June 2014

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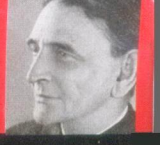

Science Reporter

A CSIR Publication

Water Footprint

Reduce the Impact!

- Pulicat & Vellayani lakes under threat
- Persistent Organic Pollutants
- Fuel of the future
- Energy from mounds of waste
- Climate change & diseases in crops
- Environmental challenges for animals

Environment Special

Also in the issue
- Fiction
- Puzzles & Quizzes
- Crossword

CSIR-NISCAIR Announces a Five-Day Course

Science Communication Through Print Media

Course dates:

13-17 October 2014

Course venue:

NISCAIR, 14, Satsang Vihar Marg, New Delhi - 110067

Course contents:

- Science popularization in India
- Basics of popular writing for magazines and newspapers
- Basics of research communication
- Creation of information resources, e.g. encyclopedic publications
- Publishing and Copyright
- Use of modern IT tools in science communication
- Role of graphic arts in popular science communication
- Production of S&T publications

Course fee:

Participants from	Without accommodation	With accommodation
India	Rs. 4000/-	Rs. 5200/-
SAARC Countries	US $ 200	US $ 260
Other Countries	US $ 300	US $ 360

Target audience:

The course is aimed at aspiring science writers/communicators, scientists, public relations professionals in scientific and R&D establishments involved in writing/communicating about science, etc.

For more details, contact:

In-charge, Training

National Institute of Science Communication and Information Resources (NISCAIR)

14-Satsang Vihar Marg, New Delhi - 110067

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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

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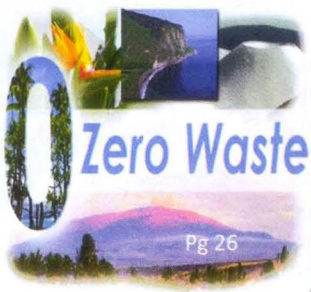

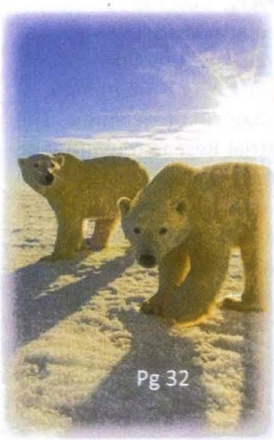

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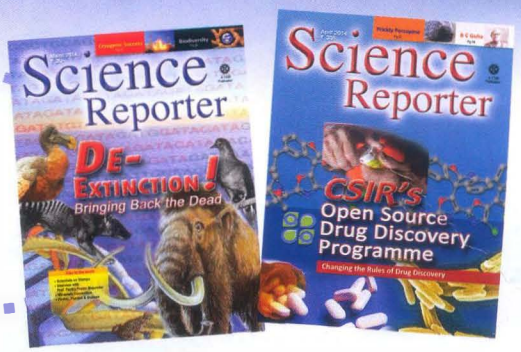
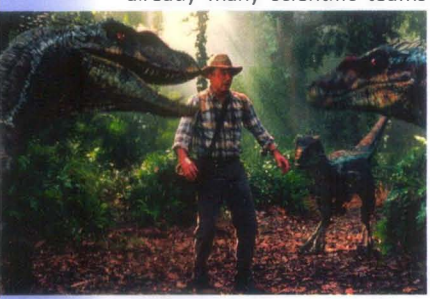


Ethical to Bring Back the Dead?

The author has indeed brought up the fascinating topic of "de-extinction" in a wonderful manner in the cover story of the March 2014 issue (**De-extinction – Resurrecting Lost Species**). The science and the technology behind the concept may be fine. There are already many scientific teams



around the world working on this technology as the article informed us.

But the question is one of moral and ethical issues. Is it right to bring back the dead and the extinct in an age and in an environment where we are not very sure they will be able to survive? This is the question that we need to ponder upon.

Mohd. Salim
Kanpur

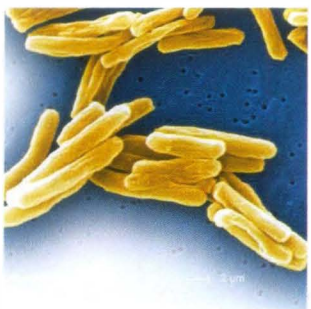
Proud Success in Space

The article on India's successful launch of GSLV-D5 riding on an indigenously built cryogenic engine made one proud (March, India's Firm Strides in Space). Reading about the story of the problems that the Indian cryogenic engine programme encountered at every turn made me sad. But at the same time despite all the odds the triumph of the country's space scientists made me very proud. I think India's space programme is one of the few endeavours that have made their mark in the entire world. The Indian space programme has made us self-reliant and a technological power too. Hats off to our space scientists.

Kartik Subramaniam
Bangalore

Educative Information

The April issue of *Science Reporter* gave a lot of educative information regarding drug



discovery, novel drugs against neglected diseases such as tuberculosis, the Open Source Drug Discovery programme of the Council of Scientific and Industrial Research (CSIR), and several other topics. So, one can easily say that Science Reporter keeps pace with the changing scientific world.

Kudos to writers, contributors and the editorial team of the magazine.

A.S.R. Murthy
Devarakonda,
Andhra Pradesh

Innovative Drug Discovery

The April issue devoted to the Open Source Drug Discovery programme of CSIR was an eye-opener. It came as a surprise to know that multinational drug companies round the world are not interested in diseases like tuberculosis that predominantly plague the developing world. As the cover story informs, "No new drugs have been discovered for TB over several decades, as TB is perceived as a disease of the poor and there is no return of investment for pharmaceutical companies to invest in it."

In this context, it is appreciable that the CSIR has taken this step of developing drugs for neglected diseases in an open sharing paradigm not restricted by intellectual property and patents. The developing world should look for such innovative solutions for problems that are primarily theirs.

Ramesh S.
Warangal, A.P.

Food Packaging

Ms Kirti Bansal, in her write-up **Food Packaging Injurious to Health** pointed out the harmful effects of the chemicals used in food packaging. It described what negative impacts these chemicals can have on one's

health if such packaged foods are consumed.

But the demand for packaged foods has tremendously increased in recent times and would never stop as all foods cannot be prepared fresh at home. So, one has to depend on packaged foods some times. As an alternative to this problem, chemists can think of using hygienic, less injurious and less reactive chemicals in food packaging. Otherwise, it would be very hard to maintain food safety with the existing chemicals used in food packaging.

Bibhash Deva Nath, Assam

HAVE YOUR SAY

If you feel strongly about any article or write-up published in *Science Reporter*, have any scientific information to share with readers, any comment or opinion on any scientific issue or any suggestions, please write to us at the following address:

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National Institute of Science Communication and Information Resources (NISCAIR)
Council of Scientific and Industrial Research (CSIR)
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New Delhi-110012

Or simply send an e-mail at **sr@niscair.res.in**. We will make your views and opinions known more widely among our readers through this column.

Science Reporter

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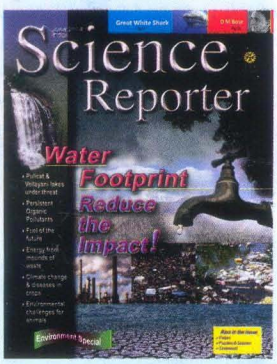

COVER DESIGN
NEERU SHARMA

WATER WOES – SET TO INTENSIFY

This year, in February itself, when officially it was not yet summer, the Kerala Water Authority (KWA) admitted that it would not be able to meet the water needs of Kochi and its suburbs.

In Karnataka, experts say the state's reservoirs have depleted, with 93% of the lakes and tanks having dried up. This has raised fears of a looming drinking water crisis. Even parts of Shimoga and Chikmagalur, which are among the districts that receive the highest annual rainfall, are starved of water this summer.

Meanwhile, acute water shortage has hit about 48 seaside villages of the Kendrapada district in Odisha. Many tubewells are not working and so villagers are forced to use contaminated water from ponds, rivers and other water sources. News of drinking water crises is also trickling in from other parts of the country such as Madurai, Lucknow and even Imphal where major rivers and water project sites are drying up owing to scanty rainfall.

The water crisis and the consequent misery and conflicts over availability of drinking water are becoming all to frequent in the country. These events peak around the summers every year and are becoming more pronounced with each passing year. One reads about women and girls having to trudge several kilometres daily to fetch small quantities of water. Scenes of ugly fights around water tankers supplying drinking water and municipal taps are all too common. When often even posh localities in cities are forced to depend on tankers to meet their daily quota of water, one can imagine the pitiable state of the poorer and underprivileged communities. The portents for the future are ominous.

According to the 2030 Water Resources Group, demand for water in India is set to outstrip supply by 50% by 2030. In fact, according to a report, ***Business Case for Water Disclosure in India****, brought out by a not-for-profit NGO Carbon Disclosure Project (CDP) based in the United Kingdom, India could become a water-scarce country by 2020. The water crisis in India is set to worsen in the coming years with rapid population growth, mass industrializatio*
says the report. Coupled with the uncertainties of climate change the situation could further worsen.

Another report, ***Water in India: Situation and Prospects****, brought out by UNICEF and Food and Agriculture Organisation, says that India needs to formulate new indices to measure available water resources as the calculations per capita water availability do not include disparity in water allocation and access. This disparity is identified as a major determining factor for water access and use. India's Planning Commission also last year established that the country's existing approach to water jeopardizes its economic growth and political stability. It recommended a paradigm shift in the management of water resources.*

There is much that needs to be done to salvage safe drinking water for the vast majority of the population in this country. These include nurturing of fresh water bodies in and around villages and cities and checking pollution of these resources, making industries more responsible for treating waste water, improving sanitation as it impacts water quality profoundly, and, above all, making water harvesting and optimal use of water a culture.

As the UNICEF and FAO report says, "The focus has to be to evolve an environment where water is available for all in a sustainable manner – safe drinking water for basic needs, adequate water for agriculture, and water for industry and for the ecosystem."

Hasan Jawaid Khan ■

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SUPER-SENSITIVE INSTRUMENTS GIVE INSIGHT INTO AGEING

Mass spectrometry is a technique that allows researchers to measure the mass of molecules. It can prove if a person was poisoned to death by analyzing blood samples. But it also holds the potential to unlock a host of other mysteries — including those that surround the aging process.

Ann English, a professor in the Department of Chemistry and Biochemistry and executive director of Concordia's Centre for Biological Applications of Mass Spectrometry, is among the researchers who are making major advances in its study. She says: "Understanding how cells age at the molecular level would have a huge impact on society."

The availability of super-sensitive instruments has made it a lot easier to find out what free metal ions like iron and copper do to the proteins they come in contact with in cells. Researchers are now able to quantify changes in protein mass and chemical composition.

"We're very interested in how the proteins are modified in cells, particularly due to metal-induced oxidation, oxidative stress and aging. In more recent years, we've begun to get a really good picture of how proteins are modified with age," says Ann English.

English and her colleagues are probing how the aging process could alter brain cells — and slow them down. As certain proteins aggregate, clumps begin to form, leading neural cells to become less functional.

The research they are producing could change the way we treat diseases like Alzheimer's, Huntington's and Parkinson's.

(Courtesy: Concordia University)

REWARDING COURAGE

The village of Kanalsi is situated in the Jagadhri tehsil, a district of Yamuna Nagar in Haryana, India. It comprises of farmers who rely on sugarcane and Poplar tree cultivation for their livelihood. The chief water source for the villagers here is a perennial river, Thapana, which has a confluence with the Yamuna river system downstream.

Having heard about the conservation efforts of this village from two Trusts (based in the UK and New Delhi), I jumped at the opportunity to carry out a river and biodiversity survey here. I was extremely excited and arrived in Kanalsi on a cold winter night in December 2012.

Over breakfast the next morning, I was informed that the villagers of Kanalsi practised organic farming. Despite the low yield and the process requiring considerable amount of time, they were happy with the technique, and proudly pointed at my plate, "Don't you notice the freshness of the vegetables, Sir? It's from our own field."

I seized this opportunity and asked my first question. "How do you sustain yourself through organic farming in today's rapidly growing and competitive agricultural market"? The answer was a humbling one. "Sir; we are aware that organic farming does not give us as much output as inorganic farming, but we do not want to use chemicals and damage our health."

The next day I explored the conservation work being done at the river. I was pleasantly surprised to see saplings of native trees planted across the field. The village members proudly identified each and every one of them and explained their value to me. "Sir, we have been especially careful in planting only the native trees."

Huge posters were put up across the river informing people of its protection status and requesting them not to carry out any fishing or dumping of pollutants into the river.

I could see the river with its rippled flow shining in the morning sunlight, unlike the state some of our Indian rivers.

The farmers had planted sugarcane on the left bank of the river and Poplar trees on the right. They had maintained a distance of ~25 metres from the river banks, and above all, they practised organic farming. As we progressed, this left over land now grew dense with long grasses and scrubs, forming an impenetrable habitat. "It is our mini-

How Mothers Help Children Explore Right and Wrong

Mothers want their children to grow up to be good people — but how do they actually help their offspring sort out moral issues.

According to a new study published in Developmental Psychology and led by Holly Recchia, assistant professor in Concordia's Department of Education and Centre for Research in Human Development, many mums talk to their kids in ways that help them understand moral missteps.

The study observed 100 pairs of mothers and children aged seven, 11 or 16. Each child was asked to describe one incident where they had helped a friend, and one incident where they had hurt a friend, and subsequently spoke to their mums about the experience.

When referring to their offspring's helpful behaviour, the mothers focused on the children's feelings of pride, expressed enthusiasm at their behaviour, and reflected on how the experience revealed their children's positive traits.

With hurtful behaviour, the conversations were a bit more delicate, in that the mothers found ways to acknowledge the harm while also emphasizing that it didn't define their children. For instance, they focused on the child's good intentions or noted his or her capacity for repair.

The study also shows that the nature of this maternal role develops along with the children, as parents evolve from gentle teachers for youngsters to sounding boards for teenagers. The mothers prompted younger children more often and focused more on the concrete details of the event. In contrast, teenagers took more ownership of the conversations, and the topics themselves also changed.

(Suzanne Bowness; Courtesy: Concordia University)

wetland Sir." Over the course of the survey, I documented 79 species of birds, 7 butterfly species, 5 dragonfly species, 5 mammalian species, 2 reptilian species, and 12 species of fishes. A majority of these were also recorded from this "mini-wetland".

Huge posters were put up across the river informing people of its protection status and requesting them not to carry out any fishing or dumping of pollutants into the river. In fact, as I made sketches and took photographs, I was often stopped by people who first questioned me, and then requested/warned me not to do anything which would damage the ecosystem and the wildlife in anyway.

I was also informed that some villagers upstream of the river applied chemicals to their crops to increase the production. This often troubled the people of Kanalsi. "The chemicals entering into the river upstream would eventually reach our village water too," they said. "Sir; we often raise such issues at the local council meetings. We have also erected hoardings upstream of the river."

As we headed back towards the village, I sincerely hoped that their effort is fruitful in the coming years, as their sheer determination to protect each and every stretch of their precious river and its biodiversity was credible indeed.

(This article is based on the author's experiences during the river and biodiversity survey which he undertook in December 2012, for PEACE Institute Charitable Trust, New Delhi and Thames Rivers Trust, United Kingdom. The full version of this article has been selected for the 'Leader of Tomorrow' 2013 award, St. Gallen Symposium, Switzerland).

Contributed by Nishikant Gupta* and Navneet Singh, Department of Geography, King's College London, Strand, London WC2R 2LS, UK. Address: *Nishikant Gupta, C/o Mrs. Sonal Gupta, Flat no. 404, Swati A2, DSK Akashganga, New D.P. Road, Aundh, Pune-411007, Maharashtra; Email: nishikantgupta@live.in

CLEAN-UP ACT

While cleaning their nests, birds dispose off eggshells and ingest or remove the fecal matter of their nestling. Nests can become home to many other organisms including parasites and pathogens. The excreta of the fledglings also pose a problem.

Fecal sac is a mucous membrane, generally white or clear with a dark end, which surrounds the feces of some species of nestling birds. The nestling usually produces a fecal sac within seconds of being fed; if not, a waiting adult may prod around the nestling's cloaca to stimulate excretion. In most passerines, the adults actively dispose the fecal sac of the young at a distance or consume them. This is believed to help prevent ground predators from detecting nests. Young birds of prey (eagles, kites, buzzards, falcons, vultures and other such birds) however usually void their excreta beyond the rims of their nests.

Some birds have been shown to choose aromatic green plant material for constructing nests that may have insecticidal properties, while others may use materials such as carnivore scat to repel smaller predators. Some birds use pieces of snake slough in their nests to deter some nest predators.

Photo credit: Pavan Patel

The photograph shown here was taken at the Sundarvan Nature Discovery Centre, Ahmedabad. This coppersmith barbet Megalaima haemacephala is coming out from its nest hole with some waste materials in its beak to dispose it away from the nest. This waste removal happened once the feeding of the nestling was over.

Contributed by S. Sivakumar, Centre for Environment Education, Thaltej Tekra, Ahmedabad–380054; Wildlifessiva2050@gmail.com

WHEAT STEM RUST UG99: THREAT TO GLOBAL WHEAT CROPS

Wheat is an important staple food crop for more than 4.5 billion people across the globe, second only to rice as a source of calories (21%) and the major source of protein (20%). However, pest strains such as race Ug99 of the stem rust fungus, *Puccinia graminis*, could pose a threat to wheat crops round the world.

Even the Nobel Laureate Dr. Norman Borlaug warned that wheat rust is a "disease that never sleeps", and hence there is no room for complacency. Eventually, several research projects are underway to mitigate the Ug99 threat, in a coordinated manner, under the umbrella of the Borlaug Global Rust Initiative (http://www.globalrust.org).

The evolution and migration of the Ug99 cluster of races is being carefully monitored to provide early warning in case of a rust epidemic. The Rust Tracker information system was launched in 2008, as part of an array of early warning tools developed to combat the Ug99. Recently large areas of India (North-west plains and Northern Hill zones), Eritrea, and southern Ethiopia, have been put on high alert, after a rust-resistant cultivar suddenly became susceptible in late 2013, eventually leading to localised severe rusts. Early prediction of rust epidemics will help farmers to take up rust management measures like spraying of appropriate fungicides.

These rust races have spread to various wheat-growing countries in the eastern African highlands, as well as Zimbabwe, South Africa, Sudan, Yemen, and Iran. It is also evident that the Ug99 has spread to several other countries in Africa, Asia, and beyond and this spread is either wind-mediated or human-aided.

Recently the stem rust resistant gene "Sr35" was cloned from Triticum monococcum. This gene confers near immunity to the cluster rust races Ug99, and also the group of rust races from Africa, Yemen, and Pakistan. Similarly, another rust resistant gene "Sr33" has been cloned from the wild relative of wheat *Aegilops tauschii*. On the basis of the complementary features of Sr33 and Sr35, it might be beneficial to combine them, either by crossing or genetic engineering of wheat.

The cloning of these novel rust-resistant genes opens the door to the use of genetic engineering strategies to control this devastating disease of wheat and ultimately mitigate the global threat of Ug99.

Contributed by Basavaprabhu L. Patil (blpatil2046@gmail.com), Rohini Sreevathsa, Monika Dalal, Subodh Kumar Sinha, National Research Centre on Plant Biotechnology, Pusa, New Delhi-110012

RESPIRATORY DISORDER: IS IT COPD OR ASTHMA?

Although asthma and chronic obstructive pulmonary disease (COPD) share some properties in common, including cough, shortness of breath, chest tightness, and difficulty emptying air from the lungs, they are different diseases.

While COPD refers to irreversible airflow obstruction associated with abnormal inflammatory response of the lung to noxious particles of gases, asthma is a chronic inflammatory disorder of airways associated with airway hyperresponsiveness leading to wheezing, breathlessness, chest tightness and coughing.

India contributes a significant and growing percentage of COPD mortality, estimated to be amongst the highest in the world. Prevalence of COPD was documented to be around 4.1% (5% males to 3.2% females). Smoking is recognized to be the most important risk factor for COPD. Smokers had three times more risk of developing COPD as compared to the non-smokers. Bidi smokers were at higher risk of developing COPD (8.2%) than their cigarette smoking counterparts (5.9%). Cooking fuel exposure was documented from 2% using LPG to around 5% using kerosene and/or biomass fuels or firewood. Biomass fuels are now considered a major cause of the COPD occurrence and could be the single most common cause of COPD in the world.

Differentiating COPD from Asthma

	COPD	Bronchial Asthma
Smoker or ex-smoker	Most	Possibly
Symptoms under age 35	Rare	Common
Chronic productive cough	Common	Uncommon
Breathlessness	Persistent and progressive	Variable
Waking at night with breathlessness or wheeze	Uncommon	Common
Significant day-to-day variability of symptoms	Uncommon	Common

In India, the total estimated burden of Asthma is an overall prevalence of 3% (30 million patients), and among adults over the age of 15, a median prevalence of 2.4%. Among school children higher prevalence rates have been reported. The risk factors include allergens, infections, environmental pollutants like tobacco smoke, obesity or emotional states. In children under three years of age, viral infections are likely to be the most common trigger. After three years, allergies also begin to play an increasing role as a trigger. After 20 years of age, occupational exposure to toxic substances and allergens also can be important triggers for asthma.

Problems still remain in the diagnosis, management and follow-up of Indian COPD and Asthma patients. Lack of awareness of the disease, its symptoms or implications contribute significantly in preventing people at risk from seeking help. Even when a person with symptoms does present to general practitioners, levels of under-diagnosis are high.

The more worrying aspect of Asthma is that it accounts for about 1 in every 250 deaths worldwide and 90% of these deaths are preventable. Most deaths are due to delay in seeking help and sub-optimal long-term treatment strategies due to the lack of education and awareness about the disease.

The diagnosis of COPD and Asthma can be done through Spirometry, which is a simple, painless breathing test, reducing the burden of world's common respiratory diseases. Inhalation therapy will need to be made available to all patients suffering with COPD.

Contributed by Dr Arpana Vibhuti, Lecturer in Amity University Haryana, Amity Education Valley, Pachgaon, Gurgaon, Haryana 122001, and Prof. S.M. Paul Khurana, Director, Amity Institute of Biotechnology and former Director of the Central Potato Research Institute, Shimla and Vice Chancellor of Rani Durgawati University, Jabalpur

GREEN ENERGY FROM PEDAL AND WIND POWER

Storage batteries of UPS-units and battery-based electric vehicles can be charged using dynamos operated by pedaling-in UPS units and by wind power using dynamo attached miniature wind mills in a moving electric vehicle.

Frequently, situations arise where line supply is not available, for instance, at Army outposts, Police camps, remote and isolated locations, areas where line supply is not available due to natural calamities, etc. Generators use costly and polluting fuels. Uninterrupted Power Supply (UPS) units use storage batteries for back-up power, but for charging these batteries mains supply is needed. Under long hours of load-shedding, even battery back-up fails. A solution could be the use of pedal power.

Generators use costly and polluting fuel

Dynamos can be fitted to the rear wheel axle of bicycle – wheels can be discarded to reduce load. Upon pedaling, the dynamo generates power, which can be used to charge storage batteries via a charger. Since UPS units come with different power outputs, the dynamo capacity has to be tailored to fit the requirement. This way, dependence on mains supply can be avoided.

Similarly, wind from the direction opposite to the direction of motion of a moving vehicle can be utilized to operate a dynamo attached to a wind-mill. The power output of the dynamo can be used to charge storage batteries, which, in turn, can run a dc motor to which wheels are attached. Thus, motive power can be provided to a vehicle on the run. This can be of great help to poor cycle rickshaw or cycle van operators by reducing their physical labour.

Adoption of these simple mechanisms does not involve any sophistication or high cost. Most equipment are available in the market – UPS, battery, cars and bikes etc., hence, no elaborate and expensive manufacturing unit needs to be set up.

