Current Science Reports

Himalayan Supraglacial Lakes

Stability and dynamics

Lakes on glaciers are short lived and small. But, in the last few decades, they are getting bigger and lasting longer. Glacier melting in the Himalayas has created thousands of such lakes, posing the risk of outburst floods. So Sabyasachi Maiti and Litan Kumar Mohanty from IIT Kharagpur decided to determine what affects lake dynamics and morphology in the area.

They downloaded the data of 17 glaciers in the Everest region from GLIMS, a glacier database. Eight were large glaciers and nine smaller than thirty square kilometres. There were more than 2400 supraglacial lakes. The researchers demarcated lake boundaries and yearly variations from 2010 to 2019 using Google Earth and satellite images.

The number of lakes associated with small glaciers, they found, is decreasing. But lake size gradually increased as lakes merged. On larger glaciers, lakes are increasing at a high rate but lake size is decreasing. New lakes are forming at higher elevations, suggesting continuous ice loss. They form at glaciers which have irregular branches.

The team observed a sudden increase in the number of lakes, total lake size and average lake size in 2015. 'These may be due to the 2015 Nepal earthquakes,' says Sabyasachi Maiti.

Lake density started decreasing again, especially on smaller glaciers. Besides earthquakes, many other factors affect lake dynamics: low snowfall, consequent increase in temperature and ice melt that releases debris, decreasing slope and, therefore, velocity...

'The hindering of flow brings water up to the glacier surface. That is how lakes form there,' explains Litan Kumar Mohanty.

Ice thickness, surface velocity and slope impact lake stability. So the duo took relevant data from other sources and mapped a lake stability index. Stable lakes occur at larger glaciers, are larger and gradually merge with smaller lakes. The researchers found that only about 161 of the 2424 lakes are stable, mostly in the ablation area.

With more than 2000 unstable lakes on the 17 glaciers in the Everest region, a system for monitoring is vital for disaster management and planning.

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Himalayan Iodobacter

Twofer deal for pharma

Scientists from the CSIR-Institute of Himalayan Bioresource Technology, Palampur, scouring a kettle lake area in the Western Himalayas for microorganisms, chanced upon a unique strain. The violet coloured rod-shaped microbe belonged to the *Iodobacter* genus, known to survive freezing temperatures.

The *Iodobacter* species, they found, was also a mini-factory, producing polyhydroxybutyrate, a natural biopolymer used as bioplastics, and violacein, a versatile pigment with unique biological properties.

The team grew the bacteria in the lab and optimised temperature, carbon and nitrogen sources to get the best polyhydroxybutyrate and violacein yield. Glucose was the ideal carbon source and tryptone was best for nitrogen. The bacteria grew well at 20°C and a slightly alkaline pH. The best yield of both biomolecules was achieved in four days incubation after inoculation.

To make the yield more efficient, the researchers statistically optimised the experimental set up. Based on this, they slightly modified the media to increase biomass and biomolecule yield by two-fold.

The team then extracted the two compounds from bacterial culture in methanol. Using repeated centrifugation, they collected violacein from the supernatant and polyhydroxybutyrate from the colourless pellet.

They prepared a biofilm by dissolving the purified polyhydroxybutyrate in chloroform. The biofilm's thermal and mechanical strength was suitable for preparing bioplastics. The team also evaluated violacein pigment on six different cancer cell lines and found it anti-cancerous.

'Violacein not only inhibits cancer cells, but also kills other microbes including many pathogens,' says Vijay Kumar.

'Polyhydroxybutyrate is usually produced using bacteria like *Pseudodonghicola* and *Bacillus coagulans*. Violacein is synthesised in *Chromobacterium*, *Janthinobacterium.* But this *Iodobacter* strain produces both,' says Dharam Singh, his colleague.

'Two marketable products from one bacterium – that increases the commercial viability of the strain,' says Sanjay Kumar, CSIR-IHBT.

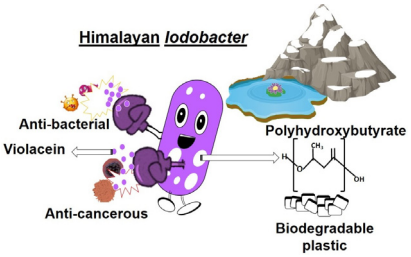

Image: K. Sri Manjari

To check whether both can indeed be extracted from *Iodobacter* at an industrial scale, the scientists scaled up production in a 22 litre fermenter under oxygenated conditions.

That is technology on a fast track.

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Indian Oil Sardine

Fluctuation in landings

Indian oil sardine data from all fish landing centres in Kerala show an average annual catch of 150 tonnes. The catch, however, fluctuates widely from year to year – from about 1.5 tonnes to nearly 400 tonnes. What conditions of the sea influence such variations?

