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An Introduction to the **Biodiversity of Bhutan**

in the Context of Climate Change and
Economic Development

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Celebrates **25** *years of services to the Tsa wa sum*

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Foreword

This book on “An Introduction to the Biodiversity of Bhutan in the context of climate change and economic development” is a result of many years of teaching and research experience by its many authors and as a statement of the current state of our knowledge of the region. It also reflects the gaps in understanding of state of the biodiversity conservation and the drivers responsible for biodiversity loss, which also lays the strong foundation for future research in Bhutan. It is a useful reference material as it attempts to integrate biodiversity conservation with economic development in the context of climate change impacts and the prospects for sustainable development. The issues pertaining to climate change, development and loss of biodiversity is complex in nature and hence integrated solutions are crucial as it is not possible to deal with these issues independently.

This volume illustrates need for in-depth research and not just fundamental and seeks for collaborative research to build a broad based network of researchers to adequately describe the Bhutan’s complex environment. This book serves as a source of sound information for many practitioners like forestry professionals and educators, and policy-makers, including general public as this book can help formulate recommendations for future policies and management strategies required to conserve rich biodiversity of Bhutan. I would like to congratulate both the editors and the authors of this book and I trust that this book would be an excellent contribution to our society at large.



Dr. Phub Dorji

President

College of Natural Resources

Preface

Rich biodiversity legacy of Bhutan is mainly attributed to the visionary leaderships of the Monarchs of Bhutan who have worked tirelessly for the benefits of the Bhutanese people. Because of their visionary leadership, the biodiversity conservation policies are strongly embedded in the Constitution of the Kingdom of Bhutan which mandates to maintain at least 60% of the country under forest cover at all times to come. Despite such efforts made by its leaders, policy makers, and implementers; Bhutan is facing new challenges on biodiversity conservation, mainly due to climate change and its impacts.

Climate change is affecting biodiversity conservation in various ways. Globally, as a result of temperature rise, mountainous regions such as the Himalayas and coastal areas have become highly vulnerable. In Bhutan, glaciers are depleting at an unprecedented rate and precipitations have become unpredictable. Incidences of natural disasters such as the Glacial Lake Outburst Floods, flash floods, landslides, and wind storms have become recurrent.

With climate change, many invasive plants and animals have taken over new habitats by surprise. These species taking over new grounds have come at a

time when trans-boundary and globalised trades have no boundary. While some of the invasive species have been introduced accidentally through trade and movement of people across borders, many have been introduced intentionally. In absence of specific pests and diseases in the new grounds, the introduced species displace or replace native species few of which will be pushed to the brink of local or global extinction. In order to avoid any such tragedy, it is important that proper documentation of biodiversity is done with scientific rigour.

Besides documentation, it is also important to conserve biodiversity – genetic, species, and ecosystem diversity to secure human well-being. In addition to providing basic needs of food, shelter, and clothing, biodiversity is important source of medicine, income, and ecosystem services. However, very often biodiversity is understood and treated in a piecemeal basis. For instance, biodiversity is understood mostly in the perspective of wild species of plants and animals by foresters. Similarly, agriculturalists tend to know only the agro-biodiversity. Therefore, this book attempts to document biodiversity of Bhutan in a holistic manner, mainly in the context of climate change and fast growing socio-economic development which otherwise might jeopardise human well-being by destroying the biodiversity base.



Thuenpa Puen Zhi – the basis for biodiversity existence in harmony

4. The Current Status of Herpetofauna in Bhutan

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4.1. Introduction

The study of herpetofauna, which includes reptiles and amphibians, has picked up in recent years as this faunal group has the largest percentage of threatened and data deficient species (Rais *et al.*, 2015). Snakes, lizards, turtles, and crocodiles are the major groups of reptiles; whereas newts, frogs, and toads are major groups of amphibians found in Bhutan (Wangyal and Gurung, 2012). Among the reptiles, two species of crocodilians (*Crocodylus palustris* Lesson and *Gavialis gangeticus* Gmelin in Linnaeus) are now thought to be locally extinct in Bhutan (Bustard, 1979; 1980a; 1980b; de Silva and Lenin, 2010; Wangyal, 2014). Reasons for such local extinction could be attributed to several factors such as poaching, dam construction downstream, and climate and environmental change.

