

Current Science Reports

Andaman Earthquake Swarm *Reactivation of fault system*

The Andaman–Nicobar region of the Indian Ocean is seismically very active. The subduction of the Indo-Australian Plate beneath the Burmese microplate, on the one hand, and a string of volcanoes, on the other, makes the region's seismicity complex.

For example, the mega earthquake of December 2004, which generated one of the largest tsunamis, was followed by a major earthquake swarm in January 2005 in the Andaman–Nicobar region. Significant earthquake swarms were detected there again in March 2014, October 2014, November 2015, and in April 2019.

Why? What are the factors responsible for this phenomenon?

A team of researchers from CSIR-NIO, Goa compiled earthquake data from 2000 to 2020. Low magnitude earthquakes are often missed by seismic stations on land. So they deployed ocean bottom seismometers in the Andaman Sea and analysed the data to gain deeper insights. They found 2552 earthquake events in the region. The January 2005 swarm had about nine hundred earthquakes!

To distinguish between the roles of tectonics and volcanism, the researchers used the Gutenberg–Richter magnitude relationship: the relationship between the number of earthquakes that occurred in a time period and their magnitudes expressed in logarithmic scale. The slope b , widely known as the b -value, represents the ratio between large and small earthquakes and is an indicator of the causative processes of seismicity. A value of b lower than one suggests earthquakes due to tectonic activity and, if it is higher than one, seismicity could be due to magmatic movements.

The researchers calculated the b value of the earthquakes and found a bimodal distribution of the b -value, suggesting that slips between plate boundaries as well as magmatic movements contribute to earthquake swarms in the region.

According to the researchers, the pressures created by megathrust events

due to plate tectonic movements led to magmatic pulsations that, in turn, caused earthquake swarms. The movement of subsurface magma in the Andaman Sea volcanic arc region has reactivated the sliver fault system in the region, they say.

'The reactivation provided a favourable tectonic and stress regime for the occurrence of frequent earthquake swarms,' explains Karanam Kattil Aswini, CSIR-NIO, Goa.

'These earthquake swarms are the result of complex tectonics arising from sliver fault systems and plate subduction processes,' says Kamesh Raju, CSIR-NIO, Goa.

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Venomous Fish to Vital Medicine *While saving marine environment*

The star-gazing stonefish is a bottom dweller in the Indian Ocean. It is not that the fish is astronomically inclined; instead of on the sides as in most fish, it has eyes on top of the head as if gazing at stars. And its spiny body is hard, almost like a stone. Hence, the scientific name, *Trachicephalus uranoscopus*, or hard headed sky watcher.

Venomous secretions from the needle-like spines on the body make these fish rather unappetising and fishers usually discard the species from their catch. This poses a threat to the marine ecosystem.

Suguna Lonchin and Iyappan Kuttalam at the CSIR-Central Leather Research Institute, Chennai knew that the hard but flexible material of the fish is composed mostly of collagen, a structural protein highly valued in pharma and cosmetic industries.

They saw this as a potential economic opportunity for fishers. If collagen can be extracted from the star-gazing stonefish, it will also reduce environmental damage due to discarded fish. So they set their students to the task.

Gopika Selvakumar of CSIR-CLRI and Sankari Mukundan, University of Madras went around collecting discarded star-gazing stonefish from the seashore. They extracted collagen and characterised the protein. The collagen extracted from the fish was similar to

collagen derived from cows. So it can be an alternative for bovine collagen.

The collagen structure had good cross-linking efficiency and formed strong chemical bonds with adjacent fibre units. The micro fibrous architecture of the collagen accelerated the haemostatic process, suggesting use for stopping blood loss.

The extracted collagen also showed promise for applications in tissue engineering.

'Apart from adding to marine pollution, discarding fish leads to loss of proteins, minerals, and lipids. These nutrients can be converted into value-added products,' says Suguna Lonchin, CSIR-CLRI.

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Improving Bread Wheat *Using wild relatives*

Wheat is believed to have been domesticated somewhere in the Fertile Crescent along the catchment areas of the Tigris and Nile, ten thousand years ago. Since then, wheat yields have increased many folds, especially in the recent decades. But this happened at the cost of loss of resistance to diseases and pests and loss of tolerance to heat stress – properties which wild wheat possessed.

