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Steep mountains in Himachal Pradesh, India, give rise to a rich variety of species.

CLIMATE CHANGE

Himalayan plants seek cooler climes

Race is on to record mountain biodiversity before it is lost.

BY T. V. PADMA IN SHIMLA, INDIA

In India's Western Himalayas, changes in altitude are so dramatic and steep that alluvial grasslands, subtropical forests, conifers and alpine meadows lie stacked almost on top of each other, producing a spectacular range of vegetation. Now, the myriad plants that inhabit these mountains are migrating upwards because of climate change — and some are in danger of being lost before anyone has even recorded their existence.

"Indian scientists have not documented many of the species in the Western Himalayas, so one does not know what species existed in the first place, and where they have shifted to," says Vaneet Jishtu, a botanist at the Himalayan Forest Research Institute in Shimla in the north Indian state of Himachal Pradesh. Jishtu and his team are midway through a five-year project to catalogue the upward migration.

Although melting glaciers are often the focus of climate-change concerns in the Himalayas, the range is also home to one-tenth of the world's known higher-altitude plant and animal species, and half of India's native plant species. Particularly rich in biodiversity are the Western Himalayas that, in India, include the states of Himachal Pradesh, Jammu and Kashmir, Uttarakhand and Sikkim (see 'Peak plants'). There, mountains that rise steeply from 300 metres to more than 6,000 metres have diverse ecosystems and act as a natural barrier to species migration. But data collection on biodiversity in the Himalayas is sporadic — and there is much less information than from the European Alps or the Andes, says Nakul Chettri, coordinator of the transboundary landscapes programme at the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu.

The studies that do exist tend to be on well-known species, but give an idea of the extent of the upward shift. Over the past decade, tropical plants such as the nuisance weed *Parthenium hysterophorus* and the water fern *Azolla cristata* have settled in the formerly temperate climate of the Kashmir Himalayas, according to studies by Zafar Reshi, a botanist at the University of Kashmir in Srinagar in Jammu and Kashmir state (see, for instance, B. Ahad *et al. Am. Fern J.* **102,** 224–227; 2012). He also notes that the flowering and fruiting cycles of pear and apple trees — for which the region is famous — have shifted in line with rising temperatures during the past 50 years, leading to changes in fruit size, colour and taste (B. Basannagari and C. P. Kala *PLoS ONE* **8,** e77976; 2013).

Himalayan blue pines (*Pinus wallichiana*) are on the move too. They are now seen at heights of 4,000 metres, whereas two or three decades ago they grew at altitudes no higher than 3,000 metres, says a team led by Sher Singh Samant, head of the biodiversity and conservation team at the Himachal Pradesh unit of the G. B. Pant Institute of Himalayan Environment and Development. "In the past, heavy snowfall in higher regions prevented the upward shift of species. Now there is less snow and it has started melting faster, bringing about changes in vegetation and alpine meadows," he says. Even species among the glacier-deposited rocks at 4,500–5,500 metres are moving upwards to cooler climes, he notes.

Researchers know much less about — or have not even documented — many of the region's native species, especially ones that inhabit high-altitude transition zones, or ecotones, where one ecosystem gives way to another. Species in these zones are most affected by climatic change, says Chettri: "They either have to adapt by shifting to higher altitudes, or they die."

Such fears prompted the launch in 2012 of Jishtu's five-year project to assess the impact of global warming on transition zones in Himachal Pradesh. "We are still collecting and analysing data," he says. He is also setting up an arboretum in Shimla to conserve Himalayan plants that are endangered or rapidly disappearing.

One problem with existing Himalayan biodiversity assessments is a tendency to limit them to protected areas and certain species, says Chettri. This affects data on animals as well as on plants. He cites a draft ICIMOD analysis of the Eastern Himalayas that noted the cataloguing of biodiversity there is skewed towards charismatic species such as the red panda (*Ailurus fulgens*), with lower vertebrates and invertebrates sidelined. Even preliminary information about algae, fungi, insects, mosses and ferns is still scarce in the Kashmir Himalayas in India, adds Reshi.

The data that do exist can be hard for researchers to find. Past records of the region's biodiversity are scattered, inaccessible or lost in obscure natural history museums, says Reshi. "There is little systematic digitization of the collected data, and access to the data is limited, leading to duplication and misuse of resources and time," adds Chettri.

And time could be in short supply: species can migrate upwards for only so long before they hit inhabitable terrain. The upper Himalayas comprise mostly rocks, without soils to support plant growth. ■