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*** While Chemwatch has taken all efforts to ensure the accuracy of information in this publication, it is not intended to be comprehensive or to render advice. Websites rendered are subject to change.**

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ASIA PACIFIC

Chemical added to the Inventory following issue of assessment certificate (early listing) - 30 March 2023

2023-03-30

The following industrial chemical has been added to the Australian Inventory of Industrial Chemicals under section 83 of the Industrial Chemicals Act 2019.

CAS number	1631962-93-0
Chemical name	Benzene, 1-(2-methylpropyl)-4-(propoxymethyl)-
Molecular formula	C14H22O
Defined scope of assessment	The chemical has been assessed: as a fragrance component imported into Australia at up to 1 tonne per annum imported as a component of liquid fragrance formulations at up to 10% concentration, for local reformulation into finished cosmetic and household products imported or formulated as a component of finished cosmetic and household products up to: 0.03% concentration in non-spray deodorant 0.1% concentration in leave-on cosmetic products 0.2% concentration in fine fragrances 0.4% concentration in hair care products 0.6% concentration in rinse-off cosmetic and household products 5% concentration in air care products
Listing date	13 March 2023

Chemical added to the Inventory following the issue of an assessment certificate

Published date

30 March 2023

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Read More

AICIS, 30-03-23

<https://www.industrialchemicals.gov.au/news-and-notice/chemical-added-inventory-following-issue-assessment-certificate-early-listing-30-march-2023>

New guidance on completing a Pre-Introduction Report: internationally-assessed for human health and the environment

2023-03-29

Our practical guide includes tips to help you successfully submit a Pre-Introduction Report (PIR) for 'internationally-assessed for human health and the environment'.

This guide:

- has a checklist for you to make sure you have the correct information before you start
- shows you the questions that you must answer in the PIR form in AICIS Business Services for the type 'internationally-assessed for both human health and the environment'
- is designed to help you avoid common errors

Who should read this guide?

If you need to submit a PIR because you have categorised your chemical introduction and it meets the reported introduction criteria for the type - internationally-assessed for human health and the environment.

Read More

AICIS, 29-03-23

<https://www.industrialchemicals.gov.au/news-and-notice/new-guidance-completing-pre-introduction-report-internationally-assessed-human-health-and-environment>

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10 New Pesticide Products Approved for Registration in China

2023-03-30

China's Ministry of Agriculture and Rural Affairs has announced the approval of 10 new pesticide product registrations from Sichuan Jinzhu Ecological Agricultural Science and Technology Co., Ltd. and three other enterprises. The National Pesticide Registration Review Committee has completed a technical and evaluation review of the applications, in accordance with the "Regulations on Pesticide Administration" and "Administrative Measures for Pesticide Registration."

Read More

REACH24, 30-03-23

<https://www.reach24h.com/en/news/industry-news/agrochemical/10-new-pesticide-products-approved-for-registration-in-china.html>

Shanghai to Regulate Microplastics and BPA as Key New Pollutants

2023-03-27

From March 2023, strict control measures will be carried out in Shanghai to manage microplastics and BPA, especially for their uses in food contact materials.

On February 3, 2023, the Shanghai Municipal Bureau of Ecology and Environment released a notice to make public Shanghai's list of new pollutants subject to priority management (hereinafter referred to as the Shanghai List), which was formulated based on the national list – List of New Pollutants for Priority Management (2023) and Shanghai's Workplan for New Pollutants Treatment. It will come into force on March 1, 2023.

Compared with the national list (includes 14 types of new pollutants), the Shanghai List adds 2 more types of new pollutants – 'microplastics' and 'bisphenol A (BPA; CAS No. 80-05-7)' with the corresponding control measures, as well as some additional local requirements for nonyl phenol and antibiotics.

