Current Science Reports

Understory Invasion

In Nilgiri Biosphere Reserve

The Nilgiri Biosphere Reserve in the Western Ghats is facing increasing human interference such as cattle grazing, firewood collection and induced forest fires. The growing presence of non-native species is also a concern.

R. Jayakumar, University of Delhi and K. K. N. Nair, Kerala Forest Research Institute, Thrissur decided to collaborate to investigate the issue. They evaluated the diversity of native and alien species in the understory layer of the Nilgiri Biosphere Reserve in Kerala.

They counted trees with girth more than 30 centimetres at breast height in selected sample sites in disturbed and undisturbed areas. They quantified all the herb and shrub species growing in the understory layer.

The researchers thus identified 62 exotic species out of the 303 species recorded. Most of the exotic species were herbs, followed by shrubs, trees and vines.

About 80% of invasive species belonged to the Asteraceae, Fabaceae and Euphorbiaceae families. Nearly two-thirds of these species were natives of South America.

The researchers used the data to find correlations between the presence of exotic species and the density of tree species. The frequency of exotic shrubs and herbs tended to reduce in areas with higher density of trees.

'The exotics flourished in ample sunlight in open areas created by humans to grow cash crops,' remarks K. K. N. Nair.

'Floristic diversity of exotics was higher in deforested areas and were negligible in undisturbed areas,' adds R. Jayakumar.

DOI: 10.1007/s42965-021-00191-0

Bumble Bees on Decline

Modelling species distribution

Bumble bees are important pollinators in the upper Himalayan regions. But climate change is affecting their habitat. What will bumble bee distribution be like after thirty years, wondered Amar Paul Singh, Wildlife Institute of India, Dehradun.

Along with his team, he decided to record and model the distribution of existing bee species in the Great Himalayan National Park, Himachal Pradesh. In the summer of 2018, they went around the park with sampling nets, sweeping through the potential nests of bumble bees. They identified the bees collected using the taxonomic key. There were nine distinct species.

They correlated the distribution of the nine bee species with nineteen climate variables and biotic factors. Precipitation, mean diurnal range and land use had considerable impact on the distribution of bees in the area.

The researchers projected the climatic condition of the study area in 2050 as per the trajectory proposed by the Intergovernmental Panel on Climate Change. Using the maximum entropy algorithm, they modelled the future distribution of the bees.

They found that, out of the nine species, *Bombus tunicatus*, *B. haemorrhoidalis*, *B. festivus* and *B. asiaticus* had least potential for survival, if climate in the region changes as predicted.

'The habitat of bees may shrink by 2050,' cautions Agni Chandra, Wildlife Institute of India, Dehradun.

'The shrinkage can also create a lack of synchrony between host plants and bees and impact pollination,' explains Kritish De, Sri Sathya Sai University for Human Excellence, Kalaburagi.

Ecologists and conservationists need to make long-term management plans to mitigate such an eventuality.

DOI: 10.1080/00305316.2022.2040631

Dietary Copper Requirement

For rohu fingerlings

Rohu, a freshwater fish valued for its taste, has high market demand. So, rohu aquaculture is popular in India. The dietary requirements of important micronutrients for rohu are now well known. Except for copper.

Copper is a micronutrient essential in the synthesis of many enzymes and glycoproteins for important biological functions. Yet it can be toxic in high quantities.

Mohammad Musharraf and colleagues from the Aligarh Muslim University have now come up with data on the nutritional requirements of copper for rohu fingerlings.

Image: Nandlal Meshram

They graded and cultured healthy rohu fingerlings with varying levels of copper in their diets for eight weeks. The researchers then examined the effects on fish tissue and blood.

Rohu fingerlings fed with copper-deficient diets had low feed conversion efficiency. Diets with excess copper, on the other hand, caused liver damage, leading to sudden death.

'Copper concentrations of 4.5 to 4.7 milligrams per kilogram are ideal for the growth of rohu fingerlings,' says Mukhtar A. Khanf, Aligarh Muslim University.

'Micronutrient levels in aquaculture should be monitored along with macronutrients such as proteins, carbohydrates and lipids,' adds Mohammad Musharraf, his colleague.

DOI: 10.1016/j.aquaculture.2021.737742

Cisplatin-induced Nephrotoxicity

Golimumab for amelioration?

Cisplatin is used for treating cancers. The drug accumulates in the kidneys and increases the expression and levels of tumour necrosis factor α. This leads to inflammation and oxidative stress in the renal tubules, causing kidney damage and even renal failure among cancer patients taking cisplatin.

