

First record of the Arunachal Cascade Frog, *Nanorana arunachalensis* (Saikia et al., 2017), from the Himalayan Kingdom of Bhutan

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To manage various wildlife species and their ecosystem, understanding specifically where the species are found is important. Monitoring, evaluation, and habitat manipulation to suit target species is possible only when occurrence data are available. Since species occupy different habitats, depending on their ecological needs, distributional data can help understand these requirements from a conservation standpoint. Globally, an important, yet data-deficient taxa group are Anura, of which over 30% are threatened with extinction (Stuart et al., 2004) making amphibian research critical. Rugged mountain terrains, deep valleys, and numerous streams in Bhutan serve as vibrant biogeographic barriers separating physically close species. Herpetological surveys in remote forested eastern Bhutan, including the Trashigang and Trashiyangtse Districts, remain scarce but recent field research has turned up new and unexpected records (Wangyal et al., 2020, 2022). Here we present the first record of the Arunachal Cascade Frog, in the genus *Nanorana*, Günther, 1896 from eastern Bhutan. Currently, we refer to this individual as *Nanorana arunachalensis* (Saikia, Sinha, and Kharkongor, 2017) although future studies of anuran populations in this region might reveal different results.

Nanorana arunachalensis was described as a member of the genus *Odorrana* Fei, Ye & Huang, 1990 by Saikia et al. (2017) and was later reassigned to the genus *Nanorana* (Qi et al., 2019). Saikia et al.

(2017) described the species from Tamen Road in the outskirts of Ziro, and Pange and Tassi Budag in the Talle Valley Wildlife Sanctuary, Lower Subansiri District (27.63943°N, 93.87043°E, 1677 m elevation), in the state of Arunachal Pradesh in India (Fig. 1).

Bhutan has around 83 species of amphibians, most of which are confined to the warm and humid southern foothills and central mountain ranges (Wangyal, 2022; Wangyal et al., 2021, 2022). Data on amphibians are collected 'wherever and whenever observed' by interested Foresters and citizens although currently, as there are no amphibian-focused research initiatives in Bhutan. Thus, information on Bhutan amphibians is collected as part of the regular forest management activities of Foresters, such as national forest inventory, anti-poaching patrolling, socio-economic surveys, etc. Foresters in Bhutan also have the additional responsibility of managing wild animals that enter settlements (mostly villages or suburbs). Our specimen of *N. arunachalensis* was detected while relocating an injured Sambar Deer (*Rusa unicorn*) from Tongseng village to Dongdhi Forest Management Unit area, Trashiyangtse District, Bhutan (27.567153°N, 91.431918°E), 2338 m elevation at 19:00 h on 29 September 2022, 10 km from the closest village, Phordung on a forest road (Fig. 1). Upon capture, the frog was immediately measured and photographed. The distance between the type locality and the new location site was approximately 240.4 km, which was measured using Movable Type Scripts (<https://www.movable-type.co.uk/scripts/latlong.html>).

The specimen was released back in its natural habitat and not vouchered due to lack of materials to euthanise without causing pain. Further, specimen vouchering is not typically done in Bhutan in line with Buddhist ethos of value and respect for life which is a fundamental code underpinning most wildlife management and conservation activities in the country (Sangay et al., 2014). However, five images (Fig. 2A–E) of the species have been catalogued with the Zoological Reference

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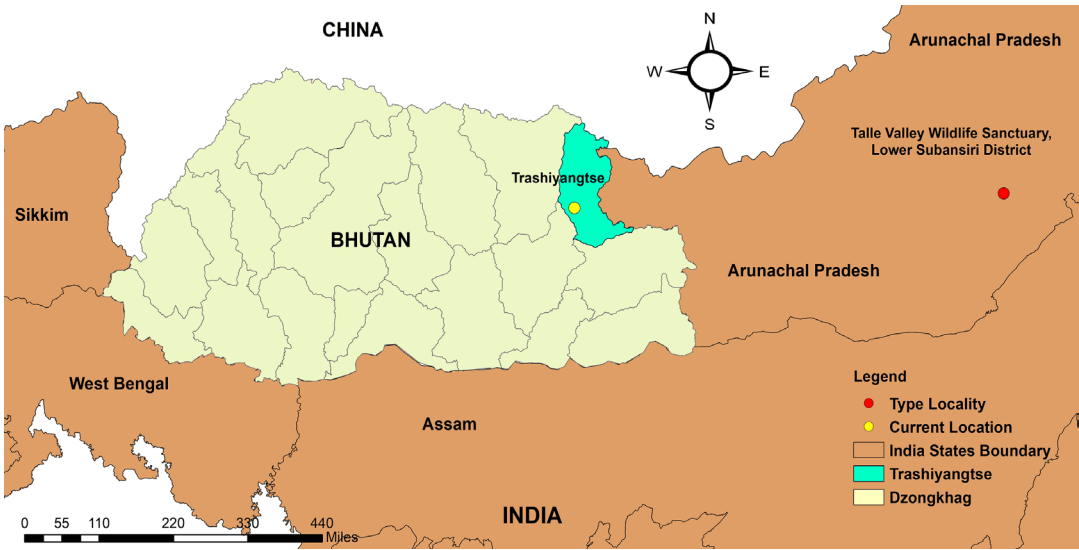


