

## Current Science Reports

### Ungulates of Eastern Ladakh

#### Predicting range shift

Changthang in eastern Ladakh is a high altitude area with small patches of grassy meadows that support a wide range of wild ungulates, hoofed mammals. As the climate changes and glaciers recede, water supply and storage could decrease, impacting the grasslands. How will this affect the distribution of ungulates in the Changthang region?



Image: Elroy Serrao via Wikimedia Commons

Researchers from the Department of Wildlife, Leh collaborated with colleagues from Amity University, Noida to model habitat suitability for four ungulates in the region: blue sheep, Tibetan gazelles, Tibetan argalis and kiangs.

From field surveys conducted between 2018 and 2021, the team had some data on ungulate occurrence points. The researchers used an ensemble model to train and predict the distribution of the four species.

By correlating this data with environmental data, it is possible to predict the distribution of the four ungulates even in areas where field surveys were not carried out. The researchers examined scientific literature on the ungulates to identify bioclimatic variables that are important for their survival and reproduction. Temperature, seasonality, annual precipitation, slope and its direction as well as terrain ruggedness influenced the distribution of all four ungulates. Precipitation in the warmest quarter and mean temperature of driest and coldest quarters had implications on the distribution of the Tibetan argali. The distribution of kiangs was also influenced by the mean temperature of the wettest and driest quarters. Precipitation in the driest month only influenced Tibetan gazelle distribution.

To predict where the ungulates were likely to be found now, the researchers combined different modelling techniques, using the biomod2 package, a collection of tools for species distribution modelling in R. This ensemble modelling was then run on R software, an open-source software environment. The results from these techniques showed that among the four ungulates, blue sheep had the highest distribution range and the Tibetan gazelle had the lowest – less than 2000 square kilometres.

How will the projected climate change influence the distribution of the four ungulates?

To predict the future distribution, the researchers used the Global Circulation Model System from the WorldClim database for the period 2050 to 2070. The model simulation predicted that the four ungulate species may lose up to sixty-one per cent of their current range, with a northward shift in their ranges.

The highest range loss will be for the Tibetan gazelle, placing it in the endangered category. Only 9 per cent of its present habitat will be suitable by 2070. The researchers predict both loss and gain in suitable habitat for the Tibetan argali.

'All four species will show a range shift towards the north and the east in the near future,' says Anchal Bhasin, Amity University, Noida.

There is a need for conservation planning for these species in this region including the protection and restoration of the grassland ecosystems there.

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### Ber Shelf Life

#### Hexanal increases

The ber, *Ziziphus mauritiana*, has high nutritional value. But it has a very short shelf life: about three to five days after harvest.

Recent research on using a pre-harvest spray of hexanal, a six carbon atom, alkyl aldehyde, with a fresh smell found in many plants, indicates that it can enhance the shelf life of fruits such as mangoes, strawberries and apples.

So S. K. Jawandha, Harsimrat K. Bons and Anil Sharma, Punjab Agriculture University, Ludhiana, in collaboration with a researcher based in the US, have been examining how applying hexanal helps extend the shelf-life of ber during cold storage.

Now they asked themselves a related question: what concentration of hexanal should we use pre-harvest to prevent spoilage and to extend the postharvest shelf-life of bers?

They divided fifteen-year-old jujube trees of the Umran variety into three groups and sprayed the trees with different concentrations of hexanal during the pit hardening and colour break stage.



Image: Tom Rulkens via Flickr

The ripened fruits were harvested and preserved in cold storage using standard commercial practices. Thirty fruits were taken at weekly intervals over four weeks for physio-chemical and enzymatic analysis.

The researchers used a digital hand penetrometer to measure the firmness of the ripened fruits and found that treated fruits were firmer than those that were untreated.

After three weeks of cold storage, more than a third of untreated bers was spoiled. In those treated with 0.2% hexanal, only a little more than one-fifth of the fruits were spoiled.

To understand the possible reasons for this, the researchers analysed enzyme markers of food spoilage such as polyphenol oxidase, polygalacturonase, pectin methyl esterase and catalase.

Hexanal treatment led to a reduction in polyphenol oxidase which causes the browning of fruits. The expression of polygalacturonase and pectin methyl esterase was reduced, resulting in

increased fruit firmness and the preservation of cell membrane integrity.

Prolonged shelf-life means fewer items are rejected, giving farmers better profit margins. The increase in shelf-life makes transport easy, benefitting the traders. The researchers recommend that farmers spray 0.2% hexanal on ber trees during fruiting to improve the shelf-life of the fruits after harvest.