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Read More

REACH24, 27-03-23

<https://www.reach24h.com/en/news/industry-news/food-contact-materials/shanghai-to-regulate-microplastics-and-bpa-as-key-new-pollutants.html>

AMERICA

FTC Extends Deadline For Comments On Green Guides To April 24, 2023

2023-03-06

On February 6, 2023, the Federal Trade Commission (FTC) extended the deadline for public comment on its Guides for the Use of Environmental Marketing Claims (Green Guides) to April 24, 2023. 88 Fed. Reg. 7656. FTC states in its December 14, 2022, news release that it seeks to update the Green Guides "based on increasing consumer interest in buying environmentally friendly products." More information and an insightful Commentary are available in our December 16, 2022, memorandum.

Read More

JDSupra, 06-03-23

<https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/>

New York Bans PFAS in Apparel

2023-03-29

On March 24, 2023, New York Governor Kathy Hochul signed a bill prohibiting the sale of apparel containing "intentionally added" per- and polyfluoroalkyl substances (PFAS) in clothing apparel starting on January 1, 2025. Additionally, by January 1, 2027, the new law bans the sale of any new apparel unintentionally containing PFAS at an amount to be set by the Department of Environmental Conservation (DEC) in regulation.

PFAS, in use since the 1940s, are found in hundreds of widely used products and do not readily degrade in the environment, a characteristic earning them the description, "forever chemicals." California has similarly banned the sale of apparel containing intentionally added PFAS substances. Those who violate the law will be subject to a fine of up to

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\$1,000 a day for the first violation and up to \$2,500 a day for continued violations. Notably, there is a safe harbor for sellers of apparel who have a certificate of compliance from the manufacturer.

One of the critical considerations for businesses is whether their products fall under the provision of “apparel,” defined as “clothing items intended for regular wear or formal occasions including, but not limited to, undergarments, shirts, pants, skirts, dresses, overalls, bodysuits, vests, dancewear, suits, saris, scarves, tops, leggings, leisurewear, formal wear, outdoor apparel, onesies, bibs, and diapers.” It does not include “professional uniforms that are worn to protect the wearer from health or environmental hazards, including personal protective equipment.”

However, it does ban outdoor apparel for severe wet conditions by Jan. 1, 2028. Such apparel is defined as “apparel that are extreme and extended use products designed for outdoor sports experts for applications that provide protection against extended exposure to extreme rain conditions or against extended immersion in water or wet conditions, such as from snow, in order to protect the health and safety of the user and that are not marketed for general consumer use.”

Businesses also should understand the definition of “intentionally added” as outlined in the law, which is delineated as “a chemical in a product that serves an intended function or technical effect in the product or product component.”

An issue not addressed by the new law is the question of whether PFAS-containing products will need to be segregated from the general solid waste stream that is typically destined for landfills or waste-to-energy facilities. This will potentially become difficult to manage (and likely litigious) issue for waste haulers, landfill operators, and owners of waste-to-energy facilities.

Read More

JD Supra, 29-03-23

<https://www.jdsupra.com/legalnews/new-york-bans-pfas-in-apparel-5790150/>

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ATSDR Announces Availability Of Four Draft Toxicological Profiles

2023-03-06

The Agency for Toxic Substances and Disease Registry (ATSDR) announced on February 9, 2023, the opening of a docket to obtain comments on drafts of four updated toxicological profiles: cobalt; hexachlorocyclohexanes; 1,1,1-trichloroethane; and vinyl chloride. 88 Fed. Reg. 8427. ATSDR states that it prepared the drafts based on current understanding of the health effects and availability of new studies and other information since their initial release.

Comments are due May 10, 2023.

Read More

JDSupra, 06-03-23

<https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/>

Democrats Call On EPA To Address Plastics Crisis

2023-03-06

On February 9, 2023, Senator Cory Booker (D-NJ), Representative Jared Huffman (D-CA), and Senator Jeff Merkley (D-OR) led 45 Democrats in the Senate and House in a letter to EPA Administrator Michael Regan “encouraging the agency to expand its current efforts to address the plastic production crisis.” According to Booker’s February 9, 2023, press release, EPA can take the following actions to protect communities, climate, and the environment from plastic production and pollution:

