

early-warning systems and disaster-response teams to minimize the effects of natural hazards occurring in the region and (d) create centers of information on mountain ecosystems. It is inevitable to implement these measures without local participation. The government should



Figure 1. Early spring view of Chopta subalpine-timberline area with flowering *Rhododendron* sp. in Rudraprayag, Uttarakhand. This area remains under heavy pressures of tourists, pilgrims and grazing during summer-rainy months (Photo: C. P. Kuniyal).

incentivize locals to conserve resources using environment-friendly technology. Apart from implementing measures to improve crop productivity, horticulture practices, efforts should be made towards conservation. There is a need to integrate traditional knowledge with modern technology to conserve soil moisture, rare and endangered species and to tackle the adversities caused by natural hazards. A policy should be formulated to effectively manage protected area networks, water resources, forests and strengthen institutes in skill-building and decision making.

It is important to involve local people in conservation programmes. To engage the locals in large numbers periodic programmes on sustainable mountain development should be organized to sensitize leaders, decision-makers, media, school children and developmental agencies. In the wake of global climate change, regional instability and lack of education lead to degradation in the mountain ecosystem; sustainable mountain develop-

ment in IHR will remain a Himalayan tragedy².

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Conservation through cultivation: a promising opportunity for the critically endangered tree *Gymnocladus assamica*

Extinction of species is considered as one of the greatest threats to humankind. Unfortunately, 99% of the species are threatened due to human activities¹ such as habitat fragmentation, resource exploitation and global climate change. With the alarming increase of species extinction, scientists estimated the rate as high as 1,000–10,000 times higher than the natural extinction rate². If the process continues, we will be losing as many as 30–50% of all species by mid-century³. Therefore, effective conservation and management of the biological diversity is urgently needed to face the challenges of climate change, sustainable development and food security.

Plants are often being extinct due to over harvesting for foods, medicines, timber and similar uses to make other resources. Different approaches have been developed to conserve 'species at risk' in both *in-situ* and *ex-situ* conditions. Conservation through cultivation (CTC) is one of the successful approaches for conservation of endangered plant species

which gained more popularity for several species. The CTC programme was developed by Limbe Botanic Garden in Mount Cameroon to conserve the rich and fragile biodiversity through reducing harvesting pressures and providing cultivated material⁴. The story of *Prunus africana* in Limbe Botanic Garden⁵ showed the pathway for conservation to similar species at risk. American ginseng, Mahogany and many orchid species have also been recovered from the verge of extinction through cultivation for their economic and aesthetic values.

Another successful and perhaps the most popular CTC is the story of the oldest tree on Earth (*Ginkgo biloba*), popularly known as 'living fossil'. Unchanged for more than 200 million years, the species have been extinct in the wild for centuries. The Ginkgo tree is adored in many parts of the world as a street tree and ornamental tree for its beauty and longevity, other than the medicinal values. In a recent interview, Peter Crane, Yale School of Forestry and Environ-

mental Studies Professor and the author of *Ginkgo* agreed that humans have aided to ensure Ginkgo's survival and CTC is an important toolkit for conserving plant diversity⁶.

Gymnocladus assamica is a critically endangered tree species endemic in Northeast India. Over-harvesting of mature pods for traditional uses and habitat degradation posed serious threat to the remnant populations in West Kameng and Tawang districts of Arunachal Pradesh, India⁷. The CTC could be the most suitable approach for *G. assamica* for two reasons. First, highly saponaceous pods are used for multiple purposes; for example religious activities, day-to-day cleansing, shampooing and expelling leeches from domestic animals⁸. Mature pods are preserved by the local people and offered as a precious gift. Therefore, cultivation in homegardens is an ideal approach to increase the population locally. Secondly, *G. assamica* leaves turn into elegant, bright yellow colour during autumn (September to



Figure 1. *a*, *Gymnocladus assamica* naturally growing in Arunachal Pradesh (India); *b*, *Gleditsia triacanthos* plantation along roadside in Montreal (Canada).

November) and is distinctly visible from far distance (Figure 1 *a*). Trees with such attractive appearance are planted as ornamental tree along streets, parks and botanical gardens. *Gleditsia triacanthos*, a sister genus of *Gymnocladus*, is widely planted as street tree throughout North America for its colourful leaves during autumn and physiognomy (Figure 1 *b*). *G. triacanthos* is an Eastern Asian descendent which migrated to North America across the Bering land bridge⁹ and is a popular tree throughout the region.

G. assamica is a 15–20 m tall tree with moderate spread and upright silhouette. Light green young leaves provide filtered shade and turn bright yellow at the later stage. Though purple coloured flowers are not blazing, mature pods are used as soap substitute in rural areas of Arunachal Pradesh and adjoining areas in Northeast India. Local people also mentioned that mature pods are highly

favoured by deer and wild boar. Therefore, increase in *G. assamica* population along the homegardens, agricultural land, pastures and roadsides in mountainous terrains of the region will be helpful in survival and growth of diminishing wildlife in the region.

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Tracing the photographic plate of Comet Bappu–Bok–Newkirk

This letter is with reference to the Historical Notes ‘Comet Bappu–Bok–Newkirk – the only comet with an Indian’s name to it’ by Kapoor¹. I wish to share with the readers, the story of how the comet’s photographic plate given in the article was traced.

I am an amateur astronomer from Bangalore and have been fascinated with comets as long as I can remember. I am equally intrigued on historical aspects of comets and I do not remember exactly when, but the first seeds of excitement about Vainu Bappu finding a comet back in 1949, was implanted in me early on.

At that time, the existence of the photographic plate on which his discovery was recorded was virtually unknown to our community and I had very much wanted the photograph for inclusion on research that I had begun on Vainu Bappu’s comet C/1949 N1 (Bappu–Bok–Newkirk). Years passed with no profound insight on the missing link.

In 2012, I had started study on a larger piece of comet-related work. It was during this phase, that I contacted several amateur astronomers globally. By good fortune one among them happened to be a professional astronomer, a veteran,

William Liller, who is a retired Harvard professor. I asked him a few questions about comets, and considering that he too is from Harvard, whether he could guide me to the right source in my quest for Vainu Bappu’s comet plate. I received a reply from Liller which was startling, as it revealed, he was a good friend of Vainu Bappu. In his e-mail, although 60 years had passed by, he was very fresh with nostalgia about his friendship with Bappu during the student days. To my question on the possible existence of the photographic plate of the Comet Bappu–Bok–Newkirk, he mentioned there are