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### Thioglycosides

#### *Next generation antibacterials?*

Bacterial cell walls contain glycosides necessary for cell wall integrity. The glycans are also involved in attachment to host cells and immune evasion. Research suggests that thioglycosides, sugars where an oxygen atom is replaced by sulphur, can disrupt bacterial glycan synthesis.

But then glycosides are found in gut bacteria and even human cell membranes. Is it possible to create thioglycosides that are specific to pathogenic bacteria?

To check the possibility, Suvarn S. Kulkarni and team from IIT Bombay in collaboration with researchers in the US synthesized three thioglycoside analogues and tested their action on pathogenic bacteria, gut symbiotic bacteria and human cell lines.

They used rare glycosides such as bacillosamine, diacetamido trideoxygalactose and fucoamine found in bacteria and attached a thiobenzyl group to these rare sugars to develop thioglycoside analogues.

The researchers then tested these analogues on glycoprotein biosynthesis in *Helicobacter pylori*. Western blot analysis showed that these analogues inhibited glycoprotein biosynthesis.

Flow cytometry showed that the bacterial cells treated with concanavalin A, a carbohydrate binding lectin which activates the immune system, have low lectin binding, but that, when treated with the thioglycosides, the lectin binding increased.

The researchers then assessed bacterial growth after treating them with these analogues. Among the three analogues, fucosamine thioglycoside reduced the bacterial growth rate and biofilm formation even at very low concentrations.

The researchers assayed cell death after treatment with the thioglycosides and observed reduced bacterial motility and high cell death.

Once the bactericidal effectiveness of these analogues on pathogenic bacteria was confirmed, the researchers tested whether these treatments affect beneficial bacteria in the gut and in a human adenocarcinoma cell line, a model for the epithelial cells of the gut. The cytotoxic effect was very negligible: intestinal bacteria and adenocarcinoma cells were relatively unaffected by the treatment.

These thioglycosides not only inhibited glycan biosynthesis in *H. pylori* but also exhibited enhanced selectivity in targeting only *H. pylori*.

Though the oxygen based glycolipids and thioglycosides showed equal potency, selectively targeting pathogenic bacteria was unique to thioglycosides.

In this era of the rapid evolution of multidrug resistant bacteria, targeting specific glycan synthesis using well-designed thioglycosides seems to be emerging as a successful strategy.

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### Wound Healing

#### *Using gelatin nanoparticles*

Stromal cells, a group of connective cells which provide scaffolds for other cells to form tissues and organs, play a vital role in tissue regeneration and wound healing.

The interaction of stromal cells with the extracellular matrix accelerates the growth, regeneration and healing of wounds.

In wounds, collagen, the major fibrous protein component of the extracellular matrix, is broken. Though collagen is widely used in tissue engineering experiments, now-a-days, during wound healing, it also triggers an immunogenic response, limiting its *in vivo* application.

Gelatin, a denatured form of collagen, however, has positive qualities such as biocompatibility and hydrophilicity. Can applying external creams with active gelatin improve wound healing?

Recently, Shamayita Patra from the Shri Vaishnav Vidyapeeth Vishwavidyalaya collaborated with Piyali Basak from the Jadavpur University, Kolkata to evaluate the efficacy of gelatin in

promoting the proliferation and migration of stromal cells.

They prepared gelatin nanoparticles by crosslinking gelatin with glutaraldehyde, a commonly used chemical cross-linker. This gave the nanoparticles a heterogenous charge composition with both anions and cations unlike the traditionally used gelatin nanoparticles which were mostly cationic.

The researchers then cultured isolated stromal cells with the gelatin nanoparticles for varying periods of time. The cells were then assessed for viability, proliferation and migration.

The MTT assay, a colorimetric assay for measuring cell viability, showed that the gelatin nanoparticles do not affect the viability of the stromal cells.

In fact, they promoted the proliferation and migration of the stromal cells, accelerating wound healing. The researchers attribute the effect to the anions in the gelatin nanoparticles and their interaction with the cell membrane.

They are optimistic about the applications of the gelatin nanoparticles for promoting tissue regeneration and wound healing.

Future studies could investigate the long-term effects and stability of the gelatin nanoparticles and assess practical applications *in vivo*.

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### Hypothyroidism

#### *Zinc and phosphorus as predictors*

The thyroid hormones, thyroxine and triiodothyronine, play a role in maintaining the balance of trace elements in the body. When thyroid hormones are reduced, as in hypothyroidism, the pituitary gland increases the production of thyroid-stimulating hormones, using zinc as a cofactor. And triiodothyronine controls the movement of phosphate ions across cells.