- Create new nationwide targets for single-use plastic source reduction and reuse/refill requirements in the packaging and food service sectors;
- Incentivize the expansion of reusable and refillable systems across the country, prioritizing overburdened communities through agency grant making and public-private partnerships;
- Reject the Trump EPA’s proposal to remove pyrolysis and gasification from the definition of incinerators under Clean Air Act (CAA) Section 129;
- Remove harmful chemical recycling technologies from the National Recycling Strategy;

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- Require financial assurance requirements for new or expanded covered facilities (as defined in the Protecting Communities from Plastics Act, Section 4 (a)(3)) as a condition to receiving CAA or CWA permits;
- Initiate a rulemaking under TSCA to review the entire petrochemical industry, from their facilities to specific chemicals used, to understand how these chemicals, alone or mixed, impact human health; and
- Establish and lead a microplastics pilot program to test the efficacy and cost effectiveness of tools, technologies, and techniques to prevent the release of microplastics into the environment and to remove existing microplastics without causing additional harm to the environment.

Read More

JDSupra, 06-03-23

<https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/>

American Chemistry Council Supports Railway Safety Act of 2023

2023-03-25

Safety is a shared responsibility, and shippers, rail carriers, along with the federal government, have made steady progress by working together, notes ACC's CEO.

"We ship chemicals because the country needs chemicals to support virtually every aspect of daily life," said American Chemistry Council (ACC) President and CEO Chris Jahn in a March 23 letter commenting on the most recent Senate Rail Safety Hearing.

The letter acknowledges ACC's support for the legislative intent of the Railway Safety Act of 2023 (S. 576) and other proposals to further improve the safety of the nation's rail network.

"ACC supports a multi-layered approach to transporting hazardous materials by rail. This includes a range of measures: first, to further reduce derailments and other accidents; second, to minimize the risk a rail accident will result in the release of hazardous material; and third, to strengthen emergency response and mitigate the impacts of any hazmat incident that does occur," Jahn wrote.

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Read More

Chemical Processing, 25-03-23

<https://www.chemicalprocessing.com/safety-security/news/33002352/american-chemistry-council-supports-railway-safety-act-of-2023>

New hope in fight against mercury

2023-03-22

For the first time in over a decade, the US could see stronger limits on mercury and other toxic air pollutants from power plants.

It's found in lumbering polar bears and sleek seals in the the Arctic and it's found in the heart of seemingly pristine rainforests in Peru.

It lurks in the streams and lakes of our prized national parks and turns up unexpectedly on dinner plates.

It's pervasive, persistent and poisonous: it's mercury and it's everywhere.

New mercury regulations for power plants are on the horizon. (iStock)

Now, for the first time in over a decade, the Environmental Protection Agency is poised to strengthen its regulation from power plants.

Mercury is a highly potent neurotoxin that can have devastating impacts on the brain and nervous system especially for unborn babies and young children. It first hit the headlines in the 1950s, when an outbreak of severe neurological disorders in Minamata, Japan, was linked to decades of mercury pollution by a local chemical plant.

Exposure can cause permanent cognitive problems in children and harm cardiovascular health in adults. It is also associated with endocrine disruption, diabetes risk and compromised immune system function.

While mercury occurs naturally in rocks in the Earth's crust, human activities have helped spread it around the world at toxic levels. Concentrations of atmospheric mercury have tripled since preindustrial times. In the U.S. the largest source of manmade mercury emissions are from coal-fired power plants.

Read More

EDF, 22-03-23

<https://www.edf.org/article/new-hope-fight-against-mercury>

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EUROPE

EU panel re-examines health risks of mineral oil hydrocarbons in food

2023-03-30

On March 15, 2023, the European Food Safety Authority (EFSA) opened a public consultation on a draft opinion update of the risk assessment of mineral oil hydrocarbons (MOH) in food. The consultation is open for comments until April 30, 2023. The submitted document re-evaluates the toxicity of MOHs, the dietary exposure to European citizens, as well as a final assessment of the health risks to the EU population.