To find out, researchers from the CMFRI, Kochi and IITM Pune collected and organised nearly 60-year landing results and compared these results with atmospheric and oceanographic factors.

And they found a connection!

In all years with good catch, they found, the gradient of salinity was

higher, the mixed layer depth was shallower and the temperature was lower. The lower temperature of the sea surface leads to upwelling from below, bringing nutrients for plankton growth, attracting fish. The timing of upwelling vis-à-vis monsoon is critical for a good catch, say the researchers. Similarly, the timing of the variations in the mixed layer depth also affects the catch.

Fish feed on diatoms, phytoplanktons in the water. These chlorophyll containing organisms are found near the coast. 'So from May to September fish flock to these cooler zones to feed, become mature and spawn,' says Faseela Hamza, IITM Pune.

The years with decreased salinity in the sea at the time of spawning just before the monsoon and increased salinity during the monsoon also showed higher catch. 'Sardines prefer lower salinity during spawning and higher salinity is good for the survival of larvae and juveniles,' explains Grinson George, CMFRI.

The team then compared landing results with the Pacific and Atlantic decadal oscillations – recurrent natural processes in oceans. The Pacific decadal oscillations showed a strong, but inverse relationship while the Atlantic multidecadal oscillations were in phase with the landings.

'These two indices have more pronounced long term impact on sardine catch variability than previously reported due to El Niño and the Southern Oscillation,' says Vinu Valsala, IITM Pune.

These results are useful for fishers to allocate time and energy based on meteorological and oceanographic data.

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Hormones in Aquaculture

Cultivating snakeheads and catfish

Snakeheads have become favoured freshwater fish. Demand makes them costlier, attracting aquaculture farmers. But farming is not easy because of a shortage of seeds. And the same problem is faced by farmers breeding brackish water catfish. But hope from hormones is on the horizon.

Recently, two ICAR institutes reported using hormones to breed catfish, *Mystus gulio* and striped snakehead, *Channa striata*. Scientists from the Central Institute of Brackishwater Aquaculture used three hormones on catfish: human chorionic gonadotropin, luteinizing hormone-releasing hormone analogue and a commercial hormone. After injecting the hormones into fish muscle, they recorded the sex ratio, size of cells in the ovary and breeding performance.

Human chorionic gonadotropin and the analogue of the luteinizing hormone-releasing hormone at low concentrations improved breeding. But the researchers found the commercial hormone more suitable and cost-effective, though the concentration required was slightly higher.

The sex ratio of two females to one male is ideal, they report. Catfish females with oocyte size from 851 to 950 micrometres are ideal for induced spawning. If the diameter is less than 801–850 micrometres, a double dose of human chorionic gonadotropin gives better results.

In another study, scientists from the Central Institute of Fresh-water Aquaculture, Bhubaneswar analysed how gonadotropin treatments affect captive brood-stock maturation in striped snakehead. Striped snakeheads are bottom dwellers, usually buried in mud.

Collecting brooders from earthen ponds is quite difficult. So, the team used concrete tanks. They selected brooders weighing about half a kilo with ova size greater than one millimetre.

Image courtesy: Rajesh Kumar, CIFA

Females were injected with human chorionic gonadotropin and carp pituitary homogenate. Male snakeheads were injected with 75% of the same hormones, based on a preliminary study.

The scientists measured egg size, fertilisation and hatching rates. Hormone-treated snakeheads had higher gonado somatic index and oocyte diameter than non-treated fish.

A small dose of human chorionic gonadotropin at 2000 International Units per kilogram body weight is sufficient for maturing female gonads to produce larger eggs. With carp pituitary homogenate, 30 milligrams per kilogram of body weight showed good results in females.

Aquaculture farmers can now volunteer for field trials.

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DOI: 10.1016/j.aquaculture.2020.735821

Genetic Gain for Rice Yield

In rainfed environments

Rice is an important staple, and provides a livelihood to many Indians. Unfortunately, drought and limited water availability affect rice production in several regions. Many breeding programmes have developed improved drought-tolerant rice varieties.

But the performance of the new varieties depends on environmental factors also. Epigenetic modifications tend to stabilise the performance in a new area where the varieties are introduced. The genetic gain in a breeding programme is measured in terms of annual increase in yield through artificial selection.

ICAR institutes along with international partners measured yield in the drought-prone rainfed lowland fields of eastern and southern India. The team conducted trials under three predefined conditions of water and agronomic management – rainfed, rainfed with supplementary irrigation and irrigated control – to estimate the annual yield of the newly developed breeding lines. They pooled the available genotypes of drought resistant rice with 100–120 days duration and conducted field trials in 14 locations over ten years.