Figure 1. Location of the *Nanorana arunachalensis* in Lichen, Trashiyangtse District, Bhutan.

Collection (ZRC), using voucher numbers (A–Dorsal surface (ZRC (IMG) 1.261a); B–Ventral surface (ZRC (IMG) 1.261b); C–Vertical lateral view (ZRC (IMG) 1.261c); D–Horizontal lateral view (ZRC (IMG) 1.261d); E–Dorso-frontal view (ZRC (IMG) 1.261e); F–Dorsal view of the right foot) of the Lee Kong Chian Natural History Museum at the National University of Singapore.

The frog was observed on the side of a forest road characterised by thick layers of moss and ferns similar to the habitat described by Saikia et al. (2017). The area is a disturbed–timber extraction zone used by Bhutan’s Natural Resources Development Corporation Limited (NRDCL), a semi-governmental company that extracts and markets natural resources using machineries. The typical method used by NRDCL is to clear forest patches with productive resources along a pre-designed cable line to drag resources and leave the cleared patches to recover by itself or plant additional trees to recuperate the forest. It is in such human-induced forest openings that we reported new records of frog and other species for the Kingdom and many accounts have been made on chance encounters rather than focused systematic searches or surveys (Wangyal et al., 2020, 2022). Some prominent plant species of the area where the frog was found include *Betula utilis*, *Saurauia napaulensis*, *Pinus bhutanica*, *Quercus* spp., *Acer* spp., *Michelia* spp., *Symplocos* spp., *Rhododendron* spp., *Schima* spp., *Persea* spp. etc.

Using recent literature descriptions and diagnostic features (Saikia et al., 2018; Qi et al., 2019), the specimen was identified as *N. arunachalensis* based on the characters explained herein. Medium size frog (our specimen measured 55 mm snout-vent length) with a dark interorbital band and a pair of discontinuous dorsolateral bands. Head broader than long; body dorsoventrally flattened, supra-tympanic fold prominent, round tympanum ($1/4^{\text{th}}$ the size of the eye), smooth dorsal surface, feebly granular flanks, fingers and toes bearing discs (larger than those of the fingers) at their end, discs have grooves on the ventral side, entirely webbed toes. Teeth vomerine, brown dorsal surface and ventrum white, mottled with several black patches; relative finger lengths: I<II<IV<III.

Using the method proposed by Watters et al. (2016) we measured and recorded the basic morphometric measurements of our specimen such as SVL (snout-vent length) 55 mm, HL (Head Length) 18.3 mm, HW (Head Width) 21.5 mm, IN (inter-narial distance) 5.9 mm, EN (Distance from eye to nostril) 2.9 mm, SN (Distance from snout tip to nostril) 4 mm, EL (Eye length) 6.9 mm, TYD (Greatest Tympanum Diameter) 2 mm, HAL (Hand length) 12.9 mm, FLL (Forearm Length) 13 mm, Thigh length (THL) 33 mm, TL (Tibia Length) 32.7 mm, TFOL (Length of Tarsus and Foot) 48 mm and FOL (Foot length, from inner metatarsal tubercle to the tip of fourth toe) 27.9 mm.

