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Cover: Nile Crocodile *Crocodylus niloticus* regulating body temperature on a warm day. Digital art on Procreate by © Aakanksha Komanduri.

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COMMUNICATION

Evidence for the local extirpation of the Dehradun Stream Frog *Amolops chakrataensis* Ray, 1992 from the type locality, Chakrata in western Himalaya, India, and associated threats: a call for urgent conservation action

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Abstract: The current occurrence status of the 'Critically Endangered' Dehradun Stream Frog *Amolops chakrataensis* was assessed at its type locality in the Chakrata landscape in Dehradun District, Uttarakhand in the western Himalaya, India. Daytime and nighttime visual encounter and aural surveys were conducted for 39 survey days between 2023 and 2024, across multiple stream systems and seasons. Despite extensive effort, no individuals of *A. chakrataensis* were detected. This study identifies two additional ongoing threats under the IUCN Red List Threats Classification Scheme: pollution and residential & commercial development. Discrepancies in the current IUCN Red List distribution map were also detected, and an updated preliminary estimate of the indigenous range (sensu IUCN) was provided prior to putative local extirpation. These findings suggest a putative local extirpation at the type locality and highlight the urgent need for targeted monitoring and habitat conservation.

Keywords: Anthropogenic pressure, conservation monitoring, Critically Endangered amphibian, habitat degradation, Himalayan biodiversity, local extinction, stream habitat, pollution, type locality reassessment, unsustainable tourism.

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INTRODUCTION

Dehradun Stream Frog *Amolops chakrataensis*, Ray, 1992, is a CR amphibian found in Uttarakhand, in the western Indian Himalaya (IUCN 2023; Image 1). This status is primarily due to its extremely limited extent of occurrence (EOO) and the severe decline in both the quality and extent of its habitat at its type locality in the Chakrata Hills (Ray 1992). According to the IUCN Red List assessment, habitat degradation and modifications of the flow of streams caused by the construction of dams are the major threats to this species (IUCN 2023). This species was collected by Dr. Ray of Zoological Survey of India, Dehradun, from a stream along the Tuni road, approximately 14 km north-west of Chakrata Town, in 1985. Since then, there have not been confirmed records of this species.

Amolops chakrataensis can be easily distinguished from its congeners by distinct yellowish dorsolateral glandular folds. It is a medium-sized frog with females having a snout-vent length of approximately 55 mm. Its head is wider than long. The posterior of its thighs is blotched dark brown and creamy yellow. The dorsum is ashy brown, with the lateral sides below the dorsolateral glandular folds appearing dark green. The dorsolateral glandular folds exhibit a golden yellowish color (Ray 1999). The ecology, breeding, and behaviour of the species are also poorly known except for depositing eggs under boulders (IUCN 2023).

To determine the current status and to identify the key threats to *A. chakrataensis* at the type locality and surrounding area, the research team, including the first five authors, conducted multiple daytime and night-time visual encounter surveys and acoustic surveys (Borzée et al. 2016; Prasad et al. 2020; Nowakowski et al. 2024) across streams in the Chakrata landscape, including the type locality of *A. chakrataensis*. Surveys were conducted by a team of experienced field herpetologists with prior expertise in Himalayan amphibian identification for a total of 39 days across different seasons between 2023 and 2024 (Table 1), with efforts including two researchers for seven days in February 2023, three researchers for six days in April 2023, three researchers for nine days in June 2024, three researchers for six days in September 2024, and two researchers for 11 days in October 2024. A standard search effort across sites was applied, spending 2 h surveying each approximately 500 m stream and riparian section to allow careful inspection of available microhabitats. On each survey day or night, 5h and 30 min of active surveying were conducted. The surveys were conducted in Tuna Forest, Masak, Jadi, Kanaser, Lokhandi, Moila, Gvasa, Tiger waterfall, and Dava, at altitudes ranging from approximately 1,050–2,700 m in the Chakrata landscape in Dehradun District of Uttarakhand (Image 2). Each site was surveyed at least three times to maximize the probability of detection. Sampling was conducted during night-time (1800–2330 h) using headlamps and torches and daytime (1030–1600 h), searching through stream banks, pools, leaf litter, roadside moist habitats, and surrounding vegetation within the stream channel and immediate riparian zone, corresponding to the expected detection distance for stream-dwelling anurans. To detect the presence of any calling males of *A. chakrataensis*, a 5 min assessment of calling activity at each site prior to initiating visual encounter surveys during night-time visits (Borzee et al. 2016), with observers actively listening for calls while slowly walking along stream sections.

