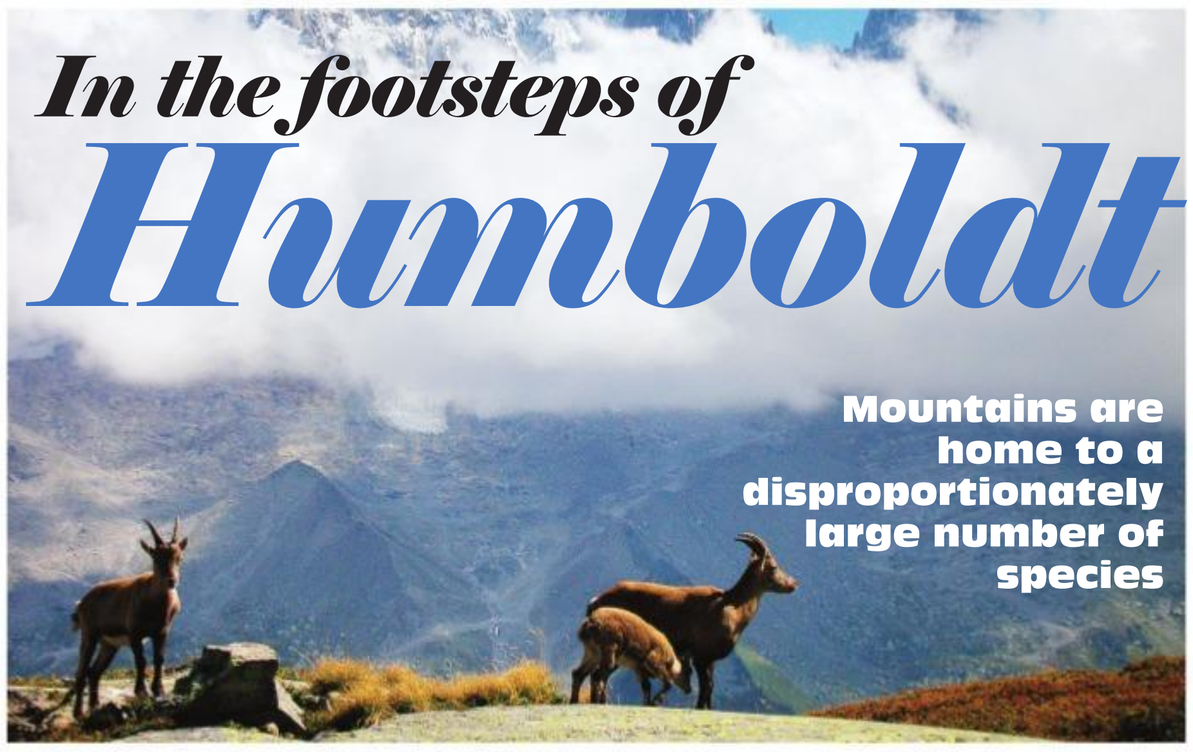


# In the footsteps of Humboldt

## Mountains are home to a disproportionately large number of species

S ANANTHANARAYANAN

The biodiversity found in mountains is a major factor in the environmental stability of the surrounding lowlands, and the Earth itself. This is because mountains act as junction points of the water cycle, distributing water and nutrients, and as a storehouse of species that are able to survive when things get difficult in the plains.

Charles Darwin, the author of our understanding of how species arise, was struck by the great variety of life forms on the Earth. Even if it was God who created living things, why did he need so many? Darwin was on his legendary voyage around South America from 1831 to 1836 and put down his work, *The Origin of the Species*, in 1859.

But the questions that he asked, in substance, had been asked by Alexander von Humboldt, a polymath, botanist, geologist, scientific adventurer, who had travelled extensively in South America and the Amazon between 1799 and 1804.

As 14 September 2019 was the 250th anniversary of Humboldt's birth, *Science*, the journal of the American Association for the Advancement of Science, carried two papers that examine a related question — how is that so much of the biodiversity of Earth is concentrated in mountains?

Mountains cover only 25 per cent of the Earth's land area. But they are home to 85 per cent of the species of amphibians, birds and mammals found on the Earth. While the wealth of species in mountains is seen to arise from the diversity of mountain terrain, and the rapid changes seen in mountains, current ideas of how species arise have not been able to account for the extremely high concentration of different species, particularly in tropical mountains. In a sense, the question of why there is so much diversity of species on Earth has morphed into, "Why is such a large part found packed in the mountains?"

