats. Panchayat members, field officials of the forest department (especially forest guards) and the members of eco-development committees, biodiversity management committees and joint forest management committees may be sensitized with these issues. Empowerment of these committees for taking legal action at local level would reduce illegal collection and trade of wildlife species.

B. Reptiles

Background

Number of reptilian species reported from Sikkim by different workers varied from 26 to 75: 46 species (Gammie, 1928), 31 (Smith, 1931, 1935, 1943), 75 (Waltner, 1973), 43 (Swan, 1993), 26 (Ganguli-Lachungpa, 1998), 76 snakes (Shaw et al., 1999), 61 (Jha and Thapa, 2002) and 42 species (Chettri, 2007). Variation in number of species reported by different workers could partly be due to geographical confusion and unequal field visits. For example Darjeeling Hills and adjacent plains were considered as greater Sikkim Himalayas during the pre-independence (Gammie, 1928) and inclusion of species found in Darjeeling area might have resulted in this inconsistency. Another reason could be the taxonomic confusion and frequent changes in nomenclature (Chettri and Bhupathy, 2007). In addition, occurrence of species such as *Draco blanfordii*, *Laudakia himalayana*, *Phrynocephalus theobaldi*, *Indotestudo elongata*, *Lissemys*

Plate 4: Frog *extraction* in Sikkim by locals during night (A): Frog kept for smoking after collection (B). The displayed frogs comprises two most extensively hunted species: *Amolops* sp and *Xenophrys* sp

punctata, Melanochelys tricarinata and *M. trijuga* in Sikkim appears doubtful (Chettri and Bhupathy, 2007). Lacertid (*Takydromus sikkimensis)* and Colubrids *(Lycodon aulicus, Dinodon gammiei, Xenochrophis sanctijohannis)* were recorded from Sikkim after 60 years and Gekkonid (*Cyrtodactylus* sp), and Elapid (*Bungarus niger*) after 30 years. Recently, a lizard *Takydromous sikkimensis* has been rediscovered from Sikkim and its taxonomic confusion is revalidated (Bhupathy et al., 2009).

With these analysis and synthesis, now a total of 88 species of reptiles have been confirmed with specific locality records in Sikkim (Appendix 2). These reptiles comprise 71 snakes and 17 lizard species. Among the total species of snakes, 19 are venomous and the rest non-venomous. All the snakes are represented under five families, of which Colubridae and Boidae contributed the maximum (58%) and minimum (2%) number of species respectively. Among 17 species of lizards, Gekkonidae contributed the highest (35%) number of species. Families such as Lacertidae, Anguidae and Varanidae are represented by single species.

Species and family richness

Our study in Sikkim along the Teesta Valley yielded 42 species of reptiles comprising of 14 lizards and 28 snakes (some of the reptiles are shown in Plate 5 & 6). A total of ten families (five each for lizards and snakes) were observed during this study. Among snakes, Colubridae contributed the highest consisting of 18 (64 %) species and the least by Boidae with only one species. Gekkonidae with five species (35%) was the most contributing lizard family. Of the ten reptile families observed, three were represented by single genera and species (Fig. 3).

Distribution pattern along elevation gradient

Among 42 species of reptiles observed during the field study along Teesta Valley in Sikkim, a maximum of 21 species were observed in zone II (500-1000m) and minimum of three species in zone VI (2500-3000m). No reptiles were encountered in zone VII (Fig. 4). Species richness decreased markedly above zone III. Along the elevation gradient, lizards and snakes slightly differ in their trend. Lizards declined monotonically along the elevation gradient, whereas snakes showed left skewed unimodel pattern with peak at 500-1000m (Fig. 4). Decline in reptile species richness along the altitude is a general pattern observed in many studies (Scott, 1976; Heatwole, 1982; Raxworthy et al., 1997). Climatic variables influence altitudinal species richness patterns in several ways (McCain, 2007; Naniwadekar and Vasudevan, 2007). Hofer et al. (1999) reported that terrestrial reptiles respond more strongly to temperature than moisture.

