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Research Paper

Threat Assessment of Two Himalayan Endemic Alpine Plant Species and Conservation Implications

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ABSTRACT

Aconitum novoluridum Munz (Ranunculaceae) and *Bistorta longispicata* Yonek. & H. Ohashi (Polygonaceae), a narrow endemic plant species confined to the Himalayas. The present study assesses the threat status of these species using the criteria of the IUCN Red List of Threatened Species based on the available occurrence records, and both of the species currently categorized as the "Endangered". As the species is simultaneously experiencing various threats and the known distribution range is relatively more narrow, it is the right time to develop conservation strategies for the sustainable utilization of these narrow endemic alpine plant species of the Himalayas.

HIGHLIGHTS

- Three subpopulation of *Aconitum novoluridum* Munz. and two subpopulations of *Bistorta longispicata* Yonek. & H. Ohashi has been recorded.
- Both *A. novoluridum* Munz. and *B. longispicata* Yonek. & H. Ohashi were classified as 'Endangered'.

Keywords: *Aconitum novoluridum, Bistorta longispicata*, conservation, Himalaya, Sikkim

Catastrophe is a natural process that has always been essential to the evolution of life. Recent historical period has had a persistently catastrophic impact on biodiversity, both loss of species and the integrity and operation of larger ecosystems (Turvey and Crees, 2019). Furthermore, many species are rapidly going to be extinct because of factors including high population growth, urbanization, habitat loss, changes in microhabitats, climate, and greater reliance of the global population on non-renewable resources (Woodruff, 2001). The rate of species extinction peaked in the second half of the 20th century, nearly unheard of in Earth's history (Frankham, 2003). However, biodiversity has been a vital source of livelihood since the beginning of human civilization because it provides distinct types of ecological services. (Costanza *et al*. 1997). The Indian Himalayan Region (IHR) contains more than 30% of India's total endemic flowering plants (Singh *et al*. 2015). The IHR is under extreme anthropogenic strain while supporting such rich biodiversity because of overexploitation, urbanization, alien species invasion, illegal trafficking in precious and therapeutic plants, deforestation, and construction operations like roads and dams. Due to the severity of the present extinction crisis, a significant amount of effort has been put into determining and monitoring the threat of extinction to the distinct species across the globe. As a result, during the past forty years, lists of threatened species on a global, regional, national, and local level have expanded (Burton, 2003). Finding populations or species that are in decline or are in danger of extinction is the first step in beginning conservation efforts

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for endangered species (Brooks *et al.* 2006). One of the most important indicators of changes in the ecosystem's health is the distribution pattern of the most fragile plants in the alpine habitat. Since a species' habitat declines because of several disturbances brought on by natural and man-made forces, reassessing the population health of previously evaluated flora at the regional level is a crucial part of plant conservation programs. To undertake threat assessments and consequently build successful conservation strategies, precise taxonomic identification and data on the population status of investigated species are also crucial. Keeping all these in mind, the present study was conceptualized with the objective of investigating the threat status of selected species under the project "*Conservation of Threatened Plants in Indian Himalayan Region: Recovery and Capacity Building*." *Aconitum novoluridum* Munz (Ranunculaceae) and *Bistorta longispicata* Yonek. & H. Ohashi (Polygonaceae), being a narrow endemic species, was studied for the first time to undertake an empirical assessment of its threat status across the Himalayas based on IUCN Red List criteria (IUCN 2012a, 2012b, 2019). In India, the species *Aconitum novoluridum* Munz is restricted in Arunachal Pradesh and Sikkim (Lahiri, 2022), while the *Bistorta longispicata* Yonek. & H. Ohashi confined in the alpine pasture of Sikkim Himalaya (Lahiri *et al*. 2019; Lahiri, 2022). The ecological niche of these two species falls under one of the fragile eastern Himalayan ecosystems. Therefore, we tried to evaluate the status of the spread of suitable habitats for these species was undertaken.