Carsten Rahbek, Michael K Borregaard, Alexandre Antonelli, Robert K Colwell, Ben G Holt, David Nogues-Bravo, Christian MØ Rasmussen, Katherine Richardson, Minik T Rosing, Robert J Whittaker, Jon Fjeldså, Bo Dalsgaard, Naia Morueta-Holme David Nogues-Bravo, from the University of Copenhagen, University of Southern Denmark, Imperial College London, University of Oxford, Royal Botanic Gardens, Kew, Surrey Gothenburg Global Biodiversity Centre Sweden, University of Connecticut, and Colorado Museum of Natural History, in the two papers in the journal, examine the mechanism that could lead to this mystery, a question known as "Humboldt's enigma".

Professor Carsten Rahbek, lead author of both papers, says, "The challenge is although it is evident that much of the global variation in biodiversity is so clearly driven by the extraordinary richness of tropical mountain regions, it is this very richness that current biodiversity models, based on contemporary climate, cannot explain. Mountains are simply too rich in species, and we are falling short of explaining global hotspots of biodiversity."

The main reasons that the studies identify is that mountains, being the products of tectonic upheavals and affected by erosion or climatic processes, undergo comparatively frequent changes. They also have varying topography and can present diverse and changing environments, at a rate many times that of non-mountainous areas. These changes result in splitting of habitats and the separation of species, leading to evolutionary adaptation, and this can lead to exponential multiplication. "These biological processes create a shifting balance between speciation and extinction, in which mountains may act as "cradles" (areas of especially rapid species origination), "museums" (areas of especially long-term persistence of species), and "graves" (areas with especially high rates of extinction) for biodiversity," one of the papers says.

"People often think of mountain climates as bleak and harsh", Michael K Borregaard, co-leader of the paper says, "But the most species-rich mountain region in the world, the Northern Andes, captures, for example, roughly half of the world's climate types in a relatively small region -- much more than is captured in nearby Amazon, a region that is more than 12 times larger".

This is particularly so, he says, in the tropics, where a point of high altitude can have what looks like Arctic conditions, and within a short distance, there could be the range of temperatures associated in the space from the Equator to the Poles. "A tropical mountain has more climate zones than a temperate mountain of similar height," the second paper says.

The normal dynamics of generation of species include movement of populations, by dispersal or shifting to a different range, specialisation, or niche evolution, persistence of a hardy species, and extinction. These processes, the paper says, are not able to account for the number of species. It is by simulation, using models that take into account realistic climatic changes in past geological ages, that better results have come. More accurate models of past climate conditions as well as models of interaction of organisms and environment are allowing us to understand how populations changed and guided evolution, the paper says.

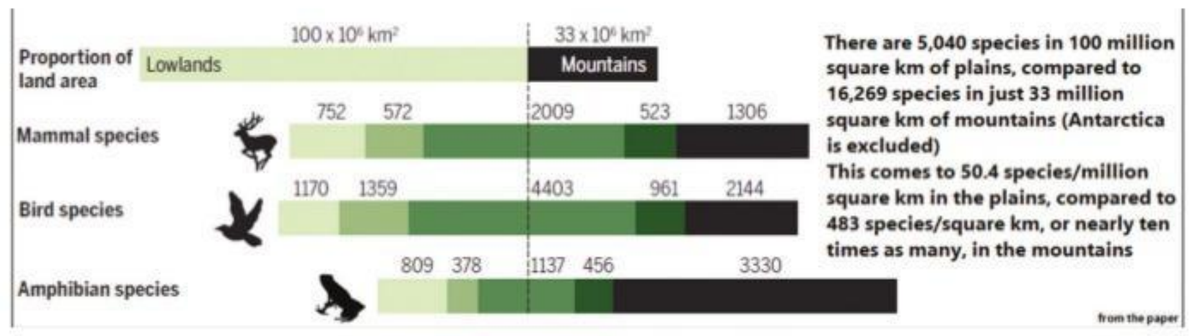
The concept that geology and biology are intimately connected — the "unity of nature" — was the message in Humboldt's major work, *Kosmos* (1845-51).