MOHs are intentionally used as additives in many different types of food contact materials (FCMs), such as plastics, adhesives, rubber articles, board, and printing inks. In food processing or the manufacture of FCMs, MOHs are additionally applied as lubricants, cleaning, or non-stick agents. Non-intentional contamination of packaging and environmental pollution present additional possible sources of MOHs in food. Whether used intentionally or not, MOHs can migrate into foodstuff from food contact materials (FCMs) during processing and from food packaging. Food packaging made from recycled paper and board is especially likely to contain MOHs (see FCCmigex), mainly due to the use of non-food grade newspaper inks.

The responsible EFSA panel states that a subgroup of MOHs, the mineral oil aromatic hydrocarbons (MOAHs), pose a risk of damaging cells and causing cancer. In addition, due to the lack of a better understanding of the toxicity of certain MOAHs, human health concerns were raised (FPF reported).

The other subgroup of MOHs, the mineral oil saturated hydrocarbons (MOSHs) were not classified as a health concern according to the Panel on Contaminants in the Food Chain (Contam). While experiments done on rats have shown adverse effects, it was concluded that the specific rat species are not an appropriate model to test for human health concerns.

Read More

Food Packaging Forum, 30-03-23

<https://www.foodpackagingforum.org/news/eu-panel-re-examines-health-risks-of-mineral-oil-hydrocarbons-in-food>

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European Commission proposes Green Claims Directive

2023-03-27

On March 22, 2023, the European Commission (EC) published the adopted proposal for a new directive on the substantiation and communication of environmental claims – known informally as the Green Claims Directive. The directive aims to ensure transparent communications of environmental claims. “Consumers will have more clarity, stronger reassurance that when something is sold as green, it actually is green, and better quality information to choose environment-friendly products and services,” the EC writes in its press release. In addition, the Commission asserts that businesses will also profit from this directive, as genuine environmental and sustainability claims will make products more attractive to consumers. By regulating the communications of such claims, the EC explains that a level playing field is ensured.

In an impact assessment study published in March 2022, the Commission found that “53.3% of examined environmental claims in the EU were found to be vague, misleading or unfounded and 40% were unsubstantiated.” According to the proposal, companies will have to independently verify any environmental claims and submit scientific evidence as proof. This includes disclosing the impacts relevant to the product and recognizing trade-offs. Furthermore, overall scoring of the environmental impact of a product will not be allowed anymore. Comparisons to other products or companies will require equivalent information and data. “Green claims are everywhere: ocean-friendly t-shirts, carbon-neutral bananas, bee-friendly juices, 100% CO2-compensated deliveries, and so on. Unfortunately, way too often these claims are made with no evidence and justification whatsoever,” says Frans Timmermans, Executive Vice-President for the European Green Deal in the press release.

Read More

Food Packaging Forum, 27-03-23

<https://www.foodpackagingforum.org/news/european-commission-proposes-green-claims-directive>

EU Approves 2035 Ban on Sales of Gas-Powered Cars

2023-03-28

EU countries have approved an end to the sale of gas-powered cars in 2035, allowing the law to enter into force.

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With its vote on Tuesday, the European Council “has taken an important step towards zero-emission mobility,” EU environment commissioner Frans Timmermans said on Twitter. “The direction is clear: in 2035 new cars and vans must have zero emissions.”

The vote comes after weeks of negotiations in which Germany lobbied for a carveout for e-fuels, which are made by combining hydrogen with carbon dioxide that has been scrubbed from the atmosphere in a process run on renewable power. Because e-fuels make use of captured carbon, they are considered carbon neutral. The EU agreed to grant the exemption, which will allow the sale of combustion vehicles that run only on e-fuels after 2035.

Around a quarter of EU emissions come from transport. The new law will require a 55 percent drop in carbon emissions across new car fleets by 2030. By 2035, all new cars must produce zero carbon dioxide.

Poland voted against the new law, saying it would drive up car prices, while Bulgaria, Romania, and Italy abstained. Italy had pushed for an exemption for biofuels, which was not granted, Reuters reports.

The exemption for e-fuels drew criticism from some on the environmental left. “The automotive sector has wholeheartedly embraced electric cars, rendering the previous debate on the matter absurd and damaging Germany’s credibility,” said Michael Bloss of Germany’s Green Party. “It is now time to make reparations.”

