

## Current Science Reports

### Arctic Soundscapes *Seals, sails and ice*

Kongsfjorden, an open glacier fjord in the Arctic, is a reference site for marine and climatic studies. Ambient sounds have an impact on seals, walrus and other life forms and play an important role in aquatic ecology. But we know little about the sounds.

To explore, Latha Ganesan and her team from the National Institute of Ocean Technology, Chennai, recorded ambient sounds in the Kongsfjorden using IndArc, an indigenous underwater multisensor mooring system, jointly developed by the National Institute of Ocean Technology and the National Centre for Polar and Ocean Research.

The team placed an omnidirectional hydrophone with a data acquisition module at a depth of 30 metres in the fjord. From July 2015 to April 2016, they recorded 2240 data sets of sounds, which they analysed by segmenting the recordings into smaller portions to identify various sound sources and their spectra.

The researchers were surprised to find that the sounds varied with sea-ice concentration in different seasons. The sounds of leaking air bubbles from melting ice, in the frequency of 1–3 kiloHertz, have higher intensity than background noise in summer.

Wind flow is another feature in the soundscape. Comparing it with hourly average wind speed data, they determined that wind-generated sounds, ranging from 0.5 to 2 kiloHertz were recorded throughout the period, with a maximum in summer. These sounds had an inverse relationship with sea-ice concentration. Sea-ice shields the sea surface and reduces wind-generated sound.

Kongsfjorden is an important breeding site for ice-dependent marine species such as walrus and bearded seals. The researchers recorded two biological sounds ranging from 0.2 to 4 kiloHertz – knocking and tapping sequences generated by walrus and the trilling vocalisations

produced by bearded seals. Walrus sounds were recorded in the breeding season, between January and April.

Using an automatic identification system of marine traffic networks, the researchers collected ship traffic data. High marine traffic during summer generated sounds at low-frequency ranges, below 0.7 kiloHertz.

We now have baseline information that might help us understand the dynamics of sea-ice boundary conditions, sea-ice coverage and the development of biological ecosystems.

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### Rare-earth Elements *Distribution in Singhbhum*

Lanthanides are metallic elements with atomic numbers between 57 and 71. Though these elements have diverse applications, their occurrence on earth is rare and limited.



Image: Peggy Greb via Wikimedia Commons

Rare-earth elements are usually associated with uranium mineralisation. And the Singhbhum Thrust Belt in Bihar is known for uranium mineralisation. But what is the concentration of rare-earths there?

Recently, scientists from the Bhabha Atomic Research Centre looked into the matter. From various locations in the belt, they collected nearly a kilo of samples.

Less than 100 milligrams of the samples from each location was bombarded with neutrons to make them radioactive. The energy of gamma rays emitted from the radioactive nucleons helped quantify the elements.

The concentrations of cerium and lanthanum were higher than those of

samarium, ytterbium and europium. Terbium and lutetium concentrations were even lower. The Singhbhum Thrust Belt thus has low to moderate concentrations of rare-earth elements.

Last year, China was the largest producer of rare-earths with 132,000 metric tonnes. However, India, with almost 35% of the world's sources of rare-earths, produced only 3000 metric tonnes – far below its potential. The results of this research provide an incentive to exploit the rare-earth elements in the Singhbhum Thrust Belt at an industrial scale.

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### Decontaminate Crude Oil Sites *Best plants for remediation*

Crude oil contributes to over a third of the world's energy consumption. However, oil spills contaminate soil. Decontaminating by chemical and physical methods is expensive. Phytoremediation, though slower, is cost-effective and environment-friendly.

The success of phytoremediation depends on the type of plants used. Which are the native plants that can help bioremediate oil spills?

Tridip Boruah, Paramita Chakravarty and Hemen Deka from Gauhati University explored abandoned and active oil drilling sites at Lakowa oil field, Assam. As control, they also chose a site where oil exploration activities were not evident.

They divided each site into twenty quadrats and recorded the plant species. They identified nearly seventy plant species belonging to twenty families from the sites.

Cyperaceae, a grass-like family, and Poaceae, grass family, were dominant. This could be attributed to their fibrous roots that spread horizontally to a larger area.

Next, the team examined the methanolic extracts of six most dominant plants. Plants growing at contaminated sites exhibited higher free radical scavenging than those at control sites. Highest antioxidant defence

was exhibited by coco-grass, *Cyperus rotundus*.