AR Wallace, British explorer, geographer, anthropologist, and biologist, had (in 1880) used the relationship to confirm that there was a series of Ice Ages from how a group of related species was distributed over islands in the Indo-Pacific. But, so far, there has always been too little data or the statistical methods were not good enough to put all biological and geological processes into a model of diversity of mountain species and evolution, the paper says.

It is now, with sophisticated technology, that we are able to reconstruct the sequence of geological changes. And with techniques of DNA analysis to connect with movements or changes of population and genetic patterns, we may create models that help us better understand how diversity and distribution of life over the earth came to be.

The writer can be contacted at response@simplescience.in


German postage stamp issued in 1969, the bicentenary of Alexander Humboldt

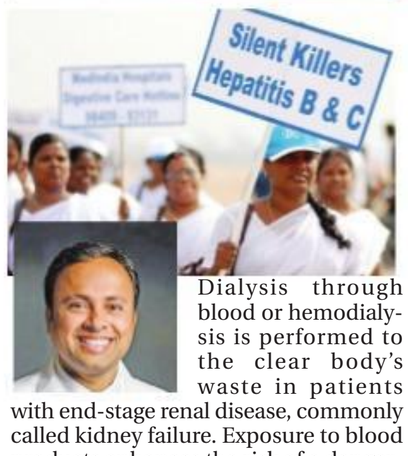



## Humboldt and environmental conservation

Apart from his work in botanical geography and geology, Humboldt was perhaps the earliest to raise the alarm about the environment. In his 1814 book on his travels in the Americas, he wrote, "When forests are destroyed, as they are everywhere in America by the European planters, with an imprudent precipitation, the springs are entirely dried up, or becoming less abundant. The beds of the rivers remaining dry during a part of the year are converted into torrents, whenever great rains fall on the heights. The sward and moss disappearing from the brushwood on the sides of the mountains, the waters falling in rain are no longer impeded in their course and instead of slowly augmenting the level of the rivers by progressive filtration, they furrow during heavy showers the sides of the hills, bear down the loose soil, and form those sudden inundations that devastate the country."

PLUS POINTS

## Treating a chronic infection


Dialysis through blood or hemodialysis is performed to the clear body's waste in patients with end-stage renal disease, commonly called kidney failure. Exposure to blood products enhances the risk of a dangerous infection called hepatitis C virus. This was highly prominent in the baby boomer generation, where unscreened blood transfusion resulted in unspecified hepatitis C infection.

Normally, we hear about hepatitis A and B viruses, which are spread by the oro-fecal and blood routes, respectively. Then, what is hepatitis C? Recent work has shown the high prevalence of this blood-borne virus in the general population, which was earlier most commonly acquired through transfusion of unscreened blood.

Hepatitis C viral infection has emerged as an important cause of chronic liver disease affecting nearly 180 million individuals. In India, the numbers are hard to predict, mainly because of inadequate screening for the virus. HCV imposes a considerable burden of mortality, morbidity and healthcare costs in India. During the last two decades, the treatment of HCV has evolved from interferon-based therapies with or without rivbavirin to pegylated-based process. Different studies say, however, the introduction of oral drugs, which target virus- specific proteins has now revolutionised the treatment of chronic HCV.

In a multi-centric original study on practice patterns of hemodialysis, Dr Girish Singhania (*in photo above*), earlier an assistant professor of internal medicine at University of Utah in the US and currently an attending nephrologist at CHI St Vincent Hospital in Little Rock, and his team, have identified the significant risk of acquiring hepatitis C infection during hemodialysis.

Dr Singhania's study has demonstrated that HCV antibody positive dialysis patients have an increased risk for all-cause mortality compared with uninfected patients. This state-of-the-art analysis appeared in the prominent journal, *Hemodialysis International*.

Hepatitis C is a silent killer. Initially, the course of the disease remains quiescent. Thereafter, it harms the liver and several other body organs. It hyperstimulates the immune system to create a newer class of proteins called cryoglobulins, which damages blood vessels throughout the body. The patients on hemodialysis co-infected with hepatitis C virus have significant risks of coronary artery disease. Hepatitis C predisposes to cancers like lymphoma, hepatocellular carcinoma and Waldenstrom's macroglobulinemia.

Autoimmune diseases like systemic lupus erythematosus, rheumatoid arthritis and auto-immune thyroid diseases can complicate the natural history of these patients. The prospect of these patients seems bright under current circumstances, as a new class of agents called "directly acting antiviral" agents like elbasvir/grazoprevir and glecaprevir/pibrentasvir (which are cleared by the liver and not the kidneys) may be used to cure the viral infection.