Pentoxifylline, a known inhibitor of the tumour necrosis factor α, is usually used to treat nephrotoxicity caused by cisplatin. But pentoxifylline, too, has side effects: chest pain, irregular heartbeat and drowsiness. Moreover, it is not recommended for use with other medicines such as aceclofenac and aspirin.

Vishal N. Pavitrakar, Rustom Mody and Selvan Ravindran, from the Symbiosis International University and Lupin Limited, Pune started searching for alternatives.

Golimumab is a human monoclonal antibody known to inhibit tumour necrosis factor α. It is already in use for treating rheumatoid arthritis, psoriatic arthritis and ulcerative colitis. So why cannot we use golimumab against the nephrotoxicity caused by cisplatin, they wondered.

They induced nephrotoxicity in Swiss Albino mice using intraperitoneal injection of cisplatin. They gave the standard drug, pentoxifylline, to one group of mice and golimumab to another group to compare the results. One group, kept as control, was administered 0.5 millilitre of normal saline daily. No therapeutic drug or saline was given to mice in yet another group.

The researchers then monitored renal function, renal damage, oxidative stress and inflammation using metabolic markers. A qualified toxicopathologist assessed kidney damage by histopathological evaluations.

The administration of golimumab and pentoxifylline enhanced overall health and renal function. These drugs could also minimise kidney damage.

Both drugs were effective in reducing oxidative stress and inflammation caused by cisplatin.

The results indicate that golimumab can be used as an alternative to pentoxifylline for cisplatin-induced nephrotoxicity, at least in Swiss albino mice.

Clinical trials need to be initiated to investigate the relative merits of golimumab and pentoxifylline for the amelioration of kidney damage in cancer patients.

DOI: 10.1002/jbt.22990

Diagnosing Cardiac Arrhythmia

Automating with transfer of learning

Diagnosing cardiac arrhythmia from ECG signals using machine learning algorithms is a useful technique to reduce the burden on specialists. But accuracy depends on the learning models used.

Transfer of learning from one model to the other can help increase the reliability of the results. So recently, researchers from the VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad used a transfer learning-based approach to increase the accuracy of automated diagnosis of cardiac arrhythmia.

They took ECG signals from the MIT-BIH Arrhythmia database. The database has 48 ECG records of 30 seconds each, containing 16 different beats. Fourteen represented arrhythmia. One was normal and one unclassified. The researchers selected 18 records that gave a fair representation of normal beats as well as six different deviations from the normal. They then removed noise from the ECG signals using filters and extracted features from these noise-free ECG signals using convolutional neural networks.

There were more than forty thousand heart beats, both normal and with cardiac arrhythmias. The researchers used more than 27,000 beats to train the models, about 4,000 to validate the results and the rest to test the models.

They then took three pretrained models: Alexnet, Googlenet and Resnet. They fine-tuned the deep learning models to identify normal ECG beats and to classify ECG beats with cardiac arrhythmia. They simulated and tested the models.

'The accuracy of the convolutional neural network-ResNet18 model reached more than 99.5%,' says Mohebbanaaz, VNR Vignana Jyothi Institute of Engineering and Technology.

'The other models took less time to train. But accuracy was lower,' adds L. V. Rajani Kumar, her colleague.

'We are now creating a hardware model for the real time detection of abnormalities in ECG signals,' says Y. Padma Sai, the team leader.

DOI: 10.1007/s11760-022-02155-w

Thermal Care in New-borns

Knowledge and practices

The first month after birth is critical for mother and new-born child. According to the WHO, about one-third of new-born deaths occur in cases where core body temperature falls below 36.5°C. Hypothermia is common in neonates whose thermoregulatory centre is still immature.

For every 1°C decrease in body temperature, there is an 80% increased risk of death. So, knowledge about thermal care for new-borns is essential for mothers and caregivers.

Image: Kottakkalnet via Wikimedia Commons

To assess knowledge and practices among caregivers, Ruchi Pandey and a team of researchers from the Government Institute of Medical Sciences, Greater Noida conducted a community-based cross-sectional study in Amroha district, Uttar Pradesh.

The district has six blocks with a total of 61 villages. The team selected seven households in each village. And, using a questionnaire, they assessed knowledge and practices about newborn thermal care in women with babies aged less than three months.

In all six blocks of Amroha district, there was a significant gap in knowledge and practices about new-born thermal care. Non-working mothers above 35 years of age, having education above 10th class, had better knowledge about new-born thermal care. Most of them belonged to higher socio-economic status, nuclear families and were followers of non-Hindu religions. Mothers from joint families who had institutional delivery also followed effective thermal care practices.