Scavenging activity for hydrogen peroxide revealed that carrot grass, *Parthenium hysterophorus*, has a strong defense mechanism to survive the stress of oil contamination.

Extracts from other plants in contaminated sites also had higher antioxidant defense against free radicals.

'Plants best suited for phytoremediation include Torenia and Bhringraj. These plants are used in ayurveda for gonorrhoea and hair health,' says Tridip Boruah.

'Other capable plants for phytoremediation are croton, coco-grass and carrot grass – plants traditionally used for curing gastro-intestinal diseases and malaria,' says Paramita Chakravarty.

'However, we have to rule out any bioaccumulation of any toxins in these plants growing in oil contaminated sites before they are used,' cautions Hemen Deka, Gauhati University.

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### Long Non-coding RNAs Against fungal infection

Grapes are great to eat but the plant, *Vitis vinifera*, is susceptible to the fungal pathogen, *Botrytis cinerea*. The fungus causes gray mould disease. The rot damages vineyard production severely. Chemical treatments are heavy on the pocket and harm the environment.



Image: Edwin via Wikimedia Commons

Instead of trying to attack the fungus, what if we improve plant defences, wondered Garima Bhatia, Panjab University.

With her mentor, Kashmir Singh, she has been studying long non-coding RNAs and how they regulate the expression of microRNAs and

genes in plants. Now, they teamed up with Santosh K. Upadhyay to study the grape long non-coding RNAs and their response to *B. cinerea* infection.

The group had already identified these RNAs and some coding sequences of grapes. When long non-coding RNAs and coding sequences co-express, they may be involved in similar functions. So, the researchers annotated the functions of these sequences using bioinformatics tools.

The sequences, they found, expressed basal defence response genes such as those for stilbene production and the scavenging of reactive oxygen species.

Do the long and short non-coding RNAs interact in response to the fungal attack?

They found that the long non-coding RNAs act as targets and as endogenous target mimics that help regulate certain micro RNAs. The researchers suggest that these long non-coding RNAs can be used for regulating *Botrytis cinerea*-induced defence response in grapes. Hope on the horizon for grape growers!

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### Endophyte Priming of Seeds For better growth of rice

Endophytes are microbes that grow inside various plant tissues. Most of these microbes are not infectious but have a symbiotic relationship with the plants. Some endophytes help growth and reproduction while some others help ward off pathogens and pests.

Rice seeds harbour a varied range of endophytes in different cultivars. Can seed-transmitted endophytes increase the growth indices of rice?

The question prompted a group of researchers from the Indian Institute of Technology Kharagpur to investigate. The team collected the mature seeds of two aromatic rice cultivars – Kalonunia and Dehradun Basmati. They sterilised and cultured the seeds in suitable media to grow the callus – an unorganised mass of cell growth. Some calli grew roots and shoots.

The researchers then isolated the seed-transmitted endophytic bacteria from the *in vitro* grown rice tissues by

grinding them and spreading the extracts on different bacterial media. Bacteria could be isolated only from calli.

The team could identify nine types of endophytes from the two aromatic rice cultivars. Of these, they found eight to be gram-negative, rod-shaped, and one to be a gram-positive cocci-shaped bacteria. Molecular screening of the nine isolates showed that they belonged to four genera: *Methylrubrum*, *Pseudomonas*, *Micrococcus* and *Methylobacterium*.

The researchers employed a battery of tests and found that the endophytes enhance nitrogen fixation and ammonia and siderophore production in the two cultivars.

Can endophytes of one variety be used to prime another type for better harvest?

The team used all the nine endophyte isolates for seed priming. Besides the seeds of the two aromatic cultivars, they primed the seeds of widely grown normal rice cultivar, IR64.

'Compared to unprimed control seeds, the primed seeds grew better – there was a notable increase in biomass in primed seeds in all three cultivars,' says Anagha Krishnamoorthy, IIT Kharagpur.



Image: Vespertunes via Wikimedia Commons

Then, the team compared *Pseudomonas fluorescens*, an established microbe used for priming seeds of IR64 rice, with the nine endophyte primed seedlings. After a fortnight, all primed seeds had a similar improvement in growth indices.

'We did microscopic analysis of the root tissues. In all cultivars primed with all four species of endophytes, we found an increase in both cell number and cell growth,' says Adin-punya Mitra, IIT Kharagpur.

The IR64 cultivar primed with the four bacterial endophytes showed an increase in plant height, chlorophyll content, flowering time and grain estimates. Metabolic profiling revealed an abundance of different metabolites in the IR64 rice grown after seed priming.