To meet the nutritional demands of growing populations, a sustainable increase of modern wheat yield is needed. So, 38 research groups from 17 countries, including Indian researchers from the Punjab Agricultural University, Ludhiana joined hands as the Open Wild Wheat Consortium.

To identify disease- and pest-resistant genes, they sequenced DNA from 242 accessions of wild wheat species collected over decades. Using genetic markers in the sequencing data, they charted the evolution of wheat varieties.

Surprisingly, they identified a previously unknown ancestor of modern wheat. The new ancestor is located far from the originally postulated origin – the Fertile Crescent region in the Middle East – and is now only found in Georgia.

The newly identified ancestor of wheat underwent independent hybridization events and contributed to the modern wheat genome which now contains six sets of chromosomes, a hexaploid.

Mapping also helped identify the candidate genes for disease and pest resistance in the wild varieties.

'Modern wheat contains only 25 per cent of disease and pest resistance genes,' says Nitika Sandhu, Punjab Agricultural University, Ludhiana.

Harnessing the genetic diversity of wild wheat species can boost the resistance of modern wheat to diseases and pests. So through the genetic transformation and hybridization of wild and modern wheat species, the researchers developed synthetic and hybrid wheat species. Thus they created a publicly available library of synthetic wheat species that contains up to 70% of wheat diversity.

This opens up opportunities for new studies aiming to meet the goal of improving resistance while increasing wheat production.

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Mechanical Paddy Transplanter Remote controlled?

In Punjab, about 70% of the paddy transplantation is done using two-wheel walk-behind paddy transplanters. The operator has to walk 14–22 km a day in puddled paddy fields during the hot humid season. Why not create an autonomous remote system for paddy transplanters to reduce such drudgery?

Recently, researchers from the Punjab Agricultural University and the Borlaug Institute for South Asia, Punjab collaborated with others in the US to create one.

They selected an efficient two-wheel, walk-behind-paddy transplanter model. Its control levers are hand-operated with push or pull-type levers. At hand level, the machine has an accelerator, a steering lever and two steering clutches. It also has two forward gears and a reverse and neutral position.

The team measured the transplanter's control parameters – height from the ground, displacement length, actu-

ating forces and torque applied to the control levers... Then they designed an electrical actuating system appropriately to control the different controlling levers of the transplanter.

The next challenge was to design a control unit to control the actuators to control the levers. The researchers designed a printed circuit board, a small, lightweight control unit for the machine. To control the linear actuators and magnetic sensors, they used an Arduino microcontroller which has a physical programmable circuit board.

Then the issue was to control the machine remotely. So, a separate wireless communication system for the purpose was designed.

The researchers assembled the parts on a mounted frame covered with PVC pipes for waterproofing. And they evaluated the performance of the remotely controlled transplanter. The system worked well and the performance was almost equal to that of a manual paddy transplanter. While steering with the remote, the response time, however, was higher than with manual operation.

'The skill of the operator was the most important parameter to minimise deviation when using steering commands through the remote control,' says Shiv Kumar Lohan, Punjab Agricultural University.

This paddy transplanter could be a boon for farmers: it reduces work strain and improves efficiency while reducing human effort. But for that to happen, entrepreneurs need to come forward to manufacture the remote controlled transplanter.

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Cure for Kidney Stones Bryophyllum leaf extract

Kidney stones are now more prevalent around the world. The surgical removal of the stones, shattering the stones using focussed ultrasound and drugs for treating kidney stones have been tried as treatments. But they have a limitation: the chances of recurrence are high.

Researchers working in colleges in Maharashtra and Tamil Nadu noted that *Bryophyllum pinnatum* is used by tribals in different parts of India for

treating kidney and urinary bladder stones. They decided to put the ethnobotanical findings to the test.



Image: Dinesh Valke via Flickr

After ethical clearance, they injected sodium oxalate into male rats. Males are known to be more susceptible to kidney stones. Kidney stones formed by sodium oxalate are used as a model for experiments with drugs for kidney stones.

The researchers examined urine and serum from the rats during 14 days of treatments. The negative control group which did not receive sodium oxalate injection had normal urine volume and controlled amounts of minerals in urine and serum.