In the absence of finding adult individuals of *A. chakrataensis*, tadpoles were sampled to confirm its presence. Based on 16S mtDNA barcoding, the six sampled tadpoles were identified as belonging to the *A. formosus* (n = 1), *A. jaunsari* (n = 1), *Nanorana vicina* (n = 2), and *N. minica* (n = 2), with no evidence of *A. chakrataensis.* DNA was extracted from the clipped tail tissue of tadpoles using the DNeasy Blood & Tissue Kit (QIAGEN), following the manufacturer's protocol. A fragment of the mitochondrial 16S rRNA gene was amplified with universal primers under standard PCR conditions. Amplicons were purified, sequenced bidirectionally, and the resulting sequences were edited and assembled in Geneious. Bayesian phylogenetic analyses were conducted to confirm species identity, following established protocols (Wang et al. 2023). Detailed laboratory protocols and full barcoding analyses will be presented in a separate manuscript. Despite the extensive efforts, no individuals of *A. chakrataensis* were recorded during the surveys.

In addition, data on the threats to *A. chakrataensis* were collected during the field surveys using visual observations of habitat, photographic documentation and taking field notes on mobile devices. Information on local land-use practices and perceived threats was further gathered through informal interviews with local villagers and tribal communities. During the surveys, it was observed that the streams in the type locality of *A. chakrataensis* were polluted with plastic waste, directly disposed into the streams. Items such as food wrappers, plastic bottles, bottle caps, grocery bags, straws, and stirrers stemming from excessive tourism are regularly thrown into the streams by tourists and hotel owners. During informal interviews in Jadi, local villagers told

us that this plastic waste is increasing primarily due to unsustainable tourism (Luo et al. 2018; Ziegler et al. 2023) in the Chakrata landscape. It was also observed that some parts of the streams were affected by algal bloom, most likely caused due to agricultural pesticide runoff from surrounding fields in nearby villages in the Chakrata landscape. Such pollution is known to alter water quality and microhabitat structure and affect the functioning of Himalayan Freshwater ecosystems (Peng 2019; Talukdar et al. 2023), which may have negative consequences for stream-dependent amphibians, particularly during aquatic life stages (Gill et al. 2025). This study identifies two additional threats to *A. chakrataensis* under the IUCN Red List Threats Classification Scheme (Version 3.3): pollution (sub-categories–garbage and solid waste, and agricultural and forestry effluents) and residential and commercial development (sub-category–tourism and recreation areas), alongside the previously recognized threats of natural system modifications and invasive and other problematic species, genes, and diseases. These threats are ongoing and are most likely to impact all populations of *A. chakrataensis* in Chakrata.

Waste dumping in streams presents a significant threat to the amphibians (Rahman et al. 2024), including *A. chakrataensis* and other sympatric anurans such as *Amolops formosus*, *A. jaunsari*¸ *Duttaphrynus himalayanus*, *Nanorana minica* and *N. vicina*. While garbage dumps may provide a constant source of food to animals, they also expose wildlife to risks of pathogen infection and toxic substances, which can have dire consequences for wildlife health and population viability (Azevedo-Santos et al. 2021). Garbage dumps act as ecological hotspots that attract invasive and toxic species, posing serious risks to environmental health (Sangkachai et al. 2024). Invasive amphibians, such as *Duttaphrynus melanostictus*, can exploit these sites for abundant food resources and potential breeding habitats, thereby enabling their establishment and spread into native ecosystems (Penerbit 2019; Dufresnes et al. 2025). This process can intensify competition and toxicity pressures, further threatening native amphibian populations (Plaza & Lambertucci 2017).

