

Science Last Fortnight

Harappan Civilisation

Displaced by climate change?

The Harappan civilisation of the Indus Valley might have witnessed mass migration induced by climatic variability, suggest scientists. Earlier palaeoclimatic studies indicate a sudden decrease in the Indian summer monsoon between about 4200 and 4000 years before present, which would have negatively impacted the Harappan civilisation. However, studies on the western Himalayan region, a major source of water for the Indus valley region, showed no significant climatic variability.

So a team of researchers from India and China examined 4500 years of past climate records from the Tso Moriri Lake, Ladakh to analyse the past climate in the north-western Himalayas that feed Indus valley. The team collected a sediment core from a water depth of five metres from the northern part of the lake for analysis.

From grain size, we can estimate the energy of water that transported the sediment. The isotopic ratios and elemental abundances also serve as proxies of the moisture source changes, intensity of monsoon and erosion in the lake catchment.

The data from this research indicates that, from about 4500 years before present, for a hundred and fifty years, till 4350 years before present, there was a warm and wet condition in the north-western Himalayas. This was followed by cold and arid conditions between 4350 and 3450 before present, due to the weakening of the Indian summer monsoon.

'An arid phase of more than 900 years in northwest Himalaya must have adversely affected the agricultural output of the Indus Valley civilisation and triggered a migration of populations – to the south-east, towards the Gangetic plains, in search of a more favourable climate and water resources for subsistence', says Som Dutt, scientist at the Wadia Institute of Himalayan Geology.

After this 900 years of dry spell, the climate became wet and warm again for 1850 years till about 600 years before present. Then, from about 550 years before present, it became cold and arid, for 330 years.

Historians may need to factor in this data about climate to interpret the history of the region.

Quat. Int., **482**: 83–92

Conflict Across Continents

Wild life and humans

Wild animals damage farm crops resulting in monetary losses to farmers. This often leads to negative attitudes against wildlife conservation. Such negative attitudes can hinder conservation initiatives.

Scientists from eight countries collaborated to undertake research on crop damage across four countries in Asia and Africa to collect crop damage data and to ascertain factors influencing crop damage.

Field officers collected data for a period of six years from two Asian countries, India and Nepal, and two African countries, Tanzania and Namibia. Crop damage caused by large herbivores within 5–7 km of the park boundary was considered in the study.

The researchers used a generalised linear model to understand the patterns in crop damage with respect to crop type, crop stage and seasonality. Results showed that crop damage by elephants was the most common in India, Nepal and Namibia whereas damage by zebras was most common in Tanzania.

The data shows seasonality in crop damage with the majority of crop damage occurring during the rainy season, when palatable crops are cultivated.

Stage of the crop was another important factor influencing crop damage. Elephant, zebra and boar/hog preferred mature and harvested crop. In contrast, species such as rhino and antelope/deer preferred intermediate crops. Primates and hippos damaged crops at all stages,

whereas buffalo did not damage crops. Thus, for effectiveness of crop protection measures, the species of herbivore and seasonality of crop should be considered, say the scientists.

It is the cultivation of palatable crops, in the vicinity of wildlife habitats, that leads to conflict with large herbivores. The scientists suggest the use of less palatable crops in these habitats to minimise conflict.

The study, with implications for managing large herbivore conflict in a global scenario, stresses the need for further research in buffer zone management, based on the species involved.

Biodiversity Conserv., **27**(8): 2029–2050

Insect Resistant Cotton

Using insect gut-binding lectin

Recently, cotton production is showing a declining trend due to pest attack. *Bt* cotton provides solutions to only chewing insect pests. The pests are developing resistance to chemical pesticides. So, we need new ways to protect cotton.



Image: Jay Phagan, via flickr.com

Scientists from the University of Agricultural Science and the Karnatak University, Dharwad reported success in expressing lectin genes in cotton, as protection against major sucking and chewing insect pests. Lectin genes, especially those from fungi, are known to confer insect resistance to plants.

The scientists took *Agrobacterium tumefaciens* and transformed it with genes which code for the protein. The tissue-cultured cotton seeds and one-week-old seedlings were in-

fectured by co-cultivation with a culture of the transformed bacteria, carrying plasmids with lectin genes.