Contributed by Dr. Dipak Guha (Ex Faculty, Indian School of Mines, Dhanbad and PhD (IIT–Bombay). Address: 379 B.M. Road, Garia, Kolkata–700084, West Bengal; Email: guha_dipak@rediffmail.com, guha_dipak@yahoo.com

Water

Time to

With awareness of the water footprint of individuals, communities, businesses, and countries perhaps a conscious effort can be put in to change consumption patterns and reduce exploitation of water – the most expensive natural resource but one that may soon leave us high and dry if we do not act urgently.

Blue water lake

WATER is essential for life. Without water neither would plants and animals survive nor would industries thrive. We all know and appreciate these facts.

But do we know that millions around the world trudge miles in search of water? Nearly 1 billion people do not have access to clean drinking water, which is making their families sick? According to the United Nations, water use has grown at more than twice the rate of population increase in the last century. Yet, about one in nine people, lack access to clean drinking water, which kills children at a rate equivalent of a jumbo jet crashing every four hours.

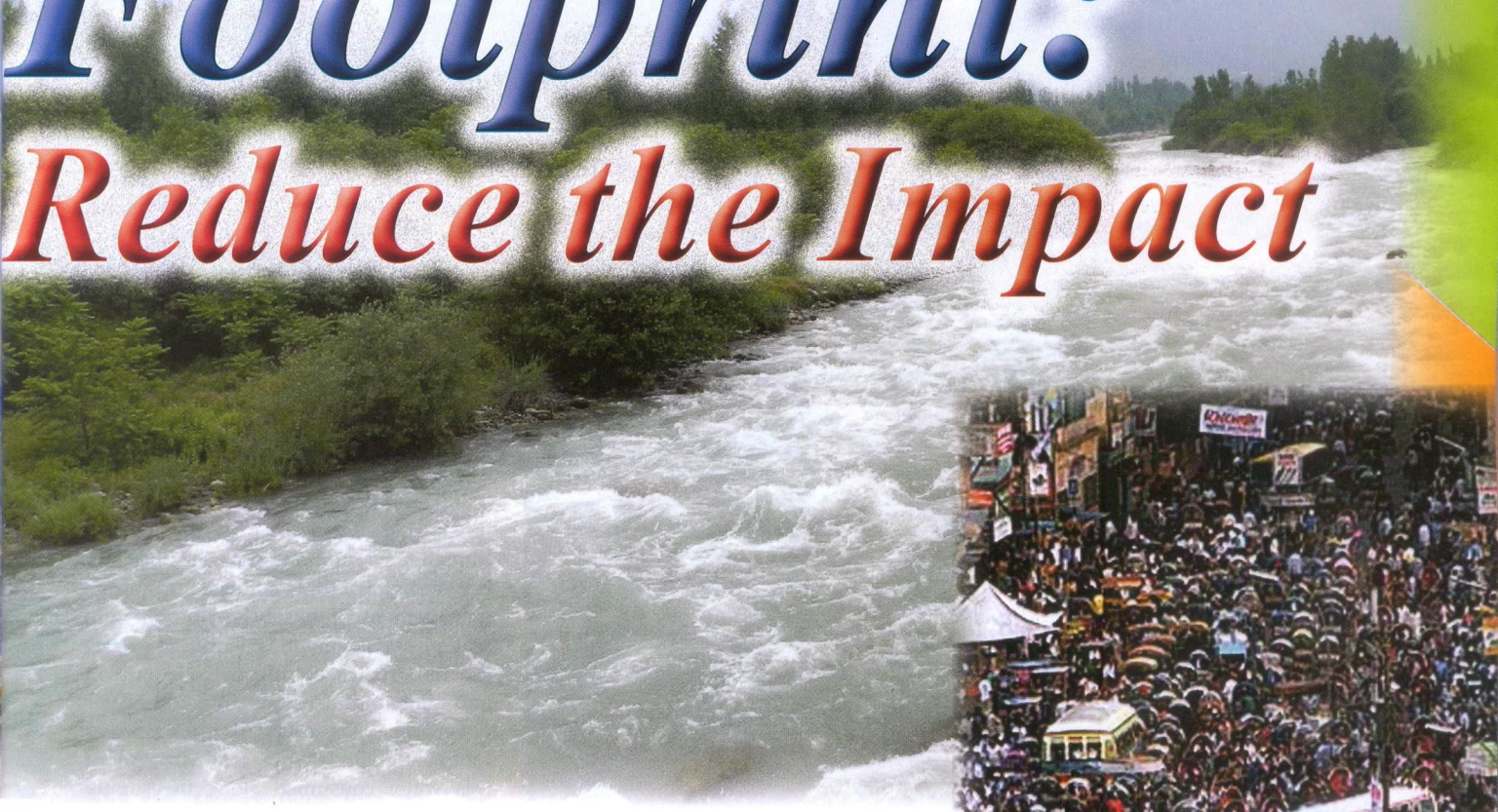
It is estimated that by 2025, an estimated 1.8 billion people will live in areas plagued by water scarcity. Population growth and socioeconomic development are currently driving a rapid increase in water demand, especially from the industrial and household sectors. Industrial water use is predicted to double by 2025 if current growth trends persist.

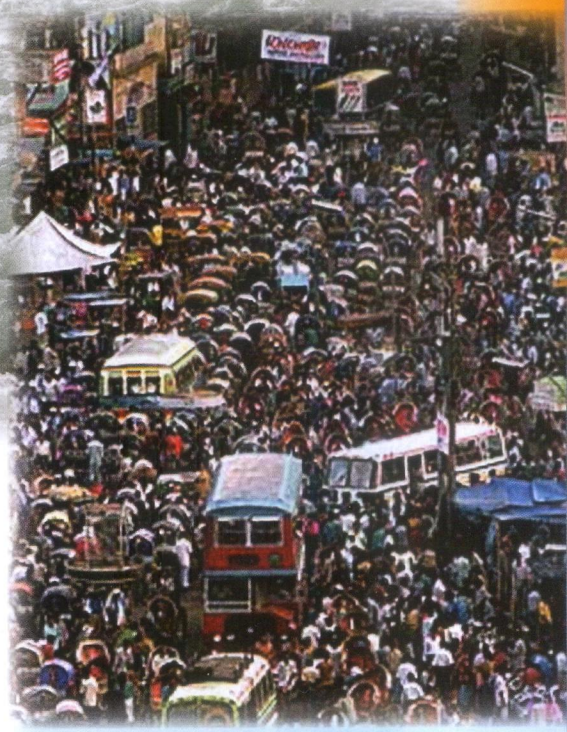
According to a United Nations assessment of freshwater resources, one-third of the world's population lives in countries experiencing moderate to high water stress. Many countries in arid and semi-arid regions of the world (e.g., Central and West Asia, North Africa) are already close to or below the threshold for water scarcity. Environmentalists working in different parts of the world unequivocally claim that up to two-thirds of the world population could experience water scarcity over the next few decades.

Agriculture accounts for about 70% of water consumption worldwide

MONIKA KOUL

Footprint: Reduce the Impact

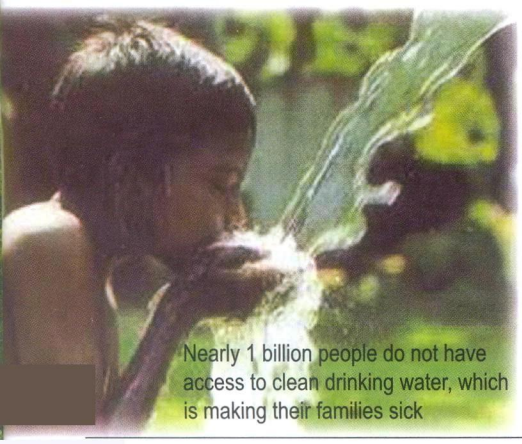




Increasing population is an increasing drain on the planet's water resources

The increasing stress on the planet's water resources is not only due to increasing population load and industrialisation. Increasing income levels have increased the demand for water-intensive products such as meat, sugar and cotton. Pollution of water bodies is further limiting the amount of water available for use. Similarly, changes in precipitation patterns as a result of climate change are adding to the pressures on our global water resources.

The challenge humanity is facing today is how to conserve and manage this important natural resource. The United Nations declared the year 2013 as the International Year for Water Cooperation. Today, the focus all over the world is at developing long-term strategies to tackle the present water crisis. One of the fundamental things one has to look at is reducing the water footprint and getting involved with local and global water conservation and advocacy efforts.



Nearly 1 billion people do not have access to clean drinking water, which is making their families sick

Reduce the water footprint by raising awareness through integrated campaigns of the negative impacts of increasing footprint on environment, and introduction of other incentives such as water-credit schemes to make people change their consumption behaviour.

The Water Footprint

So what is this water footprint and how is it going to help solve the crisis? Many indicators are today being used all across the world to correlate resource consumption in economic terms. United Nations determines each country's ratio of water consumption to water availability, that is, its use-to-resource value as one of the indices for calculating water usage by a country. This indicator has been used for long as a good gauge of overall pressure on water resources. However, not much has been gained in

Pollution of water bodies severely limits the amount of water available for use;

Changing climate patterns are adding pressures on the world's water resources

terms of conservation and management of this important ecological resource using these parameters.

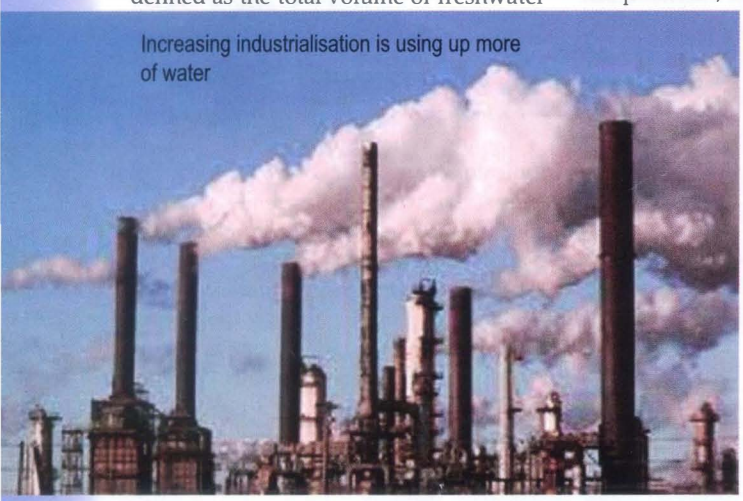
Environmental economists have been working on novel empirical tools and methods to calculate the impact of human activities on this earlier designated infinite ecological resource. Therefore, in the year 2002, the water footprint concept was introduced to have a consumption-based indicator of water use that could provide useful information in addition to the traditional production-sector-based indicators.

Water footprint is a comprehensive measure of freshwater consumption that connects consumptive water use to a certain place, time, and type of water resource. It looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater used to produce the goods and services consumed by the individual or community or produced by the business.

It includes the use of:

- blue water (rivers, lakes, aquifers)
- green water (rainfall in crop growth)
- grey water (water polluted after agricultural, industrial and household use).

Water use is measured in terms of water volumes consumed and/or polluted per unit of time. A water footprint can be calculated for a particular product, for any well-defined group of consumers (for example, an individual, family, village, city, province, state or nation) or producers (for example, a public organization, private enterprise or economic sector). The water footprint is a geographically explicit indicator, showing not only volumes of water use and pollution, but also the locations.



Increasing industrialisation is using up more of water

Environmental economists have been working on novel empirical tools and methods to calculate the impact of human activities on this earlier designated infinite ecological resource.

The concept aims primarily at illustrating the hidden links between human consumption and water use and between global trade and water resources management. It has been brought into water management science to show the importance of human consumption and global dimensions in good water governance. The calculation for a water footprint includes the total amount of freshwater consumed along the supply chain of a product. For instance, the amount of water used for a cotton dress purchased from a retail outlet or a food product from a grocery store.

Water use in agriculture is slated to increase as world food demand rises. Agriculture already accounts for about 70% of water consumption worldwide, and the United Nations projects a 50% to 100% increase in irrigation water by 2025. Agriculture is by far the largest global consumer of freshwater. In this sector, a water footprint measures the volume of evapotranspiration or water use of a crop per unit mass of yield. Comparing water footprints of different management practices in agriculture can help evaluate drought tolerance, water use efficiency, the effective use of rainfall, and the significance of irrigation.

Water footprint values of individuals, nations, and various service sectors such as industry, agriculture and live stock breeding differ in different countries and majorly depend on the lifestyle choices. The total volume of freshwater that is used to produce the goods and services consumed by the people of the nation

Water is a highly subsidized commodity in India. People pay nominal bills for water and hence there is no control over over-exploitation and wastage.

indicates the country's foot print. The water footprint of a nation is an indicator of water use in relation to the consumption volume and pattern of the people.

Since not all goods consumed in one particular country are produced in that country, the water footprint consists of water usage for the final product from other countries as well that includes use of domestic water resources and use of water outside the borders of the country. Population ecologists use water footprint as an indicator of water required to sustain the population of the country. As an aggregated indicator it shows the total water requirement of a nation, a rough measure of the impact of human consumption on the natural water environment.

Calculating Water Footprint

Calculation of water footprint is easy and can be done by pressing a button. However, it has unimaginable advantages. If an individual gets to know how much extra water one is using, probably one can be more cautious and show a sense of responsibility towards conservation.

Simple water footprint calculators have been designed by various national and international agencies to calculate the amount of water used in day-to-day activities. These are handy and work with a high degree of precision and can be used free on the web. Simple calculators work on food consumption, indoor domestic use, outdoor domestic use, and industrial goods consumption. The National Geographic uses a more graphic intensive approach to calculate water use in our household, diet, energy use, and shopping/services. The H2O Conserve Calculator is focused on the United States and calculates the water footprint on a household basis through similar questions to the other calculators.

A cursory look at the data of various countries and their water consumption patterns shows that many countries are over-exploiting this resource. According

Water Water....

Water, water everywhere but not a drop to drink
This statement is old enough and should made us think

We are facing the serious challenges of pollution
Calls for introspection and some quick solution

Rivers are carrying filth, dirt and sewage
Resulting in disease outburst and carnage

They say our rivers are no longer living
The water quality is poor and can cause massive killing

Plastics in rivers are clogging them and causing stagnation
Can we still wait for others to set off reclamation?

Heavy metals released in rivers from industry
Are taking a heavy toll of aquatic biodiversity

Gangetic Dolphins, Turtles and aquatic insects are forced to extinction
All these need conservation by immediate intervention

It is our duty and responsibility
To take care of this precious commodity

For it is important for our homes and hearth
And it is depleting fast from mother earth

Let us pledge to save every drop of water
For its value to life and its ability to nurture

Dr Monika Koul

WATER – FACTS AND FIGURES

1. 1.1 billion people live without clean drinking water
2. 2.6 billion people lack adequate sanitation (2002, UNICEF/WHO JMP 2004)
3. 1.8 million people die every year from diarrhoeal diseases.
4. 3 900 children die every day from water borne diseases (WHO 2004)
5. Daily per capita use of water in residential areas:
   - 350 litres in North America and Japan
   - 200 litres in Europe
   - 10-20 litres in sub-Saharan Africa
6. 70% of existing global freshwater is withdrawn for irrigation in agriculture
7. Quantity of water needed to produce 1 kg of:
   - wheat: 1 000 L
   - rice: 1 400 L
   - beef: 13 000 L
8. Producing one cup of black coffee (without sugar) requires 140 L of water.
9. 8,000 litres of water are used to produce a pair of leather shoes
10. 2,900 litres of water are used to produce a cotton shirt
11. 200 litres of water are used to produce the sugar in 1 can of cola

Many countries in arid and semi-arid regions of the world are already close to or below the threshold for water scarcity

The increasing stress on the planet's water resources is not only due to increasing population load and industrialisation. Increasing income levels have increased the demand for water-intensive products such as meat, sugar and cotton. Pollution of water bodies is further limiting the amount of water available for use.

WATER FOOTPRINT CALCULATORS

1. http://www.gracelinks.org/1408/water-footprint-calculator
2. http://www.waterfootprint.org/?page=cal/WaterFootprintCalculator
3. http://environment.nationalgeographic.co.in/environment/freshwater/change-the-course/water-footprint-calculator/
4. http://www.saveourh2o.org/water-use-calculator

to the World Research Institute (WRI), India, China, the USA, the Russian Federation, Indonesia, Nigeria, Brazil and Pakistan together contribute fifty percent of the total global water footprint. India (13%), China (12%) and the USA (9%) are the largest consumers of the global water resources.

India's Water Footprint

India accounts for high water footprint on account of various reasons. One of the significant reasons is increasing demand because of the vast population. Moreover, in India people have a water-intensive consumption pattern and lifestyle. India is also an agricultural economy and most of our agricultural crops need high inputs in terms of irrigation. The water requirement per unit of crop production is relatively large and because of water-inefficient agricultural practices, water productivity in terms of output per drop of water is relatively low.

The focus today should be on reducing this footprint. Some of the viable options for a country like India are to adopt production techniques that require less water per unit of product. Water productivity in agriculture can be improved, for instance, by applying advanced techniques of rainwater harvesting and supplementary irrigation.

A second way of reducing water footprint is to shift to consumption patterns that require less water, for instance by changing food habits, changing food basket and include local, indigenous, and seasonal foods in our diet. This will have a long term impact on many other associated aspects and save the country's resources.

Another aspect that needs review is our subsidy policy. Water is a highly subsidized commodity in India. People pay nominal bills for water and hence there is no control over over-exploitation and wastage. Reducing subsidy will probably help in securing this resource and force every individual to reassess the way we have been using this precious resource. Water costs are generally not well reflected in the price of products due to the subsidies in the water sector. Besides, the general public is hardly aware of the water requirement in producing their goods and services.

A subtler approach to reduce the water footprint would be raising awareness through integrated campaigns of the negative impacts of increasing footprint on environment, and introduction of other incentives such as water-credit schemes to make people change their consumption behaviour.

Governments can promote an international agreement on world-wide water footprint reduction. National targets on water footprint reduction can be translated to specific reduction targets for products, producers, industry, goods, etc. so that all the sectors are covered.

We need to realize that if something is not urgently done to reduce the water footprint, living on this planet would soon become impossible.

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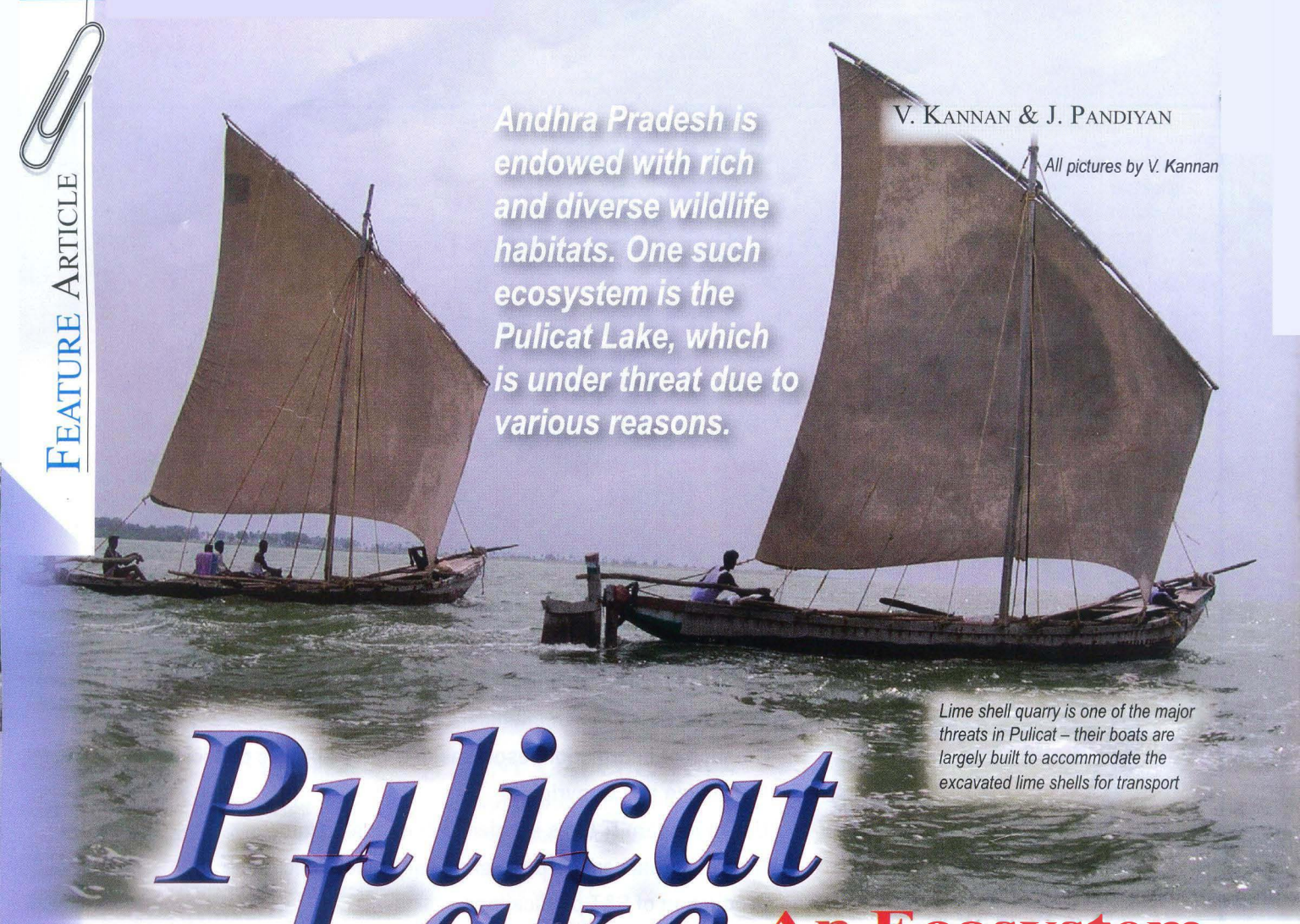
V. KANNAN & J. PANDIYAN

All pictures by V. Kannan

Andhra Pradesh is endowed with rich and diverse wildlife habitats. One such ecosystem is the Pulicat Lake, which is under threat due to various reasons.



Lime shell quarry is one of the major threats in Pulicat – their boats are largely built to accommodate the excavated lime shells for transport

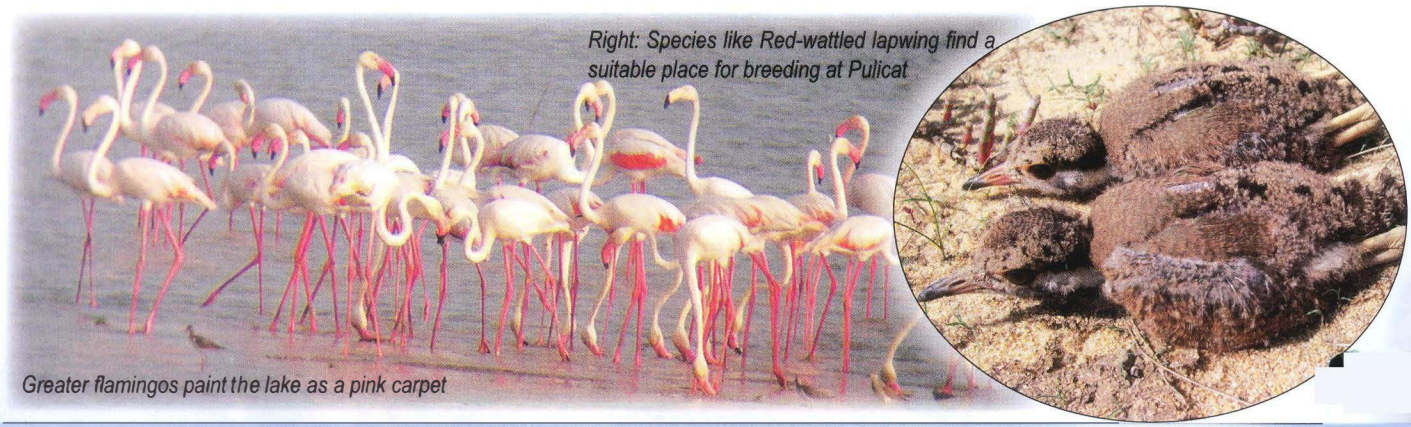
Pulicat Lake

An Ecosystem Under Threat

PULICAT is the second largest lake in India after Chilika sprawling across the states of Andhra Pradesh and Tamil Nadu. The lake has an area of 750 sq km, about 60 km length and width varying from 0.2 km to 17.5 km. During the monsoon Pulicat receives freshwater through three major rivers namely Swarnamukhi (at the northern end), Kalangi (from the northwest) and Arani (at the southern tip).