Herpetofauna are sensitive to environmental changes and their population is decreasing worldwide due to land-use change, depredation by introduced species, infection by diseases, release of toxic material in environment, overharvesting, and effect of climate change (Jolley *et al.*, 2010; Colino-Rabanal and Lizana, 2012; Rais *et al.*, 2015). So, the herpetofauna are used as indicators to monitor health of ecosystem. However, in Bhutan, factors affecting population of herpetofauna is not assessed. Information on impact of climate change, developmental activities, and harvesting on the population structure of herpetofauna is altogether missing. This is despite knowing that several species of reptiles and amphibians are collected by people for various purposes such as for self-consumption, pet trade, and medicine.

According to Alves *et al.* (2012), 331 species (284 reptiles and 47 amphibians) are used in traditional folk medicine worldwide. While herpetofaunal research has picked up well in Bhutan recently, the socio-cultural value of herpetofauna is under-documented. Recently, Wangyal (2014) has listed 84 snakes (out of which 69 are confirmed that are in the table), 22 lizards (now 27), 6 chelonians, and 35 anurans (now 56) which are known to occur in Bhutan (Table 1). From among the known species, *Nanorana leibigii* (Günther) – the Himalayan Bull Frog, is used for treating various ailments like piles, fever, and stomach problems in some parts of Bhutan (Wangyal and Gurung, 2012). The Rai community of southern Bhutan also eats several species of *Amolops*. Among reptiles, skin of Python is used for making religious instruments/drums.



Figure 4.1. Keelbed box turtle

Efforts to document the herpetofauna of Bhutan have been challenged by absence of institutional support and herpetologists (Das and Palden, 2001; Wangyal 2011; 2014). However, with the new generation picking up herpetology as their interest, the hope for conservation of Bhutanese herpetofauna is positive. Within this context, this chapter therefore makes a review of existing information on herpetofauna of Bhutan and highlights the research needs. It provides an update of species known to occur in Bhutan including assessment of trends and gaps in herpetofaunal research.

4.2. Reptiles

Bhutan is home to 102 species of reptiles represented by 69 snakes, 27 lizards, and 6 turtles and tortoises. The following sections provide overviews of these major groups.

4.2.1. Snakes

Smith (1943) reported the presence of *Vipera russelli siamensis* (Smith), now *Daboia siamensis* (Smith), in Bhutan. In 1976, Biswas recorded *Ophiophagus hannah* (Cantor) and *Amphiesma platyceps* (Malnate) from Bhutan. Later, Bauer and Günther (1992) added 11 species of snakes, including *Python molurus* Linnaeus, which was earlier reported by Harris *et al.* (1964). The erroneous record of *Boiga cyanea* (Duméril, Bibron & Duméril) by Bauer and Günther was later corrected as *B. ochracea* (Günther) by Tillack (2006). In 2000, Das and Palden reported *Psammodynastes pulverulentus* (Boie), *Sibynophis sagittarius* (Cantor), and *Bungarus fasciatus* (Schneider) and confirmed the presence of *Naja naja* (Linnaeus), which was reported by Mahendra (1984) without locality. Mitra (2009) added 16 species as new record for Bhutan with two repetitions. Later, Wangyal (2011) reported 30 new species of snakes and corrected the list of Mitra (2009). Further, Wangyal (2012) reported 10 species of snakes as new records. In 2013, Wangyal reported another species of colubrid, *Dinodon gammiei* (Wall), a rare species in the region. Pan *et al.* (2013) reported the presence of a new

viper species, *Protobothrops himalayanus* (Pan, Chettri, Yang, Jiang, Wang, Zhang, & Vogel). Wangyal (2014) reported three new species of snakes, *Oligodon taeniolatus* (Jerdon), *Viridovipera yunnanensis* (Schmidt), and *Himalayophis tibetanus* (Huang).