After a few days, the scientists subcultured the explants on selection media. As soon as shoot and roots were established, the plants were transferred to pots containing peat, soil and sand.

'We checked putative transformants for the presence of the marker gene with specific primers by polymerase chain reaction. Genomic DNA was isolated from the transgenics and subjected to PCR to confirm the presence of the marker' says Gulam Nabi Vanti, Karnatak University.

They subjected T1 generation plants to reverse transcription-PCR analysis to check the expression of the lectin gene in transgenic cotton plants. They also quantified the lectin concentration in T1 transgenic plants using indirect ELISA.

'To confirm insect resistance in the cotton plant, we did an insect bioassay. We released twenty aphids, sucking pests, and twenty *Spodoptera litura*, chewing pests of cotton, on each cotton plant. And we checked the effect on population growth and fecundity of the insects on each plant along with rate of insect mortality', says Ishwarappa Katageri, University of Agricultural Science, Dharwad.

'The severity of infestation was very high on control plants. But we noticed a reduction in aphid population in the transgenic plants. There was cent per cent mortality of *S. litura* after 96 hours in all the progeny lines tested' adds Bale Swamy, Karnatak University.

The Indian government and the Central Institute for Cotton Research can now take steps to commercialise this research. Breeders and seed companies can use this research to come out with a resistant variety to benefit farmers.

J. Biotechnol., **278**: 20–27

Starch Nanomembrane

Antibacterial patch for wound healing

Wounds continue to be a major clinical concern. There is a need to develop non-toxic wound dressing

material that not only protects wounds from infection but also accelerates healing.

Researchers have attempted to develop asymmetric membranes that mimic skin morphology, with better wound healing properties. The first such asymmetric membrane was made of polyurethane, a synthetic biodegradable material with uniform hard segments composed of butanediol and 1,4-butanediisocyanate. Such membranes, however, did not absorb wound exudates and did not allow air or vapour transmission.

Recently, scientists from the Auxilium College, Vellore and the Abdul Hakeem College, Melvisharam succeeded in fabricating an asymmetric membrane with nanostarch-reinforced chitosan. This, they say, can be used as an antibacterial patch for wound healing.

Starch is abundant, relatively inexpensive and eco-friendly. It can be easily converted into nanoparticles and used as filler to prepare bio-nanocomposites for wound dressings. Chitosan is well known for its wound healing properties. The scientists reinforced the membrane by blending these with polyvinylpyrrolidone, a biocompatible polymer. They prepared polymer blends of chitosan with various proportions of nanostarch.

The membrane so produced was made asymmetric by coating one side with 1%-stearic acid. This made that side of the membrane hydrophobic, while the other side, facing the wound, was porous and hydrophilic – asymmetric, like our skin.

The researchers checked the mechanical, barrier and swelling properties of the membrane, as well as its cytotoxicity, and haemolytic and antibacterial activities. They also did *in vivo* tests on albino rats with excision wounds.

The dressing absorbed wound exudates and showed flexibility for wound dressing, properties conferred by starch. Wound healing studies showed that the membrane has faster wound healing, than dressings without asymmetry. This was also corroborated by histological studies.

Though promising news for patients with wounds, it will take more experiments and clinical trials before this material can be commercially produced for wound healing.

Int. J. Biol. Macromol., **114**: 204–214

Toxin Turned Medicine

Arsenic to cure liver cancer

Though arsenic is a carcinogen, it was used as medicine in ancient Europe. Recent research shows it can be effectively used against white blood cell cancer. However, there is not much research on its use in the most common form of cancer – liver cancer.



Image: Sustainable Pulse

Last fortnight, a team of scientists from India and the USA revealed the impact of arsenic trioxide on the human liver cancer cell line, Hep 3B. The researchers treated the cells with different concentrations of arsenic trioxide and studied the outcome.

Upon treatment, the team detected more cell clumping among Hep 3B than in normal cells. Interestingly, they also observed lesser cell viability and higher cytotoxic effects in Hep 3B than in normal cell lines.

The scientists studied the rate of apoptosis – naturally occurring programmed cell death – in both cell types. When exposed to arsenic trioxide, apoptosis in Hep 3B cell lines increased. Normal cells were less affected. This is because of the greater suppression of the anti-apoptotic protein, Bcl-xL, among the Hep 3B cells, say the scientists.