The major portion of the lake falls in Andhra Pradesh (84%) and the remaining portion falls in Tamil Nadu (16%). However, the name Pulicat is derived from the village Pulicat (Pazhaverkadu – an altered form of the Tamil name). The name signifies the mangroves that once flourished till the end of the 18th century.

Pulicat was the most popular site since from the 6th to the 16th century due to its ecological, economic and social importance over almost four hundred



Right: Species like Red-wattled lapwing find a suitable place for breeding at Pulicat

Greater flamingos paint the lake as a pink carpet

The abandoned crop fields in Pulicat Lake serve as roosting sites for the threatened Spot-billed Pelicans

years. It was the earliest settlement of the Dutch on the mainland of India and there used to be considerable trade between Pulicat and the Straits Settlement. The 419 km long historically important Buckingham Canal dug during the early 19th century by the British traverse in a north to south direction at the eastern edge of Pulicat Lake.

The Dutch stayed on at Pulicat until about 1690 and their ships were able to enter Pulicat Lake, which was then about 3.8 m deep. Possibly, because of exploitation of the mangroves and several human interventions, the depth of the lake reduced to 2 m by about 1800 AD. Due to this, the successors of the Dutch, the British, were not able to bring their ships right into Pulicat Lake, and hence, abandoned Pulicat as a natural port.

Pulicat has three openings into the Bay of Bengal through which it plays a major role in the life forms of its ecosystem. The Pulicat Lake has several islands of which the larger ones are the Sriharikota, Venadu, Irrakam and Pernadu Islands. The islands have significant forest type called Southern Tropical Dry Evergreen Forest (TDEF) representing dominant plant species such as *Manilkara hexandra*, *Albizia amara*, *Strychnos nux-vomica* and *Maba buxifolia*.

Besides this, the northern portion of the lake has mangrove forests and littoral vegetation. About 2487 (flora and fauna) species inhabit this ecosystem including plants, butterflies, fishes, reptiles, birds and larger mammals. Due to its varied habitats the Pulicat Lake is ornithologically rich consisting of several threatened species like the Spot-billed pelican *Pelecanus philippensis*. Pulicat supports a significant population of this species and serves as a vital foraging ground. Lake Pulicat is one of the main wintering grounds for waders (shorebirds) in the Central Asian/South Asian Flyway along the east coast of India. The extinct Pink-headed duck *Rhodonessa caryophyllacea* was recorded last from the Pulicat Lake and recently a sighting of a dead leopard (*Panthera pardus*) has also been recorded.

However, the Pulicat Lake that is a foundation for rich biodiversity and livelihood for the fishing community is under grave threat due to various factors. This lake ecosystem provides essential products and services such as oxygen, food, water and medicines to humans. And the most affected are the poor communities.

Blacked-tailed godwit, a long distance migrant, arrives at Pulicat in August and moves erratically all over the lake

A regular seasonal migrant to Pulicat Lake – Eurasian spoonbill

Below from left: Graceful Lime butterfly; Sea birds like Brown-headed gull find home at Pulicat during reptile in sandy areas of Pulicat Lake – Fan-throated lizard

An evening at Pulicat Lake

Salinity increase and salt formation in summer

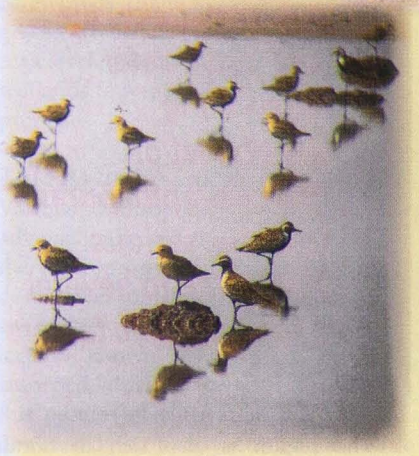
Fish migrate from rivers and are caught by the fishermen before being able to complete their life cycle

The rivers Arani and Kalangi bring in enormous quantity of water during the monsoon loaded with polluted sewage, pesticides, agricultural chemicals and industrial effluents. Besides, aquaculture farming along the eastern part of the lake also threatens the ecosystem. Due to exploitation of the mangroves and extensive siltation caused by the rivers, the lake has been reduced from 3.8 m to 2 m.

Studies have revealed that the lake supported a vast area of mangroves and about ten species of mangroves were recorded from the Pulicat Lake; the most dominant species was found to be Excoecaria agallocha. But the present scenario is alarming. The mangroves are on the verge of disappearance and at present sparse bushes of *Avicennia marina* (an endangered mangrove species) are only found in the south near Ennore, Kuruvithottu and near Dugarajapatnam in the north.

Restoration of the mangroves on a smaller scale is underway in the southern part of Pulicat Lake. However, restoration

A Rat snake sneaking out from its place



Right: Pulicat supports a sizeable population (about 600 birds) of the near-threatened Painted stork

Below: An irregular migrant the Bar-headed goose also found in the Pulicat Lake area

Top: Skittering frog adapted to saline and freshwater habitats of Pulicat Lake
Above: Pacific Golden plover, a migrant, arrives at Pulicat in December and departs in June

efforts proliferate in response to keen public awareness and concern for the health of the lake. Successful ecological restoration should improve biodiversity conservation, improve human well being, empower local people and improve ecosystem functions. At the same time, greening the lake must involve bringing back the original vegetation devoid of non-native species.

At the margins of the Pulicat Lake there are many industries such as sugar factories, granite cutting, chemical industries, textile industries, Ennore Satellite Port and the petro-chemical industrial park. These industries harm the lake as well as the ecosystem of the lake. Flyash from the North Chennai Thermal Power Station flows into the Buckingham Canal near Ennore estuary through which it empties into the Pulicat Lake. This has affected the biodiversity, fishery and water and also the livelihood of fishermen.

Formation of sand bar and sea mouth closure also pose a grave threat to the Pulicat Lake. Sea mouth closure prevents immigration and emigration of fish and other fauna for completing their life cycle. This directly affects the avifauna and also the fishermen depending on it.

Before being notified as a sanctuary, Pulicat Lake was declared a wetland of international importance in 1981 by the Government of India. Later, in 1997, the entire Pulicat Lake (in both Andhra Pradesh and Tamil Nadu) including the islands and reserved forest areas was notified as Sanctuary and also placed under category I of Coastal Regulatory Zone in 1990.

Yet, sadly, over the years due to increasing human population and hunger for land the need and care for this ecosystem is drastically diminishing. The Global Nature Fund declared the Pulicat Lake as a threatened lake in the year 2010. The highest function of ecology is the understanding of consequences, from a global scope down to an awareness of what is happening in our ecosystems. Therefore, evolving a technically sound and comprehensive approach, and people's participation in conserving this waterlogged wealth is vital.

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Vellayani Lake

BIJU DHARMAPALAN

All pictures by Biju Dharmapalan

Conserving the Vellayani Lake

Vellayani Lake, the only freshwater reservoir in the district of Thiruvananthapuram, is under serious threat due to several anthropogenic factors

VELLAYANI lake or *Vellayani kayal* as known in local language is one of the three rain-fed freshwater lakes in Kerala, the other two being Sasthamcotta lake in Kollam and Pookode lake in Wayanad.

Vellayani lake is the largest fresh water lake in Thiruvananthapuram district of Kerala. This very vast picturesque lake surrounded by lush greenery is located about 9 km away from Thiruvananthapuram city. The lake is a rich repository of flora and fauna, and the biodiversity supports the livelihood of people around the lake. About hundred species of wetland birds frequent the lake, including migratory ones.

Till 1953, the lake was solely used for the cultivation of lotus flowers for the famous Sri PadmanabhaswamyTemple. But later the water from the lake was extensively used for drinking and irrigational purposes. The Vellayani fresh water lake is the major source of drinking water for the people of Kalliyoor, Venganoor, and Vizhinjam grama panchayats.

Biodiversity of the Lake

The lake and the adjoining Punchakkari wet lands are an abode of floral as well as faunal biodiversity. Many types of birds visit the wetlands adjoining the lake. According to the reports of Kerala State Council for Science Technology and Environment the lake is home to nearly 92 species of wetland birds and 37 species of fishes.

Some of the birds that have been reported from the area are the Black headed bunting, Marsh harrier, Osprey, Water cock, Pied Crested cuckoo, Indian coot, Common Stone chat, Pied kingfisher, Cormorants, Little egret, pond heron, purple moorhen etc. The area harbors a good population of butterflies like tawny coster.

The region is also rich in floral biodiversity typical of a wetland ecosystem. Many members of Poaceae and Cyperaceae dominate the wetlands, even though members of Malvaceae, Euphorbiaceae, Passifloraceae are also noticed along the fringes. According to local people, different types of mushrooms including fairy rings were common in this locality. But now with the dwindling ecosystem these mushrooms have vanished.

Earlier, the biodiversity of the area supported the livelihood of the local people. Screwpine matt making and Kora matt making industry were common in the region. But now one can hardly find these small-scale industries because of declining population of

Lotus rearing

From left: Pied kingfisher; Cormorant; Little egret; Indian Pond heron; Tawny coster

Screwpines (Pandanus spp.) and Kora grass (Rhynchospora spp.), due to large scale reclamation of lake and adjoining wetlands for cultivation and construction purposes.

Threats to the Lake

Various anthropogenic activities have adversely affected the water quality and the environment of the lake. The initial destruction of the lake was done by an unscientific approach of cultivation locally known as "Puncha Krishi", launched during the early 1950s. In this pattern of cultivation the lake was dewatered for paddy cultivation. Since the lake is about a metre above the sea level, the dewatering is carried out easily through the Madhupalam spillway, near Thiruvallam. This practice over the period has resulted in drastic depletion of ground water.

In many houses in Kalliyoor panchayat the average depth of wells is above 100 feet. The usage of manures, fertilizers and pesticides for cultivation has deteriorated the quality of water and drastically reduced the water spread area.

The lake is encroached partly by a college and by private parties for cultivation purpose, which goes unnoticed by the authorities. The villages surrounding this lake like Palaparru and Kalliyoor are considered to be the most productive areas in vegetable cultivation. This is being heralded as an achievement, but this also brings havoc to the environment of the lake.

Most of these wetlands are slowly being converted for developmental activities both by private parties and the government. During the early 1980s one of the bund roads connecting the two ends of the lake was converted into a tarred road, which is now a major bye-pass road connecting Trivandrum and Kaliyakkavilai in Tamil Nadu. Many parts of the lake are in the process of transforming into modern roads utilizing funds from the Pradhan Mantri Gram Sadak Yojana.

Many regions of wetlands encroached by private parties are also slowly being converted for building houses. This conversion takes place in a slow manner. In the first phase the paddy plant is replaced by vegetables like Cucumber, Amaranthus, Momordica, etc. In the next phase the fields are filled with soil and banana plants and coconut palms are grown. By the end of three or five years buildings are constructed there.

The region also faces threat due to introduction of exotic plants that are not suitable to the habitat like Bamboos and Acacia. This is done purposefully with the aim of destroying the ecosystem so that it could be utilized for developmental activities.

The exploitation of water is rampant in the locality. The water from the lake as well as from the wells bored near the lake is drawn unscrupulously for sale. In addition, sand mining is also affecting the ecosystem of the lake. The leaching of agricultural residues and domestic waste has led to the growth of Eichhornia in some parts of the lake.

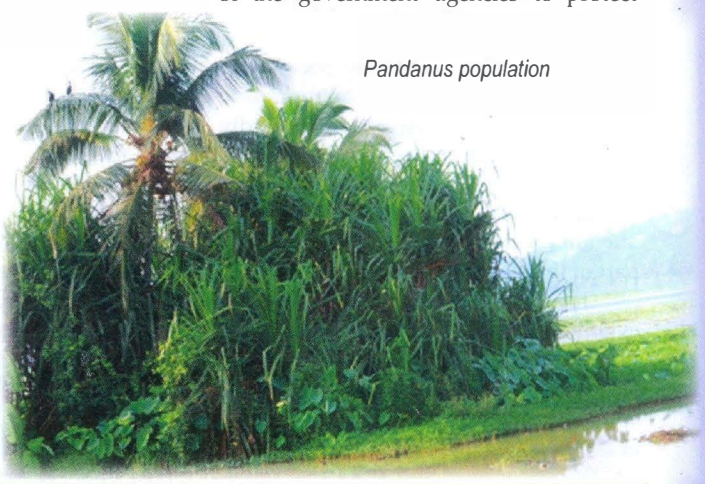
The introduction of many exotic varieties of fish as part of the government initiative to empower the local people has also adversely affected the ecosystem. According to locals this has led to genetic erosion of many local species.

Since the times of the Travancore kings the Vellayani Lake has been a centre of attraction for tourists. In recent times, irresponsible tourism activities have badly affected the ecosystem. Plastic water bottles and liquor bottles are littered in the lake. Installation of street lamps near the lake may also affect the biological rhythm of the flora and fauna present in the lake.

Even though the Kerala State Council for Science, Technology and Environment (KCSTE) has initiated steps to protect the Vellayani lake and the wetlands in the area by including them in the National Lake Conservation Plan (NLCP) formulated by the ministry of environment and forests, not much has been done by any of the government agencies to protect

Pumping station of Kerala Water Authority

Pandanus population



Above: Eichhornia menace
Left: Pumping out water by tankers
Below: Irresponsible tourism affects the biota

A new road in the making

The usage of manures, fertilizers and pesticides for cultivation has deteriorated the quality of water and drastically reduced the water spread area.

the ecosystem from depleting. The lake, which was spread over 750 hectares in 1926, has undergone an alarming rate of depletion in area, now covering hardly 450 hectares. Environmentalists have been demanding to recommend the lake for getting Ramsar tag so that international attention will help prevent the remaining part of the lake from further decline.

The dictum, "water, water everywhere, nor any drop to drink" is highly appropriate for the people living near to the lake. The water table in the adjoining areas of the lake is receding every day; even bore wells cannot gather potable water. Microbiological analysis carried out by different agencies has shown that the water from the lake is not suitable for drinking. Yet in most cases the water is pumped directly into the lane without any proper treatment mechanism.

This is the only fresh water reservoir in the entire Thiruvananthapuram district of Kerala but people are not bothered to notice the changes that are happening in their living stream. Last year, bird watchers observed unusual migratory pattern of birds visiting the Punchakkari wetlands surrounding the Vellayani Lake. Birds like Pied cuckoo, Buntings and the Brahminy starlings that prefer a drier weather visited the area indicating the change in the temperature pattern in the wetlands of this area.

It also signals a warning bell to human beings to take urgent steps to prevent the degradation of this unique ecosystem.

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KIRTI BANSAL

Energy from Mounds of Waste

The landfill site in Ghazipur

Managing solid waste is increasingly becoming a technological and social challenge. In India, along with technology, spreading social awareness among the country's citizens is imperative if we have to successfully tackle the increasing piles of waste.

THE Millennium Indraprastha Park is the longest park in Delhi created over an area of 34 hectares and stretching 2.7 km along the Ring Road. There is nothing to suggest that the huge park lush green with trees and shrubs and flowers has come up on a huge landfill site. This beautiful park took birth thanks to a scientific approach towards garbage disposal and land reclamation.

About 5 km away at Ghazipur, yet another 30-acre garbage dump, nearly 50 metres high, is not only being turned green but the methane released by the landfill will be captured and converted to compressed natural gas. This is the result of a unique experiment being conducted by the East Delhi Municipal Corporation in collaboration with Gas Authority of India Limited (GAIL). The landfill will no longer discharge toxins like lead and mercury into groundwater, or particulate matter into the air.

On the northwest fringes of Delhi, efforts are on to convert 20 acres of the Bhalswa landfill site into a lush green patch. Erosion control blankets are being fixed on the slopes to prevent the soil from eroding. Then grass and flower saplings would be planted over these blankets to complete the transformation.

The above success stories and efforts to reclaim waste dump yards are testimony to the increasing concerns for managing the colossal waste generated in

Efforts to reclaim the landfill site in Ghazipur

The Millennium Park in New Delhi has come up on a landfill site

at a rapid pace. About 55 million tonnes of waste is generated every year at an average rate of 0.5 kg of waste per person per day. It is expected to cross over 125 million tonnes by 2030.

And how is this waste being managed? Much of it is dumped on the outskirts of cities in low lying areas with no compliance of regulations. Transport of waste in open vehicles leads to littering of waste, causing breeding of mosquitoes and flies, ultimately affecting public health. The disposal is unscientific polluting air and water. The landfill sites are neither well equipped nor managed efficiently. There is no segregation of waste, which so important for scientific waste management.

Classifying Waste

In order to implement cost-effective management strategies that are beneficial to public health and environment it is practical to classify the waste. Some major classes of waste according to the manner in which they are generated are:

1. Municipal (kitchen waste, paper, wood pellets, disposable tableware, leaves, etc.)
2. Industrial (coal combustion solids, waste from pulp and paper industries)
3. Hazardous (residues from solvent and paint manufacture, petroleum refining, etc.)
4. Biomedical (syringes, body fluids, cultures from pathological laboratories, etc.)
5. Construction and demolition (concrete, asphalt, metal, rocks and soils)
6. Agricultural (animal manures and crop residues)
7. E-waste (batteries, portable computers, mobile telephones etc.)

Municipal solid waste predominantly includes domestic waste either in solid or semi-solid form. It is broadly classified as:

- Biodegradable waste: food and kitchen waste, green waste(grass, flowers, leaves etc)
- Recyclable material: paper, glass, bottles, plastics, fabrics etc
- Inert waste: soil, pebbles, dirt, ash etc.

About 115,000 tonnes of municipal solid waste is generated every day with a yearly increase of 5% (Central Pollution Control Board, India). The characteristics of municipal solid waste collected from any area depend on food habits, cultural traditions of inhabitants, life styles, climate, etc.

Although the composition of waste is changing in India with increasing use of packaging material but still the Indian waste largely comprises of organic matter compared to developed countries as shown in Table 1.

The Ministry of Environment and Forests has notified the Municipal Solid Waste (Management & Handling) Rule, 2000 under the Environment (Protection) Act, 1986 to manage the Municipal Solid Waste (MSW) generated in the country. The entire responsibility for the implementation lies with municipal authorities and the major functions include:

- Organizing house to house waste collection.
- Conducting awareness programmes to disseminate information to the public.
- Providing adequate community storage facilities.
- Use of colour code bins and promotion of waste segregation.
- Transport of wastes in covered vehicles.
- Processing of wastes by adopting an appropriate combination of composting, anaerobic digestion, pelletisation, etc.
- Upgradation of the existing dump sites and disposal of inert wastes in sanitary landfills.

However, there is no comprehensive short and long term plan with the municipal authorities to handle MSW in accordance with the MSW Rules, 2000. About 25% of waste is not collected at all and the majority of the municipal authorities do not have preparedness to set up waste processing and disposal facilities.

CONSTITUENTS OF INDIA MSW DUMPS

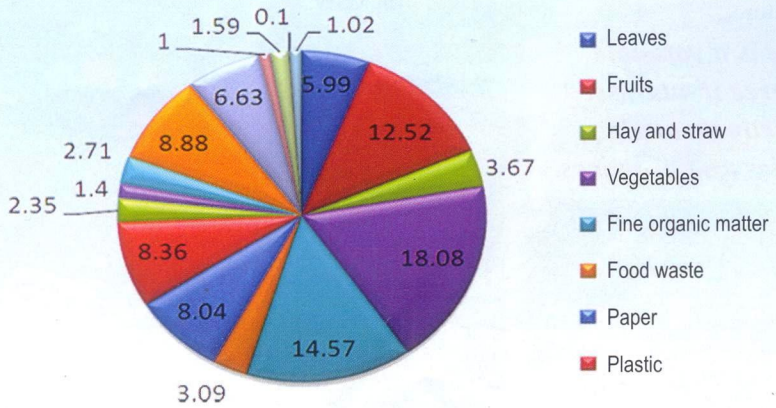
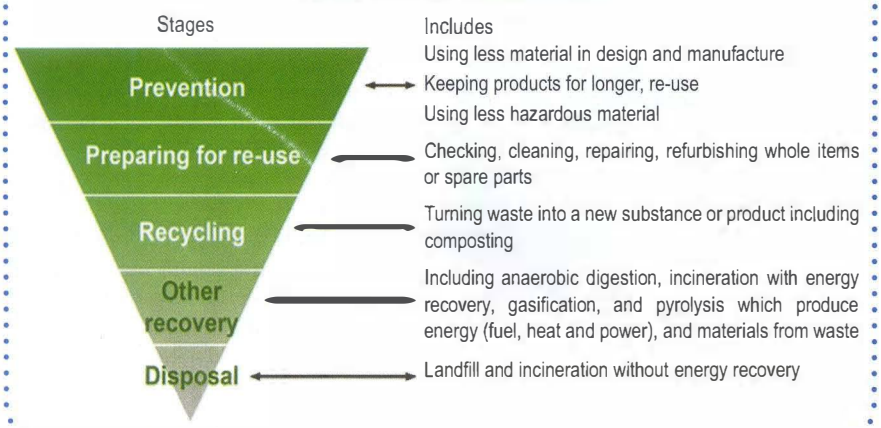


TABLE 1: COMPOSITION OF SOLID WASTE IN PER CENT BY MASS

Countries	Organic	Paper	Plastic	Glass	Others
USA	23	36	9	9	16
Canada	33	28	11	9	13
France	25	30	10	12	17
India	44	6	3.8	2	44
China	36	3	3.6	2	54
Malaysia	43	23	11.2	3	15

WASTE HIERARCHY



Treating Solid Waste

There are several methodologies available for the treatment of Solid Waste.

Waste management hierarchy: It indicates an order of preference for action to reduce and manage waste, and is usually presented diagrammatically in the form of a pyramid.

Land filling: It is a technique for the disposal of waste into or onto the land. All types of waste such as residual, commercial, residential etc and the unutilized waste left after its processing are also dumped into landfill sites. Major limitations of this process are that transportation of the MSW to a far-away site increases the cost and dumping leads to emission of the two major GHG's, methane and carbon dioxide, into the atmosphere. Land fill sites hold potential for the recovery of the landfill gas for electricity generation but there is a risk of ignition in the absence of gas ventilation. The cost of pre-treatment to upgrade the gas quality may also be significant.

Composting and Vermi Composting: Formation of the compost (humus) by the degradation of organic matter in the presence of microorganisms such as bacteria under warm, moist, aerobic or anaerobic conditions is known as composting. It is a simple and cost effective process which increases the moisture holding capacity of the soil. However, the process is not suitable for wet waste. Issues of large land requirement, methane emission, flies, bad odor and marketing of compost are of major concern. In contrast to this, vermi composting is preferred in small towns because it requires less mechanization and is easy to operate. In this process earthworms are fed on partially decomposed matter. The worm casts out a fine, odorless and granular product used as biofertilizer in agriculture.

