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TO STUDY SPECIES RICHNESS AND ALTITUDINAL DISTRIBUTION OF AMPHIBIAN (RECORDED TILL NOW) IN BHUTAN TO DRAW PEOPLE'S ATTENTION FOR ITS CONSERVATION AND FUTURE STUDIES

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ABSTRACT

Nearly 168 species of amphibians are believed to be extinct and at least 2,469 are known to be declining (Stuart, 2004). Currently, about 40 species of amphibians is reported from Bhutan (Wangyel, 2013), but the study determining its species diversity and the habitat use. This paper presents the state-of-the-knowledge on the species richness and distribution pattern of the amphibians of Bhutan. However, the study about amphibian is scanty in the country. Only 40 species of amphibians are so far reported from Bhutan of which of which 38 species are anurans, one caecilian and a Salamander. Seven families under order Anura are known to occur in Bhutan, of which, Dicroglossidae is the most specious and Hylidae the least. Amphibian fauna of Bhutan hitherto remain seriously underexplored. Further, majority of the species needs detail taxonomic treatment. The amphibian species richness peak at an altitude upto-500m asl where 15 out of 40 species are recorded.

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INTRODUCTION

According to Bhutan Biodiversity Portal (2017), Bhutan is a small, landlocked country with an area of 38,394 km2 situated on the southern slope of the Eastern Himalayas. Straddling the two major Indo-Malayan and Palearctic biogeographic realms, Bhutan is part of the Eastern Himalayan biodiversity hotspot and contains 23 Important Bird Areas (IBA), 8 ecoregions, a number of Important Plant Areas (IPA) and wetlands, including two Ramsar Sites. The diverse ecosystems and eco-floristic zones have made Bhutan home to a wide array of flora and fauna. The total area under forest cover is 70.46 percent and 51.32 percent of the country is secured as protected areas and biological corridors. The protected areas system of Bhutan is regarded as one of the most comprehensive in the world. It encompasses a continuum of representational samples of all major ecosystems found in the country, ranging from the tropical/sub-tropical grasslands and forests in the southern foothills through temperate forests in the central mountains and valleys to alpine meadows in the northern mountains (BBP, 2017). The Bhutan's scientific study on Amphibians with the exception of mammals birds and to some extent plants move very slow due of lack of interest (Wangyel, 2013). The study of Amphibians in Bhutan started with the Das and Palden's in year 2000, who studied amphibians in their herpetofaunal collection during the Royal Manas National Park workshop. Thus, the amphibians study in Bhutan is not more than 17 years old which is very recent. Recent works on amphibians by different authors reported many new records for Bhutan which showed that the research on these taxa is still poorly known. Compiling and interpreting the available data on Amphibian is an important first step for creating awareness of and interest in this ecologically important, but often overlooked, taxon. According to AmphibiaWeb (2017), Amphibians, a unique group of vertebrates containing over 7600 known species, are threatened worldwide where nearly one-third (32%) of the world's amphibians are threatened, representing 1,856 species. Amphibians have existed on earth for over 300 million years, yet in just the last two decades there have been an alarming number of extinctions, nearly 168

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species are believed to have gone extinct and at least 2,469 (43%) more have populations that are declining (Stuart et al. 2004). This indicates that the number of extinct and threatened species will probably continue to rise. Therefore, study of the taxa is very important. This paper presents a species richness and altitudinal distribution of amphibians in Bhutan through a comprehensive compiling of Amphibians of Bhutan reported till date by different authors starting from year 2000 to 2016.

MATERIALS AND METHODS

The present study has been carried out by compiling the information by systematically reviewing the published information available on the topic. For systematic searching of literatures, the search engine google.com and google.com [dot] in were used. The relevant papers are searched by employing topic and key words such as diversity of amphibians. Search is carried only for English language publication. Using search engine, various journals, reports, and authenticated internet information was used. All data in this report are based on a literature search beginning from the first ever report of Das and Palden (2000 until the latest published report by Das et al. (2016) where amphibians are part of the reports. This paper reviewed the reports of Das and Palden (2000) for a collection of Herpetofauna. Further reports of the taxa including Wangyal (2013 and 2014) and work on amphibians (Wangyal and Gurung 2012 a, b) have been also reviewed. The recent works of Nidup et al. (2016) for the *Amolopshimalayanus* and Das et al. (2016) on the herpetofauna of RMNP. For the identification of species, references used include Smith (1943), Schleich and Kästle (2002), and followed the taxonomic arrangements of Frost (2017) for amphibians. All publications available were compared and analyzed including each species' locations recorded by different authors. Furthermore, the species richness and altitudinal distribution of amphibians were tabulated and then graphed.

Abbreviations: For frequently used terms, abbreviations are as follows: BBP (Bhutan Biodiversity Portal), IBA (Important Bird Areas)**,** IPA (Important Plant Areas), m asl (meters above sea level)**,** RMNP(Royal Manas National Park).