Figure 4.2. Taiwan Mountain Pit Viper, venomous

The most recent report on the herpetofauna of the country (Das *et al.*, 2015) listed three additional snake species *Boiga gokool* (Gray), *B. siamensis* Nutaphand, and *Popeia popeorum* (Smith). Currently, there are 69 snakes (Table 4.1) represented by 8 families, dominated by members of the family Colubridae (sensu stricto) with 37 species, followed by Viperidae with 10 species.

Table 4.1. List of snakes known from Bhutan

Species	Common Name
<i>Python bivittatus</i> Kuhl	Burmese Python
<i>Ahaetulla nasuta</i> (Lacepede)	Green Vine Snake
<i>Ahaetulla prasina</i> (Boie)	Gunther's Whip Snake
<i>Amphiesma parallelum</i> (Boulenger; Kramer)	Yunnan Keelback
<i>Amphiesma platyceps</i> (Blyth; Malnate)	Himalayan Keelback
<i>Amphiesma stolatum</i> (Linnaeus)	Buff Striped Keelback
<i>Boiga cyanea</i> (Duméril, Bibron & Duméril)	Green Cat Snake
<i>Boiga gokool</i> (Gray)	Arrowhead Tree Snake
<i>Boiga multifasciata</i> (Blyth)	Many-banded Tree Snake
<i>Boiga ochraceus ochraceus</i> (Günther)	Tawny Cat Snake
<i>Boiga ochraceus stoliczkae</i> (Wall)	Tawny Cat Snake
<i>Boiga siamensis</i> Nutaphand	Eyed Cat Snake
<i>Bungarus bungaroides</i> (Cantor)	Northeastern Hill Krait
<i>Bungarus fasciatus</i> (Schneider)	Banded Krait
<i>Bungarus niger</i> Wall	Greater Black Krait
<i>Chrysopelea ornata</i> (Shaw)	Golden Flying Snake
<i>Coelognathus radiatus</i> (Boie)	Copper-head Trinket Snake
<i>Cryptelytrops albolabris</i> (Gray)	White-lipped Tree Viper
<i>Cryptelytrops erythrurus</i> (Cantor)	Redtail (bamboo) Pit Viper
<i>Daboia siamensis</i> (Shaw & Nodder)	Russel's Viper
<i>Dendrelaphis cyanochloris</i> (Wall)	Wall's Bronze-back

Species	Common Name
<i>Dendrelaphis proarchos</i> (Wall)	Common Bronze-back
<i>Dendrelaphis tristis</i> (Daudin)	Daoudin's Bronze-back
<i>Dinodon gammiei</i> (Wall)	Sikkim False Wolf Snake
<i>Dinodon septentrionalis</i> (Günther)	Mountain Wolf Snake
<i>Dryocalamus</i> cf. <i>davisonii</i> (Blanford)	Blandford's Bridal Snake
<i>Enhydryis enhydryis</i> (Schneider)	Striped Water Snake
<i>Herpetoreas sieboldii</i> (Günther)	Sikkim Keelback
<i>Himalayophis tibetanus</i> (Huang)	Tibetan Pit Viper
<i>Indotyphlops braminus</i> (Daudin)	Brahminy Blindsnake
<i>Lycodon aulicus</i> (Linnaeus)	Common Wolf Snake
<i>Lycodon fasciatus</i> (Anderson)	Banded Wolf Snake
<i>Lycodon jara</i> (Shaw)	Yellow-speckled Wolf Snake
<i>Naja kaouthia</i> Lesson	Monocled Cobra
<i>Naja naja</i> (Linnaeus)	Indo-Chinese Spitting Cobra
<i>Oligodon albocinctus</i> (Cantor)	Light-barred Kukri Snake
<i>Oligodon cinereus</i> (Günther)	Black Cross-barred Kukri Snake
<i>Oligodon cyclurus cyclurus</i> (Cantor)	Cantor's Kukri Snake
<i>Oligodon dorsalis</i> (Gray and Hardwicke)	Bengalese Kukri Snake
<i>Oligodon juglandifer</i> (Wall)	Walnut Kukri Snake
<i>Oligodon taeniolatus</i> (Jerdon)	Streaked Kukri Snake
<i>Ophiophagus hannah</i> (Cantor)	King Cobra
<i>Oreocryptophis porphyraceus</i> (Cantor)	Black-banded Trinket Snake