Importantly, as Dr Singhania, a fellow of the American Society of Nephrology, pointed out, screening of the blood products for hepatitis C viral load is the most important first step. Screening for viral hepatitis started in India in 2002, though wide rigorous screening is still not optimised. Additionally, he suggested that the use of blood-producing stimulating agents like erythropoietin has reduced the need for blood transfusion to treat anaemia in renal failure patients.

Coupled with these are increased awareness of this important viral co-infection and involvement of enhanced infectious disease screening in hemodialysis patients. Repeat transfusion in thalassemia and hemophilia patients significantly increases the risk of acquiring hepatitis C infection.

As modes of infection of HIV (human immunodeficiency virus) and HCV are parallel, it is important to take cognisance of these additional infectious agents. HCV treatment improves outcomes for the renal failure patients who are anticipating kidney transplantation, according to him.

Dr Singhania additionally emphasised screening for HCV and safer blood products in countries like India.

Subhendu Maiti

# *Chandrayaan-2*'s glorious attempt

## India's Moon mission should be considered a success and a lesson in space-faring

REBECCA ALLEN

India attempted to make history by becoming just the fourth nation to successfully land a probe on the Moon. It came agonisingly close, but after journeying millions of kilometres, the *Vikram* lander lost contact in the final few hundred metres and crash-landed on the lunar surface.

But it would be both unfair and plain wrong to label the mission a failure.

**Two-month trip**

After a postponed launch, the *Chandrayaan-2* spacecraft began its journey to the Moon on 22 July.

Onboard it carried the *Vikram* lander and *Pragyan* rover, equipped to search the lunar South Pole for water and other valuable resources. Everything seemed to be going according to plan. *Chandrayaan-2* completed several orbits around Earth and then the Moon, slowly making its way closer to the lunar surface and taking photographs the whole time.

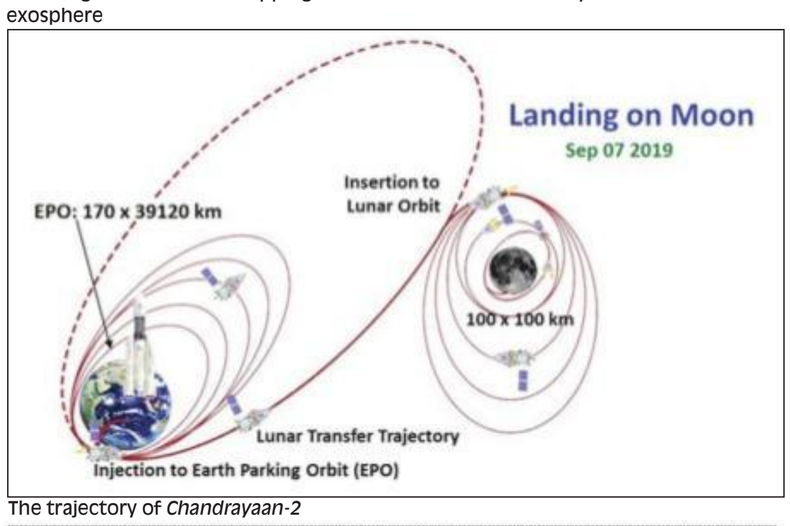
On 2 September, the *Vikram* lander separated and began to make its descent. All communications were normal until the lander was within two kms of its goal. Then it went silent — a space engineer's worst nightmare.

**_Vikram_, do you copy?**

So far, the Indian Space Research Organisation's engineers have not been able to re-establish communications with the lander. It's likely *Vikram* landed with enough force to damage its communications equipment, as well as other instruments.

But all hope was not lost, as *Chandrayaan-2* remained in orbit above the Moon and, with its high-resolution camera, was able to spot the lander. If oriented favourably, *Vikram* could still manage to power itself up. Isro has not admitted defeat and will keep trying to connect to *Vikram* for the next two weeks. However, the chances of success diminish with time.

The *Chandrayaan-2* orbiter is equipped with eight instruments to study the Moon, including a lunar terrain mapping camera and a sensor to study the Moon's thin exosphere




The trajectory of *Chandrayaan-2*

While the *Chandrayaan-2* mission has not gone as expected, it cannot be called a failure. The *Chandrayaan-2* orbiter will continue to monitor the Moon for up to seven years and the high-resolution images it takes will be vital to future international efforts to land on the Moon.