Waste is a valuable resource if addressed correctly through policies and practices.

Waste-To-Energy (WtE): Waste to energy projects have been proven worldwide but are yet to establish in India because its financial viability and sustainability is still being tested. The main factors that determine the techno-economic viability of WtE projects are quantum of investment, scale of operation, availability of quality waste, statutory requirements and project risks. WtE projects generally involve high capital investment and 500-5000 TPD waste.

Such plants are viable in developed countries because of the gate fees charged by the facility for the service of waste disposal, in addition to its revenue income from power sales. It is thereafter the sole responsibility of the facility operator to treat and dispose of the accepted waste as per statutory requirements. However, at present in India, revenue from power sales is the only source of revenue for WtE plants.

Some WtE technologies are:

- **Incineration:** MSW can be directly combusted in incinerators with the temperature varying between 980° C to 2000° C. It can reduce the waste volume by 80-90% but is not much practiced in India due to high organic material (50-60%), moisture content (40-50%) and low calorific value (800-1100 kcal/kg) content in MSW.

• **Pyrolysis/Gasification:** Pyrolysis uses heat under oxygen deficient condition to break down the solid waste producing a mixture of combustible gases (mainly methane, hydrogen and carbon monoxide), liquids and solid residues.

• **Biomethanation:** The organic waste is acted upon by anaerobic microorganisms under anaerobic conditions with the release of carbon dioxide and methane. This method is suitable for only the organic biodegradable fraction of MSW and produces 100-150 kwh per ton of waste.

• **Refuse Derived Fuel (RDF):** It is a fuel produced by either shredding the solid waste or treating it with steam pressure in an autoclave. The RDF pellets can be conveniently stored and transported. Burning RDF is more clean and efficient prior to incinerating MSW. However, the process is energy intensive and not suitable for wet MSW such as during the rainy season.

WtE Plants in India

• The first large-scale MSW incineration plant was constructed at Timarpur, New Delhi in 1987, which was capable of generating 3.75 MW power from 300 TPD MSW. It was set up at a cost of Rs. 250 million (US$5.7 million) by Miljotecknik volunteer, Denmark. The plant was out of operation after six months and the Municipal Corporation of Delhi was forced to shut down the plant due to low net calorific value of MSW.

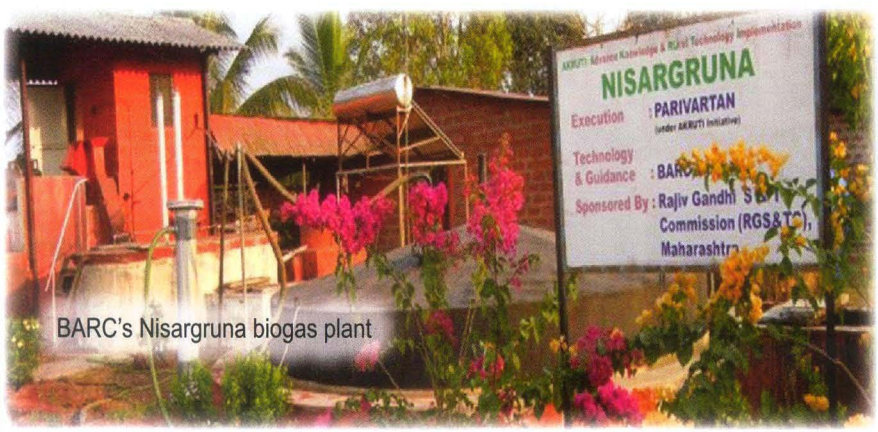
•Another incineration plant was constructed at BARC, Trombay (near Mumbai) for burning only the institutional waste, which includes mostly paper.

• A 5 MW project in Lucknow was started in 2003, based on biomethanation technology. The plant only reached 1 MW and was closed down within six months due to ineffective waste segregation system, which led to poor quality of MSW being delivered to the plant. Nisargruna biogas plant developed at BARC is an improvement on biomethanation technology as it can process all biodegradable waste rather than human waste and cow dung (material for conventional biogas plant).

• Two different designs of gasifiers exist in India. The first one (NERIFIER gasification unit) is installed at Nohar, Hanungarh, Rajasthan by Navreet Energy Research and Information (NERI) for the burning of agro-wastes, sawmill dust, and forest wastes. The waste-feeding rate is about 50-150 kg/h and its efficiency about 70-80%. About 25% of the fuel gas produced may be recycled back into the system to support the gasification process, and the remaining is recovered and used for power generation. The second unit is the TERI gasification unit installed at Gual Pahari campus, New Delhi by The Energy and Resources Institute (TERI).

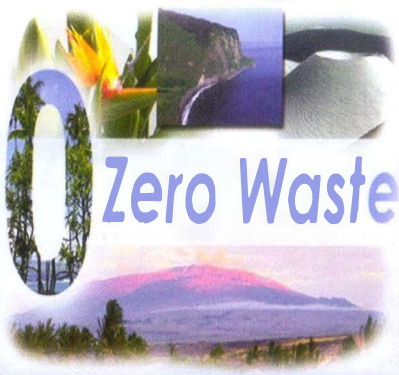
• In India, many RDF plants are in operation at Hyderabad, Guntur and Vijaywada in Andhra Pradesh. The Hyderabad RDF plant was commissioned in 1999 near the Golconda dumping ground with a 1000 t/day capacity (but receiving only 700 t/day at present). The RDF production is about 210 t/day as fluff and pellets, and it is going to be used for producing power (about 6.6 MW).

• The RDF plant at Deonar, Mumbai was set up in the early 1990s for processing garbage into fuel pellets. It is based on indigenous technology. However, the plant has not been in operation for the last few years. A similar project has been established in Bangalore and has had regular production of fuel pellets since October 1989, compacting 50 t/day of garbage, converting into 5 t of fuel pellets, which can be designed both for industrial and domestic uses.



BARC's Nisargruna biogas plant

ZERO WASTE



Zero waste is a conceptual goal that aims at elimination rather than managing waste. It represents the closed-loop philosophy (cradle to cradle) resulting in no waste. It is a new way of thinking about protection of health of everyone who produces, handles, works with, or is affected by waste.

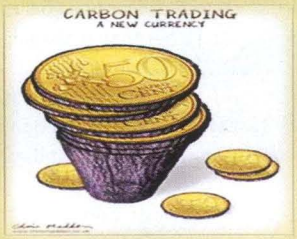
The zero waste campaigns are being adopted worldwide in many countries. Canberra was the first city in the world to adopt the zero waste vision in 1996. ZeroWIN (Towards Zero Waste in Industrial Networks) is a five year project running 2009-2014, funded by the EC under the 7th Framework Programme. It has 30 academic and industrial partners across Europe who will integrate their expertise and try the chosen strategies.

The zero waste Kovalam project in Kerala is the first initiative towards zero waste in India. It is an ongoing programme of Thanal and is jointly supported by Greenpeace, GAIA (Global Alliance for Incineration Alternatives) and KHRA (Kerala Hotels and Restaurants Association). Indian Tobacco Company (ITC), Bhadrachalam (A.P), Miranda House, an environmental NGO and Sarita Vihar, a residential colony in Delhi are some examples that have taken initiatives towards the Zero Waste vision.

Zero Waste campaign near the Saphalyam Complex, Palayam, Trivandrum

"Industries should not be produce products that cannot be reused, recycled or treated further."

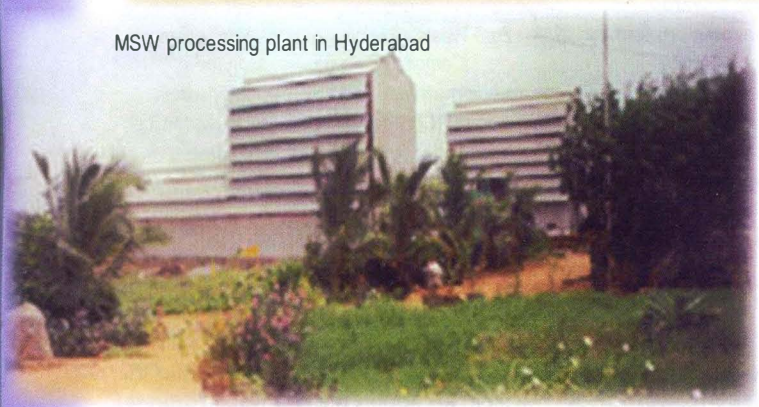
CARBON CREDITS



Carbon credit is the tradable certificate or permit that allows the holder to emit one tonne of carbon dioxide or carbon dioxide equivalent gases. These gases are Methane, Nitrous oxide, Perfluorocarbons, Hydrofluorocarbons and Sulphur hexafluoride. If any of these gases are reduced from the atmosphere, carbon credits can be earned, which could then be sold. But if carbon credits exceed their allowance they could be purchased from other organizations.

Credits generated are known as CERs (certified emission reductions). CDM (Clean Development Mechanism) under the Kyoto protocol along with VCS (Verified Carbon Standard) provides a robust platform to develop GHG emission reduction projects which will further earn carbon credits (emission reductions).

Solid waste management practices release high quantities of green house gases in the atmosphere. This sector therefore creates significant opportunities for carbon mitigation, which could eventually become tradable carbon credits. Some waste to energy projects in India have already started earning carbon credits.



MSW processing plant in Hyderabad

The Hyderabad RDF plant was commissioned in 1999 near the Golconda dumping ground with a 1000 t/day capacity (but receiving only 700 t/day at present).

WtE plants in Delhi

The city of Delhi generated approximately 8,000 MT of Municipal Solid Waste (MSW) every day in 2013 at the rate of 500 g/capita/day. More than 65% of the MSW collected is disposed off in landfills. The remaining amount of MSW is sent for either composting or WtE plants for energy generation. For treatment and processing of MSW, currently there are three WtE plants.

• **Okhla plant:** The waste to energy plant at Okhla is in operation and operates on mass combustion of MSW as its working technology. In this plant, 16 MW/day power is generated with the input volume of 1350 TPD of waste. In this plant segregation of waste takes place before combustion. Air Pollution Control Systems such as Turboreactor and Fabric Filtration Air Quality Control System are provided in this plant to prevent emission of gases without treatment. However, the plant has been under fire for quite some time on account of not adhering to pollution control norms.

Okhla w2e plant

On the northwest fringes of Delhi, efforts are on to convert 20 acres of the Bhalswa landfill site into a lush green patch. Erosion control blankets are being fixed on the slopes to prevent the soil from eroding.

• **Gazipur Plant:** The waste to energy plant at Ghazipur is under construction and proposes to adopt mass combustion of MSW as its working technology. The process would involve conversion of MSW to RDF and then combustion of RDF to generate electricity. In this plant, 12 MW/day power will be generated with the input volume of 1300 TPD of waste. The plant has a capacity of taking up 2000 TPD waste.

• **Narela-Bawana plant (MSW Combustion):** The Ramky waste to energy plant at Bawana is under construction and will operate on mass combustion of MSW as its working technology. In this plant, 12 MW/day power will be generated with the input volume of 600 TPD waste per boiler for 3 boilers. It is a part of Ramky's Integrated Waste Management Plant.

Tackling Waste

Processing and managing waste is a technological challenge. This challenge will further intensify as population increases and industries are set up.

It is also a social challenge. Unless efforts are made to create awareness and people are educated about the need to segregate waste before processing, not much headway can be made in efficiently managing the increasing piles of waste throughout the country. W reduce the waste, segregate, and change our consumption habits.

At the same time industries should not be produce products that cannot be reused, recycled or treated further. There is a need for trained man power to implement the waste management technologies. Waste is a valuable resource if addressed correctly through policies and practices.

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Climate Change Redefining Disease Prevalence in Agriculture

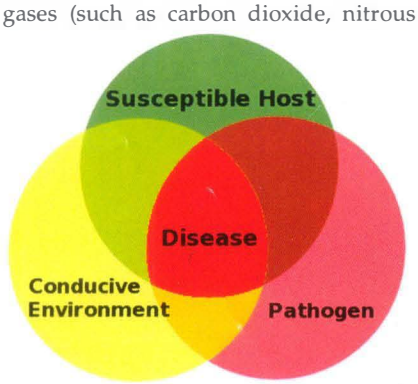
ANIRUDDHA MAITY AND PRAGATI PRAMANIK

HUMAN activities, driven by demographic, economic, technological and social changes, are progressively having a major consequence on the interactive global systems driven by climate, land, water and vegetation leading to a slow but steady change in intensity of these components. Forces that drive climate change do not act independently; rather, they act in a mysteriously complex way which hinders their independent assessment.

Agricultural productivity always depends on several factors that include biotic and abiotic resources. Uncertainty in climatic variables is magnifying the already existing barriers to produce more food for feeding our ever increasing population from the shrinking resource pool. From the agricultural perspective, responding to climate change are not only the plants but also the pathogen community. While there is an urgency to fill the demand-supply gap by producing over 260 mt of food grains, the harsh impact of climatic fluctuation has pushed this zeal under threat by promoting pathogen reproduction rates.

Components of Climate Change

Intensification of the hydrological cycle, change in temperature regime, rainfall pattern, concentration of greenhouse gases (such as carbon dioxide, nitrous oxide, methane, water vapour, and chlorofluorocarbons (CFCs) and ozone, all these have certain impact on the change in vegetation pattern as well as on the rapid evolution of pathogens.



The fast productive rate of pathogens in response to different climatic stresses leads to wider range of genotypic variants that can easily cope with the predictable physiological changes of the host. Thus the nature and magnitude of global climate change potentially will influence plant diseases and the efficacy of their management options impacting the productivity and sustainability of agricultural systems.

But how does climate change affect the severity of plant diseases? The climate influences the incidence as well as temporal and spatial distribution of plant diseases. The main factors that control growth and development of diseases are temperature, light and water. These factors also affect the type and condition of the host crop. The environment may affect a plant pathogen's survival, vigor, rate of multiplication, sporulation, direction, distance of dispersal of inoculums, rate of spore germination and penetration.

The most likely consequences are shifts in the geographical distribution of host and pathogen and altered crop losses, caused in part by changes in the efficacy of control strategies.

Let us take a look at some of the components of climate change and how they affect pathogen development and spread of diseases.

Temperature and rainfall

- Rising temperatures and changes in rainfall patterns affect initiation, development, establishment and spread of plant diseases.
- The ranges of some diseases (geographical distribution) are expanding as rising temperatures are allowing pathogens to overwinter in regions that were previously too cold for them.

- Harsh temperature regime and severity in flood and drought, in addition to change in host physiology, leads to rapid multiplication of pathogens through sexual reproduction which results in more aggressive variants.
- By means of more rapid evolution and adaptation (by short life-cycle) than that of the hosts, pathogens are always one step ahead of the host.
- Many disease-causing organisms are already known to survive in harsh temperature or moisture condition. For instance, powdery mildew can grow in minimal moisture, while blast is affected by high temperature and nematode communities are well-proven to enjoy elevated temperature.
- Rainfall pattern along with temperature changes the incidence of several diseases by changing their vector distribution. Viral diseases are of utmost importance in this regard.
- The dynamics of host-pathogen disease reaction is often under pressure by the changing components of their influencing environment, which culminate mostly in breakdown of host resistance. Thus tropical region, the earlier hub of diseases, is expanding towards the north and south

to introduce new and newer diseases that previously were not there.

• The increase in fixed carbon, temperature levels and nitrogen deposition are important factors to affect microbial communities in soil and the functioning of the microbial ecosystem.

Concentration of Carbon dioxide

• Carbon dioxide is an indispensable component of photosynthesis process which provides food for all living organisms. Modification in Rubisco biochemistry, stomatal physiology, anatomy, morphology and phenology is well known under elevated carbon dioxide, which leads to complexity in disease dynamics.

• Elevated carbon dioxide promotes more photosynthesis producing dense plant canopy which in combination with elevated temperature and erratic rainfall forms an encouraging microclimate for pathogens.

• When host produces more photosynthates, the degree of benefit by pathogens, both biotrophs and

necrotrophs, is many times greater than that of the plants itself. For example, powdery mildew, anthracnose, and rust have been reported to accelerate their growth and life-cycle at elevated carbon dioxide levels.

Concentration of Ozone

• Ozone can predispose plants to diseases in several ways.

• Elevated ozone concentrations may change the structure and properties of leaf surfaces in ways that may affect the inoculation and infection process.

• Ozone enhances senescence processes, may encourage necrosis and seems to promote attacks on plants by necrotrophic fungi.

The environment may affect a plant pathogen's survival, vigor, rate of multiplication, sporulation, direction, distance of dispersal of inoculums, rate of spore germination and penetration.

• Plant growth is inhibited and results in shorter plants with less dense canopies, which reduces its physical and physiological resistance against diseases.

Concentration of methane and other greenhouse gases, UV light, effective sunshine hours, etc. are also reported to affect the disease reactions.

Change in Management Strategy

Disease development is the cumulative effect of various factors that affect the host and pathogen. A slight change in microclimatic conditions can affect the outcome of the plant-pathogen interaction. The plant-pathogen relationship can also be affected by microbial populations or control agents. The effects of climate change differ in different plant- pathogen systems.

Nevertheless, it is clear that such effects will occur and that adaptive measures need to be developed to allow us to respond to these expected changes.

• Fungicides may continue to serve as common disease suppression agents, although alternative measures, such as cultural methods and biological control, should be developed.

• Efficacy of most plant protection chemicals depends on prevailing climatic conditions. Changed duration, intensity and frequency of rainfall events would impact on the effectiveness of chemical control measures. Still we have to come up with innovative application technologies with the existing plant protection chemicals.

• Modelling of plants and their pests in relation to climatic variables should be done in order to predict the disease well in advance.

• New cultural practice methods can be adopted to combat this problem, which needs intense research to optimise.

• Concept of refugee crops, already existing in pest-resistant transgenic cultivation, can rationally be adopted to loosen the increasing selection pressure on pathogen evolution.

• Soil-microflora should preferably be looked after to provide better establishment of the crop in fields. This provides plant community better strength to fight diseases.

• Breeding of plant cultivars with horizontal resistance can better be emphasised keeping the future evolution of pathogens in mind. By comparison, deployment of a major gene for resistance effective under a range of environmental conditions delivers high efficacy for a narrow target disease control with limited duration and high vulnerability.

• To be effective, partial resistance has to be combined with agronomic and other practices to develop robust integrated crop protection strategies, which will not suffer boom-bust cycles.

• Effect of climatic harshness on mutation rate be taken into account for formulating the future breeding strategies.

Climate change is an inevitable and irresistible process. Until and unless the causes of climate change are minimised to the maximum possible limit, the severity of plant diseases is going to increase manifold. The agriculture community has to be doubly cautious, and has to come up with novel technologies for producing more food.

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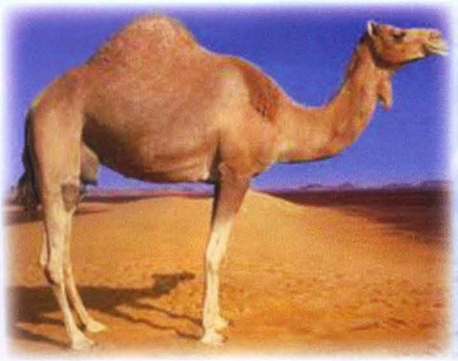

Environmental Challenges for Animals

SAFEEDA SULTANA BEGUM AND MOKHTAR HUSSAIN

CHANGES in the global environmental parameters have resulted in great alteration in the pattern of summer, winter, rainfall, wind directions, etc. Humans seemed to be adjusting well to these changing circumstances with the help of modern technologies and equipments, but animals are still struggling to adjust themselves to such great and sudden changes.

Changes in the environment (along with human poaching) have resulted in a drastic change in the pattern of distribution of the animal population worldwide, with most animals pushed to the level of endangerment while some are on the brink of extinction. A very interesting example may be cited of the coral reefs of the "Great Barrier Reef" of Australia, which is one of the several wonders of nature and is one of the structures on earth that can be viewed from outer space.

To adjust themselves to their changing environment, some animals have adopted certain mechanisms that help them to respond well to the changing circumstances as well as increase their chances of viability, survivality, longevity, reduced mortality and reproductive rate, and make them more resistant to diseases.

Such adaptation may be classified as genotypic or phenotypic adaptation. The former refers to that type of adaptation which brings about changes over successive generations, while the latter refers to the adaptation effects that persist during the lifetime of the animal. It is perhaps the genotypic adaptation that will ultimately help animals overcome the challenges due to changes in climate patterns.

Water is a vital requirement for all living organisms. There are genetic differences in animals with regard to water turnover. Goats require less water than sheep, and sheep require only half of the water requirement of cattle. In case of dry weather, or in case of dehydration, animals pass out concentrated urine and the fecal matter is passed out in the form of pellets.

In wool-producing animals, there is a greater demand for water during summer as in such animals there is a greater metabolic activity for synthesizing wool protein. Moreover, in many arid salty areas, sheep prefer to take such plants wherein the accumulation of salts is more, as the salt content of such plants rises 10% of the wet weight.

Heat is another factor that affects the health and productivity of the animal. During summer/heat stress, animals have adopted ways that help reduce their body metabolic rates and thus help in energy conservation. Such reduction is due to the stimulus of the afferent nerve impulse from the skin to the hypothalamic neuron that reduces the output of Thyroid Stimulating Hormone (TSH). This reduction of TSH reduces the output of thyroxin and triiodothyronine which determines the metabolic rate of an organism.

The blood vessels of the body are arranged in a manner that makes possible countercurrent heat exchange to take place. In such arrangements blood vessels are arranged to allow heat transfer between two sets of vessels in which the blood is flowing in opposite directions. Such arrangements allow the greatest heat transfer thereby thermally isolating the organ system protecting heat-sensitive tissues such as the brain and testes. Such mechanisms are also useful to prevent excessive loss of heat from areas that have a large surface area for heat exchange (e.g. the extremities).

Fur and fat also act as a medium of insulator in some mammals. Presence of fur in terrestrial mammals entraps air and reduces convective heat loss. But in case of aquatic mammals, due to high thermal conductivity of the liquid environment, the subcutaneous fat is used to reduce conductive heat loss e.g. subcutaneous fat (blubber) of whale. Such fat has a low melting point in order to remain in a liquid state at the temperature of water. Further heat loss of the blood flowing to the skin is minimized by drastic reduction of flow by constriction of blood vessels.

Endothermic species dwelling in hot and dry (xeric) environment (like the camel) have well developed body mechanisms to adjust themselves to

Presence of fur in terrestrial mammals entraps air and reduces convective heat loss. But in case of aquatic mammals, the subcutaneous fat is used to reduce conductive heat loss e.g. subcutaneous fat of whale.

their surrounding environment. In the hydrated camel the diurnal fluctuation in body temperature is 20° C, but this may increase to 70° C following water deprivation. The storage of heat allows the dehydrated animal to minimize the loss of water for the purposes of evaporative heat loss.

In addition to this, many species of animals that have a relatively small surface area and low metabolic rate can store the heat of the day and then dissipate it to the cool night sky without needing to invoke the use of water for thermoregulation.

Animals in hot climatic regions have thin light coloured skin/fur, a large surface area for heat exchange, and in some, subcutaneous fat stored in one subcutaneous area (the hump) rather than being distributed underneath the skin as in animals dwelling in cold climatic regions. The polar bear has an interesting adaptation in that the hair fibres are hollow which allows minimal penetration of solar radiation and minimal convective heat loss. However, in general, black-furred animals will absorb more heat than white furred animals. Interestingly, the skin under the black stripes of a zebra is hotter than the skin under the adjacent white stripes.

Other mechanisms for evaporative heat loss by animals and birds are panting, sweating, wallowing and spreading saliva. Small animal species like the dog, wolf, and jackal generally pant to compromise their heat loss. Such species inspire (to take in air) through the nostrils and expire (to give out air) through the mouth, making a highly efficient, unidirectional system. Protrusion of the moist tongue enhances the surface area available for evaporation.