The team investigated the notch protein, a key apoptotic factor that regulates cell cycle. They observed that increasing arsenic trioxide concentration up-regulates notch protein expression in Hep 3B cells, while it decreased notch protein among nor-

mal cells. This shows that prospective apoptosis induction occurs only in cancerous cell lines.

The results clearly show that arsenic trioxide is target specific in inhibiting growth and viability of liver cancer cells. Further investigation is required to optimise the dose level for animal trials – a step that needs to be taken, since this may turn out to be a cost-effective cancer medication.

Life. Sci., **205**: 9–17

Polypeptides from Neem

Antimicrobial and anticancer potential

Neem is reported to have many medicinal values. Researchers from the Osmania University, and the CSIR-Indian Institute of Chemical Technology, Hyderabad, now report extracting polypeptides with antimicrobial and anticancer properties from *Azadirachta indica* leaves.



Image: STEAMindiaReports

The researchers dried fresh tender neem leaves and pulverized them to a fine powder using mortar and pestle in liquid nitrogen. Then they extracted the proteins from the powdered tissue. They report that a gram of the tender leaves has more than 100 mg of protein.

They analysed the protein composition and antimicrobial activity of the extracts against pathogens. Six genera of bacterial pathogens and *Candida*, a common fungal pathogen, were tested for antimicrobial activity. The extracts were effective against five of the bacterial genera and *Candida*.

They also tested the efficacy of the extract on three mammalian cancer cell lines – cervical, breast and neuroblastoma. They found that the

purified protein extract was promising on the tested cancer lines.

The scientists propose that the bioactive substances present in the neem protein extract can disrupt the cell membrane by apoptosis.

The functional groups of the proteins were analysed by Fourier Transform infrared spectroscopy. Matrix assisted laser desorption/ionisation showed eight new low molecular weight polypeptide bands.

More than sixty bioactive compounds have already been isolated from the tree. This study now adds to the list.

Int. J. Biomac., **114**: 906–921

Treating Contaminated Water

Reusing coffee ground waste

Fluoride and lead are pollutants found in underground water. Both are poisonous and such contaminated water is harmful to humans. Though mineral-based aluminosilicates are quite efficient in adsorbing such pollutants, their manufacturing cost imposes a huge constraint in using them.

A team from the Koneru Lakshmaiah Education Foundation, Guntur and the IIT Madras, recently, explored the use of coffee ground waste for the removal of lead and fluoride from water. Coffee ground waste has been used for dye and metal removal.

The researchers ground and sieved used coffee grounds. They activated the absorption sites with acid treatment.

They also prepared a solution of lead nitrate and sodium fluoride to mimic contaminated water and screened the quenching of the pollutants by the activated coffee grounds at varying pH, time and temperature.

From field-emission scanning electron images, they found pores for active adsorption in the coffee grounds. After adsorption of the pollutants from the contaminated water, the coffee grounds showed particles and peaks corresponding to lead and fluoride in energy-dispersive X-ray spectra.

The activated coffee grounds could adsorb 95% lead and 89% fluoride from contaminated water. The team

confirmed adsorption of lead and fluoride from the shift observed in Fourier-transform infrared spectra. The optimum operating conditions were close to 75–105 min at 30°C with pH being acidic in the case of fluoride and neutral with lead.

The scientists also characterised the thermodynamics of the adsorption using kinetic rate equations. They found that the adsorption process had a positive enthalpy value and negative free energy, thus defining the binding of the lead and fluoride as spontaneous. The positive thermal energy measure, enthalpy, also indicated improved absorption of the contaminants by the activated coffee grounds.

Spent coffee grounds are already being used for composting, bioenergy production and mushroom growing. Now, as bio-adsorbent for lead and fluoride removal from water, this waste is a viable alternative to activated carbon for water defluoridation. Moreover, the coffee grounds could be recycled after use for five regeneration cycles. Thus, they are cost-effective.