'Our findings suggest that seed priming with endophytes may have beneficial effects on rice productivity,' says Tapas Kumar Maiti, IIT Kharagpur.

Are seed companies listening?

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### Prettify Clownfish

By feeding oleoresins

Brightly coloured fish in an aquarium are a pleasure to watch. However, the colour tends to fade in captivity.

Fish do not synthesise pigments. They use pigments available in feed. So, aquarists use synthetic additives to keep colour intact. But the additives can harm fish: they interfere with physiological processes. Can natural pigments in feed enhance fish colour?

Researchers from the CMFRI and the CIFT, Kochi teamed up to try oleoresins. This mixture of plant resins and oils imparts colour and flavour to foods.



Image: Nick Hobgood via Wikimedia Commons

For the experiments, the team selected clownfish, *Amphiprion ocellaris*, a popular aquarium fish. They prepared feed with proteins, lipids and a vitamin mix. To this, they added oleoresins from paprika, turmeric and chlorophyll, individually as well as in combination, in equal proportions. Fish feed without pigment was used as control. The researchers fed groups of fish five different feeds.

After two months, they analysed fish skin colour intensity. Red and yellow hues were higher in paprika-

fed fish. But was the change in hue and brightness due to an increase in carotenoids or due to the oleoresins?

The team extracted carotenoids from fish tissue and measured the content. The highest carotenoid content was in fish fed with paprika and oleoresins.

Though the digestive profile was normal in all the groups, growth and physiological indices increased with paprika and oleoresin combo feeds.

Fish feed with oleoresins and paprika can safely be used by aquarium enthusiasts to retain colour, claims the team.

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### Wood Boring Mechanics

Mandibles of beetle larva

The larvae of the beetle, *Xylotrechus quadripes*, though small, wreak havoc in large coffee plantations. The soft larvae easily bore through tough wood. How do they do this without damaging their mandibles?

Recently, researchers from IISc Bengaluru teamed up with researchers from Italy to study these insect samurais.

Under scanning electron microscopy, the mandibles, with sharp tips and thick bases, resembled scalpel blades. The shape is optimal to tunnel through wood layers.

The structural spectra of the tip revealed a structure that would make material scientists jealous. The tips are enriched with zinc infused in a chitin matrix, increasing the hardness and durability of the blades.

Three dimensional images showed hollow cone-like structures in the mandibles.

To understand the mechanical activity of the mandibles, the team input all the structural results into a structural model and obtained a force-depth curve of the stress force. The curve showed that the mandible has a hardness gradient. Implying that, during mechanical activity, stress forces redistribute. The tip bears the brunt of the force and the hollow region helps absorb this load.

Actuator and abductor muscles, attached to the cuticle, help rotate the mandible and generate force. The shape of the mandibles amplifies

the force from the muscles through a lever effect.

The researchers created a mechanical model of the mandible to see the tools in action. They were surprised to find that the mandible worked like an upgraded nano-chainsaw.

Could this research on the wood borer larvae inspire the designing of new tools for medical engineering?

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### Coriander for Diabetes

Relief from neuropathy

Almost 20% of diabetics suffer from diabetic neuropathy – nerve damage caused by reactive oxygen species. Antioxidants can help reduce oxidative damages. Rich in antioxidants, coriander seeds could perhaps do the trick.

So Anu Kajal and Randhir Singh from the Maharishi Markandeshwar University, Haryana, decided to investigate. They used streptozotocin to make rats diabetic.

After confirming the onset of diabetic neuropathy, the researchers measured fasting serum glucose. It was higher in diabetic rats than control, as expected.

Three groups of diabetic rats were treated with different doses of hydro-alcoholic extracts of coriander seeds. Feeding coriander extracts, at a dose of 400 milligrams per kilogram, increased serum insulin levels.

The research duo then analysed antioxidant and free radical levels in the groups. In diabetic rats, nitric oxide levels were high and antioxidant levels were low. Treatment with coriander extracts decreased levels of radicals in diabetic rats.

When treated with gabapentin, a drug that relieves nerve pain, the diabetic group did not show any increased antioxidant production.

The team also checked for advanced glycation end products – proteins or lipids that increase glucose in blood. Diabetic rats showed rise in advanced glycation end product concentrations. In rats treated with coriander extracts, however, the levels were controlled. The effect was lower in rats treated with gabapentin.