The researchers unscrambled the yield data to separate the contributions from agronomic parameters and those from genetic parameters to calculate the genetic gain. Annual yield increases by about one per cent under irrigated control and moderate drought stress at the reproductive stage. But if the crop has severe drought stress at

the reproductive stage, the annual yield gain of the new breeding lines increases to nearly two per cent.

The genetic gain assessment of grain yield indicated that yield increased not only under moderate and severe drought stress at the reproductive stage in rainfed rice, but also under irrigated control.

Now the stage is set to multiply and disseminate the seeds of the newly bred varieties for improving rice productivity in drought-prone regions in the country.

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Dressing for Burn Wounds

Blending for healing

Second-degree burns are often left open, without dressing. This not only delays recovery but also increases the risk of secondary infections. A soft dressing that can absorb the exudates and help heal burns is sorely needed. A team from the CSIR-Central Leather Research Institute, Chennai now has something to offer.

To prepare a matrix for dressing, they blended two natural polymers: polyhydroxybutyrate and gelatin. Polyhydroxybutyrate acts as storage material for medication and gelatin, a soft gel, can absorb exudates.

The microstructure of the nanofibres in the blends with varying ratios, as seen under a scanning tunneling electron microscope, revealed that the 70 : 30 polyhydroxybutyrate and gelatin blend was most uniform with no beads between threads. On this blend, the team loaded silver sulfadiazine, an effective drug for burns.

The matrix was superior to existing dressings, in porosity and absorption, allowing the easy exchange of gases and nutrients needed for skin regeneration.

The team tested the material on burn wounds in rats. One group was treated with the blend. Another was dressed with the blend loaded with silver sulfadiazine. And on a third group, silverex gel was applied.

In just five hours, the nanofibrous matrix released 40% silver sulfadiazine, followed by gradual release for 72 hours. The dressing inhibited infections by *Staphylococcus aureus, Pseudomonas aeruginosa*, *E. coli* and other pathogens. And absorbed all discharge from wounds. Within 15 days, the silver loaded matrix healed 90% of the wounds. All other treatments took nearly 21 days.

Hope on the horizon for patients with burns. But use in clinical settings awaits human trials.

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Attention Deficit Disorder

Prevalence in children

Some children have trouble paying attention and controlling impulsive behaviour. Attention deficit hyperactivity disorder is a neurodevelopmental problem and is considered a life disability.

How prevalent is it among Indian school children, wondered Himani Mahesh Joshi and Mubashir Angolkar, KLE Academy of Higher Education and Research, Belagavi.

They undertook a study in three private schools. Based on a computer generated random table of students in each standard, the team selected a sample of 156 primary school boys and girls.

They used a rating scale for behavioural parameters to diagnose the disorder based on observations about a child's behaviour. They administered this 18-item rating scale to teachers and parents, to factor in differences between school and home environments.

The prevalence of ADHD, they report, was a little less than 6%. Earlier studies in India indicate prevalence between 2% and 17%.

The team found that the prevalence of the disorder was slightly more in girls than in boys. Earlier studies in other countries, however, suggest an equal distribution among boys and girls or slightly higher prevalence in boys.

There was a disparity between the observations of parents and teachers, parents attributing ADHD more than teachers. This may be because home provides more freedom of behaviour, say the researchers. The number of children in a class also tends to impact teacher perceptions.

In the absence of epidemiological studies based on clinical diagnosis, such input from parents and teachers helps identify children who might need intervention and support to overcome the disadvantages.

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Pyrethroid Pesticides

Male infertility through food

Pyrethroids have become popular insecticides, accounting for more than a quarter of pesticide use for agriculture and household pest control. But recent studies report that exposure to pyrethroids may be linked to cancers, as well as brain, kidney and liver malfunction. They are also often associated with infertility. However, information on the effects of long-term repeated exposure to pyrethroids through food is scarce.

Recently, Anandha Rao and Suresh Yenugu, from the University of Hyderabad examined pyrethroid toxicity in rats at doses that mimic human long-term exposure through diet. They fed the rats a mixture of pyrethroids at two doses: one-fifth and one-twenty-fifth of their body weight – doses mimicking the highest and lowest doses of pyrethroids in the food we consume. The feeding was continued for 15 months, the rat equivalent of more than three decades of human life.

Even the lowest doses of pyrethroids increased the weight of the liver, lungs, testes and prostate of the rats in response to tissue injury. The highest dose resulted in decreased body weight also.