Considering these roles of zinc and phosphorus in hypothyroidism, researchers at the Integral Institute of Medical Sciences and Research, Lucknow started looking for correlations between zinc and phosphorus levels in the serum of hypothyroidism patients.

The team recruited fifty newly diagnosed patients with hypothyroidism from the outpatient department of medicine at the University Medical Hospital,

Lucknow, and 50 healthy individuals as controls. People with any disease or any other medical condition were excluded. The patients and controls had an equal number of males and females and were aged between 25 and 60 years.

The height and weight of the patients and controls confirmed that hypothyroidism influences metabolic activity, and leads to excessive fat accumulation.

Along with detailed information about the person's characteristics and medical history, the researchers took blood samples from each subject, and separated the serum from the samples using a centrifuge. Enzyme linked immunoassay, where fluorescence labelled antibodies against the hormones bind to the thyroid hormones in the serum, provided estimates of the amount of thyroid hormone in the serum samples. The researchers also determined zinc in the serum using a colorimetric method, and serum phosphorus using a UV-VS spectrophotometer method.

In patients with hypothyroidism, the levels of serum zinc were reduced, and the levels of serum phosphorus were significantly elevated.

Serum phosphorus showed a significant positive correlation with thyroid-stimulating hormone levels and body mass index among patients. Thus, the results suggest that both serum zinc and serum phosphorus are useful as predictors of hypothyroidism.

Moreover, low serum zinc is associated with complications such as hypertension, type 2 diabetes mellitus, immune dysfunction and liver cirrhosis. Similarly, elevated serum phosphorus is associated with microvascular dysfunction, coronary artery calcification and chronic kidney disease. So, it is important to keep track of these elements in serum to prevent complications among hypothyroidism patients, say the researchers.

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### Neuroendocrine Neoplasms

*New diagnostic marker*

Neuroendocrine neoplasms are rare tumours that arise from neuroendocrine cells. Like endocrine cells, they produce hormones and transmit signals like neurons. These tumours are

most commonly found in the lungs, the gastrointestinal tract and the pancreas. But they can occur at other locations in the body.

Since the symptoms can vary depending on the location, a variety of tests are needed to diagnose the disease including blood tests, imaging tests and biopsies.

Chromogranin A, a protein expressed in all neuroendocrine cells, was suggested as a marker for such neoplasms. However, it is not very specific to neoplasms. Similarly, the marker, synaptophysin, found on the membranes of vesicles, is sensitive but not very specific. Recently, insulinoma-associated protein 1 has also been suggested as a marker. But there are no studies to establish the relative usefulness of the proteins as diagnostic markers.

So Sangita Vanik, Dhaval Jetly and Karthik Dhandapani, oncologists from the Gujarat Cancer and Research Institute, Ahmedabad set out to fill that lacuna.

They took data from about 100 neuroendocrine neoplasm cases registered in a tertiary care hospital during 2019–2021. The patients were aged from 25 to 76, but most were above 50. There were four times more males than females.

The researchers took the patient tissue samples, fixed them in buffered formalin, and analysed the immunohistochemistry using monoclonal antibodies against all three marker proteins. They found that traditional markers are cytoplasmic and are difficult to identify in small biopsy samples. Insulinoma-associated protein 1 showed a significant association with neuroendocrine neoplasms and was easy to identify.

However, larger prospective studies are required to check the accuracy of the marker for different types of neuroendocrine neoplasms before it can be used as a diagnostic marker for neuroendocrine neoplasms in Indian clinics, say the researchers.

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### Copper Oxide Nanoparticles

*For efficient hydrogen production*

Hydrogen is emerging as the next generation fuel. But its production is

expensive. The easiest and least expensive method is by electrolysis of water, and this requires additional energy.

Solar panels can provide the power for electrolysis of water. But, when overheated, the panels tend to get degraded and their efficiency reduces.

To reduce the overheating of solar panels and to develop a more sustainable method for hydrogen production, S. Senthilraja from the SRM Institute of Technology, Kanchipuram collaborated with researchers from Turkey, Oman and Egypt.

Copper oxide nanoparticles have very high thermal conductivity. So, when mixed with water, they increase the thermal conductivity of water. And this can be used to reduce the chances of the overheating of solar panels, they reasoned.

The researchers dispersed copper oxide nanoparticles in deionized water. This was circulated in the solar panel and the electrolyser.