Some animals show closed-mouth-panting, and the marine mammals use thin flippers to regulate their body temperature. Some birds (like members of the heron family) bring air in and out of the upper respiratory tract for humidification by rapid contraction of the gular region known as gular fluttering while some severely heat-stressed birds show closed mouth panting. The sweating mechanism is more important in large species (like cattle and horses) than in smaller species.

Animals that have a thick subcutaneous fat, like pig and other porcine species depend on wallowing for evaporative heat loss like that of elephants. Some species of rodents and some macropod marsupials spread saliva on the fur when they are heat-stressed and thus adjust themselves to the surrounding heat.

Cold environmental surroundings also affect the health of the animals. At lower critical temperature, the body heat production is increased in order to maintain a constant body temperature. This is done by huddling to reduce the surface area for evaporation. In addition to this, animals like human beings have adapted mechanisms like non-shivering and shivering thermogenesis (heat production) to adjust themselves to the cold stress.

A special type of fat called brown fat is typically found in the subcutaneous region between the scapular and in the region of the kidneys as well as within the myocardium in bats, hibernating animals and in smaller species. This fat is also present in the newborn of many species and disappears within the first few months of life. Oxidation of this fat within the cells yields heat which involves non-shivering thermogenesis and is important for arousal from the hypothermia (a condition in which the body's core temperature drops below that required for normal metabolism and body functions) of hibernation as shivering thermogenises is diminished.

But birds such as hummingbirds do not possess brown fat, and so they use shivering thermogenesis assisted by basking behaviour.

Some animal species like humans undergo involuntary contraction of the skeletal muscle (called shivering thermogenesis) to adjust themselves to the cold environment. Since no external work is done, all degradation of substrate is transformed into heat. Shivering includes large muscle masses as well as the jaw muscles.

For some small species of birds and bats, which are unable to ingest enough food in a 24-hour period to sustain their basal metabolic rate as well as to meet their energy cost, the regulated body temperature is reduced, thereby reducing the metabolic rate and energy expenditure.

But, eventually, it is humans who have to keep assaults on the environment to the minimum so that future climates are not drastically affected and animals get slowly and steadily adapted to changing patterns. Otherwise it will spell the death knell for many species.

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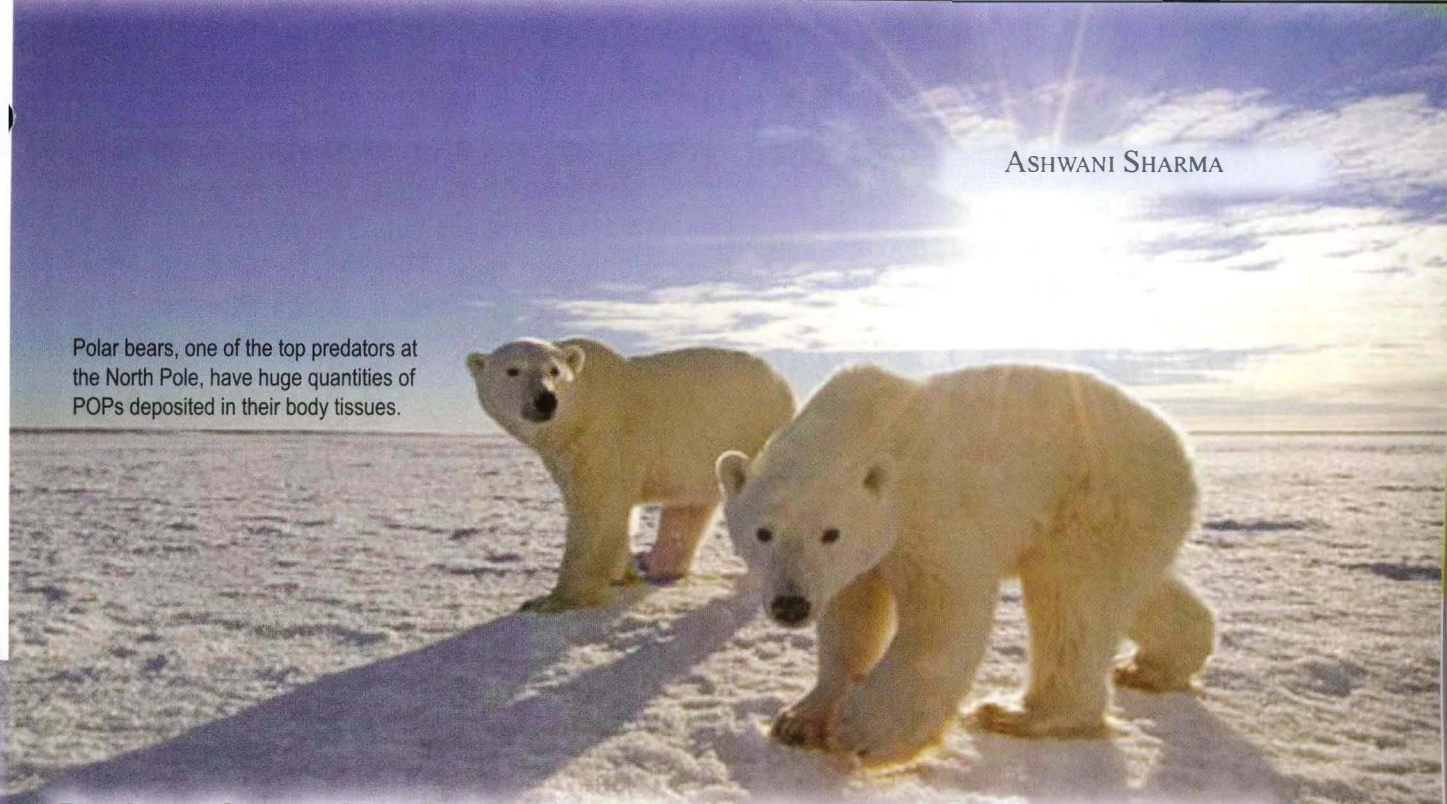
ASHWANI SHARMA



Polar bears, one of the top predators at the North Pole, have huge quantities of POPs deposited in their body tissues.

Persistent Organic Pollutants are found in air, water and soil and can cause cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, and reproductive disorders. The Stockholm Convention seeks to regulate their production.

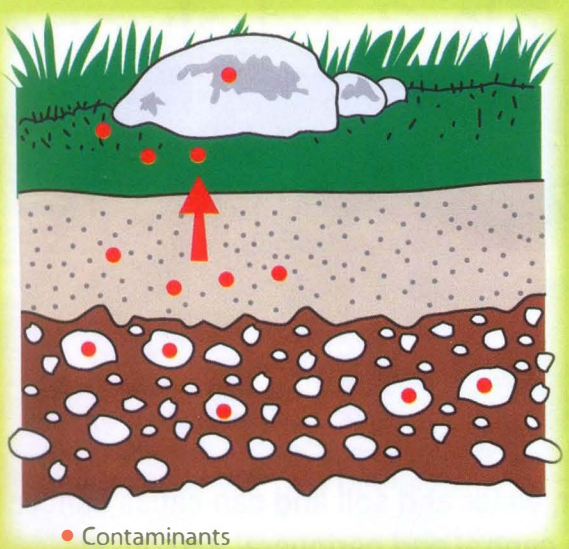
Planet in Peril: POPs!

PERSISTENT organic pollutants (POPs), as the name suggests, are pollutants which once released into the environment stay intact for long periods of time resisting degradation. They have been found to be highly toxic to both humans and wildlife.

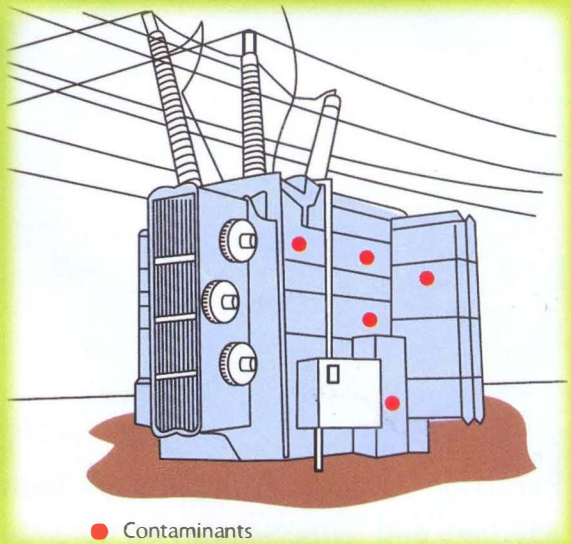
POPs are carbon-based organic compounds mostly containing chlorine and which become widely distributed throughout the environment as a result of natural processes involving soil, water and, most notably, air. They accumulate in the fatty tissue of living organisms including humans and are found at higher concentrations at higher levels in the food chain.

POPs may also be transported over long distances by air, rivers and ocean currents, and contaminate regions far from their sources. Given that POPs are ubiquitous in the environment, human are exposed to these pollutants through diet, air, adsorption through the skin, occupational exposure and transfer from mother to the fetus. Specific effects of POPs can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system. Some POPs are also considered endocrine disrupters, which, by altering the hormonal system, can damage the reproductive and immune systems of exposed individuals as well as their offspring.

POPs can be absorbed by plants, wildlife and people. POPs are stored mostly in fat. Animals that only eat plants and are naturally lean do not accumulate POPs.



PCBs were manufactured mostly for use in electrical equipment, and were also added to paints and asphalt. Their use was phased out during the mid-1970s; however, it is still present in old power type transformers.



Convention is applicable only with respect to the following chemicals that fall into three categories, some of which fall into more than one category, namely:

- *Pesticides: Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene (HCBs), Mirex, Toxaphene;*
- *Industrial chemicals: HCBs, Polychlorinated biphenyls (PCBs); and*
- *By-products: HCBs; Polychlorinated dibenzo-p-dioxins and Polychlorinated dibenzofurans, and PCBs*

The accumulation and deposition of POPs in fatty tissue is the heart of the problem. They pose serious threat to predators at the top of the food chain than those at the bottom. POPs have a tendency to concentrate in living organisms through a process known as bio-concentration. Bio-concentration and bio-magnification are associated with bioaccumulation, which refers to the accumulation of chemical substances, such as pesticides, or other organic chemicals in an organism. Bioaccumulation occurs when an organism absorbs a toxic substance at a rate greater than that at which the substance is lost. Bio-magnification refers to the tendency of pollutants to concentrate as they move from one trophic level to the next. In other words, bio-magnification is the increase in concentration of a pollutant from one link in a food chain to another. Thus, bio-concentration and bioaccumulation occur within an organism, and bio-magnification occurs across trophic (food chain) levels (Figure 1).

Many POPs were widely used during the post-World War II industrial production, when thousands of synthetic chemicals were synthesized and introduced into the environment for commercial exploitation. These substances have been used mostly in agriculture and industrial processes.

There are two categories of POPs in terms of their production – intentional and unintentional. Intentionally produced POPs are those produced for the purpose of being used in manufacturing, agriculture, pest/disease control, or other industrial uses. Unintentionally produced POPs are those that are essentially byproducts of industrial processes or combustion (for example, municipal and medical waste incineration and backyard burning of trash).

POPs in the Environment

POPs are discharged into the environment through various processes which may possibly include: release during the production process, at some point in use (e.g. pesticides), or unintentional emissions during combustion processes (e.g. dioxins/ furans).

Once released into the environment these highly stable POPs circulate globally through a repeated process of evaporation and deposition, and are transported through the atmosphere and the oceans to regions far away from the original source. Global circulations play an important role in translocation of POPs.

Atmosphere is the main transport media for the global distribution of POPs in the environment, only days to weeks being necessary for an air bundle to mix completely in the northern hemisphere, while the transport times of ocean currents can be measured in years and decades. However, ocean currents do play a significant role in transfer of relatively soluble compounds. Even the less soluble molecules are transported through the aquatic media when adsorbed on particles.

Because several physico-chemical properties governing the environmental

The Ministry of Environment & Forests (MoEF), Government of India is the nodal agency for planning, promoting and coordinating environmental programmes in India. MoEF is also the Stockholm Convention focal point in the country.

fate of POPs are temperature dependent, the atmospheric transport of POPs should be seen as single-hop pathways (a compound is emitted to the atmosphere, transported and deposited to the earth's surface, never to return to the atmosphere) or multi-hop pathways (a compound reenters the atmosphere after initial deposition on the earth's surface, and travels long distances via subsequent multiple atmospheric hops. This phenomenon is also referred to as the global distillation effect (Figure 2) or the grasshopper effect (Figure 3).

POPs can thus undertake several cycles of deposition and reemission. It is because of this, POPs such as DDT and PCBs have now been reported even near Mt Everest!

Stockholm Convention on POPs

Considering the cross-boundary pollution problem, international cooperation and efforts resulted in creation of a United Nations treaty in Stockholm, Sweden, in May 2001. Under this treaty, known as the Stockholm Convention, countries agreed to reduce or eliminate the production, use, and/or release of 12 key POPs, the so called dirty-dozen, and specified under the Convention a scientific review process that has led to the addition of other POP chemicals of global concern.

Phase-out and control of POPs is one of the predominant facets in implementing the Stockholm Convention. The Convention is a global treaty to protect human health and the environment from highly dangerous, long-lasting chemicals by restricting and/or eliminating there production, use, trade, release and storage. The Convention was adopted on 23 May 2001 and came into force on 17 May 2004.

Figure 1. **The concept of bio-accumulation and bio-magnification vis-à-vis food chain** *(Source: Seathos)*

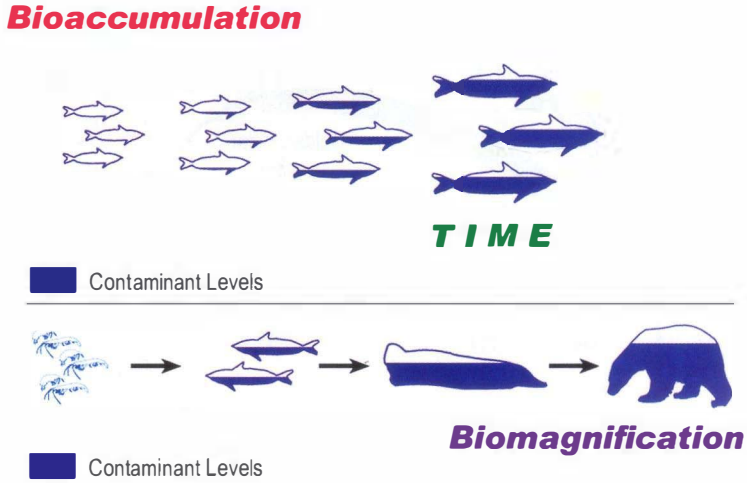
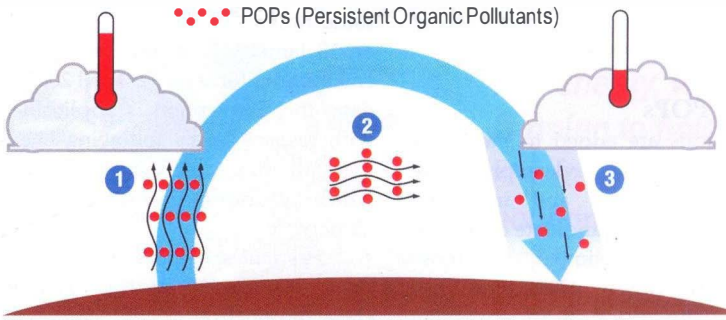


Figure 2. **The global distillation effect** (Source: POPs Canada)



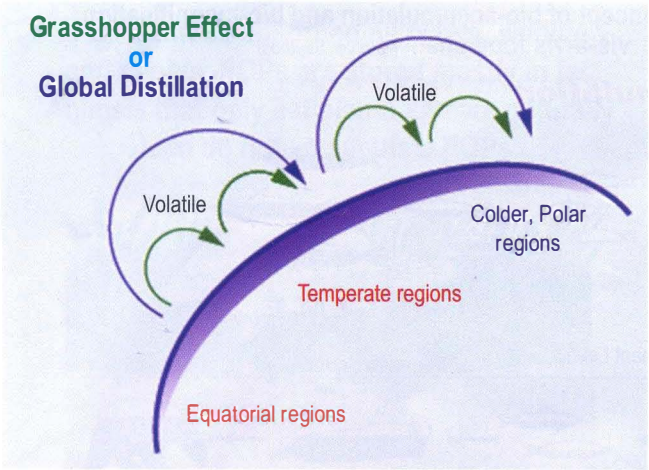
1. In warm temperatures POPs evaporate
2. POPs move in air by winds to cooler places such as the North
3. In cold temperatures POPs condense and fall to earth

As on date, including India there are 179 Parties to the Convention. Afghanistan is the latest Member State joining the Convention. The Convention has initially placed obligations on the Parties for 12 chemicals to take appropriate measures (legal and/or administrative) to eliminate or heavily restrict their production and use thereby reducing the risks to human health and the environment arising from their release.

Under the Convention, POPs are listed under various Annexes of the Convention, namely: Annex A (elimination); Annex B (restriction); and Annex C (unintentional production). For chemicals under Annex A, Parties are required to take measures to eliminate the production and use of the chemicals listed under Annex A. Specific exemptions for use or production are listed in the Annex and apply only to Parties that register for them. India never sought specific exemption for the production and use of chemicals listed under Annex A.

The Parties are also required to transmit the implementation plan to the Conference of Parties (COP) within two years of the date on which the Convention enters into force for it. India submitted its NIP to the Stockholm Convention in April 2011.

Under Annex B, Parties are required to take measures to restrict the production and use of the chemicals listed under Annex B in light of any applicable acceptable purposes and/or specific exemptions listed in the Annex. Specific exemption with respect to DDT has



POPs may also be transported over long distances by air, rivers and ocean currents, and contaminate regions far from their sources. Given that POPs are ubiquitous in the environment, human are exposed to these pollutants through diet, air, adsorption through the skin, occupational exposure and transfer from mother to the fetus.

Figure 3.

been provided to India for its use under acceptable purposes.

For Annex C chemicals, Parties are required to take measures to reduce the unintentional releases of chemicals listed under Annex C with the goal of continuing minimization and, where feasible, ultimate elimination.

The New POPs

New chemicals are added to the treaty based on a scientific review procedure that involves Parties and interested observers to propose candidate chemicals having properties similar to those of POPs. In August 2009, nine new chemicals were added in an agreement and came into force a year later. In April 2011, endosulfan became the 22nd POP.

During the sixth meeting, held in May 2013, Hexabromocyclododecane (HBCD) was included as 23rd POPs. The amendment for the listing of HBCD to Annex A of the Stockholm Convention will enter into force on 26 November 2014 for most Parties. Thus, the jurisdiction of the Stockholm Convention now covers 23 substances that have properties and characteristic of POPs.

The Convention is already in the process of reviewing some of the candidate POPs, such as short-chained chlorinated paraffins, chlorinated naphthalenes, hexachlorobutadiene, pentachlorophenol, dicofol, and decabromodiphenyl ether for their inclusion in various Annexes of the Convention having toxicity similar to those of the classic chlorinated POPs.

India, however, is yet to ratify the Stockholm Convention with respect to the new chemicals added to the convention. Till such time, provisions of the Convention would only be applicable to the initial 12 POPs.

India and the Stockholm Convention

India actively participated in the International Negotiation Committee meeting leading to the drafting and acceptance of the Stockholm Convention. India ratified the Stockholm Convention on 13 January 2006 and the Convention entered into force on 12 April 2006. As on date, the Convention is applicable only with respect to the following chemicals that fall into three categories, some of which fall into more than one category, namely:

- ***Pesticides:*** Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene (HCBs), Mirex, Toxaphene;
- ***Industrial chemicals:*** HCBs, Polychlorinated biphenyls (PCBs); and
- ***By-products:*** HCBs; Polychlorinated dibenzo-p-dioxins and Polychlorinated dibenzofurans (PCDD/PCDF), and PCBs.

The Ministry of Environment & Forests (MoEF), Government of India is the nodal agency for planning, promoting and coordinating environmental programmes in India. MoEF is also the Stockholm Convention focal point in the country. MoEF is empowered to promulgate rules under the Environment (Protection) Act, 1986 and is responsible for ensuring effective implementation of legislation, monitoring and control of pollution (including pesticide levels in soil and water), environmental clearances for industrial development projects, promotion of environmental education, training and awareness, and coordination with concerned agencies at the national and international level.

As on date, six out of ten chemicals namely – aldrin, chlordane, dieldrin, endrin, heptachlor and toxaphene—are banned. The use of DDT was banned in agriculture in 1990; however, its use is regulated and permitted only under the disease vector control programme of the Ministry of Health and Family Welfare, Government of India as per World Health Organization (WHO) guidelines till viable alternatives are found.

The other three chemicals namely HCB, mirex and PCBs are yet to be regulated as there is no national legislation for regulation of these chemicals. HCB is a pesticide (fungicide), an industrial chemical and is produced unintentionally during chemical reactions. HCB and mirex were never registered and used as pesticides in India. PCBs are currently being used in India, however, but were never manufactured here; the requirements of PCBs for numerous applications were met mainly through imports from Russia and Japan.

Under the Stockholm Convention, Parties are required to endeavor and develop a National Implementation Plan (NIP). The Parties are also required to transmit the implementation plan to the Conference of Parties (COP) within two years of the date on which the Convention enters into force for it. India submitted its NIP to the Stockholm Convention in April 2011.

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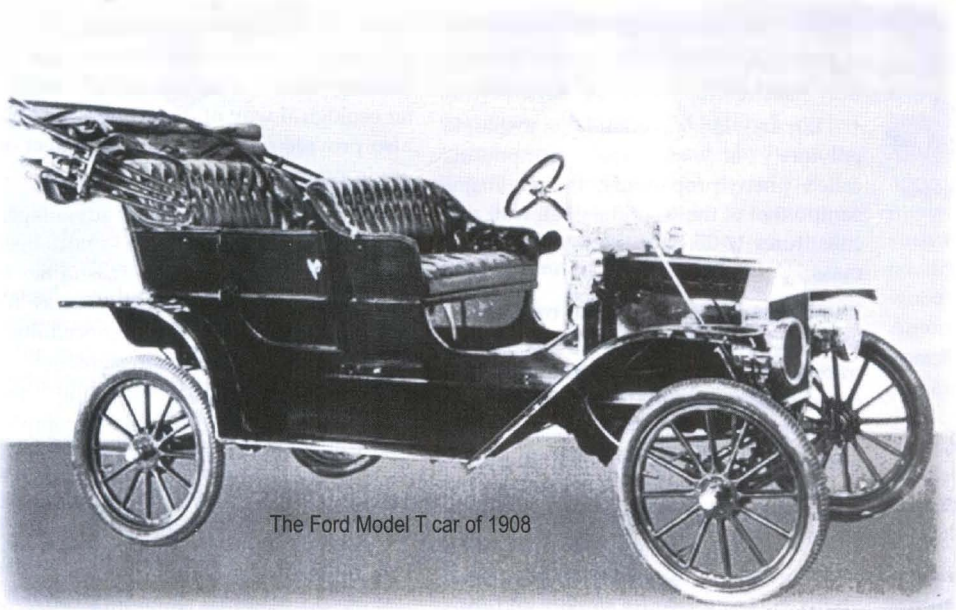
Fuel of the Future

MONIKA DALAL

Ethanol from lignocellulosic biomass provides a renewable, sustainable, and green energy alternative for fossil fuel. Efforts are being made to make lignocellulosic ethanol a viable option for liquid fuel energy, which is going to hold the key for a country's economy in the days to come.



The Ford Model T car of 1908

CONCERN over global climate change and depleting fossil fuel resources has driven the search for environment friendly, renewable and sustainable energy resource. Use of ethanol as liquid fuel energy offers an alternative.