Species	Common Name
<i>Orthriophis cantoris</i> (Boulenger)	Eastern Trinket Snake
<i>Orthriophis taeniurus</i> (Cope)	Beauty Snake
<i>Ovophis monticola</i> (Günther)	Taiwan Mountain Pit Viper
<i>Popeia popeiorum</i> (Smith)	Pope's Pit Viper
<i>Protobothrops himalayanus</i> (Pan, Chettri, Yang, Jiang, Wang, Zhang & Vogel)	Himalayan Habu Pit Viper
<i>Protobothrops jerdonii</i> (Günther)	Jerdon's Pit Viper
<i>Psammodynastes pulverulentus</i> (Boie)	Common Mock Viper
<i>Pseudoxenodon macrops</i> (Blyth)	Large-eyed False Cobra
<i>Ptyas korros</i> (Schlegel)	Indo-Chinese Rat Snake
<i>Ptyas mucosa</i> (Linnaeus)	Oriental Ratsnake
<i>Ptyas nigromarginata</i> (Blyth)	Green Rat Snake
<i>Python molurus</i> (Linnaeus)	Indian Python
<i>Rhabdophis himalayanus</i> (Günther)	Orange-collared Keelback
<i>Rhabdophis subminiatus</i> (Schlegel)	Red-necked Keelback
<i>Rhadinophis prasina</i>	Green Trinket Snake
<i>Sibynophis collaris</i> (Gray)	Collared Black-headed Snake
<i>Sibynophis sagittarius</i> (Cantor)	Cantor's Black-headed Snake
<i>Sinomicrurus macclellandii</i> (Reinhardt)	McClelland's Coral Snake
<i>Trachischium guentheri</i> Boulenger	Gunther's Oriental Worm Snake
<i>Trachischium laeve</i> Peracca	Olive Oriental Slender Snake

Species	Common Name
<i>Trachischium tenuiceps</i> (Blyth)	Yellowbelly Worm-eating Snake
<i>Typhlops diardii</i> Schlegel	Indo-Chinese Blindsnake
<i>Typhlops jerdonii</i> (Boulenger)	Jerdon's Worm Snake
<i>Viridovipera yunnanensis</i> (Schmidt)	Yunnan Pi Viper
<i>Xenochrophis piscator</i> (Schneider, 1799)	Checkered Keelback

4.2.2. Lizards

In 1976, Biswas reported three lizard species including a new species – *Calotes bhutanensis* Biswas, whose identity had been debated. Bauer and Günther (1992) reported 10 species of lizards, three of which had been reported by Biswas (1975). Their report included a description of a new species of scincid lizard, *Eutropis quadratilobus* (Bauer & Günther) from the 1972 collection of reptiles by Natural History Museum of Basel, Switzerland. Das and Palden (2000) reported the presence of *Cyrtodactylus khasiensis* (Jerdon) in Serzhong, Sarpang and *Eutropis macularia* (Blyth) from Gelephu. They also reported a sighting of *Hemidactylus garnotii* Duméril & Bibron. Wangyal (2011) reported *Calotes jerdonii* (Günther), *Eutropis carinata* (Schneider), *Lygosoma punctata* (Linnaeus), and *Varanus flavescens* (Hardwicke & Gray) as new records. Further, Wangyal (2012) confirmed the presence of *Sphenomorphus maculatus* (Blyth) and *Gekko gecko* (Linnaeus). Later, Wangyal (2014) also reported *Ptyctolaemus gularis* (Peters) from Sarpang. The most recent report of Das *et al.* (2015) is the list of four new species of lizards; *Calotes maria* Gray, *Ptyctolaemus gularis* (Peters), *Cnemaspis assamensis* Das & Sengupta and *Varanus salvator* (Laurenti).