The rats also showed increased levels of bilirubin and oxidative damage, inhibiting catalase enzymes that protect the liver. The serum contained relatively high levels of very-low-density lipoproteins and triglycerides – macromolecules that can clog arteries and lead to heart attack.

The rats produced a low number of sperms which did not mature because genes involved in sperm production and maturation are affected by both high and low doses of pyrethroids.

Insecticides like DDT which showed estrogenic effects and endosulfan

which had carcinogenic and teratogenic effects were banned for sale and use after much public outcry. It looks as if pyrethroids are headed in the same direction. A policy to promote biopesticides to replace, or at least reduce, the use of chemical pesticides is perhaps needed to reduce the impact of banning pyrethroids on agricultural productivity and health.

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Renal Disorder

Dogs of Bareilly

Renal disorder is a major cause of mortality and morbidity in dogs. Unlike in humans, the epidemiology of renal diseases in dogs is not well researched. Mahendran Karunanithy and others at the Indian Veterinary Research Institute, Bareilly recently did a survey on clinical cases of kidney disorders in dogs there.

They used veterinary clinics to screen cases to identify dogs with symptoms of renal disorders. Based on clinical signs, urine analysis and ultrasonography in 4000 cases at the referral veterinary polyclinic, they found 80 with disorders such as renomegaly, nephritis and shrunken kidneys. In other words, 2% of the dogs brought to the clinic had renal disorders.

The team found the incidence rate of kidney disorders in dogs highest in December and lowest in February. This could be due to lower intake of water in winter which leads to decreased flushing of toxins.

Male dogs are more susceptible to renal disorders and incidence rates increase with age.

Spitz is the most affected breed and pugs are least affected, say the investigators.

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Textile Effluent Bioremediation

A cost-effective method

Effluent management is a huge burden for textile industries. Treating effluents using physical or chemical methods is time consuming and expensive. So Anushree Malik and team from IIT Delhi decided to try microbes that are adapted to the effluents for decolourising the effluents.

They collected microbial consortia from textile industry effluents and cultured them with yeast extract as nitrogen source and pre-treated effluent as carbon source. The native community adsorbed 70% of colour from effluent samples. It reduced chemical oxygen demand and neutralised the pH. This reduced the steps involved in the treatment.

Would the microbial consortium survive under actual field conditions? The researchers checked endurance. The microbes worked efficiently from 30°C to 55°C and at pH ranging from 7 to 11.

Would the treated water be safe for irrigation? The researchers used the germination test. Treated effluent was less toxic to plant germination than the untreated one.

'The microbial consortium can treat dye-laden wastewater and reduce harm to the environment,' says Saurabh Samuchiwal, IIT Delhi.

'The process is reliable and cost-effective. It can easily be scaled up for industrial use,' adds Anushree Malik, his colleague.

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Indian Queenless Ant

Relocation dynamics

Ants leave pheromone trails for other ants to follow. But some ant species communicate without the chemical. *Diacamma indicum*, for instance, uses tandem running for colony relocation in response to calamities such as flooding. A system of leaders and load bearers for transporting goods without involving the queen has evolved in the species.

How often do leader and transporter get separated by interruptions in the path? How do transporters reorient to the path? Do transport type and speed change with terrain?

Sumana Annagiri and team from IISER Kolkata decided to investigate. Since the species has limited members in each colony, the researchers could collect, maintain and label ants in eight colonies containing a total of about 1000 ants and more than 600 brood items.

The colonies were exposed to environmental stresses to urge them to relocate. The team video recorded and analysed more than 1000 transports.

Exposed to the stresses, some scouts from the colony begin exploring potential nests. After identifying a site, they become 'tandem-leaders', guiding other ants to the new nest. Followers often carry pupae or larvae in their mandibles.

The researchers documented initiation, start time, type of transport and destination to calculate speed and path efficiencies. Ants returning from the new nest to the old nest were fastest – two times faster than during transportation. Solo ants transporting broods were faster than tandem transportation. Tandem leaders move slower in grassy patches to maintain leader-follower contact. However, path efficiency was lower in solo transportation.

'Faster transportation through slower movement,' quips Karunakaran Anoop, IISER Kolkata.

Barren paths increased speed but did not significantly affect interruptions in contact between ants in tandem running. Interruptions were noted in about 2.5% of the cases. But if the follower transporting goods is lost, others soon step in to lead most lost ants to the new colony. Only about one per cent is lost during relocation.

'The direction initially chosen by ants from the old nest may vary. But the paths ultimately converge on the new nest,' says Purbayan Ghosh, IISER Kolkata.

'Tandem running has evolved to a high degree of efficiency in *Diacamma indicum.* This gives the colonies an adaptive advantage for relocation,' says Sumana Annagiri, team leader.

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