MATERIAL AND METHODS

Experimental study site

Himalayas have been known as 'biodiversity hotspot'. Conservation International has zed Himalayas as one of the thirty-four global Biodiversity hotspots, which cover 2.3% of the Earth's land surface. The Indian Himalayan Region (IHR) extends between 26°20′ and 35°40′ N and between 74°50′ and 95°40′ E, covering an area of about 5 lakh km^2 (about 16.2 % of country's total geographical area), forms the northern boundary of the country. The Himalayan alpine meadows (also known as bugyals in the western Himalaya), recognized as hotspots of Himalayan biodiversity, are home to many endemic plant species. At 3000 meters above sea level, where the treeline ends, these meadows begin to appear; they extend until around 4500 meters, where the snowline begins, and flora becomes scant. This habitat in the Himalayan range, which runs from west to east, is rich in biodiversity, yet it is in jeopardy. The eastern Himalayas are essential for comprehending how climate change may affect biodiversity. The eastern Himalayas are among the world's most biodiverse temperate regions because they are at the meeting point of subtropical and temperate Asian floras and the alpine highlands of the Tibetan plateau (Mittermeier *et al*. 2005; Mutke and Barthlott, 2005) and the most affected by climate change outside polar regions (Williams *et al*. 2007). In Himalayas studies on the impacts of climate change on plant communities and biodiversity in the Himalayas have been conducted (Telwala *et al*. 2013; Dolezal *et al*. 2016). However, the study on threat assessment of alpine plants is very scanty.

Experimental methods

During the survey, the geographic coordinates of each population of the chosen alpine plant species were noted. Additionally, using Google Earth Pro software, the latitude and longitude information of previously collected plant specimens found in the herbariums of the Central National Herbarium (CAL), Sikkim Himalaya Regional Centre, Gangtok (BSHC), Eastern Regional Centre, Shillong (ASSAM), and Arunachal Pradesh regional center, Itanagar (ARUN) was extracted. In addition to the above-mentioned, the herbarium sheets that were deposited in the international herbarium were accessed through the global plant database management systems Global Plants JSTOR (https://plants.jstor.org), Global Biodiversity Information Facility (GBIF, https://www.gbif.org), Kew Herbarium Catalogue (https://apps.kew.org), etc. The Geospatial Conservation Assessment Tool (GeoCAT) was used to assess the worldwide range of a species using the geographic coordinates of all the acquired localities and herbarium data. IUCN Categories (2019) and Criteria B1 and B2 were used to calculate the extent of occurrence (EOO) and area of occupancy (AOO) using the GeoCAT as an extension for ArcView 3.x, version 1.2. There are three main criteria that were categorized, i.e.,

Critically Endangered, Endangered, and Vulnerable (Table 1).

Table 1: Summary of criterion B of the IUCN Red List Categories and Criteria (IUCN, 2019) used to evaluate if a taxon belongs to any threat category (Critically Endangered, Endangered, and Vulnerable)

Geographic range in the form of either B1 (extent of occurrence) and/ or B2 (area of occupancy)			
	Critically Endangered (CR)	**Endangered (EN)**	**Vulnerable (VU)**
B1 Extent of Occurrence	< 100 km^2	< 5000 km^2	< 20 000 km^2
B2 Area of Occupancy	< 10 km^2	< 500 km^2	< 2000 km^2
and at least two of the following three (a, b, c) conditions			
(a) severely fragmented or number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred, or projected in any of (i) EOO; (ii) AOO area; (iii) extent and or quality of habitat; (iv) number of locations or subpopulations (v) number of mature individuals.			
(c) Extreme fluctuations in any of (i) EOO; (ii) AOO; (iii) number of locations or subpopulations; (iv) number of mature individuals.			

Note: *EOO – Extent of Occurrence, AOO – Area of Occupancy.*

RESULTS AND DISCUSSION

Aconitum novoluridum Munz. Gentes Herbarum 6: 472.1945. *Aconitum luridum* Hook.f. & Thomson, Fl. Ind. 1: 55. 1855 & Fl. Brit. India 1: 28. 1872, non Salisb. 1816.

Diagnostic Characters

Perennial herbs, stem erect, simple, 1–1.5 m high, pubescent. Leaves orbicular–cordate, shallowly incised, basal leaves long petioles, cauline leaves 3–5 partite. Sepals reddish to purple, pubescent, upper sepal helmet-shaped, broad, 5–7 mm high; lateral sepals slightly obliquely obovate, 9–11 × 7–8 mm; lower sepals deflexed, oblong, *c.* 8.5 mm long, obtuse. Petal glabrous. Follicle's oblong, sub truncate, 10–12 mm long.

Flowering and fruiting: August–September.