Figure 4.3. *Calotes versicolor*, the common garden lizard

Currently, there are 27 species of lizards known to occur in Bhutan (Table 4.2), represented by 5 families, namely Agamidae (7 species), Anguidae (1 species), Gekkonidae (7 species), Scincidae (9 species), and Varanidae (3 species).

Table 4.2. List of lizards known from Bhutan

Species	Common Name
<i>Asymblepharus sikimensis</i> (Blyth)	Sikkim Ground Skink
<i>Calotes bhutanensis</i> Biswas	Bhutan Lizard
<i>Calotes jerdonii</i> (Günther)	Jerdon's Forest Lizard
<i>Calotes maria</i> Gray	Khasi Hills Forest Lizards
<i>Calotes versicolor</i> (Daudin)	Common Garden Lizard
<i>Cnemaspis assamensis</i> Das & Sengupta	Assam Day Gecko
<i>Cyrtodactylus khasiensis</i> (Jerdon)	Khasi Hills Bent-toed Gecko
<i>Dopasia gracilis</i> (Gray)	Asian Glass Lizard
<i>Eutropis carinata</i> (Schneider)	Keeled Indian Skink
<i>Eutropis dissimilis</i> (Hallowell)	Striped Grass Skink
<i>Eutropis macularia</i> (Blyth)	Bronze Skink
<i>Eutropis quadratilobus</i> (Bauer & Günther)	Bhutan Skink
<i>Gekko gekko</i> (Linnaeus)	Tokay Gecko
<i>Hemidactylus brookii</i> Gray	Spotted House Gecko
<i>Hemidactylus frenatus</i> Duméril & Bibron	Common House Gecko
<i>Hemidactylus garnotii</i> Duméril & Bibron	Fox Gecko
<i>Hemidactylus platyurus</i> (Schneider)	Flat-tailed House Gecko
<i>Japalura andersoniana</i> Annandale	Anderson's Mountain Lizard
<i>Japalura variegata</i> Gray	East Himalayan Mountain lizard
<i>Lygosoma albopunctata</i> (Gray)	White Spotted Supple Skink

Species	Common Name
<i>Lygosoma punctata</i> (Linnaeus)	Common Dotted Garden Skink
<i>Ptyctolaemus gularis</i> (Peters)	Blue-throated Lizard
<i>Sphenomorphus indicus</i> (Gray)	Himalayan Forest Skink
<i>Sphenomorphus maculatus</i> (Blyth)	Spotted Forest Skink
<i>Varanus bengalensis</i> (Daudin)	Common Indian monitor
<i>Varanus flavescens</i> (Hardwicke & Gray)	Yellow Monitor
<i>Varanus salvator</i> (Laurenti)	Common Water Monitor

4.2.3. Turtles

Following the report of *Indotestudo elongata* (Blyth) by Wangyal in 2011 from Manas, *Cuora amboinensis* (Riche in Daudin), *C. mouhotii* (Gray), *Cyclemys gemeli* Fritz, Guickling, Auer, Sommer, Wink & Hunsdörfer and *Melanochelys tricarinata* (Blyth) were added by Wangyal *et al.* in 2012. Later, Wangyal (2013) reported *Melanochelys trijuga* (Schweigger). Currently, there are six species of tortoises and turtles represented over by two families found in Bhutan (Table 4.3).