Abundance of reptiles did not follow any definite trend with altitude. Abundance reached maximum at zone VI (2500-3000m) and minimum at zone IV (1500-2000m) (Fig. 5). The high abundance in zone V and VI is due to clumped distribution of two species (*Asymblepharus sikimmensis* and *Trachischium guentheri* (Plate 7). Both of these species had patchy distribution with aggregation of many individuals. Due to severity of climatic conditions, species may become specific to a few microhabitats such as under boulders or logs resulting in aggregation of the individuals. According to Lillywhite (1987) aggregation of individuals helps in maintaining thermo-regulation through the exchange of body heat which is advantageous to maintain body temperature in colder conditions.

Elevational Range Size

Most reptile species showed narrow altitudinal width (range size) along the gradient and were concentrated in the lower altitude, hence species showed inverse relation with increasing rangesize (Fig. 6). More than 50% of total species were restricted to <1000m altitude. However, all the six species present above 2000m descended as low as 1500m or further below. Range distribution profile of reptiles demonstrates that low altitude species were specialists, whereas high altitude species showed wider range. Owing to wider climatic fluctuations in higher altitude, high altitude species can descend down to lower altitude but low altitude species cannot tolerate the climatic severity persisting in the higher altitude. Hence, preservation of low altitude forests is required for the conservation of reptiles in the Himalayan range.

Plate 5: A few lizards found in Sikkim

Japalura variegata

Takydromus sikkimensis

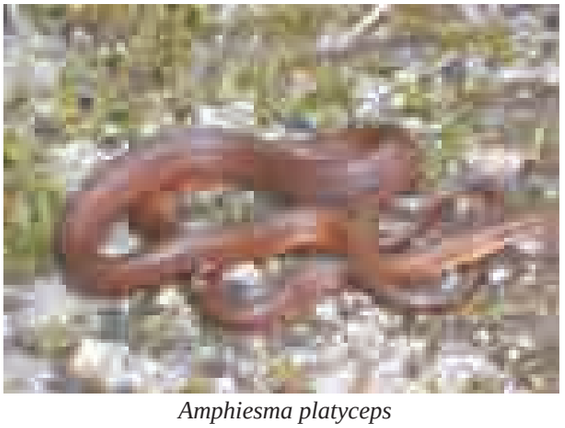
Cyrtodactylus khasiensis

Oriotaris tricarinata

Plate 6: A few snakes found in Sikkim

Oreophis porphyraceus

Dinodon gammiei



Amphiesma platyceps

Rhabdophis himalayanus

Threats and conservation issues

Indiscriminate killing has threatened many species of reptiles at global as well as at local level. The major threat for reptiles in Sikkim is also rampant killing. People consider reptiles especially snakes as their enemies and kill them the moment they encounter any individuals. All the snakes are believed to be venomous and killed despite the fact that

Plate 7. The most abundant high altitude reptile species with clumped distribution

Asymblepharus sikimmensis

Trachischium guentheri

Plate 8: Venomous snakes of Sikkim

Naja kaouthia

Ovophis monticola

only 20% are venomous. The venomous snakes are Cobras, Vipers and the Kraits (Plate 8). With some simple identification techniques, we can save ourselves from their deadly bite. Cobra can be easily identified with distinct hood. Vipers have triangular head with numerous smaller scales (not shield like other snakes) and vertical pupil. They are exclusively nocturnal. Kraits can be confused with other non-venomous snake. However, when observed carefully we can easily escape from its bite. The middle scale (known as vertebrae) is comparatively larger than the rest of the body scales. All other snakes are non-venomous and innocent creatures of nature. Similarly, people believe that lizards are deadly poisonous and there is no medicine if the person is bitten by lizards. This notion is completely untrue. None of the lizard species found in India is venomous. The only poisonous lizard in the world is Gila monster found in North America. Apart from killing, habitat destruction has caused considerable decline in the population of reptiles all over the world.

To maintain balanced ecosystem, we need to conserve all creatures ranging from minute insects to gigantic whales. Reptiles has got its unique role in ecosystem functioning. Apart from ecological role, they also have tremendous economic importance. Due to their agility, beauty and frightfulness, they are able to draw considerable attention of people in various zoos. Some tribal communities have earned their livelihood as snake charmers. Reptiles have been variously depicted in religious monuments and literatures of different faiths since time immemorial. Considering ecological, economical and religious roles of herpetofauna, their conservation is vital.

