Science Last Fortnight

Phosphorus in River Basins

Too much of a good thing

Carbon based life is dependent on phosphorous. Every nucleotide in your genetic code requires one phosphorus atom. Though the amount in the biomass is small, the role that phosphorus plays in life on earth is huge. And farmers recognize this more than most scientists do. They know that it is a primary input to the soil, to increase productivity.

But from farm to rivulets and rivers in the rainy season, phosphorus travels into river basins. In the recent issue of *Nature Geoscience*, Stephen M. Powers *et al.* present the results of their study of phosphorous fluxes in three river basins in three continents over a few decades. They report that 'human-dominated river basins may undergo a prolonged but finite accumulation phase when phosphorus inputs exceed agricultural demand, and this accumulated phosphorus may continue to mobilize long after inputs decline.'

India is a country of rivers. And in terms of human populations, India is second only to China. A system for monitoring phosphorus in Indian rivers can now be easily executed given the development of nano biosensors of various kinds.

Nature Geoscience, **9**, 353–356 (2016)

Nanocracks and Megacracks

Keeping hydrated is good for health

The recent issue of *Nature* carries a report that says 'Water content in hydrocarbon polymer membranes is regulated through nanometre-scale cracks ("nanocracks") in a hydrophobic surface coating'. Now that is a very useful insight for those who are into nano technologies. Hydrocarbon fuel cells can be made to work at temperatures where, earlier, they would not have worked efficiently.

But what is useful is not necessarily very interesting. Unless it is juxtaposed with a contrast. A report in *Nature Geoscience* talks about mega cracks: the faults. G. Bayrakci *et al*. report that 'seawater reaches the mantle only when the faults are active'. The cracks in the crust control the global flux of seawater into the Earth.

Nature, **532**, 480–483 (28 April 2016)
Nature Geoscience, **9**, 384–388 (2016)

Waking up Sleepy Heads

Do fish sleep? How do we know?

A report in the recent issue of *Science* suggests that slow waves and REM signals from the brain are good indicators. And they have managed to measure these waves in adult Pogona dragons[1]. These signals were thought to be the exclusive rights of birds and mammals. Now that Pogona dragons sleep and dream, we could try and push the boundaries further. Do fish sleep?

Of course, they do, implies another paper in the same issue of the journal. Sleep is even more primitive than the nervous system. The ionic oscillations in the extracellular medium control the state dependent patterns of neural activity[2].

Now, the diurnal oscillations in extracellular ions, led perhaps primarily by potassium ions, provide the background drone for our snores.

Do fish sleep?

[1]*Science*, **352**, 590–595 (29 April 2016);
[2]*Science*, **352**, 550–555 (29 April 2016)

Bacteria feed on Uranium!

Uranium is a radioactive element. Radioactive emissions are known to have deleterious effects on living organisms. However, certain bacteria in the subsurface of uranium ore deposits are found to be sequestrating uranium, report researchers from the Department of Biotechnology, IIT Kharagpur and Department of Microbiology, University of Kalyani, West Bengal. Sequestration is a technique used to capture a compound through a stream of various other compounds. And the bacteria in uranium-rich rocks seem to be adept at this.

The researchers isolated fourteen distinct genera of bacteria from subsurface uranium ore. *Arthrobacter*, *Microbacterium*, *Acinetobacter* and *Stenotrophomonas* were in abundance. Some of these were found to be resistant to various heavy metals, including uranium.

Microbacterium was a dominant isolate in uranium-rich rocks. The study showed that test bacteria could remove more than 50 mg U g^{-1} dry weight from 80 mg U L^{-1} uranium within 48 hours.

High resolution transmission electron microscopy of cells exposed to uranium showed that uranium was mostly sequestered around the cell periphery.

It is expected that quite soon these microorganisms will assist us in the bioremediation of radiation-affected areas. Radioactive sites can be decontaminated using bacteria indigenous to uranium ore deposits. The bacteria may also find use in dealing with radiological waste from nuclear power plants, industrial units, research and medical units.

Ecotoxicology and Environmental Safety, **127** (12–21 May 2016)

Safer Water with Watermelon Shell

Copper is a toxic metal, which adversely affects the biotic component of our eco system. Efficient removal of copper from water has been an unsolved problem. But now, researchers in the Institute of Chemical Technology, Mumbai, say that watermelon shells can resolve this issue.

Researchers activated watermelon shells with calcium hydroxide and citric acid. The product was capable of removing copper from its aqueous solution, claim researchers.

Using ultrasound, they were able to increase the adsorption rate of copper – ultrasound reduces time from 60 minutes to 20 minutes, for a given solution. An optimum pH value of 5 favours a higher adsorption rate. Maximum adsorption capacity was found to be 31.25 mg/g for watermelon shells treated with calcium hydroxide. While for watermelon treated with citric acid it was 27.027 mg/g.

