

## Current Science Reports

### Tree Diversity of India *Bridging the knowledge gap*

In recent times, many inventories of tree diversity have come up and researchers have begun to curate the massive global biodiversity data. Integrated biotic inventories provide baseline information for conservation and management strategies.

The most recent inventory is Global-TreeSearch which has applications in global policymaking. Although it is a comprehensive database on the trees of the world, some researchers point out discrepancies and errors in the database. So there is an urgent need to rectify, augment and update the database, especially the tree diversity of places that harbour most of the world's biodiversity.

Out of the world's thirty-six global hotspots, India has four. So addressing the data gap from India was an effort that needed to be taken up.

To assemble the taxonomic distribution and to quantify the endemic inventory of tree flora in India, Anzar Ahmad Khuroo and his team from the University of Kashmir collaborated with the Forest Biodiversity and Ecology Division of the National Remote Sensing Centre, ISRO, Hyderabad. To distinguish trees from shrubs, they followed the definition of IUCN's Global Tree Specialist Group: a woody plant with usually a single stem growing to a height of at least two metres, or, if multi-stemmed, then at least one vertical stem five centimetres in diameter at breast height.

The researchers did an extensive search on literature published over the last 150 years to identify all relevant material and created an inventory of trees of India. Most studies of tree flora in India have been conducted at sub-national scale: states, provinces and districts. The team decided to use Indian states as the unit to understand the distribution.

They also compared their inventory with GlobalTreeSearch to add any missing tree species to the database. To avoid multiple species entries on the basis of synonymy, the researchers

followed scientific nomenclature as per Plants of the World Online. Some species records had to be manually resolved case by case using the taxonomic expertise of the senior authors.

The Trees of India database has thus grown to cover around 3708 species, 1199 tree species more than earlier listed for India in GlobalTreeSearch. There are 3599 angiosperms and 108 gymnosperms in the country. The database created by the team followed the Angiosperm Phylogeny Group-IV Classification for family arrangement.

The distribution of each recorded tree species was validated using various online databases. All the infra-specific categories such as subspecies, varieties and forma were treated as separate taxa.

The researchers equally distributed the species range into seven classes based on the number of states where each tree is found. The highest number of 1250 tree species was reported from Tamil Nadu to the south, while the lowest number of 45 tree species was found in Ladakh to the north.

They also classified the tree species as endemic that have restricted distribution but are strictly within the political limits of India based on published literature, the Plants of the World Online database, and the International Union for Conservation of Nature.

Six hundred tree species were found to be endemic to the country. The highest number of endemic species were reported in Kerala, Tamil Nadu and Karnataka.

There are around three hundred and fifty species in the Trees of India database that are in the IUCN's threatened species categories.

The findings of this study are a first step towards filling the knowledge gap in the tree diversity of India. Presently, the diversity data is organised statewide. But within each state, there are spatial variations in the distribution of ecosystems.

'We are looking into the possibility of creating a distribution of trees of various species at a higher resolution using a combination of remote sensing, drone technology, artificial intelligence and

citizen scientists,' says Anzar Ahmad Khuroo, University of Kashmir.

DOI: 10.1007/s10531-023-02659-y

### Chilgoza Pine Distribution *Western Himalaya*



Image via Wikimedia Commons

The Chilgoza pine, *Pinus gerardiana*, mostly found in the western parts of the Himalaya, provides a livelihood for the tribal people in the region. In autumn and early winter, the edible seeds of the Chilgoza pine are harvested. But the conversion of pine forests for agricultural purposes, habitat fragmentation, cone harvesting, overgrazing and forest fires have made the pine near threatened.

Swaran Lata and team from the ICFRE-Himalayan Forest Research Institute, Shimla, Himachal Pradesh decided to investigate the distribution of the tree. Across various areas of Himachal Pradesh, the researchers identified 60 points of the primary distribution of the Chilgoza pine. To identify suitable areas for the species, they used distribution modelling.

They used bioclimatic variables and resampled soil, elevation and land use and land cover data, in the region at one kilometre resolution. Jackknife resampling indicated that precipitation in the warmest quarter and driest month are crucial factors in the distribution of the Chilgoza pine. Precipitation seasonality influenced 56% of the variation in the habitat model of the Chilgoza pine.

How would the projected climate change impact the pine population?

Based on future climate scenarios from the Coupled Model Intercomparison Project Phase 6, the researchers project an increase of 3% for the period 2041–2060. Between 2061 and 2080,

the model indicated an increase of 1% in total suitable areas along the boundaries of the present habitats.