Read More

YALE E360, 28-03-23

<https://e360.yale.edu/digest/eu-gas-car-phaseout-2035>

Measures to improve Irish drinking water standards signed into law

2023-03-23

Included in the requirements is a commitment to supply information to the public on water quality

New regulations have been signed by the Minister for Housing, Local Government and Heritage, Darragh O’Brien, to improve the standards of Irish drinking water. Minimum hygiene requirements will be introduced for materials that come into contact with water and there will be increased water access for vulnerable and marginalised groups of people.

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The regulations ensure the State is meeting its EU obligations for the management of drinking water.

The Environmental Protection Agency (EPA), Ireland’s drinking water quality regulator, and the Commission for the Regulation of Utilities will oversee water suppliers affected by the regulations, including Uisce Éireann and group water schemes.

“These new regulations will add additional quality measures to continue to ensure that our drinking water remains wholesome and clean,” said Mr O’Brien. “Guided by an expert working group of all relevant stakeholders providing professional advice, we have developed – and will now implement – regulations which will ensure we comply with EU standards and, crucially, provide high quality water supplies to the people of Ireland.”

Read More

The Irish Times, 23-03-23

<https://www.irishtimes.com/environment/2023/03/23/minister-signs-eu-drinking-water-regulations-into-irish-law/>

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REACH Update

APR. 07, 2023

Enforcement authorities to target PFCAs and related substances

2023-03-23

ECHA's Enforcement Forum agreed to run a pilot project to check for the presence of restricted perfluorocarboxylic acids (PFCAs) and related substances in consumer products such as cosmetics.

Helsinki, 23 March 2023 - Inspections in this pilot project will begin in 2023 and continue throughout 12 participating countries during 2024. The objective is to protect consumers from being exposed to PFCAs and related substances, including perfluorooctanoic acid (PFOA), which have been identified as substances of very high concern due to their hazardous properties.

The project will also raise awareness about the restrictions under the REACH and Persistent Organic Pollutants (POPs) regulations among companies that sell cosmetics and other consumer products. It was triggered by cases of PFOA, the use of which is restricted under the POPs Regulation, found in cosmetics sold on the EU market.

Inspectors may enforce restrictions under the REACH or POPs Regulation, as applicable. Where breaches are detected, inspectors will take enforcement measures to ensure compliance with the applicable legislation. The project report should be published at the end of 2024.

During the March meeting, Forum members also initiated an enforcement action on controlling the presence of restricted substances in tattoo inks. The action aims to protect consumers from unsafe tattooing inks and bolster the enforcement capacity for such controls. The initiative is spearheaded by the Netherlands and has generated much interest among the Member States. Its timeline and participants will be confirmed in the coming months.

Background

PFOA and related substances are prohibited from being placed on the market in the EU under the POPs Regulation. Cosmetics are not exempted from this prohibition. REACH also restricts the use of PFCAs as substances on their own as well as in mixtures and articles. In addition, REACH specifically restricts the use of certain substances that are toxic to aquatic life in wash off cosmetics.

The Enforcement Forum including its subgroup (BPRS) is a network of enforcement authorities from the EU and EEA. They are responsible for

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coordinating the enforcement of the REACH, CLP, PIC, POPs and the Biocidal Products regulations with the aim of protecting our health and the environment while ensuring a level playing field for companies across the EU market.

The Forum met remotely on 14-17 March and the BPRS on 21 March 2023. The next meeting will take place in June 2023.

Read More

ECHA, 23-03-23

<https://echa.europa.eu/-/enforcement-authorities-to-target-pfcas-and-related-substances>

ECHA's Risk Assessment Committee backs PFAS ban in firefighting foams

2023-03-24

ECHA's Committee for Risk Assessment (RAC) supports the proposed restriction on per- and polyfluoroalkyl substances (PFAS) in firefighting foams. The draft opinion of the Committee for Socio-Economic Analysis (SEAC) is open for consultation until 15 May.

Helsinki, 24 March 2023 – RAC has adopted its opinion on the proposal to restrict the placing on the market, use and formulation of all PFAS in firefighting foams, after sector-specific transition periods.