The positive group which received sodium oxalate injection had reduced urine volume due to calcium accumulation. The urine had excess oxalate, uric acid, creatinine and phosphorus. The serum had elevated levels of potent kidney damaging elements like sodium, uric acid, creatinine and potassium.

All groups with *Bryophyllum* extract treatments showed significant increase in urine levels. The amount of critical parameters in urine and serum showed a dose dependent response. The responses were similar to those seen in rats treated with cystone, a standard drug for kidney stones.

Histopathological imaging of the kidney showed that sodium oxalate damages normal kidney structures by increasing the width of internal tubes and causes injuries via crystal formations.

'Administering *Bryophyllum* extracts reduced damage in the kidney,' says Sangameswaran Balakrishnan, SSM College of Pharmacy, Erode.

The researchers then homogenised the test rat kidneys for analysis.

'The reduction in calcium deposition was evident in rats treated with Bryophyllum extracts,' says Ramdas B. Pandhare, MES College of Pharmacy, Ahmednagar, Maharashtra.

'On increasing the Bryophyllum extract doses, the chances of stone formation kept reducing,' adds R. R. Shende, his colleague.

Plant extracts from *Bryophyllum pinnatum* have phytochemicals like alkaloids, flavonoids, anthraquinones, saponins, etc. Identifying the active principles in the plant leaf extract remains a challenge, say the researchers.

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Petting and Trust

In free-ranging dogs

Dogs are trustworthy pets and show remarkable sensitivity to human instructions and cues. Unlike pet dogs, stray dogs are not as familiar with humans and their behaviour flexibility is less often observed and studied. Anindita Bhadra and Debottam Bhattacharjee from IISER Kolkata have been studying free ranging strays for years now.



Image: Pranjal Nath via Wikimedia Commons

Recently, they reported the influence of petting on the response of free-ranging dogs to the communicative behaviour of human beings.

They selected 80 free-ranging dogs in urban and semi-urban areas. The dog population consisting of an equal number of adult males and females was divided into two groups – petting and non-petting.

The design of the experiment was simple. The researchers would place two bowls of raw chicken pieces covered with opaque cardboard boxes, equidistant from each dog. Then they would point to either of the boxes. Upon finding the right box, the dog was rewarded with food. The researchers had the option of giving an

informative cue by pointing to the box with food, or a deceptive cue by pointing to the box without food. They assigned informative and deceptive cues randomly to dogs in both groups.

The team conducted a five-day experiment. On day one, experiments were done only to familiarise the dogs with the experimental setup.

From the second to the fourth day, the petting group was patted for about 10 seconds. On day 5, the researchers recorded the responses on video for further analysis.

Statistical analysis revealed that the likelihood of point-following by the petting group increased from 55% on day one to 98% on day five. Petted dogs followed the pointing cues regardless of their informative or deceptive nature. But the non-petting group only identified and followed informative cues.

'These results demonstrate that free-ranging dogs can follow human communicative cues flexibly, using conditional strategies,' says Anindita.

Animal lovers can perhaps socialise stray dogs via brief petting so that they become more trusting and, therefore, less aggressive to humans.

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Bringing Back the Birds

Active Restoration

The Anamalai hills, in the Western Ghats, are home to over a hundred bird species. But plantations of cash crops, such as coffee, tea and pepper, have fragmented rainforests there into smaller patches. Habitat destruction is threatening tropical rainforest birds there.

Can human intervention in the form of active restoration help these birds return to once-degraded forest fragments? Or should nature be allowed to regenerate on its own?

Concerned, Priyanka Hariharan and T. R. Shankar Raman from the Nature Conservation Foundation examined the recovery of tropical rainforest birds in the Anamalai hills.

From point count surveys of birds there, they could determine the effect of active restoration on rainforest birds and compare it with that of natural regeneration.

Compared to natural regeneration, active restoration practices, such as planting native trees and removing invasive species, they found, contribute to a complex vegetation structure that attracted rainforest bird species and kept out open country generalist species. Yet, even 20 years after such restoration, the bird community in these sites is still not comparable to that of undisturbed rainforests within the Anamalai Tiger Reserve.