To collect information on potential distribution areas for this species, the researchers used Maximum Entropy Modelling, a method for predicting environmentally favourable areas to identify suitable areas and reintroduce the species even when there is limited data of occurrence points.

The results indicate that 5% of Himachal Pradesh is favourable for the existence of the species. More than 1% of the geographical area of the state is suitable for reintroducing the Chilgoza pine. The areas with high suitability potential for habitat are mostly scattered in the Kinnaur and Chamba districts of the state.

These results can help forest managers to plan the plantation in most suitable habitats to help eco-restoration of the habitat. Since the Chilgoza pine is a source of food and livelihood, involving people in the region in conservation efforts will yield better results.

DOI: 10.1007/s11355-023-00570-w

### Turmeric as Potential Pesticide *Targetting chitin*

Most insecticides work by targeting acetylcholinesterase in the nervous system of insects. But these chemicals impact human health also. Chitin synthesis, an important developmental stage in insects, is a safer target for pest control.

Chitin is a crucial component of insect exoskeletons and curcumin is reported to inhibit chitin synthesis. Researchers from Gujarat recently investigated the effects of curcumin on chitin synthesis and larval development in *Aedes aegypti* mosquitoes.

They treated *A. aegypti* larvae with curcumin. To quantify chitin breakdown, they measured the total carbohydrate content of the larvae in a late stage of development. Even sub-lethal amounts of curcumin, they found, significantly reduced overall chitin content and disrupted cuticle development in the larvae. This was also confirmed by a fluorescence imaging of chitin levels in the larvae.

To understand how curcumin interacts with chitin synthase, the research-

ers used computational methods. Molecular docking showed that curcumin binds to the same site as polyoxin D, a known inhibitor of chitin synthase.

With the rise of dengue cases in cities, a handful of turmeric is always handy. Cost effective and readily available, it can be used as a potential insecticide for other insects as well.

DOI: 10.1007/s11030-023-10672-0

### Triple Negative Breast Cancer *Vaccine design*

Triple-negative breast cancer does not have the typical markers of other types of breast cancer: high levels of the oestrogen receptor, the progesterone receptor, and the human epidermal growth factor receptor 2.

In the immune response to fight against such cancers, the enzyme, tripartite motif containing 25, is an important factor. Finding a suitable tumour antigen to trigger an immune response to the enzyme can perhaps help develop vaccines against triple-negative breast cancer.

So researchers from REVA University, Bengaluru, and Vellore Institute of Technology collaborated with Imam Abdulrahman Bin Faisal University, Saudi Arabia, to search for a suitable antigen.

They downloaded a tripartite motif containing 25 sequence-specific genes for triple-negative breast cancer from Uniport, a protein sequence database. The three-dimensional structure of immune receptors was downloaded from the Protein Data Bank, a publicly available database where the experimentally determined three-dimensional structures of biological macromolecules are archived.

From the NCBI database, a popular biological database, they downloaded specific amino acid sequences in vaccines which help create a strong immune response.

They used only potentially antigenic, non-toxic, non-allergic peptides from the immune epitope database. To predict antigens toxic to cells, they applied the NetMHCpan method, an artificial neural network.

To predict antigenicity and human leukocyte antigen recognition, the researchers used software VaxiJen v2.0

and AllerTOP.v2.0 to predict non-allergenic properties.

To design a vaccine with multiple epitopes, the team chose seven epitopes on the enzyme based on antigenicity and antigen recognition. The ROSETTA server helped them predict the tertiary structure of the vaccines.

Thus they constructed four potential vaccines against triple-negative tumour cells.

To evaluate the characteristics of the vaccines, ProtParam, VaxiJen v2.0, AllerTOP v2.0, SOLUPROT and other web-based tools came in handy.

To identify adequate immune responses to the designed vaccine, the researchers used the C-ImmSim server.

Two of the four vaccine conformations had high affinity scores with the immune receptors.

Now the pharmaceutical industry can invest in *in-vitro* and *in-vivo* studies to make a vaccine for clinical trials on triple-negative breast cancer.

DOI: 10.1016/j.ijbiomac.2023.125209

### Cholesterol Lowering Agents *In-silico identification*

The degradation of low-density lipoprotein or LDL cholesterol, implicated in cardiovascular diseases, is done by the proprotein, convertase subtilisin/kexin type 9. Drugs that inactivate this protein help lower harmful cholesterol.

In 2015, researchers produced monoclonal antibodies that could inactivate the enzyme. But monoclonal antibodies are very big molecules and their production is costly.

Identifying small chemical molecules that can inhibit the proprotein would provide a more economical solution. So researchers from the Institute of Chemical Technology, Mumbai, and the Goa College of Pharmacy started searching for such a molecule.