With 470 tonnes of PFAS released into the environment each year, the committee concluded that there is an EU-wide risk for people and the environment from their use in firefighting foams. The proposed restriction would effectively reduce emissions and the associated risks posed by these persistent substances. The committee's concerns are based on the 'very persistent' property combined with others, such as 'mobility'.

"When a fire has occurred, or during training when firefighting foams are used, they are dispersed rapidly into the environment with no opportunity to collect them or to prevent the waste from entering the environment. This is seen as a European-wide problem and only certain sites have the possibility of applying risk management measures," says Tim Bowmer, Chair of the RAC, in a new episode of the Safer Chemicals podcast.

The draft opinion of the Committee for Socio-Economic Analysis (SEAC) also lends support to the proposed restriction. According to SEAC, the proposal is the most appropriate EU-wide measure for addressing

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identified risks, taking into account the availability of alternatives and the proportionality of its benefits and costs to society.

Nevertheless, SEAC suggests that a review of available and feasible alternatives is conducted before the end of the transition period for sites that produce, treat or store dangerous substances (covered by the Seveso Directive). This review is considered important to maintain safety where fires may have high impacts on the environment and human health. The 60-day consultation for the draft opinion is open until 15 May 2023.

“We are looking for more information during the consultation, for example, on the transition period needed for PFAS-containing portable fire extinguishers, and uses by the marine sector and municipal fire brigades,” says María Ottati, Chair of the SEAC. The committee is expected to adopt its opinion in June 2023.

Other outcomes of the March meetings:

- RAC and SEAC concluded that the universal restriction proposal on PFAS by Denmark, Germany, the Netherlands, Norway and Sweden conforms to the requirements of REACH. A six-month consultation on the proposal opened on 22 March 2023;
- RAC adopted its opinion supporting the Netherlands’ restriction proposal, which concerns occupational exposure to aprotic solvents DMAC and NEP. A 60-day consultation on SEAC’s draft opinion will run until 22 May 2023;
- RAC adopted its opinion on Italy’s proposal to restrict terphenyl, hydrogenated. A 60-day consultation on SEAC’s draft opinion will run until 15 May 2023;
- RAC adopted 11 opinions on harmonised classification and labelling;
- RAC adopted two opinions on the scientific evaluation of occupational exposure limits (OELs); and
- RAC and SEAC agreed on one draft opinion on a review report to renew an existing authorisation for diglyme and 14 draft opinions on applications for authorisation mainly of chromium trioxide. The opinions will be adopted at a later stage.

Read More

ECHA, 24-03-23

<https://echa.europa.eu/-/echa-s-risk-assessment-committee-backs-pfas-ban-in-firefighting-foams>

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Janet’s Corner

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Presents for Biologists

2023-04-07



<https://xkcd.com/2747/>

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Hazard Alert

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Nitric Acid

2023-04-07

Nitric acid, also known as aqua fortis and spirit of niter, is a highly corrosive strong mineral acid with the molecular formula HNO_3 . The pure compound is colourless, but older samples tend to acquire a yellow cast due to decomposition into oxides of nitrogen and water. Most commercially available nitric acid has a concentration of 68%. When the solution contains more than 86% HNO_3 , it is referred to as fuming nitric acid. Depending on the amount of nitrogen dioxide present, fuming nitric acid is further characterised as white fuming nitric acid or red fuming nitric acid, at concentrations above 95%. Nitric acid is the primary reagent used for nitration - the addition of a nitro group, typically to an organic molecule. Nitric acid is also a strong oxidising agent. [1]

USES [2]

Nitric acid is used in a wide variety of chemical processes where cleaning, oxidising or etching is required, including making synthetic fibres, dyeing, electrical circuit board making, electroplating, explosives, laboratory chemicals, metal cleaning and etching, semiconductors, pharmaceutical manufacture. It is used in the manufacture of fertilisers and other organic chemicals, in the printing industry for photoengraving, in jewellery manufacturing, and for wet chemical etching.