But do coriander extracts relieve neuropathic pain? The researchers applied mechanical and thermal stress to the rats to record pain thresholds. The diabetic rats were more sensitive to pain. With coriander extracts, their ability to withstand pain improved.

After 90 days, the researchers removed the sciatic nerve, a nerve connecting spinal cord to toes, and measured the tumour necrosis factor, responsible for nerve hyper-excitability in neuropathy.

The tumour necrosis factor alpha was higher in diabetic rats than in the control group. But coriander extracts reduced the levels. Treatment with 400 milligrams per kilogram was most effective. This could perhaps be attributed to flavonoids in coriander seeds, say the researchers.

Sciatic nerve images showed that diabetic rats had swollen axons. The axons showed partial separation from myelinated nerve fibres. Treatment with coriander extracts not only reduced the axon swelling but also regenerated the myelinated fibres.

'So coriander seeds in food may help reduce the chances of developing neuropathy,' says Anu Kajal.

'Of course, we need more research on the active components before we can relieve diabetic neuropathy in humans,' says Randhir Singh, her colleague.

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### Soupomatics

#### Optimising soup mix recipes

Ready-to-eat soup mixes are in demand. Getting a uniform ideal combination for mass production is, however, a challenge. Changes in the nutritional quality of the raw material during processing, the chemistry of mixing ingredients, the physics of viscosity and the texture of the soup and the senses that savour the consistency, flavour and taste – all determine the success of a soup mix.

So when I. H. Mondal and colleagues from IIT Guwahati decided to create soups based on cheap locally

available green leafy vegetables, they had to develop the mathematics behind an ideal soup formulation.

They selected leaves of water spinach, bottle gourd and pui, as starting point. During drying, properties may change – for the better or for the worse. So the researchers evaluated those factors first.

Then it was a question of ratios of cornflour and the other ingredients. Experts evaluated four different vegetable to cornflour ratios and combinations with powders of the three leaves. They rated the soups for appearance, texture, taste, flavour, consistency, mouth feel and after feel on a 9-point hedonic scale.

From the results, they evolved the recipe for a soup that most will like: boil 400 millilitres of water; add half a gram each of water spinach, ginger, onion, garlic powder and black pepper; mix it with 5 grams cornflour, 3.75 grams bottle gourd leaf powder and 0.75 grams pui powder; now add one gram milk powder, three grams salt and two grams carrot flakes. Drizzle two millilitres vegetable oil at the end, and you can sip the delicious soup.

Bottle gourd leaves, the researchers found, are a major contributor to the favourable attributes of the soup.

The work that they put in will be valuable to food industries, especially those in the North-East.

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### Iron-rich Snack

#### Ready-to-eat

Anaemia is a pressing problem in India. How can we make tasty and nutritious snacks to counter the problem, wondered Shweta Suri from the Govind Ballabh Pant University of Agriculture and Technology, Uttarakhand. With colleagues, she decided to optimise extrusion technology to make iron-rich snacks.

Extrusion technology is a 'high-temperature short-time' technique, where ingredients are forced through a temperature-controlled barrel. The process reduces microbial contamination but retains nutrients.

To prepare the snacks, the team used nutritious raw ingredients: barnyard millet, defatted soy flour and amla. Barnyard millet is rich in protein, fibre and iron. Defatted soy is a proteinaceous extract. And amla is a good vitamin C source. It enhances iron absorption and taste.

The researchers varied barrel temperature, amla content and the millet-soy flour blend ratio to test how these variables influenced the product's characteristics. Bulk density decreased and puffiness increased with increase in barrel temperature. This, the scientists say, may be due to enhanced bubble formation and low viscosity at higher temperatures.

Bulk density increased with increase in blend ratio. This could be due to high fibre and protein in millets, aiding starch gelatinisation, say the researchers.

Higher temperature and amla led to a crispier and darker extrudate.

Iron, the target nutritional component, was highest in the extrudate with the highest millet and amla content. Amla contributed to ascorbic acid content. And higher millet and barrel temperature retained ascorbic acid in the extrudate.

As expected, protein content was highest for the blend ratio with highest relative soy content. Increase in barrel temperature did not result in protein loss.

The best qualities emerged at a barrel temperature of 115°C, a 6:1 blend ratio, and 12 grams per 100 grams amla. The optimised product contained 16% iron, 19% protein and 31% ascorbic acid.

Food industries could use this optimised process to reduce nutritional anaemia in the country.

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