Table 4.3. List of turtles known from Bhutan

Species	Common Name
<i>Cuora amboinensis</i> (Riche in Daudin)	South Asian Box Turtle
<i>Cuora mouhotii</i> (Gray)	Keeled Box Turtle
<i>Cyclemys gemeli</i> Fritz, Guickling, Auer, Sommer, Wink & Hunsdörfer	Assam Leaf Turtle
<i>Indotestudo elongata</i> (Blyth)	Yellow-headed Tortoise
<i>Melanochelys tricarinata</i> (Blyth)	Three-keeled land Turtle
<i>Melanochelys trijuga</i> (Schweigger)	Indian Black Turtle

4.3. Amphibians

There were no studies on amphibians of Bhutan until Das and Paden's (2000) herpetofaunal collection during a herpetological workshop conducted in 1999 at the Royal Manas National Park. They reported seven amphibians from three families (one megophryid, one bufonid, and five ranids). The country thus far has 56 species (Table 4) of amphibians, belonging to nine families. Wangyal (2011) reported eight species with at least one identification mistake. Wangyal (2012) studied amphibians of Punakha–Wangdiphodrang Valley and reconfirmed the presence of *Tylototriton verrucosus* Anderson reported by Frost (1985) and Palden (2003) while the presence of *Clinotarsus alticola* (Boulenger) reported by Ahmed *et al.* (2009) has to be further verified. Work of Das and Palden (2000) on presence of *Duttaphrynus melanostictus* (Schneider), *Amolops marmoratus* (Blyth), *Euphlyctis cyanophlyctis* (Schneider), *Hoplobatrachus tigerinus* (Daudin), *Fejervarya* cf. *limnocharis* (Gravenhorst) with an exception of a ranid frog “*Rana (Sylvirana)*” sp. from southern Bhutan are verified. The report of the presence of *Nanorana liebigii* in Haa District by Deuti (2010), who, based on the 1969 collection of Zoological Survey of India reported the same is

also verified. Report of *Duttaphrynus* cf. *stuarti* (Smith), *Amolops monticola* (Anderson), *Megophrys* cf. *nankiangensis* (Liu & Hu), *Polypedates* cf. *himalayensis* (Annandale) and an un-described species of *Nanorana* genus by Wangyal and Gurung (2012) need verification.

Wangyal (2013) reported 13 new records of anuran amphibians, including six dicroglossids, three megophryids and four ranids for Bhutan, and in the subsequent year (Wangyal, 2014) reported an additional four new records of frog species for the country, including *Nanorana annandalii* (Boulenger), *Feihyla vittata* (Boulenger), *Polypedates maculatus* (Gray) and *Rhacophorus maximus* Günther. The latest field report (Das *et al.*, 2015) listed three more new records of amphibians namely, *Uperodon globulosus* (Günther), *Ingerana borealis* (Annandale), and *Rhacophorus bipunctatus* Ahl for Bhutan. Delorme and Dubois (2001) described a new species of Bhutan Cat-eyed Toad (*Scutiger bhutanensis* Delorme & Dubois) without any locality data. Frost (1985) reported the presence of *Tylototriton verrucosus* in Bhutan, without locality information, which was subsequently confirmed by Palden (2003). Wangyal (2012) noted the presence of the species in Punakha and Wangdiphodrang valley including a small population in Dagana's Tshangkha Lake. With the recent naming (*T. himalayanus*) of the western population of the *T. verrucosus* group (Khatriwada *et al.*, 2015) as distinct species, it remains to be seen which species occurs in Bhutan. Bhutan also is known to have a single species of caecilian, *Ichthyophis sikkimensis* Taylor.

A synthesis of all valid records (see Table 4.4), Bhutan is currently home to 56 species of amphibians belonging to nine families, with the Dicroglossidae being the most speciose, with 16 species, followed by the Ranidae, 12 species and Rhacophoridae, 10 species. Additional families represented include the Megophryidae, with seven species, Microhylidae, with four species, Bufonidae, with three species, while Hylidae, Salamandridae, and Ichthyophiidae contain a single species each.