Ethanol can be blended with petrol or diesel (e-diesel, ethanol mixed diesel), it has higher octane number and higher heat of vaporization. The history of ethanol as a biofuel dates back to 1826 when it was used to power an engine. Later Henry Ford, in 1896, designed his first car, the Quadricycle to run on pure ethanol followed by the famous Ford Model T capable of running on ethanol, gasoline or a combination of both in 1908.

In modern times, ethanol first became a component of fuel as oxygenate and replaced methyl tertiary-butyl ether (MTBE), which causes environmental pollution and health hazards. Now ethanol has been seen as an alternative to liquid fossil fuel and as "green energy". It was in Brazil in the 1970s that ethanol got a major boost as liquid fuel energy.

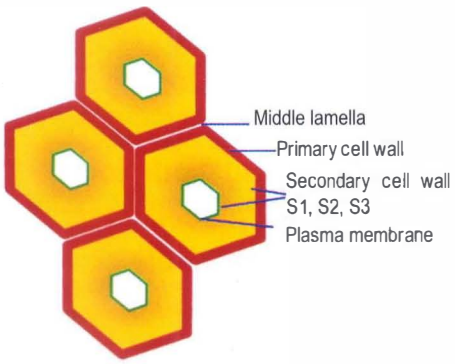
The problem associated with pure ethanol as fuel is that it cannot be transported in pipes, and engines cannot run on pure ethanol, because hydrophilic ethanol corrodes the metal. However, ethanol can be mixed up to 85% and the automobile companies are also making flex-fuel vehicles (FFV) that can use both petrol and E85 (85% ethanol & 15 % petrol) and now even E100 dedicated vehicles are also being designed.

Fuel ethanol, also known as first-generation biofuel, comes primarily from sugarcane and starch-rich sources such as corn grains, potato, etc. The United States of America is the front-runner with about 52.6 billion liters, followed by Brazil with 21.1 billion liters of ethanol production in 2011.

In USA, the prime source of ethanol is corn grain, while sugarcane is being used in Brazil. The use of grain for biofuel production requires large cultivated land and competes with food, resulting in food price rise. Moreover, it has a high feedstock value and covers only a percentage of fossil fuel requirements.

This paved the way for the second-generation bioethanol known as lignocellulosic or cellulosic ethanol. Lignocellulosic ethanol is derived from biomass, which mainly consists of cell walls harvested from agricultural or forest residues such as stover from corn and sorghum, straw from wheat and rice, Bagasse from sugarcane and sweet sorghum, or dedicated bioenergy crops such as Switchgrass (*Panicum virgatum* L.), Elephant grass (*Miscanthus*

Source of lignocellulosic biomass – rice, wheat and sorghum



Schematic presentation of cell with its different layers of primary and secondary cell wall

giganteus) and even sorted municipal waste.

Plant cell walls are dynamic and chemically complex structures surrounding the cells. Cell walls define the cell size, shape, and structural integrity of the plant and defend against biotic and abiotic stresses. Depending on the age and tissue type, the cells may have primary as well as secondary cell walls.

Cell wall composition varies with taxa, age, cell, and tissue type. There are three major components of a cell wall namely cellulose, hemicelluloses and lignin.

- Cellulose is a polysaccharide, a linear polymer of glucose in which glucose residues (2000-20,000) are linked by alpha 1, 4-glycosidic linkage. It exists in the form of microfibrils, which are several glucan chains bound together through hydrogen bond along their length. Cellulose is the most abundant molecule on earth. It is produced by all the living plant cell and constitutes 15-30% of the dry mass of the primary cell walls and up to 40% in secondary cell wall.

- Hemicelluloses are highly branched polysaccharides and cross-link the cellulose microfibrils. It is a heteropolymer of pentoses, hexoses and sugar acids and constitutes 20-40% of the cell dry mass.

- Lignin is a complex insoluble polymer of aromatic compounds called phenylpropanoids. It is a major component of the secondary cell wall and constitutes 10-25 % of the total plant dry mass.

Lignocellulosic content of the cell walls is a rich source of solar energy trapped as carbohydrates and therefore could make a significant contribution to liquid fuel demand. The advantages of using lignocellulose include abundant renewable supply, eco-friendly, sustainable with limited conflict for cultivable land, food and feed production and raw material (biomass) is widespread, and it does not require import and thus can bring self sufficiency.

Let's take an example of rice and wheat that are the most widely grown crops in the world. As per FAO statistics,

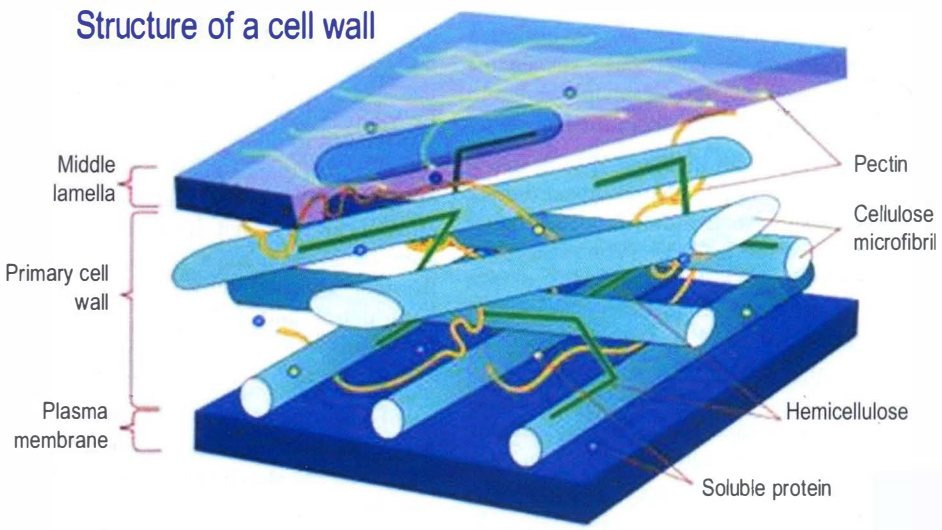
Sugarcane still rules the biofuel chart because it has potential to be used as both sugar based and biomass based biofuel.

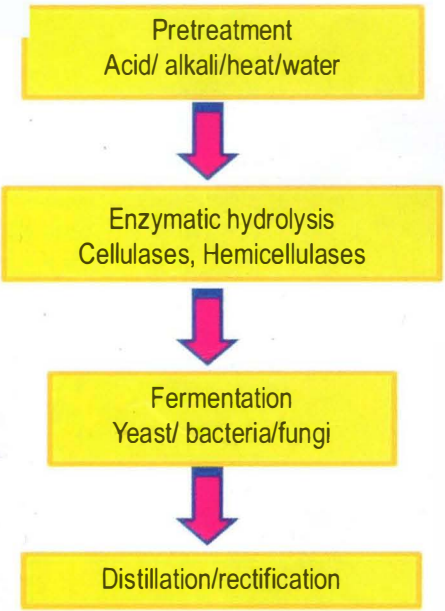
India's annual production of wheat and rice in 2011 was about 156 and 87 million tons respectively. Assuming a residue per crop ratio of 1.3, a total of 315 million tons of rice and wheat straw was produced. Even if a part of this straw was kept as cattle feed, left on field or used for other activities, a major portion is usually burned which again is a source of environmental pollution. If this remaining biomass residue were used for making ethanol, it would not only become an ecological way of disposing waste but also provide fuel with minimal effect on environment.

In spite of so many advantages, lignocellulosic ethanol has not been able to come up front. The reason lies in its processing. A standard process for producing ethanol from lignocellulosic biomass includes four main steps:

1. Pretreatment — loosening and de-structuring of the complex lignocellulosic matrix
2. Enzymatic hydrolysis/ saccharification — breaking down cellulose and hemicelluloses to simple sugars by enzymes
3. Fermentation — converting sugars to ethanol by yeast/ bacteria/fungi
4. Distillation/rectification — separating and purifying the ethanol.

Structure of a cell wall





Processing of lignocellulosic material for ethanol production

Brown midrib mutants of sorghum

The problem associated with pure ethanol as fuel is that it cannot be transported in pipes, and engines cannot run on pure ethanol, because hydrophilic ethanol corrodes the metal.

The steps 2 to 4 are common with ethanol production from starch/sugar. Pretreatment is the major limiting factor in the success of lignocellulosic ethanol production. The complex and rigid nature of the cell wall has evolved to protect the plants against adverse environmental and pathogen attacks, degradation and to give strength to the plant structure in general. This feature or property of the cell wall is a hindrance in pretreatment.

The crystalline nature of cellulose makes it impervious to hydrolyzing enzymes. The cellulose and hemicellulose can be broken down to sugars but lignin is recalcitrant to hydrolysis. Moreover, intricate cross-linking of lignin with cellulose and hemicellulose inhibits the hydrolytic enzymes and chemicals from accessing cellulosic components. Thus, degree of lignification as well as cellulose crystallinity and extent of its polymerization contribute to the recalcitrance of lignocellulosic biomass to chemicals or enzymes.

Since the composition of the cell wall differs from species to species, cell wall composition has been analyzed for the potential feedstocks so that appropriate pretreatments can be applied. Besides optimizing the chemical and physical pretreatments, efforts have also been made to optimize the cell wall composition and/or content by breeding and genetic engineering.

The genetic engineering approaches involve modulation of the lignin biosynthetic pathway to reduce the content or composition of lignin. Targeted expression of cell wall hydrolyzing enzymes has been carried out so that the cell wall hydrolysis can be programmed in plants and can be initiated at the desired time.

Besides, there are certain mutants known as brown midrib mutants, found in certain cereals such as maize, sorghum, pearl millet. These mutants are associated with altered lignin content/composition and increased in vitro digestibility and saccharification efficiency (glucose yields). In sorghum, these mutants are being crossed with high biomass sweet sorghum genotypes. This serves many purposes, the juice from sweet sorghum stalk can be directly used for fermentation, the bagasse and remaining biomass (stover) can be used for lignocellulosic ethanol and grain can be used for food or feed purposes.

Another variation and hurdle in lignocellulosic process is that unlike sugar or starch fermentation, lignocellulose hydrolysis yields mixed sugars containing six-carbon (hexoses) and five-carbon (pentoses) sugars as well as fermentation inhibitory compounds. The pentose sugars such as xylose and arabinose are not fermented by commonly used yeast (*Saccharomyces cerevisiae*) strains. Therefore, strains need to be modified or engineered to make them capable of utilizing various sugars or different microbes or fungi need to be identified and their optimum combination needs to be optimized for increasing the efficiency.

If feedstock is to be cultivated then they need to be more efficient for land, water and nutrient use. At present, sorghum and maize have the potential of being bioenergy crops. However, maize is a higher input crop than sorghum. Moreover, sweet sorghum fits more appropriately in the bioenergy crop model. There are other biomass crops such as the fast-growing perennial grasses (switchgrass and giant miscanthus), and woody crops (poplar and shrub willow). Among these, miscanthus and switch grasses gain points over poplar, as these are C4 crops with higher water and nutrient use efficiency, and can be grown on marginal lands. The C4 crops may be good for tropics and lands with low water availability while temperate regions can benefit from woody C3 plants like poplar.

Sugarcane still rules the biofuel chart because it has potential to be used as both sugar based and biomass based biofuel. As far as other crops are concerned, there is a need to maximize the biomass yield per hectare, bring sustainability with minimum input and pose least competition with food or feed. For overall success of lignocellulosic ethanol, all the dicsciplines including biology, chemistry to engineering to economics need to work together to make it an economically viable alternative to fossil fuel.

Ethanol is the prime candidate in the renewable liquid biofuel market and with all its advantages lignocellulosic ethanol holds the key for the future especially for a country like India that has a primarily agriculture-based economy.

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"Climate Change ...."

Gregory V. Jones is a professor and research climatologist in the Department of Environmental Studies at Southern Oregon University, USA who specializes in the study of climate structure and its suitability for viticulture, and how climate variability and change influence grapevine growth, wine production and quality. He conducts applied research for the grape and wine industry in Oregon.

He is author of numerous book chapters, including being a contributing author to the 2008 Nobel Peace Prize winning Intergovernmental Panel on Climate Change Report, and other reports and articles on wine economics, grapevine phenology, site assessment methods for viticulture, climatological assessments of viticulture potential, and climate change. He was recently named to Decanter magazine's 2009 Power List representing the top 50 most influential people in the world of wine and the Oregon Wine Press's 2009 Wine Person of the Year, and has been in the top 100 most influential people in the US wine industry in 2012 and 2013 (intowine.com).

Gregory spoke with **Jaimini Sarkar** on climate change and its effects on viticulture.

Jaimini Sarkar: Your area of work has been climate change and its effect on crops. A section of scientists claim global warming is just hype. What do you say?

Gregory V. Jones: The 'section of scientists' that claim that global warming is just hype is very small. Yet, a small few can gain tremendous media coverage because it generates controversy and sells! The issue is that the vast majority of climate scientists (over 95%) believe climates are changing and that humans are playing an increasing role in the process.

Jaimini Sarkar: How do you perceive the world agriculture scenario changing as climate changes?

Gregory V. Jones: Complicated, mainly because of how different crop systems respond to changes in climate, but also because climate does not change the exactly same everywhere.

Jaimini Sarkar: Do you think there is not going to be much of an overall change, as far as agricultural production is concerned, as it gets averaged out due to varying changes in different parts of the world?

Gregory V. Jones: I think it varies by region and by crop. Some crops have a much greater range in climates that they can produce in, while others have very narrow ranges. So small changes in one region may have not much impact right away for some crops, but for others the impacts could be very severe.

Jaimini Sarkar: Can you give us some idea of the type of changes envisaged in this part of the world?

Gregory V. Jones: While I am not an expert on India and south-east Asia, much of the research points to clearly warmer conditions projected over the next century. However, the challenge will be much greater in terms of rainfall and whether it is consistent in the future or has strong variability. Some research is projecting that the monsoons may become more variable in the future; if this is the case then many crops will suffer and it will be hard for many growers to deal with the loss of natural water inputs.

Jaimini Sarkar: You have done a lot of work on grapevine. What is the ideal climate for the growth of grapevine?

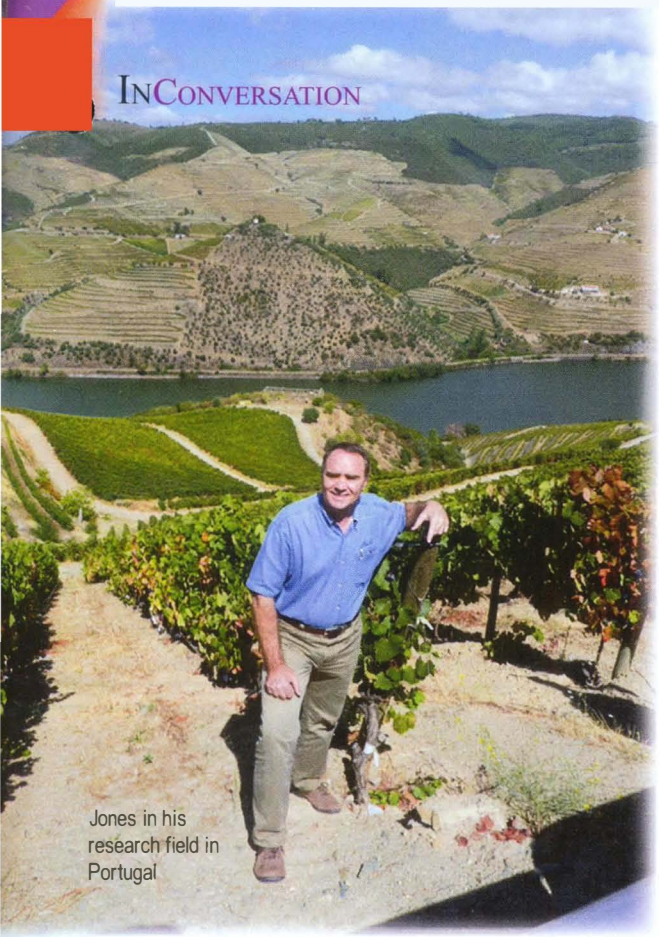
Gregory V. Jones: It depends on the variety, but typically a climate that provides moderate winter chilling and precipitation, followed by warm, sunny springs with low risk of frost, followed by warm dry summers that allow the vine to ripen the fruit, and then a cool, dry fall that allows for the maturation of the grapes to sugar, acid, and flavors that produce quality wines.

Jaimini Sarkar: How is climate change predicted to impact the cultivation of grapevine?

Gregory V. Jones: Mostly through warmer growing seasons, more rapid plant growth cycles, and altered ripening profiles. However, changes in precipitation could be problematic as well with increased heat and loss of rainfall leading to more heat stress and unbalanced vines and fruit.

Jaimini Sarkar: How is the European wine industry/viticulture different from Indian viticulture?

Gregory V. Jones: The mid-latitudes of Europe simply offer a wider range of climates that are conducive to viticulture



Jones in his research field in Portugal

"... While I am not an expert on India and south-east Asia, much of the research points to clearly warmer conditions projected over the next century. However, the challenge will be much greater in terms of rainfall.."

"I also have become increasingly aware of the role that climate variability plays in agriculture and am examining ways in which we can increase our ability to provide seasonal forecasts to growers."

and wine production. India has some zones that are suitable, but they are more limited in area because the country does not have the same amount of land mass at the latitudes that provide the more ideal climates. Also the landscape to the north in India is dominated by the Asian landmass and the role that monsoons play in the climate. Europe just does not have this as an issue.

Jaimini Sarkar: Vitis vinifera, the common grape vine, native to an area ranging from Western Europe to the Persian shores of the Caspian Sea, shows high levels of adaptability and will sometimes mutate to accommodate a new environment after its introduction. How this characteristic of the plant can be used by Indian farmers to cope up with changing climatic conditions in India?

Gregory V. Jones: I am not sure that genetic mutation is what would be the answer for Indian viticulture. I would think that the best thing to do is to 1) find the best sites with good landscapes and soils that have the most suitable climate with low risk of frost, freeze, hail, heavy rain, etc., and 2) match those climates to varieties that are known to perform in other areas of the world that have similar climates. I do think that some plant breeding might help find new varieties that could be better suited to different climates in India, but this requires research and a strong breeding programme that can provide information back to the growers.

Jaimini Sarkar: Nearby lakes and rivers can serve as protection for drastic temperature drops at night by releasing the heat that the water has stored during the day to warm the vines. But if there is drought in the neighboring districts/area, how does it affect the vineyards?

Gregory V. Jones: Lakes and rivers can provide some protection from frosts and freezes, but a poor site that is frost prone may not be helped much at all. So a good site is critical anywhere. Drought is problematic in different ways depending whether irrigation is used or not. If irrigation is used then the demands for water from urban society needs will likely impact irrigation amounts and result in stressed growing conditions. If the vineyards depend on natural precipitation and there is a drought, then the vines could suffer drought and potentially heat stress, making it hard to produce a crop.

Jaimini Sarkar: In India, the state of Maharashtra contributes to 85% of the Indian wine industry. However, according to the India Meteorological Department, Pune, over the last 106 years, climate has shown a changing pattern in Maharashtra. Every year there is rise in temperature and rainfall is very heavy in the first 2-3 months of monsoon. How will this change affect the wine industry?

Gregory V. Jones: Warmer temperatures may have both good and bad effects on wine production. If the temperatures warm to make it more suitable for some varieties, then the grower has a better chance for some varieties to ripen. However, if it gets too warm then it may become increasingly difficult to ripen balanced fruit due to heat stress. If the monsoon timing and amounts bring more rainfall during critical growth stages of the vines, then disruption of flowering or disease could become a problem.

Jaimini Sarkar: What would be your advice to Indian farmers to cope up with the consequences of climate change?

Gregory V. Jones: The first issue would be to stay aware of how climates change and how they have changed in their own regions. Adaptation will be very important and if a farmer does not know how the climates are changing, then understanding how to adapt is very difficult. Also it is important to seek out information on the crop such that current research can help innovate or adapt the crop system to a changing climate.

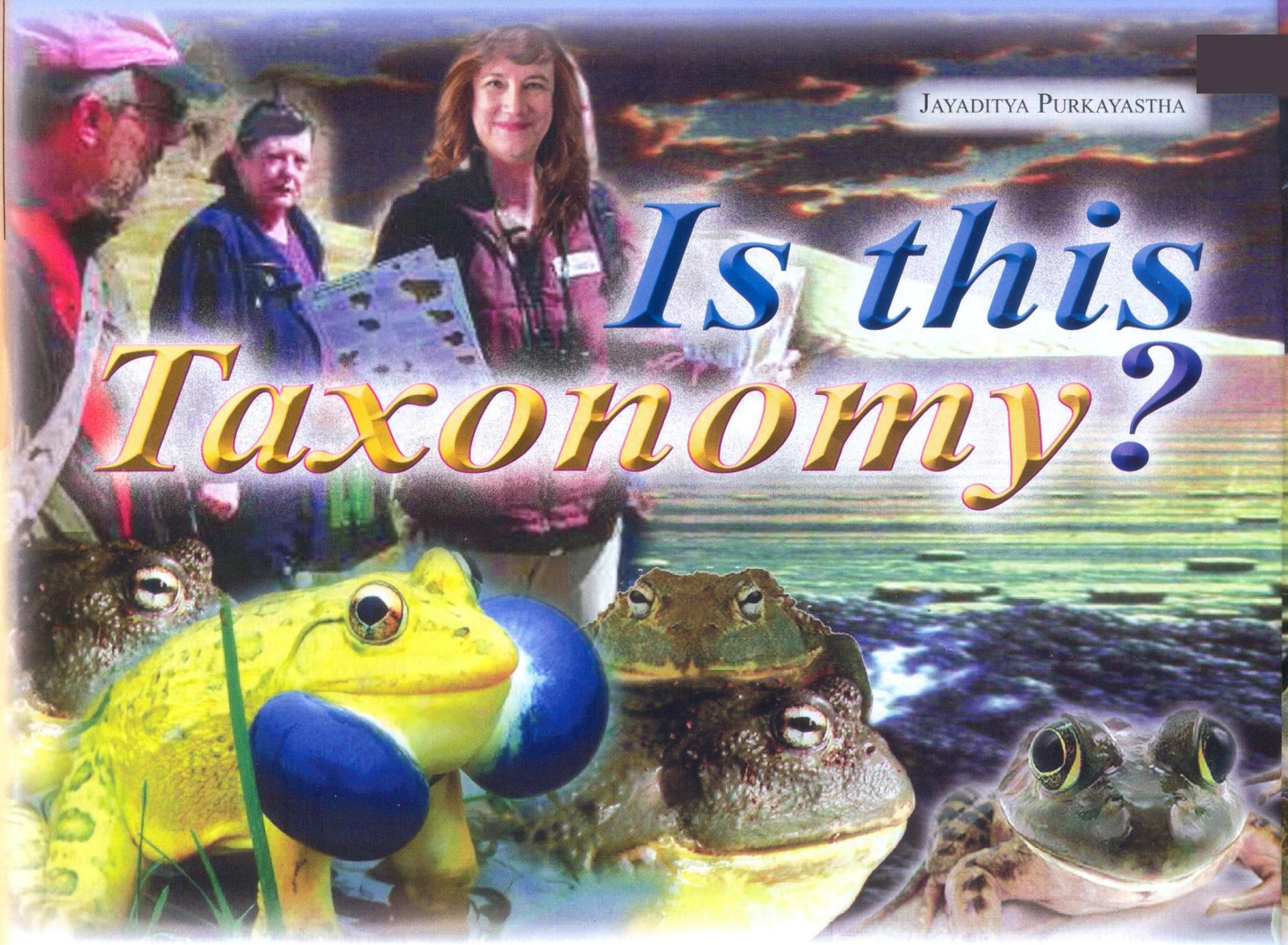
Jaimini Sarkar: What are the future areas that you plan to study?