Plastic pollution poses a lethal threat to amphibians in freshwater ecosystems, affecting several species of amphibians (Azevedo-Santos et al. 2021). Plastic pollution poses significant risks to amphibians as the microplastics accumulate in the organs, causing external morphological changes, mutagenic effects, and

Image 1. Holotype of *Amolops chakrataensis* in the Museum of Zoological Survey of India, Dehradun, collected in 1985. The registration number 'A.197' was noted on the holotype during our visit, whereas Ray (1999) referred to it as 'NRS/ZSI A-25'. © Vishal Kumar Prasad.

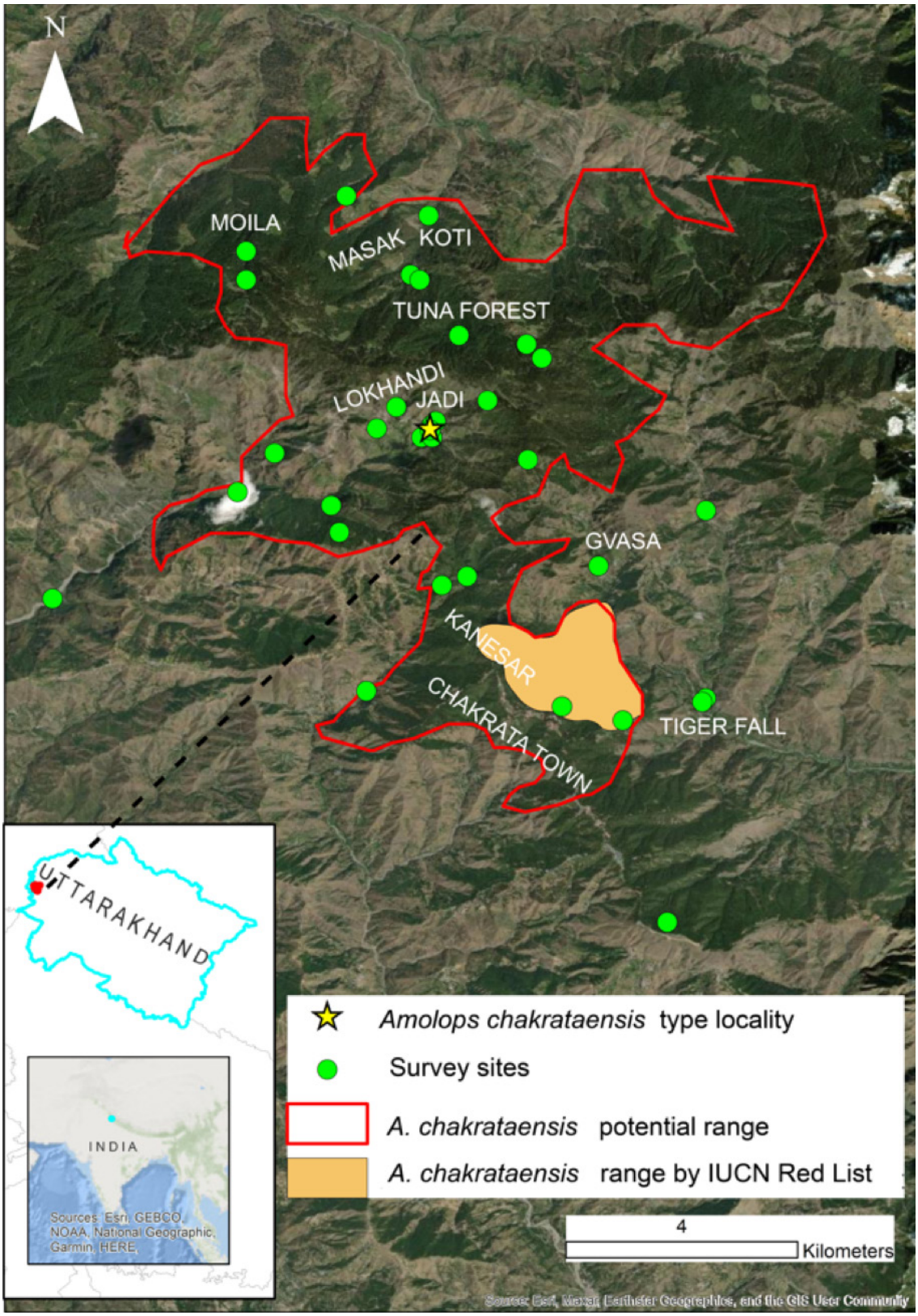

Image 2. Map of the survey area in the Chakrata landscape explored for *Amolops chakrataensis* in in this study. The yellow star marks the type locality of *A. chakrataensis*. Green dots represent the survey sites within streams where visual encounter and aural surveys were conducted in the Chakrata landscape, Dehradun District (Uttarakhand, India). The red outline represents a potential distribution range of *A. chakrataensis* in the Chakrata landscape. The orange polygon indicates the range of *A. chakrataensis* as shown in the IUCN Red List of Threatened Species that requires an update.

Table 1. Details of sampling sites surveyed for *Amolops chakrataensis* in the Chakrata landscape (Dehradun District) and the Bhagirathi River basin (Uttarkashi District), Uttarakhand, India, between 2023–2025. The table summarises geographic location, elevation, survey effort, seasonal coverage, habitat characteristics, observed associated threats, and other amphibian species detected at each site. Coordinates are provided in decimal degrees (WGS84), and altitude is in metres. Sampling seasons are as I = Spring (February–March), II = Summer (April–May), III = Pre-monsoon (June), and IV = Post-monsoon (September–October).

Sites	Latitude	Longitude	Altitude (m)	Number of observers	Sampling season	Target species	Other amphibians	Habitat type	Observed associated threats
Tuna Forest	30.7825	77.8375	1,936	2	I, II, III, IV	Absent	*Duttaphrynus himalayanus, Nanorana minica, N. vicina*	Deodar–pine forest streams	Plastic pollution