Table 4.4. List of amphibians known from Bhutan

Species	Common name
<i>Amolops formosus</i> (Günther)	Assam Cascade Frog
<i>Amolops gerbillus</i> (Annandale)	Yembung Sucker Frog
<i>Amolops himalayanus</i> (Boulenger)	Himalaya cascade frog
<i>Amolops mantzorum</i> (David)	Mouping Sucker Frog
<i>Amolops marmoratus</i> (Blyth)	Marbled Sucker Frog
<i>Amolops monticola</i> (Anderson)	Mountain Cascade Frog
<i>Clinotarsus alticola</i> (Boulenger)	Point-nosed Frog
<i>Duttaphrynus</i> cf. <i>stuarti</i> (Smith)	Stuart's Toad
<i>Duttaphrynus himalayanus</i> (Günther)	Himalayan Toad
<i>Duttaphrynus melanostictus</i> (Schneider)	Asian Common Toad
<i>Euphlyctis cyanophlyctis</i> (Schneider)	Common Skittering Frog
<i>Feihyla vittata</i> (Boulenger)	Striped Asian Tree Frog
<i>Fejervarya limnocharis</i> (Gravenhorst)	Common Pond Frog
<i>Fejervarya nepalensis</i> (Dubois)	Nepal Cricket Frog
<i>Fejervarya pierrei</i> (Dubois)	Pierre's Cricket Frog
<i>Fejervarya teraiensis</i> (Dubois)	Terai Wart Frog
<i>Hoplobatrachus crassus</i> (Jerdon)	Jerdon's Bullfrog
<i>Hoplobatrachus tigerinus</i> (Daudin)	Indian Bullfrog
<i>Humerana humeralis</i> (Boulenger)	Bhamo Frog
<i>Hydrophylax leptoglossa</i> (Cope)	Cope's Assam Frog
<i>Hyla annectans</i> (Jerdon)	Assam Treefrog
<i>Hylarana taipehensis</i> (van Denburgh)	The two-striped grass frog
<i>Hylarana tytleri</i> (Theobald)	Leaf Frog

Species	Common name
<i>Ichthyophis sikkimensis</i> Taylor	Darjeeling Caecilian
<i>Ingerana borealis</i> (Annandale)	Northern Frog
<i>Megophrys</i> cf. <i>nankiangensis</i> Liu & Hu	Nankiang Horned Toad
<i>Megophrys glandulosa</i> Fei, Ye & Huang	
<i>Megophrys major</i> Boulenger	White-lipped Horned Toad
<i>Megophrys minor</i> Stejneger	White Horned Toad
<i>Megophrys parva</i> (Boulenger)	Concave-crowned Horned Toad
<i>Microhyla</i> cf. <i>butleri</i> Boulenger	Tubercled Pygmy Frog
<i>Microhyla ornata</i> (Duméril & Bibron)	Ant Frog
<i>Micryletta inornata</i> (Boulenger)	Deli Paddy Frog
<i>Nanorana annandalii</i> (Boulenger)	Annandale's Paa Frog
<i>Nanorana arnoldi</i> (Dubois)	Arnold's Paa Frog
<i>Nanorana blanfordii</i> (Boulenger)	Blandford's Paa Frog
<i>Nanorana conaensis</i> (Fei & Huang)	Cona Paa Frog
<i>Nanorana liebigii</i> (Günther)	Liebig's Mountain Frog
<i>Nanorana parkeri</i> (Stejneger)	Parker's slow frog
<i>Nanorana pleskei</i> (Günther)	Pleske's high altitude frog
<i>Nanorana vicina</i> (Stoliczka)	Himalaya paa frog
<i>Ombrana sikimensis</i> (Jerdon)	Sikkimese Frog
<i>Philautus</i> cf. <i>garoensis</i> (Boulenger)	Boulenger's Garo Hill Frog
<i>Polypedates himalayensis</i> (Annandale)	Himalayan Tree Frog
<i>Polypedates leucomystax</i> (Gravenhorst)	White-lipped Tree Frog
<i>Polypedates maculatus</i> (Gray)	Indian Tree Frog
<i>Rhacophorus bipunctatus</i> Ahl	Himalaya Flying Frog