The researchers recommend skin-to-skin contact immediately after birth, to soothe the baby.

'Then dry and wrap the baby and delay bathing until the second day. The babies should be breastfed soon after birth and frequently later. The baby should also be covered, ensuring thermal comfort,' says Anurag Srivatsava.

Ruchi Pandey and team stress the need to raise community awareness about the prevention and management of neonatal hypothermia in the district to reduce neonatal mortnality.

DOI: 10.1186/s13690-022-00809-2

Diagnosing Meconium Aspiration

From umbilical cord parameters

Meconium is the first stool passed by babies after birth. However, in some cases, meconium is passed before birth. It then mixes with the amniotic fluid that surrounds and protects the baby in the womb. When a baby breathes this mixture into its lungs during birth, it causes rapid breathing, bluish skin, grunting sounds and enlarged chest.

Meconium aspiration syndrome can be diagnosed by the colour of amniotic fluid and by X-rays. However, lack of correlation with clinical severity and delayed clinical action can cause mortality in neonates.

Meconium aspiration causes difficulty in breathing and hypoxia. This increases lactate levels, which, in turn, can alter the pH of cord blood.

So, Y. Ramesh Bhat and team from the Kasturba Medical College, Manipal decided to examine cord blood pH, base deficit and lactate levels as markers for the early detection of the problem.

The researchers collected umbilical cord blood from about 200 babies with meconium aspiration syndrome. They found a significantly low mean cord blood pH in neonates with meconium aspiration syndrome. Lactate and base deficit levels also differed significantly from the normal.

The data suggests that cord blood pH less than 7.20, lactate concentration more than 3.55 millimoles/litre and base deficit more than –5.3 millimoles/litre can be predictive markers for meconium aspiration syndrome.

If these parameters are abnormal, the neonate has to be closely monitored and necessary clinical support needs to be provided for survival.

DOI: 10.1007/s12098-022-04082-7

Heart Defects in New-borns

Due to nutrient deficiencies?

A hundred thousand babies in India are born per year with major congenital heart defects. When the structure or function of the heart is defective, flow of blood through the heart and the rest of the body is affected. For survival, a quarter of such babies require surgery or some major medical procedure.

The causative factors behind congenital heart defects are not clear. Improper medication, alcohol, smoking and diabetes during pregnancy have been suggested as possible indirect reasons.

Reva Tyagi and a group of paediatrics and cardiology researchers from Chandigarh and Tamil Nadu recently assessed the role of nutrient deficiencies in congenital heart defects. They hypothesised low serum levels of folate and vitamin-B12 and high levels of homocysteine as possible indicators of heart defects.

With prior ethical approval, they did a prospective cross-sectional study of confirmed cases of congenital heart diseases among infants registered in a tertiary care hospital.

They analysed the blood samples of forty-five infants below 6 months of age with congenital heart defects along with those of their mothers. This was then compared with the data of a control group of equal numbers of normal infants and their mothers.

The homocysteine levels were equally high in the study group as well as in controls.

Though vitamin-B12 deficiency was more among the baby–mother pairs in the study group, the difference was not significant, say the researchers. But analysis of folic acid levels in serum presented a totally different scenario. In the study group, the proportion of baby–mother pairs with very low serum folate was more than double the proportion in the control group. The mean serum folate in babies with congenital heart diseases as well as that of their mothers was also seen to be low.

The next obvious question is whether folate supplements from conception to delivery can reduce the rate of congenital heart disease in new-borns. Though ethics will pose problems in research on the question, folate supplements in pregnancy as a health policy might be useful.

DOI: 10.1007/s12098-022-04125-z

Radiative Coolers

An alternative to air conditioners

Conventional air conditioning systems require external energy sources for cooling. Passive radiative cooling materials, on the other hand, do not consume energy. They emit heat as infrared radiations that can pass through the atmosphere to outer space.

Most passive radiative coolers operate only at night because materials absorb more solar radiations and emit less during the day. For a radiative cooler to work during daytime, the material should reflect the solar and atmospheric radiations falling on it. It should also absorb heat from the surroundings and emit them in the atmospheric transmittance window.

Recently, Ashish Kumar Chowdhary and colleagues from IIT Guwahati modelled such a passive radiative cooler which operates during daytime.

Daytime cooling can be achieved using polymer-based passive radiative coolers. But, unfortunately, oxidation degrades the polymers; their lifespan is limited.