J. Environ. Manage., **218**: 602–612

Waste Segregation at Source

Community sensitisation is the key

India's household income is increasing at a steady rate. So is the municipal solid waste generated. Delhi alone generates 9620 tonnes of municipal garbage per day. Rules, related to waste management and disposal, recommend segregation of waste at source. However, lack of public involvement and initiative makes waste disposal a massive problem, especially in highly populated cities.

Shivani Wadehra of the TERI School of Advanced Studies, New Delhi and Arabinda Mishra of the International Centre for Integrated Mountain Development, Kathmandu investigated waste segregation and scope of intervention to encourage waste segregation in Delhi. They wanted to understand the attitudes and behaviour of people from fifteen localities of Delhi, against the back-

ground of the Solid Waste Management Rules, 2016.

They adopted randomised cluster sampling for data collection and chose group housing societies or apartment colonies from one ward each of the three municipal corporations of Delhi – North, South and East Delhi. They stratified the study area into two categories based on property tax. They selected five localities from one category and six localities from the other. There were two control localities in each category.

The study was conducted with the cooperation of the resident associations, which levy charges for waste collection from the households. These associations employ garbage collectors.

To have prior understanding about the waste disposal behaviour of the residents in the localities, the researchers conducted a baseline survey using questionnaires. The researchers found that the residents were aware of plastic ban and other environmental concerns, but 96% were unaware of the Solid Waste Management Rules, 2016. Further, there was no practice of waste segregation.



Image: S. Suresh Ramanan

The researchers then introduced three types of interventions – information only, information plus norms and information plus monetary incentive. For information-only-intervention, they used brochures to educate households about types of waste. In addition to this, brochures for the information and norms intervention group contained information about the Solid Waste Management Rules. The last set of intervention was the information plus monetary incentive for households adopting waste segregation.

Once the groups were sensitised, the researchers did two more surveys. The first survey was done one week after and the second, five weeks after sensitisation. The team found that information plus monetary intervention had better waste segregation at first week. However, by the fifth week, better waste segregation was observed in the information plus norms intervention.

The study clearly proves that sensitising society based on awareness and social cost is more effective in the long run. Policymakers should allocate time and resources to sensitise stakeholders such as housewives, maids and garbage collectors to implement waste management rules effectively.

Resourc. Conserv. Recycl., **134**: 239–247

Brick Manufacturing Using water hyacinth

Brick manufacturing consumes large amounts of fertile soil. Recently, Gaurav Goel and Ajay Kalamdhad from the IIT Guwahati struck upon a new idea to make brick production sustainable by using lesser amounts of soil, using a perennial aquatic weed – water hyacinth – in brick production.

Water hyacinth causes widespread environmental, ecological and economic damage. Large amounts of marble processing, and glass waste as well as fly-ash, mining tailings, paper mill sludge, rice husk, and sawdust have been used in brick production.

Encouraged by such frugal innovations, the team from the IIT Guwahati produced fired bricks using water hyacinth. X-ray diffraction results confirmed that adding water hyacinth does not cause compositional changes in the phase but leads to increased porosity in bricks. The cellulose fibres stabilise linear shrinkage.

‘Water hyacinth contains various fluxing agents. These fluxing agents help in early and complete burning of brick. This reduces the firing temperature required to produce a brick, says Goel.

‘The bricks manufactured by this method are eco-friendly, light weight and porous. These bricks have good

insulation properties, thus reducing the air-conditioning load during peak summers, says Kalamdhad.

The researchers performed a battery of tests and found that these bricks meet the Indian standards code.



Image: Ted Center via Wikimedia Commons

Policy makers should note this sustainable, cost-effective brick making method and make appropriate regulations to reduce energy consumption, to convert waste to resource and to save fertile topsoil.

J. Cleaner Product., **190**: 261–271

Indian Scientific Productivity

In 2009, Thomson and Reuters published a Global Research Report, ‘India: Research and Collaboration in the new Geography of Science, where they pointed out that India doubled its scientific productivity within the span of a decade. Now, it appears, from the data available in the Web of Science, that the rate of growth has increased in this decade. However, in the mean time, Web of Science has changed hands – from Thomson and Reuters to Clarivate Analytics. Will Clarivate continue the tradition of publishing such Global Reports? And will such a report shock the Indian scientific community from complacency by the magnitude of difference between Indian and Chinese scientific output?

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