RESULTS

Species Richness

Compiling all the past records (Das and Palden 2000; Wangyal 2013 and 2014; Wangyal and Gurung 2012a, b; Das et al. 2016; Nidup et al. 2016), eleven Districts of the country were studied out of twenty Districts on amphibians (Figure 1). Bhutan thus far has 40 species of amphibians (38 anurans, one caudate, and one caecilian). But, some of these species are identified only to the genus level (Table 1) or data deficient. Seven families under order Anura are known to occur in Bhutan, of which, Dicroglossidae is the most specious family while; Hylidae is the least species family.

Altitudinal distribution

By dividing the Bhutan into nine zones with a deference of 500 m elevation bands, it is found that more diversity of amphibians are distributed in Zone I (i.e., lower altitude range of up to 500m asl) compared to higher altitude zones (Table 2) (Das and Palden, 2000; Wangyel and Gurung a, b, 2012; Wangyel, 2013 and 2014; Nidup et al. 2016; Das et al. 2016). However, the species such as *Scutiger bhutanensis, Scutiger sikimmensis, Clinotarsus alticola, Amolops marmoratus, and Ichthyophis sikkimensis* are excluded from altitudinal distribution as their distribution data are lacking in the country.

DISCUSSION

Bhutan thus far has 40 species of amphibians where, seven families under order Anura are known to occur in Bhutan, of which, Dicroglossidae is the most specious. However, some of these species are identified only to the genus level or data deficient. Therefore, further studies and researches are required to carry out in the country to confirm their identification and verification as well as to have a proper scientific data about the given genera. The amphibians in Bhutan are mostly diversified at the lower altitude range (Zone I) with 15 reported species.

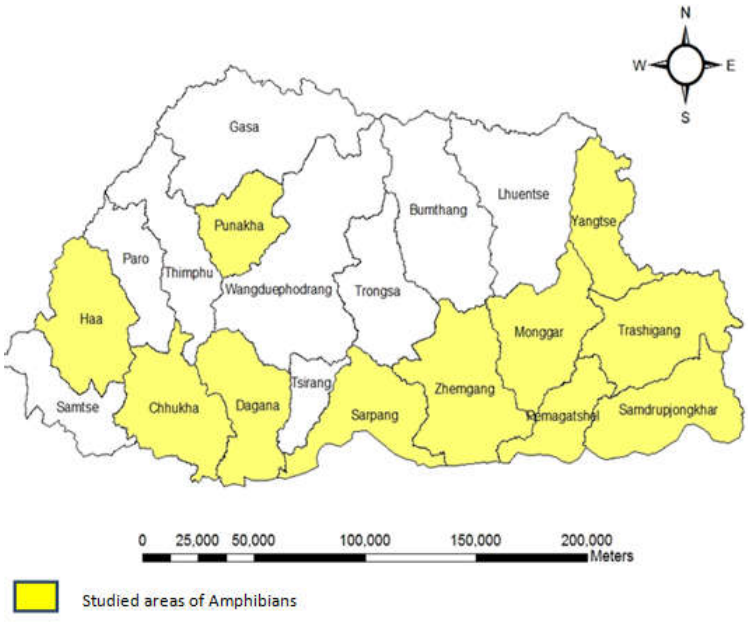

Figure 1. Bhutan map showing the areas (in District wise) where amphibians study have been done

Table 1. Species richness in each family of Order Anura

Sl. No.	Order	Family	No. of Genus	No. of Species
1	Anura	Bufonidae	1	3
2		Dicroglossidae	4	12
3		Hylidae	1	1
4		Megophrydae	4	7
5		Microhylidae	2	2
6		Ranidae	3	8
7		Rhacophoridae	2	5
8	Gymnophiona	Ichthyophiidae	1	1
9	Urodela	Salamandridae	1	1

Table 2. An altitudinal distribution of amphibians of Bhutan

Zone	Altitude Range (m asl)	Name of the Species	Total No. of Species
I.	›500	*Euphlyctiscyanophlyctis, Fejervaryapierrei, F. teraiensis, F. nepalensis, F. limnocharis, Hylaranataipehensis, H. leptoglossa, Hoplobatrachustigerinus, Ingerana borealis, Duttaphrynusmelanostictus, Microhylaornata, Uperodonglobulosa, Polypedatesmaculatus, Rhacophorusbipunctatus, R. maximus,*	15
II.	500-1000	*E. cyanophlyctis , H. guentheri*	2
III.	1000-1500	*E. cyanophlyctis, Xenophrys minor, H. guentheri, Nanoranaliebigii, Chromantisvittatus, Tylototritonverrucosus*	6
IV.	1500-2000	*X. major, X. glandulosa, Amolopsmantzorum, Nanoranaliebigii, Raorchestesannandalii , T. verrucosus*	6
V.	2000-2500	*Nanoranaliebigii, Amolopshimalayanus, Tylototritonverrucosus*	3
VI.	2500-3000	*N. liebigii, N. annandalii, N. blandfordil, T. verrucosus*	4
VII.	3000-3500	*N. liebigii,*	1
VIII.	3500-4000	*N. liebigii*	1
IX.	4000-4500	*N. conaensis, N. pleskei*	2