Masak	30.7698	77.8223	2,330	2	I, II, III	Absent	*D. himalayanus, N. minica, N. vicina*	Deodar forest streams	Plastic pollution
Jadi village	30.7465	77.8505	2,246	3	I, II, III, IV	Absent	*N. minica, N. vicina*	Mixed forest–urban interface	Road widening, urbanization, plastic pollution, algal blooms
Kanaser	30.7127	77.8662	2,029	3	I, II, IV	Absent	*N. minica, N. vicina*	Deodar forest streams	Plastic pollution
Lokhandi village	30.7586	77.8109	2,415	3	I, II, IV	Absent	*N. minica, N. vicina*	Deodar forest streams	Road widening, urbanization, tourism pressure
Moila forest	30.7765	77.7883	n/a	2	II, III, IV	Absent	*N. minica, N. vicina*	Deodar–pine forest streams	Household wastewater, plastic pollution
Gvasa forest	30.7229	77.8786	1,819	3	I, II, III	Absent	*D. himalayanus, Amolops formosus, N. minica*	Forest streams near settlements	Plastic pollution, tourism pressure
Tiger waterfall	30.7046	77.894	1,524	2	II, III, IV	Absent	*A. formosus, A. jaunsari, D. himalayanus, N. minica*	Open stream, semi-urban	Tourism pressure, urbanization
Dava	30.7336	77.8933	1,776	2	I, II, III	Absent	*D. himalayanus, N. minica*	Agricultural land with oak patches	Agricultural disturbance
Dabri Khadd	30.7701	77.8475	1,882	2	I, II, III	Absent	*D. himalayanus*	Agricultural land with oak patches	Agricultural disturbance
Sahiya	30.6241	77.8663	1,096	3	I, II, IV	Absent	*A. jaunsari, D. himalayanus, D. melanosticus, N. minica, Minervarya* sp.	Wide stream/ river system	Urbanization, tourism pressure
Bhagirathi River basin (Maneri) 1	30.7283	78.5314	1,321	2	IV	Absent	*A. formosus, A. jaunsari, N. minica*	Stream bordered by forest and paddy fields	Agriculture, dam influence
Bhagirathi River basin (Maneri) 2	30.7668	78.591	1,409	2	IV	Absent	*A. formosus, A. jaunsari, N. minica*	Stream bordered by forest and paddy fields	Agriculture, dam influence

cytotoxic damage, which severely affect the health and development of amphibians (da Costa Araújo et al. 2020). Large freshwater amphibians also face entanglement in fishing nets (Azevedo-Santos et al. 2021). The trend of threat from plastic waste to amphibians in Chakrata is most likely similar; this needs a detailed assessment (Image 3).