Threat assessment

Aconitum novoluridum Munz was first collected by Sir J.D. Hooker from the Tankra Pass and Cho-la in the easternmost of Sikkim in 1849 and subsequently described as *Aconitum luridum* Hook. *f.* & Thomson in 1855. Later, Munz (1945), proposed a new name for this species as *Aconitum novoluridum* Munz. There is no representation of this species in any of the Indian herbaria (ARUN, BSD, BSHC, CAL, DD) until 2017, when it was rediscovered from Kyongnosla Alpine Sanctuary of Sikkim Himalaya (Dahal *et al*. 2017). After that, we collected (collection this species again in 2018 from Kyongnosla alpine sanctuary (Dash *et al*. 2021).

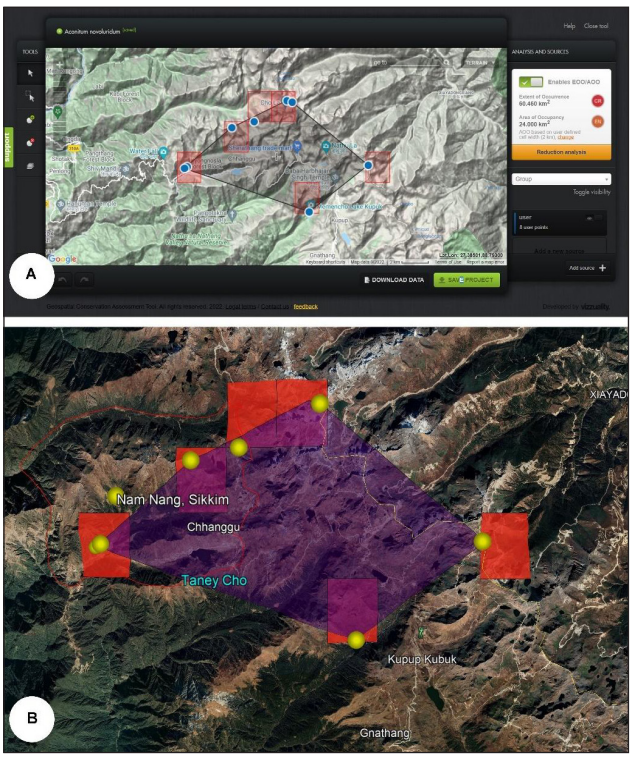

Fig. 1: Map showing the geographic range of *A. novoluridum* Munz **(a)** View in GeoCAT **(b)** View in Google Earth

During our studies, we were able to locate three subpopulation of *Aconitum novoluridum* in Kyongnosla Alpine Sanctuary, Sikkim, and its surrounding areas like Tsongmo lake, Memencho lake distributed over eight geocoordinate (GPS coordinates: N 27°.379, E 88°.863; N 27°.422, E 88°.801; N 27°.421, E 88°.805; N 27°.378, E 88°.725; N 27°.408, E 88°.776; N 27°.404, E 88°.759; N 27°.377, E 88°.723; N 27°.348, E 88°.818) (Fig. 1). According to the GPS coordinates, the extent of occurrence (EOO) of the species *Aconitum novoluridum* was calculated to be 60.46 km^2, and the area of occupancy (AOO) 24 km^2. With the currently available information, the threat status for *Aconitum novoluridum* in the Indian

perspective can be assessed as 'Endangered' [EN B1ab(iii) + 2ab(iii)] (Fig. 1) in the Indian perspective.

Ecological note

The species grows in marshy alpine grassland, which experiences heavy snowfall and is prone to a high rate of grazing. In general, the root of this species has medicinal importance, but there is such proof regarding the overexploitation of the species that was reported. During the present study, we have collected and evaluated the occurrence of this species from Kyongnosla Alpine Sanctuary, east Sikkim, with an important value index (IVI) was 4.65. The dominant associated species were *Primula sikkimensis*, *Potentilla peduncularis*, *Oxyria digyna*, etc. The number of mature individuals at the collection site was about seventeen individuals, thus representing by small population size (Lahiri, 2022).

Bistorta longispicata Yonek. & H.Ohashi, J. Jap. Bot. 76: 346. 2001.