They downloaded the X-ray crystal structure of the proprotein convertase subtilisin/kexin type 9 from the Protein Data Bank, where three-dimensional structures of proteins are archived. The researchers also downloaded potential candidates against the enzyme target from Enamine, a database of synthesizable drug-like compounds for drug discovery projects.

Using the structures of the small molecules and the proprotein, they performed comprehensive molecular docking studies and found seven molecules that bind with the proprotein.

The seven molecules identified have the potential for use as cholesterol-lowering agents. However, *in-vitro* and *in-vivo* experiments are needed to select the best among the seven for clinical trials.

DOI: 10.1080/07391102.2023.2222173

### **Limonic-coated Capacitive Sensor For COVID detection**

Partha P. Sahu and colleagues from Tezpur University have been investigating methods to detect and quantify limonin, a bitter chemical found in citrus fruits. After they succeeded, they recently turned their investigation upside down by using limonin to detect SARS-CoV-2.

Limonin is a plant metabolite with high biological activity and in the process of searching for potential treatments for COVID-19, researchers elsewhere had reported limonin's interaction with the virus. This piqued the interests of Partha and team.

First they tested the idea by checking that limonin's structure indeed docks with the structure of the spike protein of the virus. It did and that too, with high affinity.

Now the problem was using this information to design a test for SARS-CoV-2. When limonin interacts with the spike protein, the molecule's electronic configuration will change. And that change can be detected using an appropriate electrochemical method.

The team took small strips of Whatman paper and drew two enmeshed comb structures on it using a silver pen. The two comb structures acted as two electrodes. In the small space between the comb structures, they dropped limonin solution as a dielectric material. Now if the spike protein comes into contact with the limonin in between the electrodes, it should change the capacitance between the electrodes.

The team analysed the capacitance for three different concentrations of S-protein standard solutions. The capacitance increased with increasing concentration and was saturated within 3 minutes.

Then the team tested their sensor using swab samples collected from patients at the Regional Medical Research Centre of ICMR, Dibrugarh. They calibrated the paper capacitor by testing it with 31 COVID positive samples, 27 COVID negative samples and 30 influenza samples.

For COVID positive samples, the capacitance ranged from 303 to 414 microfarad. When tested with viruses such as influenza A, influenza B and viral transport media, the response was lower.

'There was a clear demarcation. If the capacitance was greater than 300, the sample was COVID positive,' says Satyajit Das, Tezpur University.

'RT-PCR, the standard test for COVID-19 is cumbersome, time consuming and costly. The paper-based sensor for SARS-CoV 2 will prove to be a much cheaper alternative,' says Biswajyoti Borkakoty, ICMR Regional Medical Research Centre, Dibrugarh.

The antibody test often gives false positives. This paper based test promises to overcome that problem too.

'Since it takes only 3 minutes, it can become a point of care test,' adds Biswajyoti Borkakoty.

DOI: 10.1016/j.aca.2023.341500

### **Maternal Health Care Insurance Improves?**

Though the maternal death rate in India has been reducing in the last few decades, the country is a major contributor to global maternal deaths and is far from achieving international goals on maternal health. To improve maternal health by addressing financial obstacles in using maternal healthcare services, the government of India introduced the world's largest conditional cash transfer scheme, Janani Suraksha Yojana. This too did not make the intended impact on the use of maternal health services. Would health insurance impact the use of maternal healthcare services?

To find out, Ravi Durga Prasad and team from the Gokhale Institute of Politics and Economics, Pune used clinical and socioeconomic data from the most recent National Family Health Survey 2019–21. They extracted and analysed data of around two lakh women who

had given birth in the past 5 years before the survey. Only 24% were covered by health insurance.

The researchers also analysed data on antenatal visits, skilled birth attendants, and post-natal care for the child. Nagaland, Arunachal Pradesh and Meghalaya in the north-east, Bihar and Jharkhand in north central India showed the least uptake of these services. Southern states like Tamil Nadu showed the highest.

The team examined variables such as age, education, geographical region and wealth index. Women aged 35 and above, with secondary and higher education, frequent mass media exposure and the richest wealth quintile were three times more likely to have skilled birth attendants. Women below 20 who were uneducated, had no exposure to mass media and were from the poorest wealth quintile were least likely to use birth attendants.

The researchers used a logistic regression model to understand the impact of socioeconomic, demographic and cultural variables on the use of maternal health care services. Socioeconomic factors were significantly associated with the use of maternal healthcare services in India.

Those who had medical insurance tended to use maternal health services more. This effect was stronger for women from poorer households. So it appears that health insurance coverage can help improve the use of maternal healthcare services.