'Restoration efforts have a significant role in bird conservation in tropical landscapes. But we must continue to protect mature rainforests,' says Priyanka Hariharan, NCF.

She advocates planting mixed native tree species in high diversity.

'Even small forest fragments within plantations can benefit significantly,' remarks Priyanka.

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Mobile Electrophoresis Kit

For experiments in schools

Electrophoresis is used to separate biological macromolecules such as DNA, RNA or proteins. Negatively charged molecules like to move towards a positive charge in the electric field, separating differently charged molecules.

Electrophoresis requires a wide range of chemicals and is used only in well-equipped and well-spaced laboratories. Simple portable and cost-effective electrophoresis equipment can enable even our school students to do biochemistry experiments.

Researchers from the ICAR-Central Inland Fisheries Research Institute, Kolkata and Kendriya Vidyalaya, Bhubaneswar collaborated to develop such an electrophoresis kit.

To make the kit, they used inexpensive, off-the-rack components: acrylic boxes, acrylic sheets, a gel casting cradle, a thick base plate, silicone rubber gaskets, glass plates, spacers, toothed comb... The kits were fabricated in a local workshop.

Now the problem was to check the kit's performance in the field. The researchers designed a biochemistry course schedule for students and teachers. Practical exercises with the mobile electrophoresis kit were performed

by about 100 high school students from three different schools.

After attaining skills and abilities during practical classes, the participants evaluated the training programme. The teachers and technical personnel of the schools found the kit and the experiments acceptable for students.

'The electrophoresis equipment is compact – a perfect mobile electrophoresis kit suitable for schools,' says Arpita Basu Kendriya Vidyalaya, Bhubaneswar.

'Of course, researchers can also use our kit for any vertically oriented electrophoresis technique,' says Praveen Maurye, ICAR-CIFRI, Kolkata.

Educational entrepreneurs can make use of this opportunity to equip rural schools with advanced technologies.

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Biodiesel from Microalgae *Consortium for better results*

Biodiesel is a good alternative to fossil fuels. Microalgae are renewable resources and growing them for biodiesel production helps sequester carbon dioxide. However, when this model moves from lab to outdoor for large scale production, it faces limitations: low yield, contamination and low quality fuel. In fact, some international biodiesel projects discontinued their operations due to discouraging results while implementing biodiesel projects on a large scale.

Nooruddin Thajuddin and team from the National Repository for Microalgae and Cyanobacteria-Freshwater, Bharathidasan University, however, were not discouraged. A consortium of microalgae may do better than culturing single microalgae for biofuel, they hypothesised.

The team screened four microalgae species and their consortia in the lab and in an outdoor pond facility for fatty acid production. They chose *Chlorella vulgaris*, *Scenedesmus dimorphus*, *Coelastrella* sp., *Chlorococcum* sp. and grew them in the lab. Once the cultures grew to their maximum, the team harvested the biomass and measured the dry cell weight. They obtained more biomass from *Chlorella vulgaris* and *Scenedesmus dimorphus*.

So the researchers made a consortium of these two microalgae and cultured it in the lab. The consortium showed better growth in biomass than the individual species.

The team inoculated the consortium as well as individual microalgae into outdoor ponds. The consortium had higher biomass than individual microalgae in the outdoor pond also. In fact, the outdoor pond had better growth than in the lab.



Image: N. Thajuddin

The team found that the lipid content was higher for *C. vulgaris* and *S. dimorphus* than for the other individual algae. And the content was even higher for the consortium.

However, the lipid content was reduced in outdoor pond cultures. The lipid content in the consortium decreased from 39% to 34%. This, the researchers say, can be improved by limiting nutrients in outdoor ponds. Microalgae, under nutrient-limited conditions, produce higher amounts of fatty acids.

It is the composition of fatty acids that decides the quality of fuel. The researchers extracted lipids from the cultures and converted them to fatty acid methyl esters. They analysed the esters in a gas chromatography instrument to map the fatty acid profile. The consortium had around 53% oleic acid – a favourable proportion. Oleic acid imparts better fuel properties with better tolerance towards auto-oxidation and cold environments.

Next in line will be to optimise biodiesel production from the consortium, say the researchers. Stakeholders for biodiesel production need to keep their eyes on the solutions on the table.

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