Gregory V. Jones: I am looking at new regions, like China and India, in terms of how the climate structure there makes the regions either suitable or not suitable to growing grapes. I also have become increasingly aware of the role that climate variability plays in agriculture and am examining ways in which we can increase our ability to provide seasonal forecasts to growers.

Dr. Jaimini Sarkar is a freelance science writer. Address: 147, M.H.B. Building-3, Near Suyog chs, Shiv-Vallabh Road, Ashokvan, Dahisar (E), Mumbai-400066, Maharashtra; Email: jaimini_dhane@hotmail.com

JAYADITYA PURKAYASTHA

Is this Taxonomy?



In a desolated island "Croakisland", far from traces of humanity, lived a family of bullfrogs. This was a joint family, where everybody cried when one was in pain and indulged in merry making on one's success.

Crock, the eldest of the group and the most experienced, lived in the southern part of the island "Frogsburg" throughout his life. He gave up his personal life for the sake of the family. Kwak, cousin of Crock, was a little younger than him and was a traveler. He had travelled the entire length of the island and was presently compiling a book on his travelling experiences.

He has bags filled with fascinating stories for the froglets. When froglets are with him time flies. A brave heart, he was also an accomplished singer, entertainer in the truest sense of the term! Every night he used to give singing lessons by the pool side.

This island was a part of the mainland which recently got detached by a devastating earthquake. Kwak lived at the bridge of the island and had lost his wife during the earthquake. He now has 68 motherless kids to look after. Any single father would know how tough it is to raise a single kid and poor Kwak had quite a handful.

On knowing Kwak's condition Crock summoned him and asked him to be a part of their family. So, now Crock had a brother who could share his responsibility in guiding the next generation.

All was going very well in Frogsburg, love and mutual care were the order of their life. The family lived together, and grew together.

But thousands of miles away, another animal was planning to change it forever.

Stephanie Hues is the world's leading amphibian expert from USA. She and her team have found out many new species of amphibians from the untouched parts of the world. She is often referred to as the frog mother for her contribution to this field.

Of late, she has joined Jim Harold of Germany who is an expert in molecular studies and Erapalli Sreesant of India, an expert in statistics. "Systematics in light of modern technology available is a better systematic," says Stephanie. "Molecular studies and statistical analysis help us resolve taxa-specific confusions. New species are always better for conservational measures. In last two years itself our team has discovered amphibians more than any time before. Thanks primarily to these two techniques, statistics and molecular biology, now we look forward to go to Croak Island and unveil its amphibians."

Very soon the team reached the farfetched island, a totally undisturbed place ...until now... The team plotted their survey sites on the map and started their expedition. Within a week they discovered eight new species of amphibians, differently coloured and differently structured.

A very happy team now moved towards the southern part of the Island where our Crock and Kwak lived. This time too the frog mother again spotted these bull frogs, but unfortunately this was not a new species as this species is widely distributed in the mainland as well.

....the frogs looked perplexed towards the ocean as a sudden surge of wave came up. With the wave rose a beautiful human form... in tears! She was Mother Nature!.....

It was raining very hard. So, the disappointed team sat within the camp very tired and dejected as they could not find anything new.

Because of this incessant rain, some of the adults of Crock's family had developed throat problem. But Kwak, a strict teacher he was, made them attend the evening singing classes even with their sore throats. What could the poor froglets do, but to sing! The classes started and a few were really sounding out of tune.

Suddenly, Shelly the bio-acoustic expert of the team, jumped up and said, "Madam! I hear something new. It must be a new species. Let's record the call."

The whole night Shelly analyzed the call on her laptop and found that though the calls were almost the same, they differed in dominant frequencies from the mainland bull frogs. She reported this to the team leader the next morning. Now the team had something to work with.

Soon the team started catching frogs. They collected 36 frogs, Kwak was also trapped. On reaching the camp site they used the best of lighting equipment to see the frogs.

"Apparently they look same to me," said our statistician, who had spent so much time with frog people boasting on his capacity to identify frogs.

"Right you are!" said Stephanie "But you know looks can be deceptive, so now it is your turn to look beyond the looks. Within

Suddenly, Shelly the bio-acoustic expert of the team, jumped up and said, "Madam! I hear something new. It must be a new species. Let's record the call."

a day or two we will measure all the parameters and give you the data for you to analyze. We will have to euthanize them."

Well, euthanization is a glorified word for slaughtering. The process started and one after another frogs were being killed and measured. The sole driving force for the team was large sample size, more accurate date and publication in a high impact factor journal. Their main worry was continued funding from the "Droffur Large Grant Foundation"...

Our molecular man and statistician friend were working hard day and night to establish the fact that there was a cryptic species within them. Well, a cryptic species is one that nature cannot distinguish but humans can.

Finally, good news for madam from the molecular lab and statistician's desk: the team found two group of frogs supported by bioacoustics, molecular and statistical analyses. Our Kwak and a few others were in a group where as Crock's family were in another group. Kwak was similar to the frogs found on the mainland, while Crock and his family were given a new species status.

Soon, the team installed a board in Frogsburg: "Do not be fooled, here we have two species of bulls."

However, this artificial demarcation brought about a division of hearts between Crock's and Kwak's families. The two families now in fight one another; they now believe that they are two different groups and so need to save their territories.

One day, while the two groups of frogs were busy fighting each other, the frogs looked perplexed towards the ocean as a sudden surge of wave came up. With the wave rose a beautiful human form... in tears! She was Mother Nature!

"My children, it is painful to see you fighting each other," she said. "Why are you engaged in this ruthless battle because of those humans? Who are they to decide....you know they themselves are a confused lot... what they call a distinct species today, tomorrow becomes a variant population. Humans are just a part of me as you are, with a little more brain power than you. When this added advantage was bestowed upon them, I thought they would use it to make the earth a better place. But as I now see, when less was the race educated, better was my condition. As they expanded their mental ability they ate away into my bones. What if you discover a new species, it hardly matters, what matters is these species are there. You increase the rate of discovery of new species and on the other hand you keep on adding to the list of threatened animals and plants, with more rapidity. In the name of science and preserving specimen, they are simply killing my children. Would you let yourself or your children be designated a proud holotype by some more advanced species?"

With these words the wave disappeared into the ocean. The frogs of Frogsburg realized their mistake and again started to live as one big family. They replaced the old board with a new one that said: "We are the bull and we know that."

Mr Jayaditya Purkayastha is pursuing his PhD (Zoology) at Gauhati University. Address: H. No. 16, Raghunath Choudhury Path, Lachit Nagar, Guwahati-781007; Email: mail.jayaditya@gmail.com

Prize Puzzle

NUMBER PUZZLE

A two-digit number is such that the sum of the two digits is 9 and the number formed by interchanging the digits is 9 more than the original number. What is the original number?

ANSWER: .....

Contributed by Rahul Bhowmick, Shib Nagar, PO Pradhan Nagar, Siliguri-734003

There are three prizes of Rs 500/- each for three correct entries. In case of a large number of correct entries, the prize winners will be selected through a draw of lots. The decision of the Editor, *Science Reporter* will be final.

Send your entries to:
Puzzle Corner
Editor, *Science Reporter*
National Institute of Science Communication & Information Resources (NISCAIR)
Council of Scientific and Industrial Research (CSIR)
Dr KS Krishnan Marg, Pusa Campus
New Delhi-110012

Last date for the entries to reach us: 05-07-2014

Name : .....
Address : .....
.....
..... Pin code: .....
Age : ..... Email: ..... Sex: .....

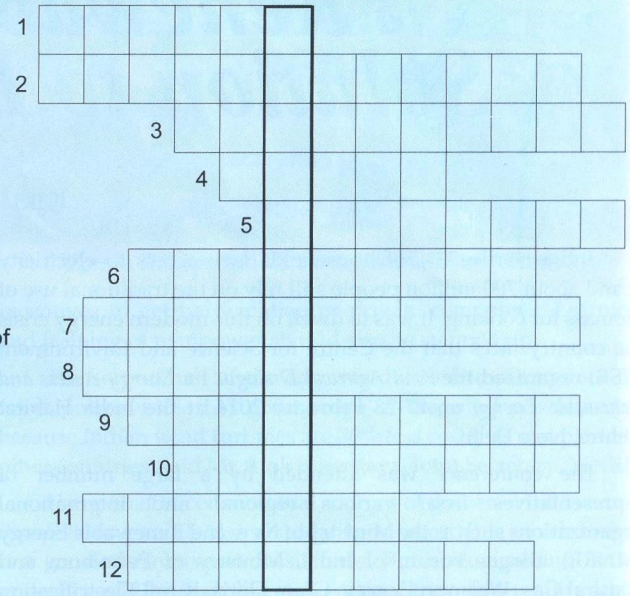
Occupation : ☐ Student ☐ Housewife ☐ Teacher ☐ Professional ☐ Retired ☐ Other

Educational level : ☐ Primary ☐ Secondary ☐ Graduate ☐ Postgraduate

- *Please fill up the questionnaire at the back*
- *You can send your answers on a photocopy of this page as well.*

THE TISSUE ISSUE

Using the clues, find the names or different terms related to the tissues of a plant and fill them in the horizontal boxes. After filling up the horizontal boxes the thick-lined vertical box will read the name of "the embryonic tissue in the mature plant body, the cells of which continue to divide indefinitely and as a result new cells are added continuously to the plant body".



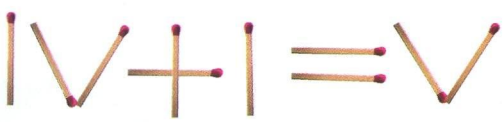
Clues:

1. Complex tissue responsible for conduction of the main organic food through the plant body.
2. Simple permanent tissue, consisting of mature non-living cells, possessing secondary walls and exhibiting elastic properties. The elongated cells often have simple or elongated pits over their walls.
3. Primary, permanent and simple tissue forms the ground tissue of plants. Consists of living, mostly isodiametric cells with intercellular spaces. Cells of this tissue are differentiated into two Chlorenchyma and Aerenchyma on the basis of presence of chloroplast and well-developed specialized intercellular spaces respectively.
4. Component of the sclerenchyma that functions in providing mechanical support to plants. Present in the testa of seeds of cotton, is economically very important.
5. Component of the scelerenchyma that occurs as idioblast in the pericarp of fruits such as Pyrus, Psidum, etc. On the basis of shape, size and nature of cell wall, this tissue is classified as Brachy, Macro, Osteo and Tricho.
6. Examples of external secretory structures usually containing nectar.
7. Complex tissue and a major component of the vascular bundle which conducts water and solutes throughout the plant body.
8. Simple, primary and permanent tissue, consisting of living cells with thick walls; has morphological and physiological relationship with parenchyma, therefore, commonly interpreted as a thick-walled type of parenchyma, structurally specialized as a mechanical tissue.
9. Specialized structure of the external secretory tissue, present at the leaf-margin and functions in exuding water droplets during conditions of low transpiration and high root pressure, a phenomenon often termed "guttation".
10. Specialized internal secretory tissue, secreting latex and can be classified as articulated and non-articulated.
11. Cellular plant tissue from which phloem, xylem, or cork grows by division, resulting (in woody plants) in secondary thickening.
12. Element of the xylem, of two types – tracheids and tracheae – and composed of non-living cells that function in transport of water as well as provide mechanical support.

Contributed by Arpita Nandan , 2, R.B. Nandan Main Road, P.O. Bansberia, Dist. Hooghly, West Bengal-712502; Email: nandanarpita@gmail.com

Solutions to the puzzles published in the April 2014 issue

Prize Puzzle: MATCH PUZZLE



MOON PUZZLE

1.	MARGARET	2.	HALIMEDE
3.	TITAN	4.	THYONE
5.	METHONE	6.	DESPINA
7.	CORDELIA	8.	DEIMOS

SUDOKU

E	G	F	H	I	C	D	B	A
B	A	C	F	E	D	G	I	H
D	H	I	A	B	G	C	F	E
C	I	E	D	H	B	A	G	F
H	B	G	E	A	F	I	D	C
A	F	D	C	G	I	H	E	B
I	E	A	G	F	H	B	C	D
F	C	B	I	D	A	E	H	G
G	D	H	B	C	E	F	A	I

The names of the prizewinners based on the draw of lots from among the correct entries are as follows:

1. Venkata Anusha (21 yrs), W/o S. Veera Sivaji, LIG-71, Housing Board Colony, Medchal, Ranga Reddy District, AP-501401
2. Beeran Kutty K.V. (61 yrs), 'BEEPAS', Opposite Court, Parappanangadi (PO), Malappuram (dist.), Kerala-676303
3. Ramesh Babu R. (52 yrs), Library, Sri Ramanasram, Tiruvannama

Congratulations all the winners!

REPORT

Anil Agarwal Dialogue on Energy Access and Renewable Energy

"Renewable Energy: Solution to Energy Crisis

KIRTI BANSAL

IN India nearly 33% of households lack access to electricity and about 700 million people still rely on the traditional use of biomass for cooking. It was to dwell on this modern energy crisis the country faces that the Centre for Science and Environment (CSE) organized the *Anil Agarwal Dialogue on Energy Access and Renewable Energy* on 27-28 February 2014 at the India Habitat Centre, New Delhi.

The conference was attended by a large number of representatives from various regional and international organizations such as the Ministry of New and Renewable Energy (MNRE), Biogas Forum of India, Ministry of Petroleum and Natural Gas, Welspun Energy, Gram Oorja, Rural Electrification Corporation, Central Electricity Regulatory Commission, Suzlon Energy, Indo-German Energy Programme, etc.

In her opening remarks, Ms Sunita Narain, Director General, CSE talked about the challenges of energy access in India. She said energy poverty still continues even after many solutions have been explored over the years. She asked, is the leapfrog possible from energy poverty to energy access and renewables? It could be difficult because of continuous climatic changes and because people in India want everything cheap. But energy needs to be priced.

Ms Sunita Narain, DG-CSE addressing the audience

Said Narain: "Renewables are expensive compared to fossil fuels today, but they will become cheaper tomorrow. The benefits of moving to renewables are immense – energy security, climate protection, reduced pollution and health benefits."

As the dialogue progressed, it became clear that access to clean cooking energy is low particularly in rural areas. The major population in rural areas still depends on solid and biomass fuels which cause large emission of black carbon leading to respiratory problems (lung cancer, asthma, etc.), cataracts and premature death. So, there is a need to move towards clean cooking fuel because 20% of the income in rural areas is wasted in purchasing wood or charcoal and crop residues for cooking. It is the women who suffer the most.

For the health security of the poor and for a green atmosphere, improved cook stoves, biogas plants and LPG are some alternatives available but the proper use and uptake of these alternatives has been slow in rural areas because

1. Dealer network in the rural area is poor and this should be expanded
2. High cost of manufacture, which makes them unaffordable for the rural people and
3. Lack of awareness regarding disadvantages of using solid and biomass fuels.

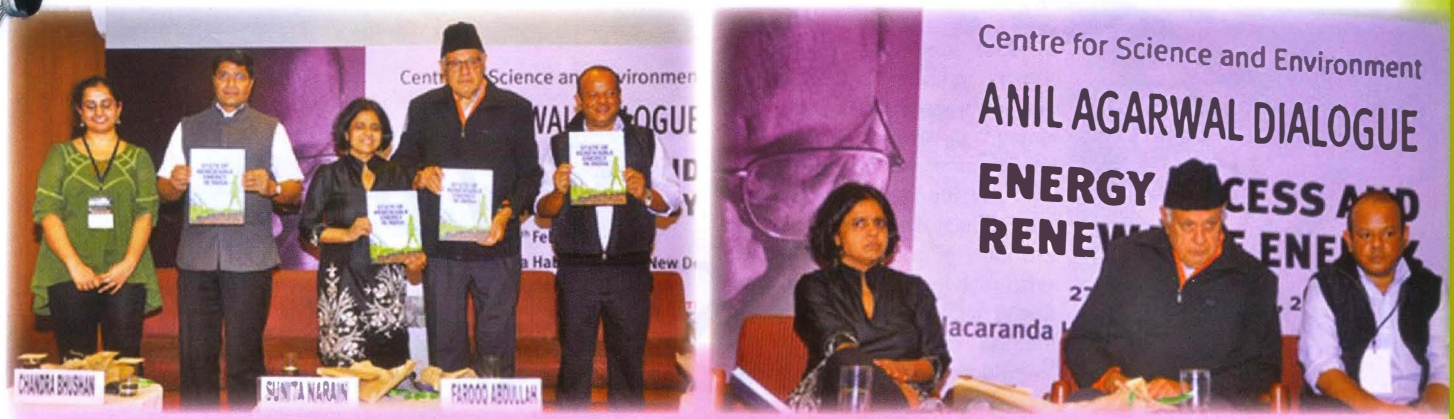
According to census 2011, 31% population still used kerosene for lighting. Although 7% electricity generation has grown between 2002 and 2013, electricity had still not reached everyone in the country. Electricity access is poor mainly in Uttar Pradesh, Assam, Orissa, Jharkhand, Rajasthan and West Bengal. These states form 84.8% of the total rural household without electricity access, said Mr B.K. Chaturvedi, Member, Planning Commission.

The centralized energy infrastructure has not been successful in achieving electricity access, said Mr Satish Balram Agnihotri, Cecretary, MNRE. This is because of grid power shortage, improper consumption of electricity, cost of delivery being high. Almost 97% households covered under the Rajiv Gandhi Grameen Vidyutikaran Yojana were using and spending on kerosene as an alternative source of lighting. In this scenario, Decentralized Distributed Systems (DDS) provide the most viable alternative.

Renewable energy offers solar photovoltaic, mini/micro hydro, biomass gasifiers, small wind aero generators in hybrid mode, etc. Mini-grid based solar electrification and solar home lighting systems are well established technological solutions. However, there are operational challenges in opting for these

Renewable sources possess huge potential as energy sources. They reduce carbon emissions, mitigate health effects.

Mr Satish Balram Agnihotri puts his point across



Mr Farooq Abdullah releasing the book *State of Renewable Energy – A Citizen's Report* (left) Ms Sunita Narain with the Minister (right)

systems apart from low market returns that repulse private equity. Besides, loads in rural areas are low and inconsistent in nature.

The first day sessions culminated with a discussion on the need for a roadmap for sustainable energy access in India. Despite making new policies and regulations, change in the mindset and approach of policy makers should also be considered. Availability of sources has improved but access to modern energy carriers remains limited, said Mr Shirish Sinha, Swiss Agency for Development and Cooperation. Clean and advanced cooking solutions and grid extension remains out of reach of the people, added Mr T.L. Sankar, former Principal, Administrative Staff College of India (ASCI), Hyderabad. The challenges are to restrict subsidies only to the poor, involvement of private parties as service providers and improvement in delivery pathways to the poor.

The second day of the Anil Agarwal Dialogue on Energy Access and Renewable Energy addressed the issue of meeting the unmet demand in the country through renewable energy. With increasing population the energy demand is increasing. We have to import nearly 35% of the energy requirement. Renewable sources possess huge potential as energy sources. They reduce carbon emissions, mitigate health effects and also ensure energy security increase by reducing the energy import.

The deliberations echoed the view that for scaling up the renewable sources we have to believe in the renewables and change the mindset. There is also a need to go in for integrated or hybridized renewables, not in isolation. Make RPO (Renewable Purchase Obligation), REC (Renewable Energy Certificate) and FiTs (Feed-in Tariffs) efficient and redistribute subsidies to promote the renewables.

It was informed that the Jawaharlal Nehru National Solar Mission (JNNSM) is the major initiative by the Govt. of India addressing the energy security challenges. Among the various renewable energy resources solar energy has a great potential as a future energy resource because sunshine is available for longer hours per day in great intensity in India. The objective of the national solar mission is to establish India as a global leader in solar energy.

Replication of solar photo voltaic (PV) mini grids is inhibited due to the dearth of trained manpower, financial support and operational challenges across lakhs of villages. On the technical side, battery maintenance and replacement is a challenge for solar systems. There is a need to build up public awareness and give incentives to get participation of private companies. Learning and training of manpower should also be stepped up.

The second half of the day was devoted to discussions on wind power. India has great scope in the wind power sector because Indian wind turbines are 30% less costly as compared to other countries, said Mr Alok Srivastava, Joint Secretary, MNRE.

Compared to conventional sources of power, wind is much less polluting and is also abundant and affordable which makes it a good alternative to fossil fuels. But ecological and social impacts could be high like soil erosion; they also require large land size due to which wildlife habitat may be affected. Then there are also sound and vibration issues.

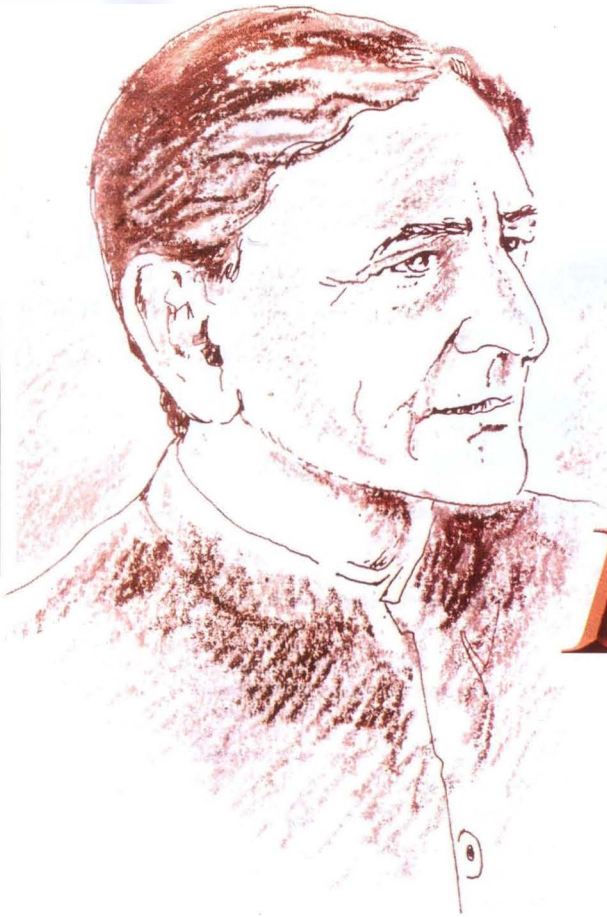
Transmission remains a major challenge in scaling up and increasing wind access. This has contributed considerably towards the decline of the wind power sector. There is a need for clear regulations and standards while installing wind turbines like limiting amount of noise pollution and impact on wildlife and identification of potential areas.

The two-day dialogue concluded with the release of CSE's book, *State of Renewable Energy – A Citizen's Report* by Mr Farooq Abdullah, Minister, MNRE. The report provides an insight into the current status and barriers in development of renewable energy in India. It also covers field reports from various states of the country and policy changes in solar, wind, small hydro, municipal waste to energy and biomass sector.

Releasing the book, Mr Farooq Abdullah said that renewable energy is not just the future of India, but the future of the entire world. We need to ensure how to utilize and stored the generated power. He also said that while obtaining renewable energy benefits we should not harm the environment by ruining the forest. But Mr Abdullah was candid in commenting that giving electricity free to people is like giving them cocaine as they get addicted and expect more. Energy should be priced.

Mr Abdullah said that rooftop energy has potential but we need to think how to store this energy for longer times (night hours). There is a need to produce technologies and manufacture them in India itself for lesser import dependence, said the Minister. He also said stakeholders and industries should play a pro-active role in achieving the target and the government needed to do more for promoting the green technology.