Watermelon is an eco-friendly, economical, natural product that offers highly efficient biosorption. The rind of the watermelon is usually thrown away. Thus, the raw material is available in plenty in summer when water scarcity becomes a big problem.

Ultrasonics Sonochemistry, **30**, 113–122 (May 2016)

Macro-ecological Patterns

Rapid biodiversity assessment

Many biodiversity-rich areas in the hot and humid northeast of India remain as yet unexplored. Lack of data has often been a barrier to effective planning and implementation of conservation actions. Researchers from the Department of Zoology, Tripura University, propose Rapid Biodiversity Assessment (RBA) as a good tool to predict species richness, utilizing faunal indicator taxa.

Insect diversity, which represents a major proportion of the faunal diversity of tropical forests, can be utilized for rapid assessment because they are widespread, taxonomically well-known and effective indicators of forest health. They also serve as surrogate index for biodiversity since they are highly dependent on plant diversity.

Researchers in Tripura considered the high diversity of butterflies in the northeastern states as a reflection of the floral and faunal richness of this biogeographical region. And they used butterflies as indicator taxa to estimate species richness and diversity.

They tested the assumption in the Rowa Wildlife Sanctuary, the heart of the Indo-Burmese hotspot. This wildlife sanctuary is marked by the richness of forest types with narrow and wide canopies. They checked the species richness and diversity in three habitat types of the sanctuary: regenerated secondary forest, a botanical garden and bamboo bush. And they found that the abundance of butterfly species in the habitat is indeed directly related to the availability of larval host plants and adult nectar sources.

They could collect and identify butterflies representing 53 species from 5 families in the region. Seven among them are listed in the threatened category in south Asia. The study also reported eight new species of butterflies in the state.

The biodiversity hotspots in the Himalayan region resist comprehensive studies on biodiversity richness due to widely varying altitudes and difficult terrain. The study showed that a short duration systematic assessment of biodiversity in a wildlife area is a cost and time effective method of exploring the biodiversity of tropical habitats.

Tropical Ecology, **57**(2), 231–242 (2016)

Biofuel using Fungus

In India, petrol-driven vehicles often use a combination of petrol and ethanol for various reasons. The source of ethanol is primarily cellulose. Montmorillonite K-10/LiOH solution is used to isolate cellulose from plant sources. Cellulose is then converted to glucose by using acid hydrolysis. Glucose is a sustainable source of sugar that can be readily fermented to ethanol.

The North East Institute of Science & Technology, Jorhat, Assam used an eco-friendly process – a novel fungal strain of *Myrothecium gramineum* to obtain bioethanol. The *M. gramineum* strain was isolated from the acacia plant.

They extracted cellulose from rice husk using *M. gramineum*. The study revealed that cellulose, glucose and bioethanol yields were at 68%, 60% and 25%, respectively.

Analysis techniques like FT-IR, GC, etc. were used to characterize the synthesized cellulose, glucose and ethanol. Bioethanol obtained from this process was comparable to laboratory ethanol and the ethanol obtained from *Aspergillus niger*, another microbe.

Researchers say that rice husk is a good source of bioethanol.

Carbohydrate Polymers, **14**, 20–27 (5 May 2016)

Another Case for Open Access?

While the number of open journals is increasing, while the lobby for open access to public funded research is increasing its pitch, there are still die-hard journals that turn a blind eye to the writing on the wall.

Researchers in India at least, cannot afford to pay in dollars for each paper they read. So a Facebook page became quite a hit with many young Indians. If you can get hold of a research paper that you want desperately, all you have to do is to ask in the Facebook group. Some Good Samaritan from somewhere will send you the PDF file.

But what if you don't want to sign in to Facebook? What if you are the stereotypical, socially awkward, scientist, too shy to interact even on Facebook? You would perhaps go to Sci-Hub.

Sci-Hub has become so popular that the number of users is expanding more rapidly than that of Facebook.

If you want to know the inside story, the gossip behind pirated PDF copies of scientific papers that are being downloaded every day, you may need to read the recent issue of *Science*. An editorial and two feature articles will give you the inside stories of a young woman taking on scientific publishers. Surprisingly, it seems that even those who can get hold of the papers from legal sources seem to prefer downloading it from Sci-Hub.

Downloading movies and serials from torrents had hurt the entertainment industries badly. The music industry too had to restructure itself to survive. Now perhaps it is the turn of scientific publishers. Will they be able to withstand the drop in revenue for long? Will they evolve a pricing strategy that allows scientists from the developing world access to information without jeopardizing their livelihoods? Time will tell.

ACKNOWLEDGEMENT. Science Media Centre, IISER Pune for providing access to databases and journals.

Reports by Manish Kumar Tekam, Kshitij Singh, K. P. Madhu and Gita Madhu.
scienceandmediaworkshops@gmail.com