The researchers considered silicon dioxide and aluminium nitride. These materials have low optical density corresponding to the wavelength range of solar and atmospheric radiations. But at the atmospheric transmittance wavelengths, they have high optical density. When optical density is high, radiations travel slower through a medium and get absorbed more. Then the material emits all the absorbed radiations at thermal equilibrium, like a black body.

Instead of a single layer, the team cascaded silicon dioxide and aluminium nitride layers on a silver ground metal placed over a silicon substrate. The cooler they thus designed achieved about 97% reflectance for solar and atmospheric radiations and 80% emissivity for radiations in atmospheric transmittance wavelengths.

'By increasing the number of layers, cooling power increased 1.3 times,' says Ashish Kumar Chowdhary.

'The design is not prone to imperfections during fabrication and the cooling power is unlikely to degrade after construction,' adds Debabrata Sikdar, the team leader.

Cooler manufacturers can now explore radiative cooling to make electricity-free cooling systems.

DOI: 10.1088/1361-6463/ac3701

Traffic Flow Prediction

Using time series data

Traffic congestion is a major problem in Indian cities. During peak hours, the

number of vehicles overwhelms the capacity of roads. Can deep learning models help predict congestion and ease traffic movement?

Image: Arne via Wikimedia Commons

Md Ashifuddin Mondal and Zeenat Rehena from Aliah University took Baruipur Road, Kolkata as case study. Baruipur Road is connected to Kulpi Road, Caning Road and Sashan Road. From earlier attempts at predicting traffic congestion, the researchers realised that, unless they took into account the road network as a whole, predictions from models would be inaccurate. So, from April to December, they collected data on traffic in the network. They also took into account the historical traffic data of the Baruipur Road network.

The researchers designed a deeply interconnected neural network, stacking Long Short Term Memory with a dense layer as a model. They trained their model with present and historical traffic flow data using data from Baruipur Road alone and predicted the traffic. The difference between actual and predicted traffic flow was high.

Using correlations, the researchers identified neighbouring roads that impact traffic flow at Baruipur Road. Kulpi Road and Caning Road influenced traffic flow more than Sashan Road.

Taking these correlations into account, the researchers used a multivariate analysis, a combination of traffic flow on the main road and neighbouring segments to train their stacked model. This gave a better short-term traffic prediction.

'The stacked Long Short Term Memory model performed better than other models for traffic flow prediction. It works well for regular as well as unusual traffic conditions like holidays,' claims Zeenat Rehena.

'This technique will help drivers select routes, as it provides advanced traffic flow information,' says Md Ashifuddin Mondal, the team leader.

A model that predicts the traffic flow accurately will be a boon for authorities to effectively manage traffic. So training the model with data from other road networks in Indian cities needs to be undertaken.

DOI: s13369-022-06575-1

Understanding Buyer Behaviour

For palm leaf handicrafts

Handicrafts made with palm leaves are eco-friendly and aesthetic. They showcase culture and traditions. However, most artisans lack an understanding of market and customer needs. So palm leaf handicrafts have low sales and artisans often face financial crises.

The first step to overcome the problem is to analyse handicraft buying behaviour. And that is what a group of researchers from Chennai, Bengaluru and West Bengal recently did.

They used a questionnaire to identify palm leaf craft buying patterns in Tamil Nadu. The questionnaire included basic demographic information and the factors involved in the buying of handicrafts. The researchers then statistically correlated buyer behaviour with demographic information.

Level of education and income directly affect the buying of handicrafts. People with higher education appreciate product aesthetics better. People above 31 years had more awareness of handicraft-related traditions than consumers aged between 18 and 24.

'Artisans can perhaps use digital marketing to better target the younger generation,' says G. Krishnaraj, National Institute of Fashion Technology, Chennai.

The data also suggests that married people appreciate handicrafts more than the unmarried. And homemakers value craft items more than self-employed groups.

'Targeting the right groups can enhance handicraft sales,' says Chidambaram Prakash, Indian Institute of Handloom Technology, West Bengal.

More than 50% of the buyers spent less than 1000 rupees on handicraft products in six months.

'Artisans must leverage on this data strategically to evolve a pricing policy for their products,' says N. Elangovan, Christ University, Bengaluru.

Unlike modern start-ups, traditional artisans in India do not get advice and guidance on pricing and targeted marketing. Appropriate input, based on evidence, can help artisans maintain income stability. Are concerned authorities listening?

DOI: 10.1080/15440478.2022.2029664

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ACKNOWLEDGEMENT: NCPOR, Goa for access to scientific databases.

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