The researchers recommend that public health programmes target districts with poor healthcare and improve awareness about maternal healthcare, especially among poor women.

'The quality of existing programmes, including the conditional cash transfer scheme, needs to be improved to put the country on the track to achieving the Sustainable Development Goals,' says Ravi Durga Prasad.

DOI: 10.1007/s10389-023-01960-y

### **Food Security – Sundarbans Delta Impact of climate change**

People in the Sundarbans Delta, depend on fish, crabs and shrimps for protein nutrition and on rice cultivation for carbohydrates. But the region is

frequently impacted by severe cyclones and is susceptible to storm surges, floods and sea level fluctuations. This results in salinization, permanent inundation and water logging in low lying areas. These events affect the livelihood of five million people living in India's Sundarbans Delta. But how do they impact food security in the region?

Researchers at IIT Kharagpur in collaboration with the Asian Development Bank Institute, Japan examined previously published literature to determine the impact of water-related threats on food access, availability, stability and consumption. Then they selected a panel of seven experts from different academic backgrounds to discuss the outcomes from the literature survey and prioritise strategies to improve food security in the region.

The decline in marine fish and invertebrates reduced the availability of protein-rich food. The salinization of soil led to a reduction in arable lands and decreased agricultural yield. The damage to grain storage facilities, the decrease in fish drying areas and reduced honey production affected food availability and access, leading to food insecurity. Access to food decreased further due to the relocation of communities to shelters, and out-migration in search of new homes. Income reduced due to the loss in conventional agro-fisheries. Decreased purchasing power affected women and children more.

Poor water quality, sanitation and hygiene affect millions more each year and resulted in the death of 225 residents of the Sundarbans. Increased frequency and intensity of extreme weather events, and wildlife conflict also affected food security in the area.

To improve food security, the researchers created a list of 81 management strategies and actions. Of these, experts ranked seven strategies as the highest priority.

To protect low lying areas, they suggest long-term monitoring of water quality parameters for growing suitable mangrove species and scientifically designed embankments and plantations of mangroves.

To increase food availability, the experts recommend soil testing for suitable cropping, use of salt-tolerant crops, and improvements in agricultural practices.

To reduce food spoilage, embankment management and building all-weather storage for seeds and crops are necessary.

To improve the health and productive capacity of the people there, the government has to extend schemes such as Swajal that address the need for clean water and better hygiene.

'To empower women there, self-help groups can step in to adopt alternative livelihoods. There is also a need to raise awareness about government programmes, including access to health care,' says Bhagirath Behera, IIT Kharagpur.

To make all these possible, coordination among all stakeholders is necessary. Who will bell the cat?

DOI: 10.1080/07900627.2023.2224459

### **Iron-doped Hydroxyapatite** *For supercapacitor electrode*

Double-layer capacitors store charges in the electric field between the layers, while pseudocapacitors store charges between the electrodes and electrolytes via chemical reactions. Metal phosphate pseudocapacitors have greater capacitance than electric double layer capacitors. But they have low cyclic stability. Can we modify them for supercapacitor applications?

A group of researchers from Tamil Nadu started experimenting with hydroxyapatite, a naturally occurring, inexpensive mineral. The structure of hydroxyl groups gives it energy storing properties. But it lacks sufficient con-

ductivity for electrochemical applications.

To enhance its electrochemical storage and stability for use in supercapacitor applications, the team doped hydroxyapatite with iron ions. They synthesised a pure sample of hydroxyapatite and samples of different concentrations of iron-doped hydroxyapatite using chemical co-precipitation.

Examining the structure of the sample using powder X-ray diffraction, the functional group using Fourier transform infrared spectroscopy, and the crystal size under a transmission electron microscope, the researchers found that iron ions with a smaller ionic radius replaced the bigger calcium ions and decreased the crystal size of hydroxyapatite.

They fabricated working electrodes using the samples and measured the specific capacitance, power density and cycle stability. The sample with 0.01 molar iron-doped hydroxyapatite showed increased surface properties and had the highest specific capacitance of 351.30 farad per gram. The cell made of these electrodes was stable for 5000 charging cycles.

'Iron-doped hydroxyapatite has sufficient cyclic stability and is a potential candidate for supercapacitor applications,' says Anita R. Warriar, Academy of Maritime Education and Training, Chennai.

Researchers and supercapacitor manufacturers can now use the material to develop low cost charge storage devices.

DOI: 10.1016/j.molstruc.2023.135950

**Reports by Sheikh Aneaus, Amit Kumar, M. S. Induja, Manish Kumar Tekam and Sileesh Mullasserri**

scienceandmediaworkshops@gmail.com