Raising awareness among people is one of the major conservation initiatives in Sikkim. In collaboration with the Forest Department, Government of Sikkim and various NGOs, we have been raising awareness on importance (ecological and economical) and conservation needs of herpetofauna in Sikkim. The major target groups include local communities, panchayats and students. More such awareness of the communities is required at various level such as students (school and college), villagers, foresters and policy makers.

In Sikkim 31% of the total geographical area is under protection but most PAs are located above 1500m. Except Kitam Bird Sanctuary (area = 6 km^2) none of the PAs extends below 1000m. Protected areas which are framed based on larger vertebrates may not do equal justice to minor vertebrates such as reptiles and amphibians (Vasudevan et al., 2006). Multi-species study in Hong Kong (Yip et al., 2004) and Nepal (Hunter and Yonzon, 1993) have also found mis-match between species richness and protected areas. Hence, while planning the protected areas, consideration of minor taxa also is highly recommended. In Sikkim, elevation gradient (1500-2000m) having maximum richness of amphibian is well represented in PAs but the diversity of reptile is high below 1000m. Hence for the conservation of herpetofauna we recommend the extension of existing PAs and creation of new PAs below 1000m. An alternative would be to upgrade the conservation status of low elevation reserve forests. Mosaic patch of forest sandwiched between agricultural landscapes can be preserved with the help of community participation. This is the only possibility to conserve the human inhabited low altitude forest which possesses high diversity of herpetofauna.

Acknowledgments

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Table 1. Categorization of the study area in Sikkim based on altitude (500m interval)

Altitudinal zone	Altitude (m)	Forest type
Zone I	< 500	Tropical Semi Deciduous Forest
Zone II	500-1000	Tropical Semi Deciduous Forest
Zone III	1000-1500	Tropical Broad Leaved Forest
Zone IV	1500-2000	Tropical + Temperate Broad-Leaved Forest
Zone V	2000-2500	Temperate Broad-Leaved Forest
Zone VI	2500-3000	Temperate Broad-Leaved + Coniferous Forest
Zone VII	>3000	Coniferous Forest + Sub-alpine + Alpine

Figure 1. Species richness and abundance pattern of amphibians along elevation gradient of Sikkim