Diagnostic Characters

Perennial herbs, rootstock woody, rhizomatous. Stem erect, 9–13 cm long, pale purple. Basal leaves coriaceous, oblong-lanceolate, 0.6–1 × 3–3.5cm. Inflorescence terminal, on a cylindrical raceme, compact, 2–2.8 × 0.9–1.3 cm, rachis 3–5 cm long, glabrous; subtended with a leafy involucral bract. Flowers pinkish, pedicel 2–3 cm long; bract subulate, 3–4 mm long; ovate, acute at apex. Perianths pink, tepals 5, oblong, obtuse at apex, 3.5–5 × 2–2.5 mm; adaxial tepal slightly larger than others. Stamen 8, diplostemonous. Ovary superior, trigonous; style trifurcated. Achene oblong, trigonous.

Flowering and fruiting: July– September.

Threat assessment

Bistorta longispicata Yonek. & H.Ohashi was first reported from India by Lahiri *et al.* (2019) from West Sikkim near Samiti Lake area at an altitude 4300 m. This is the only known location of this species during the present study reported in 6 small fragmented locations belonging to 2–7 individuals each. The species is dwindling in its natural habitat due to several anthropogenic threat's heavy tourist influx, and local grazing. However, Gogoi *et al.* reported another location near Gurudongmar lake of north Sikkim. Here we consider two subpopulations of *B. longispicata* spread over seven occurrence points (GPS coordinates: N 27°.541, E 88°.186; N 27°.560, E 88°.188; N 27°.560, E 88°.187; N 27°.560, E 88°.188; N 27°.552, E 88°.187; N 27°.551, E 88°.187; N 28°.018, E 88°.70). According to the GPS coordinates, the extent of occurrence (EOO) of the species *Bistorta longispicata* was calculated to be 51.484 km^2, and the area of occupancy (AOO) 12.000 km^2. With the information presently available, the threat status of *Bistorta longispicata* Yonek. & H.Ohashi in India could be classified as 'Endangered' [EN B1ab (iii) + 2ab (iii)] (Fig. 2).

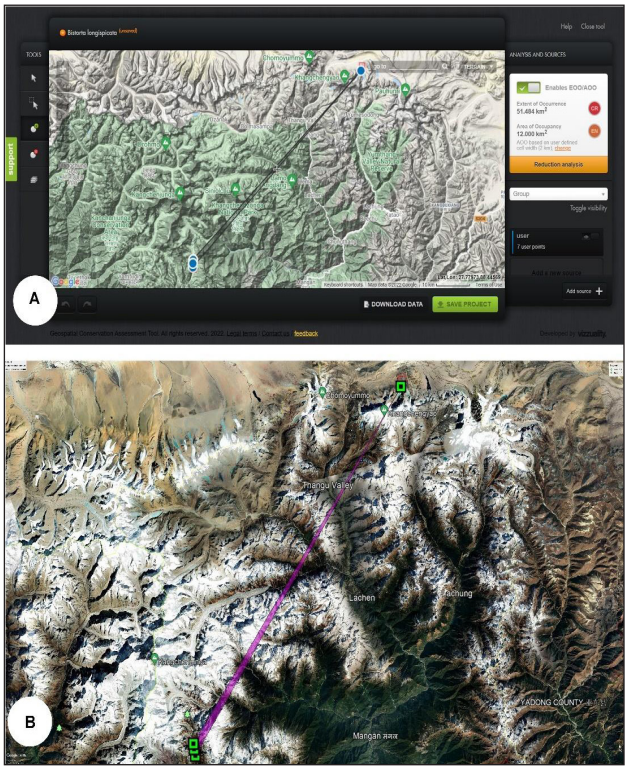

Fig. 2: Map showing the geographic range of *B. longispicata* Yonek. & H.Ohashi **(a)** View in GeoCAT **(b)** View in Google Earth Map

Ecological note: The species grows in the open alpine meadows of Sikkim Himalaya (in India), which experience high-speed winds and are prone to the high stress of anthropogenic activities and grazing. However, there was no proof for the species was over-exploited by local villagers or by herbal healers, and the whole plant, along with roots, was extracted. During the present study, the species was recorded only at one site near Samiti Lake, and Goecha La of Khangchendzonga Biosphere Reserve with a recorded importance value index was 5.24 between the altitude 4100–4200 m and 9.15 between

4200–4300 m. The number of mature individuals at the collection site was about sixty-two individuals, thus represented by minor population size.