They measured the temperature and flow rate at different points in the circulation path and measured the amount of hydrogen produced. They also repeated the process for different irradiances of the solar panel and different flow rates of the nanofluids. In each case, they calculated the energy efficiency – the amount of hydrogen produced per unit solar energy input.

The team estimated the energy efficiency by circulating air as well as pure water through the solar panel and compared the results with those obtained by circulating the nanofluid. They found that copper oxide nanoparticles in water worked better and could increase the energy efficiency by 20 per cent.

Fuel producers and researchers can now use this method to increase the efficiency of sustainable hydrogen production. These nanofluids can also be used for other thermal applications, say the researchers.

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### Graphene Nanoribbons

*From organic compounds*

Mitali Saha and team at NIT Agartala have been preparing graphene sheets, graphene nanotubes, etc., each with its own set of interesting properties. But, when they tried making nanoribbons, is

they hit a roadblock. They could only get a mixture of graphene oxide and graphene ribbons of non-uniform size. And that too in very small quantities.

Recently, they changed their tactics. Since graphene nanoribbons have benzene-like structures, could we prepare nanoribbons through simple condensation reactions starting with such compounds?

The researchers selected para-aminobenzoic acid and ortho-aminophenol to test their hunch.

They heated para-aminobenzoic acid above its melting temperature for different time intervals. The formation of a black powder on heating, considered an indication of the presence of graphene powders, was observed after 30 minutes. Further heating was done to complete the reaction of the samples. After heating at 185 degrees Celsius for 60 minutes, the researchers studied the morphology of the structure obtained using a scanning electron microscope. The images revealed the morphology of a nanoribbon. The researchers re-confirmed the structure of the nanoribbons by observing specific peaks for graphene nanoribbons using Raman and X-ray spectra.

This morphology started evolving from 30 minutes of heating and was completed after 90 minutes of heating. The researchers attribute the formation of graphene nanoribbons from heating para-aminobenzoic acid to the presence of acid and amine groups in the compound. On heating, the compound releases water molecules, and further heating produces the complex highly ordered network structure of the nanoribbon.

The researchers then tried heating ortho-aminophenol above its melting temperature for different time intervals. The signature black powder was formed after one hour. Though they tried heat-

ing for two and three hours, one hour was adequate to create nanoribbons from ortho-aminophenol. The ribbon-like structure was confirmed using a scanning electron microscope and re-confirmed using Raman and X-ray spectra.

'The amino and phenol groups in ortho-aminophenol condensed together, and further dehydration produced a nanoribbon-like graphene structure,' explains Mitali Saha.

Due to their peculiar structure, graphene nanoribbons can be used as sensors. The success in preparing nanoribbons using two different starting materials will lead to the use of graphene nanoribbons in electronics and related sectors and change the context of conventional devices that we use in our day-to-day lives.

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### Decoding Linguistic Structure *Grammar in Tamil songs*

The advent of Indian cinema led to an increase in the production of songs. For more than a century, Tamil lyricists and poets experimented with their rich vocabulary and idiom, and began contributing to song writing using different literary styles.

Now, with the evolution of natural language processing, it is possible to lay bare the linguistic structures of Tamil songs. So R. V. Venkatesan and Louis Raja from the SRM Institute of Science and Technology, Chennai started exploring.

Tamil is an agglutinative language where multiple meanings can be derived from a root word by adding suffixes or prefixes. However, this quality makes it harder for computers to learn the language.

The researchers selected 20 song lyrics contributed by 25 lyricists be-

longing to different eras of Tamil film music to analyse the text using natural language processing tools to classify each song into different parts of speech, such as verbs, nouns, adjectives.

Realizing that there were not many studies done in Tamil language processing, the team developed a linear regression model to find the differences in linguistic choices of the lyricists.

With the Tamil language regression model that they had developed, they found that some lyricists use a lot of nouns and pronouns for writing love songs. Sad songs contained a higher proportion of adjectives and adverbs than other genres. And songs targeting younger audiences had simpler sentences than those for older people.

Different poets used different parts of speech and sentence structures to write songs. More than a thousand nouns and two hundred verbs in songs from at least 17 lyricists were identified.

The researchers validated the results from the model using other statistical tools like the Chi square test and residual plots.

'Our results show that the grammatical structure of Tamil lyrics is more diverse than previously thought,' says R. V. Venkatesan.

'The regression model can now be used to develop further tools and resources for Tamil language processing,' adds Louis Raja, his colleague.

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