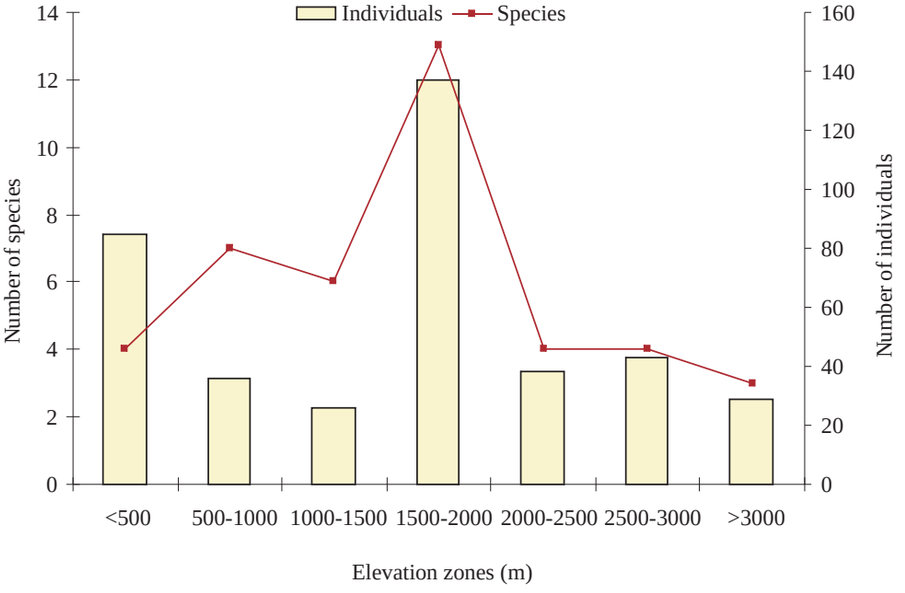


Figure 2. Elevational range profile of amphibians in Sikkim

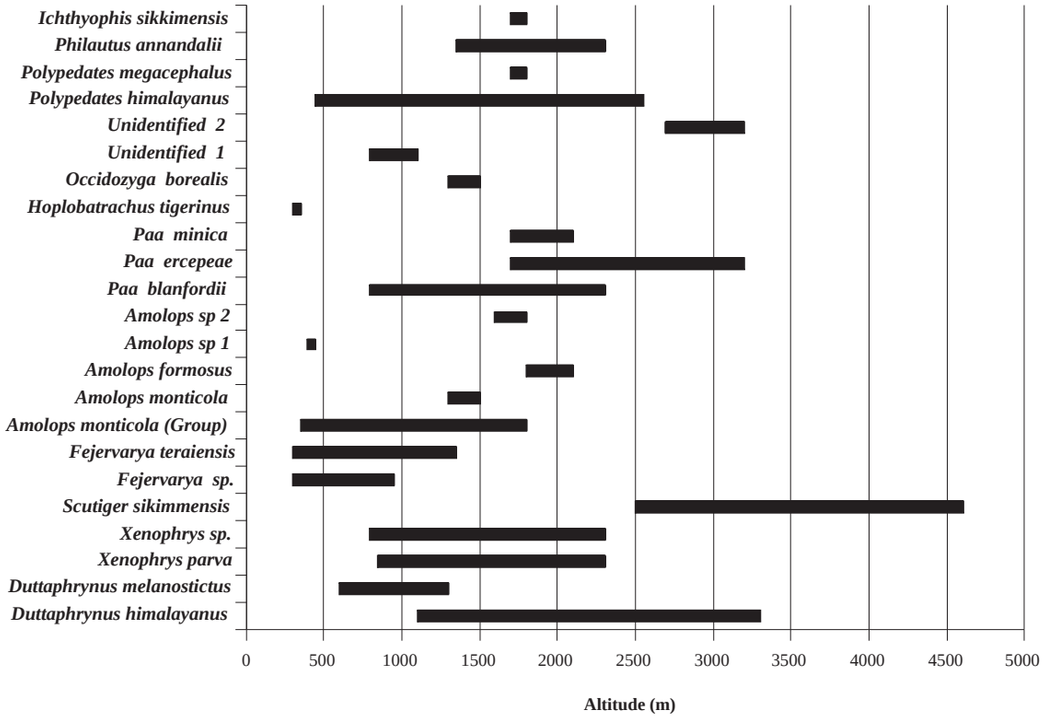


Figure 3. Taxonomic representation of reptiles observed in Sikkim

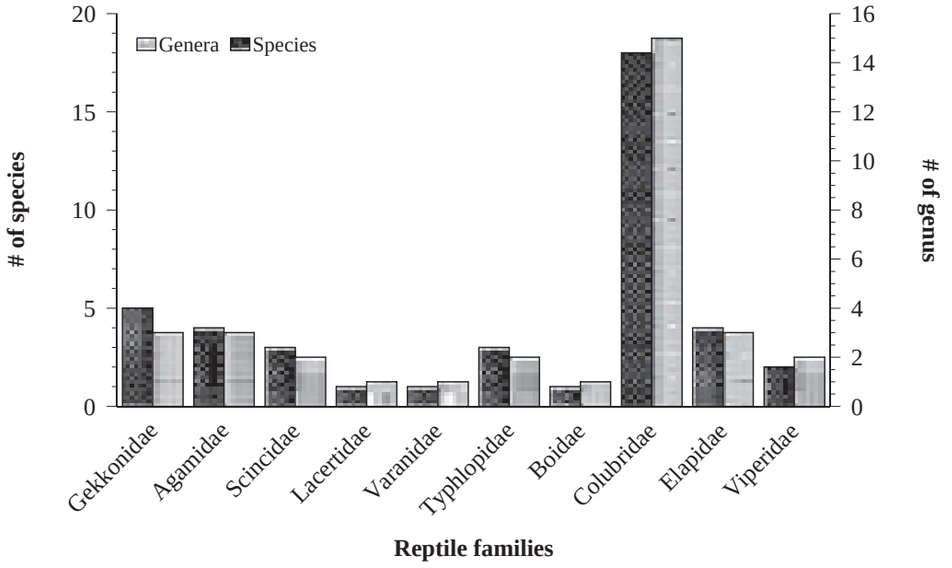


Figure 4. Reptile (lizards and snakes) species richness pattern along elevational gradient in Sikkim