Despite extensive surveys between 2024 and 2025, no individuals of *Amolops chakrataensis* were detected, which is concerning. Since its original description, there have been no confirmed records of this elusive and rare species. Non-detection does not necessarily indicate extirpation and may reflect low detectability associated with rarity, small population size, cryptic behaviour, seasonal variability or sampling efforts (Button & Borzée 2024). This absence may also partly reflect historical limitations, including a lack of targeted surveys, limited scientific exploration, and the absence of long-term monitoring. Therefore, a putative extirpation was referred to the type locality, pending further targeted assessments. Additionally, the IUCN Red List reports the presence of *A. chakrataensis* in the Bhagirathi River basin (IUCN 2023); this record is not supported by published literature and is also not represented in the IUCN Red List range map. Hence, it warrants verification.

This site was sampled in October 2024, but did not detect the species. Moreover, this locality lies approximately 65 km (straight-line distance) from Chakrata. In addition, the current IUCN Red List distribution map appears inaccurate, as it excludes the

Image 3. Plastic waste disposed and thrown in the stream habitats in the type locality of *Amolops chakrataensis*. © A—Vishal Kumar Prasad, B,C,D—Devendra Singh.

type locality and places the range approximately 5 km away from the locality reported by Ray (1992, 1999). Based on the field surveys, an updated preliminary range map for *A. chakrataensis* (Image 2) is provided, estimating an extent of occurrence of 52.79 km², compared to the 4 km² currently depicted in the IUCN Red List range polygon. The area was calculated in ArcGIS Pro (version 3.1.5) using the calculate geometry attributes tool. This revised range map can serve as a baseline for future targeted surveys, resampling efforts, and conservation assessments.

It is recommended to conduct targeted seasonal surveys during peak breeding periods to improve detectability. The collection of live individuals as vouchers should be strictly prohibited for this species to prevent further population decline (Minteer et al. 2014). Environmental DNA (eDNA) surveys may serve as a sensitive, non-invasive tool for assessing the presence of species in low-density populations. Surveys should also extend beyond the type locality to evaluate the potential persistence of the species in adjacent stream systems. Habitat restoration measures, including removing accumulated plastic waste, reducing agricultural runoff, and maintaining natural stream flow regimes, should be implemented to enhance microhabitat quality for this stream-dependent amphibian. On a broader scale, engaging with district-level policy frameworks, along with actively involving local communities in amphibian conservation initiatives in Uttarakhand, is essential to integrate freshwater biodiversity considerations into tourism regulation, waste management planning, and watershed conservation strategies. Implementing these measures would establish baseline ecological conditions necessary for future monitoring, reassessment, and potential recovery initiatives for *A. chakrataensis*.

It is concluded that the 'Critically Endangered' *A. chakrataensis* has become an extremely rare amphibian and is likely on the verge of extinction, given the absence of confirmed sightings or collections since its original description based on a single holotype. This indicates a high risk of range-wide extinction and highlights the urgent need for immediate conservation action. The putative local extirpation of *A. chakrataensis* from its type locality, Chakrata, highlights the critical necessity of prioritizing amphibian conservation in the western Himalaya (Lötters et al. 2023; Luedtke et al. 2023; Wren et al. 2024). Consistent with recent global amphibian synthesis, targeted habitat protection, improved

monitoring including eDNA sampling, and integration of site-based conservation frameworks are essential to halt further declines and prevent irreversible biodiversity loss (Borzée et al. 2025). Rapid and coordinated interventions can help ensure that other amphibian species in this fragile Himalayan ecosystem do not follow similar extirpation trajectories.

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