CONCLUSION

The findings of the current study have broad significance in developing effective conservation strategies for this unique species in high-altitude ecosystems of the Himalayas in an era of fast land-use change and climate crises. This study highlights the value of conducting conservation assessments using the most recent regional IUCN Red List recommendations. Following these criteria, our findings reveal the conservation status of all the two evaluated species to be "Endangered"

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REFERENCES

Brooks, T.M., Mittermeier, R.A., da Fonseca, G.A., Gerlach, J., Hoffmann, M., Lamoreux, J.F., Mittermeier, C.G., Pilgrim, J.D., Rodrigues, A.S. 2006. Global biodiversity conservation priorities. *Science*, **313**(5783): 58-61.

Burton, J. A. 2003. The context of red data books, with a complete bibliography of the IUCN publications. *In*: De Iongh, H. H., Bánki, O. S., Bergmans, W., and Van derWerff ten Bosch M. J. (Eds.), The harmonization of red lists for threatened species in Europe. Leiden, The Netherlands: Commission for International Nature Protection, 291–300.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Naeem, S., Limburg, K., Paruelo, J., O'Neill, R.V., Raskin, R., Sutton, P. and van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. *Nature*, **387**: 253–260.

Dahal, S., Sharma, T.P. and Borthakur, S.K. 2017. Rediscovery of *Aconitum novoluridum* (Ranunculaceae) from Sikkim Himalaya, India. *Rheedea.*, **27**(2): 116–118.

Dolezal, J., Dvorsky, M., Kopecky, M., Liancourt, P., Hiiesalu, I., Macek, M., Altman, J., Chlumska, Z., Rehakova, K., Capkova, K., Borovec, J., Mudrak, O., Wild, J. and Schweingruber, F. 2016. Vegetation dynamics at the upper elevational limit of vascular plants in Himalaya. *Sci. Rep.*, **6**: 24881.

Frankham, R. 2003. Genetics and conservation biology. *Comptes Rendus Biologies*, **326**: 22–29.

IUCN. 2012a. Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0. Gland, Switzerland and Cambridge, UK: IUCN. iii + 41pp

IUCN. 2012b. IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.

IUCN. 2019. IUCN Standards and Petitions Committee. Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. Gland, Switzerland.

Lahiri, S. 2022. Studies on Alpine and Subalpine Vascular Plant Diversity and Community Structure of Two Landscapes of Sikkim Himalaya [thesis]. Burdwan (WB): University of Burdwan. Unpublished.

Lahiri, S., Dash, S.S., Sinha, B.K., Ghosh, A. and Das, M. 2019. *Bistorta longispicata* Yonekura & H. Ohashi, (Polygonaceae): A new record to Indian Flora. *Ind. J. Forest*, **42**(1): 9–13.

Lahiri, S., Dash, S.S., Sinha, B.K., Ghosh, A. and Das, M. 2019. *Bistorta longispicata* Yonekura & H. Ohashi, (Polygonaceae): A new record to Indian Flora. *Ind. J. Forest*, **42**(1): 9–13.

Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoureux, J. and da Foncesca, G.A.B. 2005. Conservation International; Washington, DC: Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions.

Moat, J. 2007. Conservation assessment tools extension for ArcView 3.x (1.2.). GIS Unit, Royal Botanic Gardens, Kew.

Mutke, J. and Barthlott, W. 2005. Patterns of vascular plant diversity at continental to global scales. *Biol. Skr.*, **55**: 521–537.

Singh, P., Karthigeyan, K., Lakshminarasimhan, P. and Dash, S.S. 2015. Endemic Vascular Plants of India. *Bot. Surv. India*, Kolkata.

Telwala, Y., Brook, B.W., Manish, K. and Pandit, M.K. 2013. Climate-induced elevational range shifts and increase

in plant species richness in a Himalayan biodiversity epicentre. *PLoS ONE*, **8**: e57103.

Turvey, S.T. and Crees, J.J. 2019. Extinction in the Anthropocene. *Curr. Biol.*, **29**(19): R982–R986.

Williams, J.W., Jackson, S.T. and Kutzbach, J.E. 2007. Projected distributions of novel and disappearing climates by 2100 AD. *Proc. Natl. Acad. Sci. U.S.A.*, **104**: 5738–5742.

Woodruff, D.S. 2001. Declines of biomes and biotas and the future of evolution. *Proc. Natl. Acad. Sci. U.S.A.*, **98**: 5471–5476.