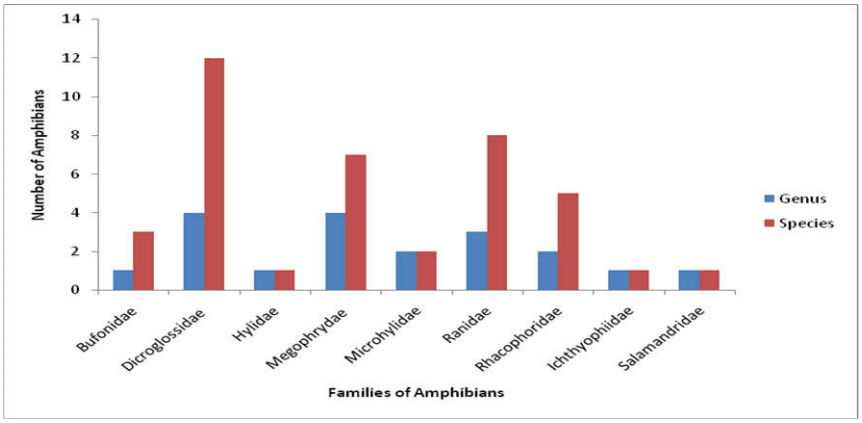

Figure 2. Showing the number of Genus and Species of different families of Amphibians

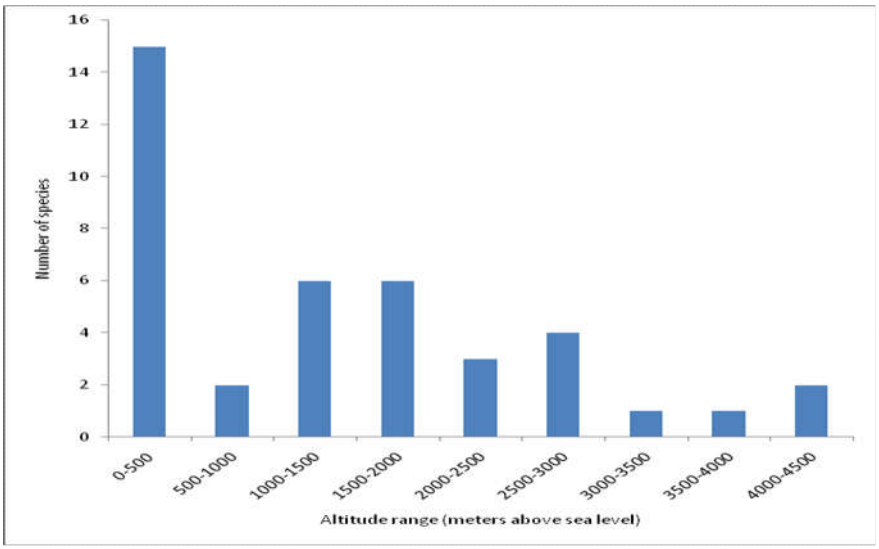

Figure 3. Showing an altitudinal distribution of amphibians of Bhutan

However, the diversity of amphibians in the country doesn't decrease with the increase of an altitude. It is found out that, Zone II has only two species while, and Zone III and IV has six species each. And also, some species of amphibians are known to occur in wide altitude ranges such as *Euphlyctiscyanophlyctis* which is known to occur in Zones I, II and III. While some species are known to occur in constrict altitude range such as *Nanoranaconaensis* which is only known to occur in Zone IX. Therefore, the presence of most diversified amphibian species at the lower altitude indicates that the habitats of the species are most suitable for their survival. Or, on the other hand, discrete distribution of diversity of amphibian species also means that, the study of amphibians of Bhutan are all done sporadically on selected sites and the most portions of the country remain un-studied. One very interesting this about the elevational distribution pattern is that although lowest Zone represents highest species richness yet mid elevation (1000-2000m) is also showed significantly richness. Mid elevation zone contain range restricted and unique species and thus important from conservation point of view. Therefore, it is high time for Bhutan to conduct a detail study of the amphibians of the country to assess the status of each species of amphibians, so that, protection status can be given by the state if the research finds imminent threat to the species. Till now Bhutan don't have any conservation issues regarding the amphibians showing an imminent time for conservation as lots of habitats are being destroyed due to socio-economic developmental activities.

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