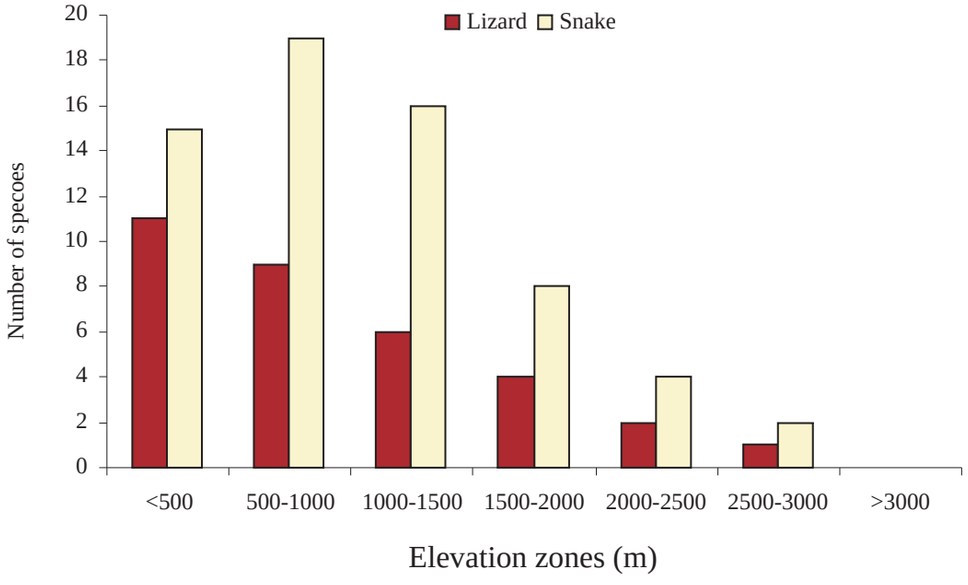


Figure 5. Abundance of reptiles along the elevation zones in Sikkim

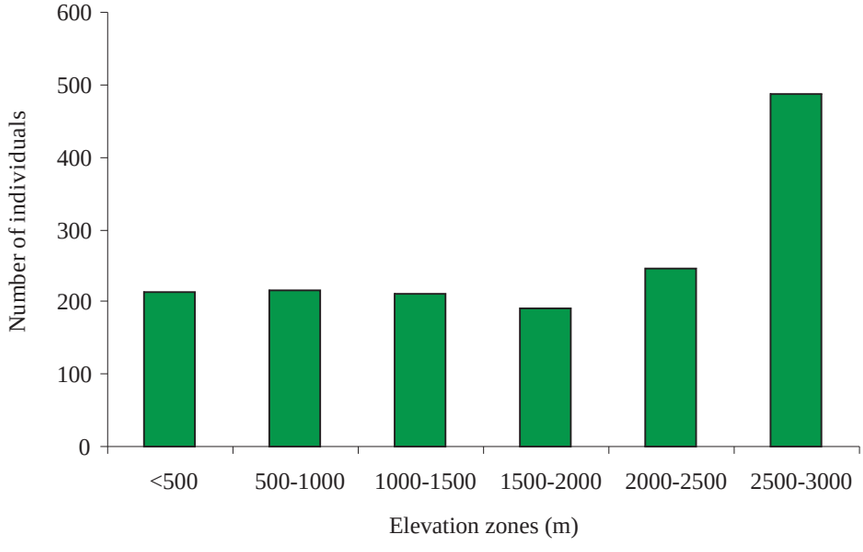
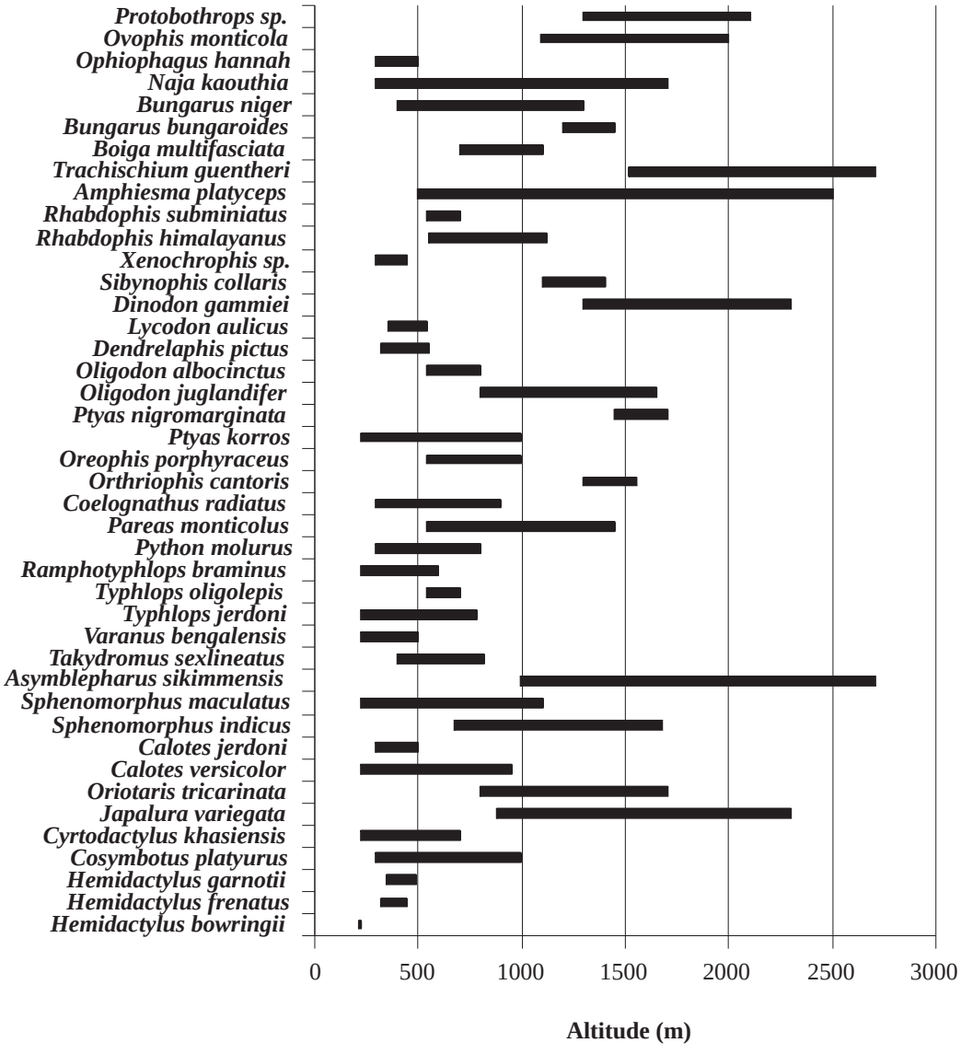


Figure 6. Elevational range of reptile species distributed in Sikkim



Appendix 1. Checklist of Amphibian species found in Sikkim

Family	Species
Bufonidae	*Duttaphrynus melanostictus**
	*Duttaphrynus himalayana**
	Bufo stomaticus
Megophryidae	*Xenophrys parva**
	Xenophrys major
	*Xenophrys robusta**
	*Scutiger sikkimensis**
Ranidae	*Amolops monticola**
	*Amolops formosus**
	Amolops marmoratus
	Amolops afghanus
	Amolops gerbillus
	Amolops himalayana
	Amolops assamensis
	Hylarana taipehensis

Family	Species
Bufonidae	*Duttaphrynus melanostictus**
	*Duttaphrynus himalayana**
	Bufo stomaticus
Megophryidae	*Xenophrys parva**
	Xenophrys major
	*Xenophrys robusta**
	*Scutiger sikkimensis**
Ranidae	*Amolops monticola**
	*Amolops formosus**
	Amolops marmoratus
	Amolops afghanus
	Amolops gerbillus
	Amolops himalayana
	Amolops assamensis
	Hylarana taipehensis
Rhacophoridae	*Philautus annandalii**
	Philautus andersoni
	Philautus argus
	Philautus dubius
	Philautus microdiscus
	Philautus jerdonii
	Chiromantis simus
	Polypedates leucomystax
	Polypedates maculatus
	*Polypedates himalayanus**
	*Polypedates megacephalus**
	Polypedates taeniatus
	Rhacophorus bipunctatus
	Rhacophorus tuberculatus
	Rhacophorus reinwardtii
	Rhacophorus maximus
Salamandridae	*Tylototriton verrucosus*
Ichthyophiidae	*Ichthyophis sikkimensis**
Total Species	**50**