In addition to the type locality, Saikia et al. (2017)

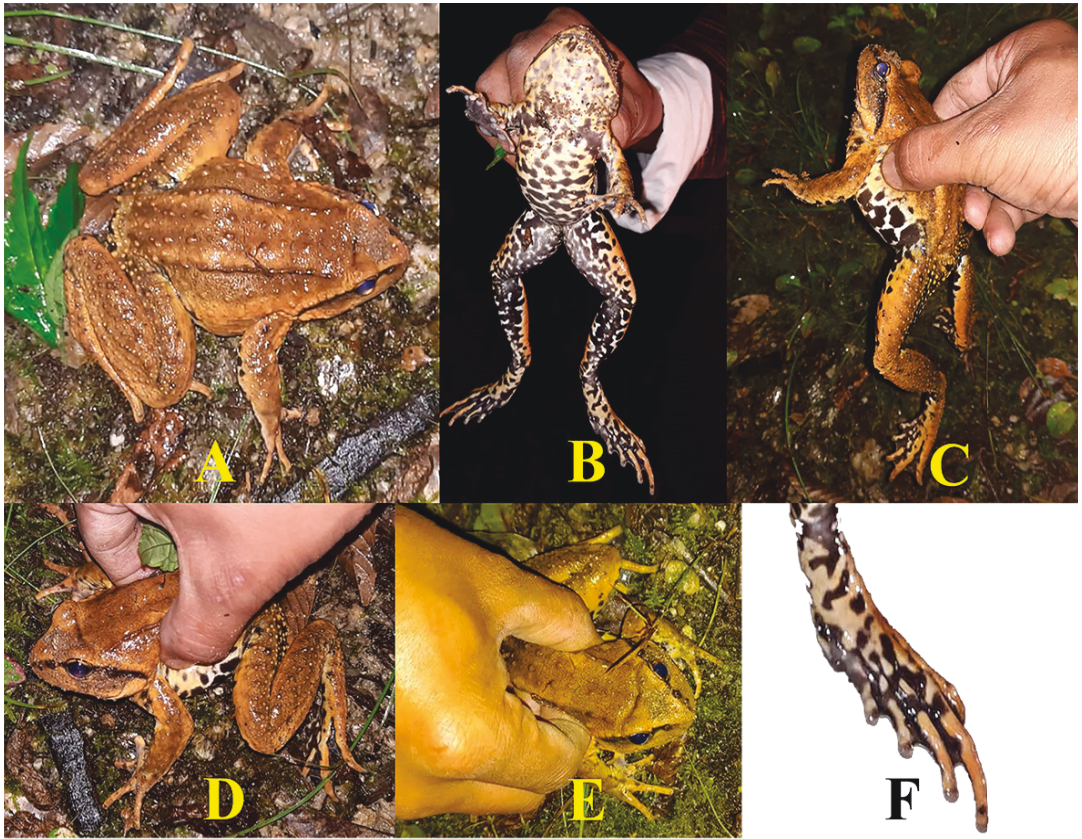


Figure 2. Arunachal Cascade Frog, *Nanorana arunachalensis*. (A) Dorsal surface; (B) Ventral surface; (C) Vertical lateral view; (D) Horizontal lateral view; (E) Dorso-frontal view; (F) Dorsal view of the right foot. Photos by Namgay Shacha.

mentioned the possibility of this species' occurrence in other river valleys of the same system which was later proven by observations in Dibang Valley in the Dibang Wildlife Sanctuary in 2018–2019 between the elevational ranges of 1400 and 2500 m elevation (Ahmed et al., 2020). This meant that the species could occupy a larger range, hence its presence in Bhutan is not a surprise.

The species is possibly threatened by over-collection during the breeding season for food consumption (Ahmed et al., 2020). Additionally, logging, infrastructure development, such as hydroelectric projects, agriculture, road construction and stream deposition from mud during road construction, are also considered to be threats to the species (Ahmed et al., 2020). Climate change is considered a future threat as it may cause the drying-up of its habitat while *Batrachochytrium dendrobatidis* is also a potential threat to this species (Ahmed et al., 2020).

In Bhutan, amphibians are not protected by any national law or policy. However, their habitats are well protected, and so it is assumed that by protecting stream ecosystems, the local species are preserved to some extent. Furthermore, the predominant Buddhist community in this region does not exploit animals due to their religious practices but the use of plants, and in rare cases some animals (such as frogs), for indigenous medical practices are allowed (Wangyal et al., 2021). However, studies to understand the population, habitat and natural history of *N. arunachalensis* must be conducted to ensure the survival of this rare species.

Based on our present record, we confirm the occurrence of *N. arunachalensis* in Bhutan. Our record highlights the importance of inventorying fauna in this unique region and initiating future broad faunal surveys. In order to conserve this species, as well as other amphibians, all uses of *N. arunachalensis* by the people in Bhutan should be the subject of future research.

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