Species	Common name
<i>Rhacophorus maximus</i> Günther	Giant Tree Frog
<i>Rhacophorus tuberculatus</i> (Anderson)	Tuberculate Tree Frog
<i>Scutiger bhutanensis</i> Delorme & Dubois	Bhutan Frog
<i>Scutiger sikimensis</i> (Blyth)	Sikkim Alpine Toad
<i>Sylvirana guentheri</i> (Boulenger)	Gunther's Amoy Frog
<i>Theloderma andersoni</i> (Ahl)	Anderson's Bubble-nest Frog
<i>Theloderma asperum</i> (Boulenger)	Hill Garden Bug-eyed Frog
<i>Tylototriton verrucosus</i> Anderson	Himalayan Salamander
<i>Uperodon globulosus</i> (Günther)	Indian Balloon Frog

4.4. Trends and Way Forward in the Study of Herpetofauna

Study of herpetofauna in Bhutan started with the report of five reptile species by Biswas in 1976. Consequently until 2000, report on herpetofauna of Bhutan was limited to that of by Frost in 1985. While the study intensified with the report on herpetofauna by Das and Palden in 2000, a series of publications by Wangyal, starting 2011, has changed the scenario of herpetofaunal diversity records in Bhutan. Recently, herpetologists have started to study herpetofaunal diversity even at local level (Koirala *et al.*, 2016).

Even though the herpetofaunal research in Bhutan has increased in recent years, the focus given is mainly on diversity assessment. Therefore, as mentioned herein, there is a need to expand the herpetofaunal related research in Bhutan to a wider area. For instance, there is a need to confirm the report *Vipera russelli siamensis* in Bhutan hills by Smith in 1943. Since herpetologists have not reported this species thereafter, it is possible that this report is erroneous or misreported. The new scincid lizard, *Eutropis*

quadratilobus Bauer and Günther, which is endemic to southwest Bhutan, needs its distributional range and ecological information re-examined. For all species reported, information on distributional range and ecology is scanty. Also, there is lack of information on use of herpetofaunal species in medicine, pet trade, and home consumption in Bhutan including information on crocodile habitats and their occurrences (Whitaker, 1987). Likewise, information on the impact of climate change and developmental activities on herpetofauna is unavailable. Study of such impact is important as the rainfall is becoming erratic and the trend of temperature is rising (Rai *et al.*, 2017) and information is missing on as to how species are responding to such climate variable changes. Additionally, records of snake-bite death cases are not easily accessible, perhaps not available. This information is important to improve the quality delivery of health services in Bhutan.

4.5. Conclusion

This review records 102 species of reptiles (69 species of snakes, 27 species of lizards, and 6 species of tortoises) and 56 species of amphibians, which are known to occur in Bhutan. Since the herpetofaunal research in Bhutan picked up recently only, the number of species recorded is commendable. However, the research has focused mostly on diversity assessment, giving less attention to assessment of distributional range and collection of ecological information for each species. While the diversity assessment ascertains the presence of species in a locality, this is not enough for making conservation decision. Species conservation decision requires information on distribution range, population structure, and ecological information. Additionally, contribution of herpetofauna to the wellbeing of Bhutanese people remains underexplored. It is also uncertain on how climate change and development activities are impacting the population structure of herpetofauna in Bhutan. Therefore, herpetofaunal research in future should focus on generating comprehensive information for each species, which will be useful in making conservation decision in the current scenario of climate and land-use changes.

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