Compiled by Ms Kirti Bansal, Research Intern, National Institute of Science Communication and Information Resources (NISCAIR), CSIR, New Delhi



Silent Scientist Debendra Mohan Bose

A man of few words, unassuming, a silent worker and a strikingly handsome figure is how people who knew Debendra Mohan Bose describe him. Yet today very few even know about, let alone remember, the man who was honoured in India and recognised abroad for pioneering researches in the field of cosmic rays, artificial radioactivity and neutron physics.

Debendra Mohan Bose built the first indigenous cloud chamber to track ionizing radiations way back in the 1920s. He is also remembered as the scientist who more than once came close to making major breakthroughs which later won the Nobel Prize.

If one were to talk about formative influences on young Debendra there would be no dearth of it. He had illustrious peers all around him. Debendra was born in Calcutta on 26 November 1885. His father, Mohini Mohan Bose, who was a practising Homeopathic physician was among the first Indians to have visited the United States of America. His uncle, Ananda Mohan Bose, was the first Indian Wrangler in Mathematical Tripos from Cambridge. Debendra Mohan's mother was Subarnaprabha Bose, younger sister of Sir Jagadis Chandra Bose, the renowned physicist and plant physiologist. J.C. Bose lived in the same house with Debendra's family at 64/1, Mechuabazar Street. For some time P.C. Ray, the famous chemist and a close friend of J.C. Bose too stayed in the same house.

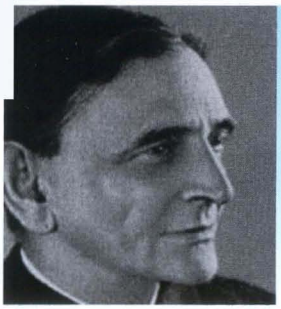
In 1901 the family shifted to 92/3, Upper Circular Road. P.C. Ray who had by then shifted to 91, Upper Circular Road founded the Bengal Chemical and Pharmaceutical Works. Young Debendra had the good fortune of interacting with people like Nil Ratan Sircar, Rabindranath Tagore, Loken Palit, Sarala Debi, Charuchandra Dutta and Sister Nivedita all of whom were regular visitors to P.C. Ray's house. Debendra Mohan was also inspired by the renowned Swedish scholar M. Hammergren who had come to gather material about Raja Rammohan Roy and the Brahmo Samaj.

Serious business apart, young Debendra was a versatile sportsman too. He was one of the founders of the Sporting Union Club and the captain of the club's hockey team in 1905-06. While a student of the Presidency College he excelled in cycling, football and cricket.

Debendra Mohan's uncle J.C. Bose had by far the most formidable influence in shaping his life and career. It has been tacitly assumed during his boyhood that Debendra Mohan would undergo training in science to enable him to carry on his uncle's pioneering researches. But fate intervened. Debendra's father died in 1901. Now it became necessary for him to take up a profession to support his family. After he passed his F.A. examination from Presidency College in 1902. J.C. Bose suggested that Debendra Mohan join the Bengal Engineering College at Sibpur. But after one year of study there Debendra went down with a severe attack of fever and abandoned the idea of returning to the malaria-infested place again.

With the aim of moving on to the engineering college in Poona, Debendra got himself admitted to the third year BSc class of Presidency College in 1903 with Physics as the main and Geology as one of the subsidiary subjects. He passed the BSc examination with honours in 1905 and the M.A. examination in Physics in 1906 standing first in Calcutta University. For a year thereafter he worked as a research scholar under J.C. Bose and obtained his initiation into his uncle's investigations in plant physiology.

The very next year, in 1907, Bose got an opportunity to go to England where he was admitted as an advanced student in Christ's College, Cambridge. He worked in the Cavendish Laboratory for some time under the guidance of Sir J.J. Thomson. Here he had the opportunity of observing C.T.R Wilson develop his technique of employing the cloud chamber for photographing the tracks of ionizing particles. In 1910, he joined the Royal College of Science,



After the death of Sir J.C. Bose, a couple of years later he took over the mantle of Bose Institute as Director in 1938. He served the institute with rare distinction for almost thirty years and retired in 1967 when his health began to fail.

London from where he obtained in 1912 the A.R.C.S diploma as well as B.Sc in physics with a first class.

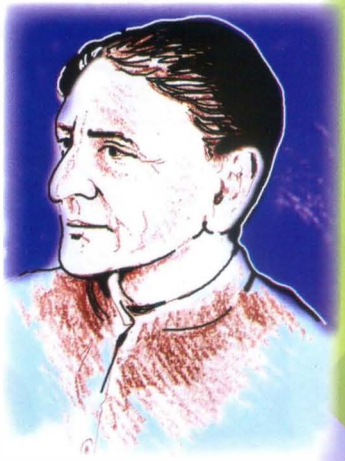
On his return to Calcutta, in 1913, he joined the City College as Professor of Physics. Soon thereafter, in April 1914, he was appointed Rash Behari Ghosh Professor of Physics at the Calcutta University. Sir C.V Raman was a Palit Professor in the same department. Besides, there were a number of brilliant lecturers like P.N. Ghosh, Satyendranath Bose, Meghnad Saha and S.K. Mitra. Soon after Debendra Mohan was awarded the Ghosh Travelling Fellowship for two year's advanced study in Physics abroad. He worked with Professor E. Regener at the Berlin University.

Unfortunately, the First World War broke out and Bose got trapped in Germany for quite sometime. However, he was allowed to continue his studies under Professor Regener who assigned him the task of constructing a new cloud chamber. His training under C.T.R. Wilson proved useful. He managed to design a modified Wilson-type cloud chamber to photograph the tracks of recoil protons produced during the passage of fast alpha particles through a hydrogen-filled chamber. However, he was not permitted to present his PhD thesis until the War ended.

During his stay in Germany Bose had the rare opportunity of attending the lectures of Max Planck, Albert Einstein, Rubens, Warburg, Hertz, Max Born and others. Bose obtained his PhD (magna cum laude) degree from the Berlin University in March 1919 and returned to Calcutta to resume his Ghosh chair at the Calcutta University which he held till 1935. In 1935, Sir C.V. Raman left for Bangalore as Director of the Indian Institute of Science. D.M. Bose succeeded him as Palit Professor of Physics. After the death of Sir J.C. Bose, a couple of years later he took over the mantle of Bose Institute as Director in 1938. He served the institute with rare distinction for almost thirty years and retired in 1967 when his health began to fail.

D.M. Bose's main area of research was the study of nuclear collisions and disintegration by means of Wilson cloud chamber and photographic emulsions. He had seen C.T.R. Wilson develop his technique of employing the cloud chamber for photographing the tracks of ionizing particles. With the modified cloud chamber he developed in Germany Bose was able to verify Darwin's formula for collision between fast moving charged particles and molecules. He also made some studies on delta particles.

On his return to Calcutta Bose constructed an indigenous cloud chamber. He took photographs of recoil tracks of radioactive nuclei during the process of alpha particle emission, and of the simultaneous emission of two ionizing electron tracks from a helium atom, due to collision with an alpha particle. One photograph obtained by them was later interpreted as showing the disintegration of nitrogen nucleus. Quite some time later P.M.S. Blackett, who went on to win the Nobel Prize, revealed the way in which a stable atomic nucleus can be disintegrated by bombarding it with alpha particles.



After joining the Bose Institute in 1938 Bose took up the study of tracks of cosmic ray ionizing particles using the photographic emulsion technique. He determined the mass of mu mesons by this method. With the departure of his associate Bibha Choudhri to England in 1945 this work was discontinued. Later on, Cecil Frank Powell, a British physicist was able to prepare such improved emulsions. Powell was awarded the Nobel Prize in Physics in 1950 for his investigations along this line. He actually acknowledged the priority of Bose and Choudhri's work about mu mesons during the course of his lecture at Bose Institute sometime later.

Professor Bose made a special study of the plant physiological investigations of Sir J.C. Bose who had shown that plants respond to external stimulus. D.M. Bose suggested that there were certain biochemical processes that intervened between stimulation and mechanical response in plants. He initiated the investigation regarding the source of energy of mechanical response in plant organs, including the spontaneous pulsation of leaflets of Desmodium gyrans.

Both as Professor of Physics in the University College of Science and as Director of the Bose Institute, D.M. Bose trained and inspired a generation of scientists. He initiated several lines of investigation during his tenure. The time-variation and altitude-dependence of cosmic rays was measured using a Compton-Bennet type of Ionization Chamber. Several interesting cases of sudden variations in cosmic ray intensity associated with solar flares and magnetic storms were recorded. For work in neutron physics a 14.5 MeV neutron generator was fabricated and operated at the Bose Institute under Professor Bose's guidance. Incidentally, it was the first instrument of its kind to be installed in India.

"Bose was a man of few words, and more or less a silent worker, inspite of his vast erudition and wide interest", says S.D. Chaterjee, Professor Bose's colleague. "He avoided both the limelight of public applause and the patronage of the powers that be. His nature and his uncompromising principles were praiseworthy."

Due to exposure to several cultural figures during his childhood Bose evinced keen interest in social and cultural matters. H was closely associated with the management of the City College and the Sadharan Brahmo Samaj. He served the Viswabharati University as its Honorary Treasurer for about 18 years. Professor Bose was deeply interested in the history of science. He was one of the editors-in-chief of A Concise History of Science of India, a publication of the Indian National Science Academy (INSA). He was also the editor-in-chief of the Indian Journal of History of Science published by INSA.

Professor Bose had been in the habit of taking long walks. But while in Germany he started suffering from arthritis. This put an end to his walks. But still he would walk to the Bose Institute and back home a few times every day. Eventually, failing health forced Professor Bose to take retirement from the Institute.

He passed away in the morning hours of 2 June 1975.

Great White Shark

Their powerful teeth are triangular and serrated, and they can have as many as 3,000! Coupled with their extremely powerful jaws these sharks are virtually munching machines that can cut through anything that comes their way.

THOSE who have seen the movie `Jaws' will find the real world Great White Shark not very far off from the reel shark. Some of the popular names for the great white include death shark, man-eater, tommy, uptail, white death and white pointer – ample testimony to the notoriety attached with these deadly sharks.

These formidable sharks can grow to over six metres in length, but their average size is about four metres. The largest recorded great white was a mighty eight metres long! Great white sharks have a white belly and a grey back, and their snouts are long and pointed. Their powerful teeth are triangular and serrated, and they can have as many as 3,000! Coupled with their extremely powerful jaws these sharks are virtually munching machines that can cut through anything that comes their way. Their two-tone coloration makes it difficult for other animals to spot them because when viewed from above, the darker shade blends in with the sea.

The great white shark is equipped with two of the most powerful sensing mechanisms in Nature, a highly developed sense of "smell" and the ability to sense the electrical fields radiating from living creatures. Since "breathing" takes place in the gills, the nostrils of a shark are used solely for olfactory purposes – to sniff out their prey. Each nostril is divided by a small skin flap that separates the water the shark is swimming through into two flows, one incoming and one outgoing. This flow passes through an area that contains a large number of small sensory organs known as lamellae. These lamellae are shaped like tiny flower petals and are in turn covered with millions of olfactory cells. These cells are in turn directly connected to the center of the brain responsible for detecting odors, turning the shark into a swimming nose.

Since "breathing" takes place in the gills, the nostrils of a shark are used solely for olfactory purposes – to sniff out their prey.

They can reach speeds of 25 mph when in pursuit of prey, and have been known to leap out of the water.

White sharks are found both close inshore and well offshore over the deep oceans. They are most often found in warm temperate seas. The GW is an apex predator at the top of the food chain with no natural predators. They prey on fish, rays, sea lions, seals, sea birds, small whales, turtles, porpoises, carrion and other sharks. Their favourite prey, however, are seals and sea lions. They tend to attack from below, taking a large bite of their prey and waiting for the victim to weaken from loss of blood.

They can reach speeds of 25 mph when in pursuit of prey, and have been known to leap out of the water. As well as a sharp sense of smell, great whites have good vision and are the only sharks known to lift their heads clear out of the water to inspect objects on the surface.

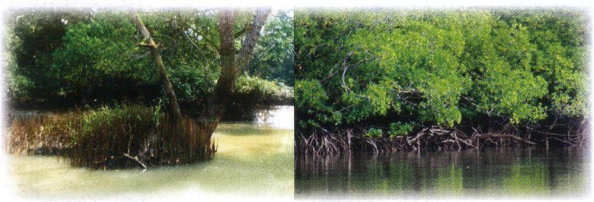
Great white sharks are legally protected in South Africa, Namibia, California, Florida, all of Australia and Malta.

Mangroves

AMAL KUMAR MONDAL AND SANJUKTA MONDAL (PARUI)

1. The plant community that grows on a mangrove swamp is usually a forest with a dense canopy and is called a

a. Mangrove swamp forest b. Simply mangrove
c. Mangal d. All of the above
e. None of the above

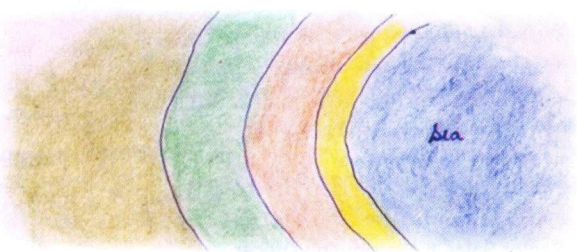


2. Mangals occur along more than _____ of all saltwater tropical coastline parallel to the shoreline.

a. 2/3rd b. 1/3rd
c. 2/4th d. None of the above

3. Mangal along a tropical bay characteristically shows_____ zonations.

a. 3 b. 4
c. 2 d. None of the above

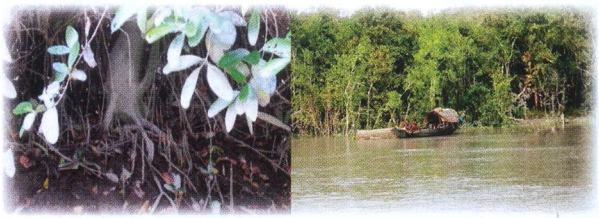


4. The largest mangrove in India is

a. Sundarban b. Bhitarkanika
c. Andaman & Nicobar Islands d. Gulf of Kachchh in Gujarat
e. None of the above

5. The smallest mangrove vegetation in India is

a. Machranga Deep, West Bengal b. Daman & Diu
c. Pondicherry d. None of the above



6. Mangrove associated plants are

a. *Acanthus ilicifolius* b. *Rhizophora mucronata*
c. *Bruguiera gymnorrhiza* d. *Spinifex squamosus*
e. None of the above

7. True mangrove has important characters such as

a. Pneumatophores b. Vivipary germination
c. All of the above d. None of the above

8. Only one mangrove fern

a. Drynaria sp b. Ampilopteris sp
c. Acrostichum sp d. None of the above

9. Kneed-like pneumatophores are common in

a. *Avicennia alba* b. *Bruguiera cylindrica*
c. *Heritiera littoralis* d. *Xylocarpus granatum*
e. *None of the above*

10. Vesiculated trichomes are commonly found in

a. Excretive halophytes
b. Succulent halophytes
c. Both of the above
d. None of the above

11. Stem-less palm in halophytes

a. *Nypa fruticans* b. *Borassus flabellifer*
c. *Lodoicea maldivica* d. *Corypha india*
e. None of the above

12. Vivipary germination is commonly found in

a. True mangroves
b. Mangrove associate plants
c. Both of the above
d. None of the above

13. Cryptovivipary is that

a. Not visually obvious
b. Visually obvious
c. Both of the above
d. None of the above

14. Vivipary is a strategy for

a. Floating on sea water
b. A dispersal mechanism
c. To avoid toxic effect on germination/mechanism favoring germination
d. None of the above

15. Two hypothesis proposed to explain this anomalous bio-geographic distribution of mangroves.

a. Centre of origin hypothesis b. The vicariance hypothesis
Both of the above d. None of the above

16. Salt Gland is commonly found in

a. Succulent Plants
b. Halophyte Plants
c. Xerophytic Plants
d. None of the above

17. Common yieldable vegetable in halophytic areas in spite of high concentrated NaCl in the cell sap

a. Salicornia sp b. Spinach sp
c. Amaranthus sp d. None of the above

18. The common name is hetal i.e. Phoenix paludosa. It is a

a. True mangrove b. Mangrove associate plant
c. Both of the above d. None of the above

19. Main crash crop in Sundarban mangrove areas

a. Honey
b. Tiger
c. Fishing
d. None of the above

20. The main honeybee in Sundarban mangrove is

a. *Apis dorsata*
b. *Apis mellifera*
c. None of the above
d. All of the above

Answers

1.d,	2.a,	3.a,	4.a,	5.b,	6.a,
7.c,	8.c,	9.b,	10.a,	11.a,	12.a,
13.a,	14.c,	15.c,	16.a,	17.a,	18.b,
19.a,	20.a				

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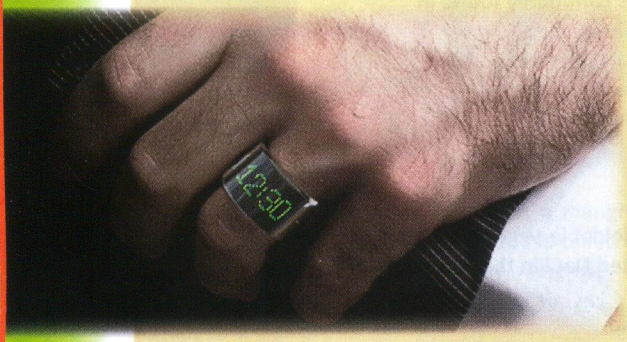
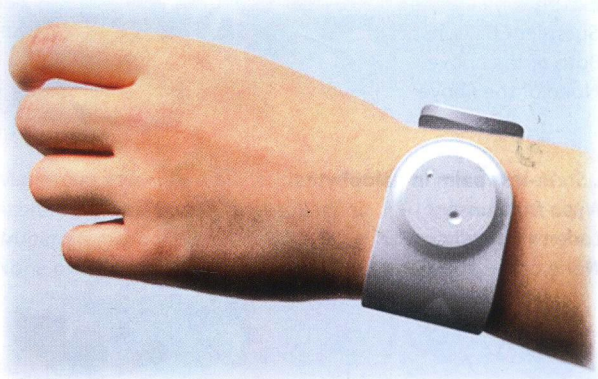


SMART RING CONTROLS SMART PHONE

Before most of the world has even had time to adapt to smart watches, the next big thing is on its way: smart rings. When paired with a smart phone, the Smart Ring comes with a rather long list of capabilities. Besides looking pretty, the ring can alert you to calls or texts or social media alerts, accept or reject calls, control music, trigger your phone's camera, and even make outgoing calls to preset numbers. If you step too far away from your paired smart phone, it will alert you so that you never leave your phone behind.

TIME TO GET TOUCHY-FEELY

Like most other timepiece concepts geared toward blind people, the Rub Feel Know watch relies on some element of tactile sensation to keep users updated on the current time. But this slick-looking concept features an intriguing element. The hour indicator is a concave space: a small dip in the plastic that, when considered along with its position on the face, indicates the current hour. The minute indicator is a smaller convex dot, jutting out slightly from the watch's face. A quick brush of the fingertips against the watch face tells the time with ease. The hour "hand" is warm to the touch while the minute indicator is cool to the touch.

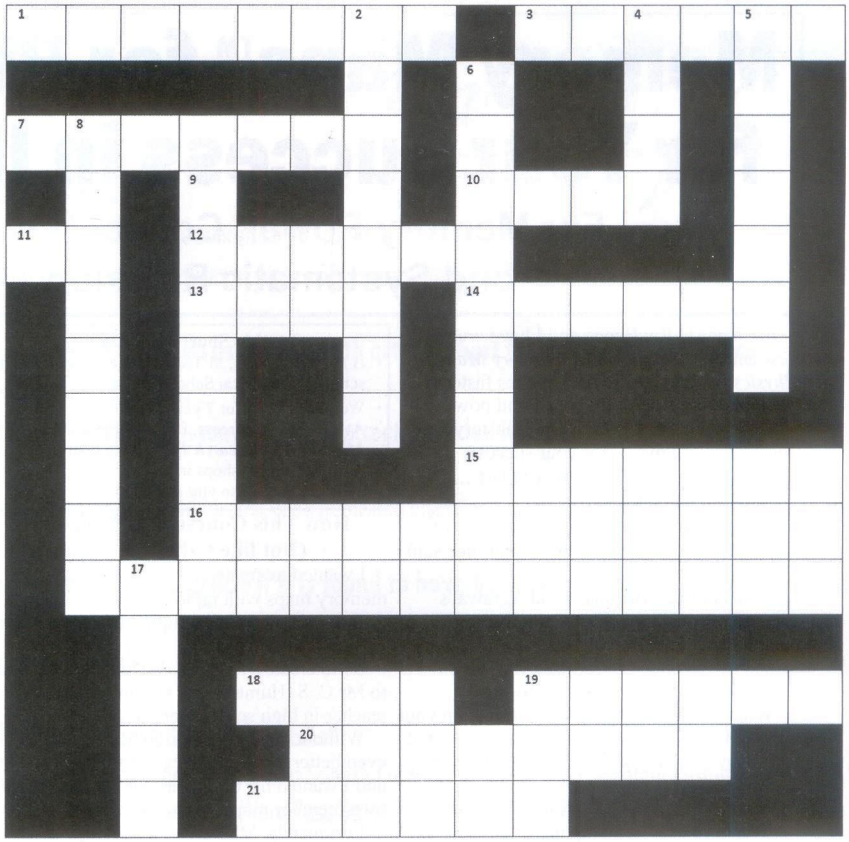


VEGGIE SCANNING SYSTEM

Opening the fridge to reach for that cup of yogurt or bowl of fruit only to find it has spoiled is quite frustrating. But since we can't remember to either write a date on the packages or look at them once in a while, designers came up with the QR Code Fridge Magnet. It can scan the QR codes on the food. Scanning the code will tell you the expiration date as well as the food's origin and production date. You can stick the reader right to the front of your fridge. As the days tick by, the colour of the magnet changes. Green means still good to eat; orange means about to expire, and red means it is spoiled.

SILENT NIGHTS

Pillow nudges snorer's head to stop the noise. Sleeping next to a snorer is like a hell from which escape can only be achieved by one partner being banished to the couch but the Snore Activated Nudging Pillow might do the trick. The pillow is a slightly friendlier alternative to stop the snoring. It contains a microphone that picks up the distinctive sonic pattern of snoring. When it does, an internal bladder inflates, prompting the snorer to change sleeping positions. The microphone sensitivity can be adjusted. Although the pillow won't stop a snorer's nocturnal noise-making for good, it might at least help make the nights more bearable.



ACROSS

1) Science of identification, nomenclature and classification of organisms (8)
3) The complete set of genes or genetic material present in a cell or organism (6)
7) Electrically excitable cell that processes and transmits information through electrochemical signals (6)
10) Nicotinamide adenine dinucleotide, abbreviated (3)
11) Chemical symbol of Nickel (2)
12) The scientific name for the gold ore (5)
13) Fully ripe internal egg masses in the ovaries of fish (3)
14) Angiotensinogenase is also known as (5)
15) S.I. unit of electrical conductance (7)
16) Growth of organisms in response to light (12)
17) Subjection of seeds or seedlings to low temperature in order to hasten plant development and flowering (13)
18) A molecular unit of heredity of a living organism (4)
19) A segment of a DNA or RNA molecule which does not code for proteins and interrupts the sequence of genes (6)
20) Hormone which stimulates contraction of the uterus during labour (8)
21) Also known as vitamin B3 (6)

DOWN

2) Soft bodied animals are included in the phylum (8)
4) Chemical element with atomic number 10 (4)
5) Type of cell division that forms two daughter cells each having the same number of chromosomes (7)
6) Gland in human body partly exocrine and partly endocrine
8) Outermost layer of the skin (9)
9) Cartilaginous organ located between the Pharynx and the Trachea (6)
17) Blood vessels that carry blood towards the heart (5)
19) A charged atom (3)

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Solution
May 2014 Crossword