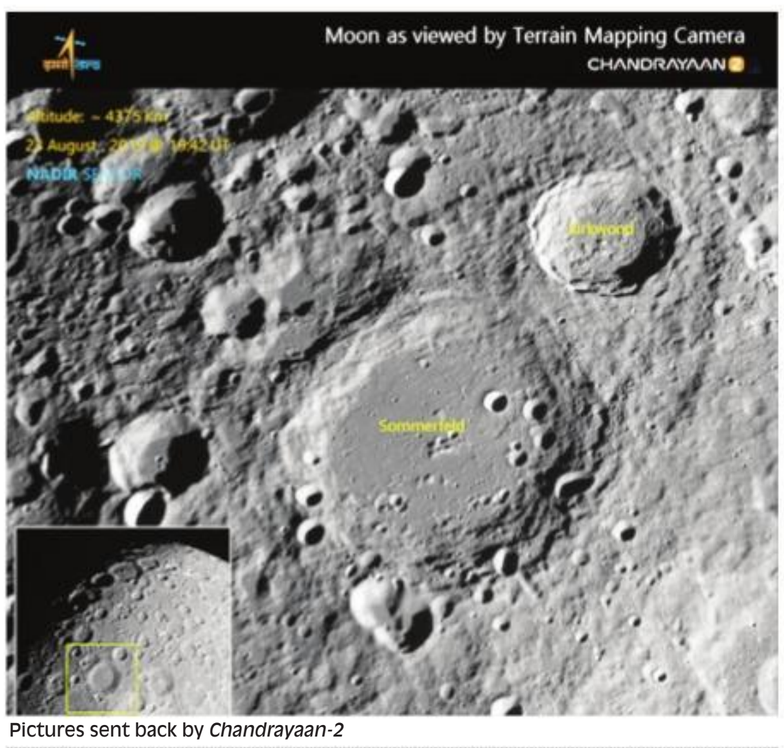
**Technically a success**

The near success of *Vikram*'s landing should be celebrated. To appreciate just how hard it is, let's delve into some physics.

Earth is rotating and also hurtling through space at more than 100,000 km per hour. The Moon is almost 400,000 km away and travelling around 4,000 km per hour as it orbits Earth.

To reach the Moon, you first have to escape Earth's gravity and ensure you're going at the right speed to orbit Earth a few times before moving far enough to be caught by the Moon. Then you slowly decrease your distance to the lunar surface, inching closer over several orbits until you are low enough to use powered assistance to land.

It took the United States and Russia decades to design, plan and execute missions to the Moon. In fact, the Isro was founded shortly after the successful Apollo 11 mission.




Pictures sent back by *Chandrayaan-2*

We should applaud the hard work India has done over the past 50 years to get this far. This sentiment was clear as Indian Prime Minister Narendra Modi addressed his country, all of whom stood in solidarity with the scientists who spent countless hours in pursuit of their goal.

**A global space community**

The story of the Indian lander echoes that of the failed Israeli landing attempt earlier this year.

The Beresheet lander was built by private company SpaceIL, which was chasing the coveted Google Lunar XPrize when an engine malfunction caused it to swan dive into the Moon's surface.

I mention this mission to reiterate just how hard the task is, but also to demonstrate that the old Cold War space superpowers are no longer the only ones in the game. Countries and even private companies across the world are gaining space-faring capabilities and undertaking incredible missions that will enable humankind to go further than ever before.

In the next five years, more than a dozen missions to the Moon from six different countries, including Japan and Korea, are slated. This doesn't include Nasa's ambitious Artemis mission that seeks to put the first woman on the Moon.

But as the cliché goes, with great power comes great responsibility.

Now that countries across the world can send things into space, we must have solidarity as a global space-faring community to consider how our actions up there will affect us on Earth and to ensure long-term success in space ventures.

This is not the last international space mission you will hear about in the news this year. In coming years, we may even be discussing Australian ventures into space — and maybe even to the Moon itself.

The writer is Swinburne space office project Coordinator and manager Swinburne astronomy productions, Swinburne University of Technology, Melbourne, Australia. This article first appeared on www.theconversation.com