* Observed during the present study

Appendix 2. Checklist of Reptiles found in Sikkim

Families	Species
Gekkonidae	*Hemidactylus frenatus**
	*Hemidactylus bowringii**
	*Hemidactylus garnotii**
	*Cosymbotus platyurus**
	*Cyrtodactylus khasiensis**
	Cyrtodactylus gubernatoris
Agamidae	*Calotes versicolor**
	*Calotes jerdoni**
	*Oriotaris tricarinata**
	*Japalura variegate**
Scincidae	*Sphenomorphus indicus**
	*Sphenomorphus maculates**
	Mabuya carinata
	*Asymblepharus sikimmensis**
Lacertidae	*Takydromus sikkimensis **
Anguidae	*Ophisaurus gracilis*
Varanidae	*Varanus bengalensis**
Typhlopidae	*Typhlops oligolepis**
	*Typhlops jerdoni**
	*Ramphotyphlops braminus**
Boidae	*Python molurus**
	Eryx conicus
Colubridae	*Elaphe prasina*
	*Coelognathus radiatus**
	Orthriophis hodgsonii
	*Orthriophis cantoris**
	*Oreophis porphyraceus**
	Orthriophis taeniurus
	Coelognathus helena
	*Pareas monticolus**
	Pareas macularius
	Elaschistodon westermanni
	Ptyas mucosa
	*Ptyas korros**
	*Ptyas nigromarginata**
	Argyrogena fasciolata
	Liopeltis stoliczkae
	Liopeltis rappii
	*Oligodon albocinctus**
	Oligodon erythrogaster
	Oligodon melaneus
	*Oligodon juglandifer**
	*Dendrelaphis tristis**
	Dendrelaphis pictus
	Dendrelaphis cyanochloris
	Dendrelaphis gorei
	Chrysopelea ornate
	Lycodon jara
	*Lycodon aulicus**

Families	Species
	Lycodon fasciatus
	*Dinodon gammiei**
	Dinodon septentrionalis
	Xenochrophis piscator
	*Xenochrophis sanctijohannis**
	*Sibynophis collaris**
	Amphiesma parallelum
	Amphiesma stolatum
	*Amphiesma platyceps**
	*Rhabdophis subminiatus**
	*Rhabdophis himalayanus**
	Pseudoxenodon macrops#
	Trachischium fuscum
	*Trachischium guentheri**
	Trachischium tenuiceps
	Boiga trigonata
	Boiga ochraceus
	Boiga gokool
	*Boiga multifasciata**
	Boiga ocellata
	Boiga forsteni
	Psammodynastes pulverulentus
	Ahaetulla prasina
	Ahaetulla fronticincta
Elapidae	*Ophiophagus hannah**
	*Naja kaouthia**
	Bungarus fasciatus
	*Bungarus bungaroides**
	Bungarus lividus
	*Bungarus niger**
	Bungarus caeruleus
	Sinomicrurus macclellandi
Viperidae	*Daboia russelii*
	Gloydius himalayanus
	Trimeresurus gramineus
	*Ovophis monticola**
	Protobothrops jerdonii
	Trimeresurus popeiorum
	Trimeresurus erythrurus
	Trimeresurus albolabris
	Trimeresurus gumprechti
	*Trimeresurus sp**
Total number of species	**88**

Source: *Present study (2003-2006) denotes observations along the Teesta Valley; Gammie (1928); Smith (1931, 1935, 1943); Waltner (1973 a,b,c,d); Ganguli-Lachungpa (1998); Shaw et. al. (1999); Jha and Thapa (2002). # denotes opportunistic observations in MaenamWildlife Sanctuary (not included in analysis).

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Pit-viper found in the temperate forest of Sikkim. Note the attacking posture of the poisonous snake

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