ROUTES OF EXPOSURE

- Industry sources: Released from industries producing, using or handling nitric acid, for example chemical plants, metal, electronic, printing, glass, rubber and plastics plants and industries. Where ever very high temperature combustion takes place in the atmosphere in the presence of nitrogen, oxygen and water. May be present in small amounts in some wastewater from intensive farm factories and other facilities, which produce wastewater containing high level of nitrogen.
- Diffuse sources: May be present in exhaust gases from motor vehicles, the exhaust of incinerators or other chemical plants, or where these are in contact with moisture in the air. Unlikely to persist in nature because it readily reacts with a wide variety of naturally occurring substances.
- Natural sources: Rare in nature as a gas in the atmosphere, in groundwater around active volcanic regions, or drainage from areas where accumulated organic or animal wastes are present.
- Transport sources: Exhaust chambers in motor vehicles.

Nitric acid, also known as aqua fortis and spirit of niter, is a highly corrosive strong mineral acid with the molecular formula HNO_3 .

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- Consumer products: Could be retained as small amounts in products where it has been used in the manufacturing or treatment process.

The major routes of exposure to nitric acid are:

- inhalation,
- ingestion,
- skin and/or eye contact

HEALTH EFFECTS [4]

Acute Effects

- Nitric acid is irritating and corrosive to all tissues with which it comes into contact. The severity of effects is dependent upon concentration and duration of exposure.
- Acute inhalation of nitric acid vapour can lead to symptoms such as ocular and nasal irritation, sore throat, cough, chest tightness, headache, ataxia and confusion
- In severe cases, pulmonary oedema may develop hours or days following exposure
- Acute ingestion may cause burns to the oesophagus and stomach, which can include ulceration, haemorrhage and perforation. Abdominal pain, difficulty swallowing, nausea, salivation, vomiting, diarrhoea and haematemesis may also occur, and in some cases may be fatal
- Dermal exposure may result in deep burns, blisters and permanent scarring
- Ocular exposure may cause corneal burns, lacrimation, conjunctivitis, photophobia and, in severe cases, could lead to permanent blindness

Chronic Effects

- Chronic inhalation exposure to nitric acid can cause respiratory irritation, leading to bronchitis and airways hyperreactivity and erosion of dental enamel.
- Chronic ingestion is unlikely due to the adverse effect of acute ingestion
- Dermal exposure to low concentrations of nitric acid can result in dermatitis
- Nitric acid is not considered to be carcinogenic or mutagenic

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SAFETY [5]

First Aid Measures

- Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.
- Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. **WARNING:** It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
- Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Fire & Explosion Information

Flammability Information

Nitric acid is flammable in the presence of cellulose or other combustible materials. Phosphine, hydrogen sulphide, selenide all ignite when fuming nitric acid is dripped into gas. Phosphine ignites in concentrated nitric acid. Nickel tetrathiosulphate ignites with fuming nitric acid. Contact with metals may evolve flammable hydrogen gas. A jet of ammonia will ignite nitric acid vapour. Cellulose may be converted to the highly flammable nitrate ester on contact with the vapour of nitric acid as well as the liquid.

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Explosion Information

Nitric acid reacts explosively with metallic powders, carbides, cyanides, sulphides, alkalis and turpentine. Can react explosively with many reducing agents. Arsine, phosphine, tetraborane all oxidised explosively in presence of nitric acid. Caesium and rubidium acetylides explode in contact with nitric acid. Explosive reaction with Nitric Acid + Nitrobenzene + water. Detonation with Nitric Acid + 4-Methylcyclohexane. The addition of warm fuming nitric acid to phosphine causes explosion. Addition of water to nitration mixture diluted with an equal volume of water can cause a low order explosion. Cyclopentadiene reacts explosively with fuming nitric acid. Mixtures of fuming nitric acid and acetonitrile are high explosives. (Nitric acid, fuming).

Exposure Controls & Personal Protection

Engineering Controls

Exhaust ventilation or other engineering controls should be provided to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the workstation location.

Personal Protective Equipment

The following personal protective equipment is recommended when handling nitric acid:

- Face shield;
- Full suit;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves;
- Boots

Personal Protective Equipment in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Vapour respirator;
- Boots;
- Gloves;
- A self-contained breathing apparatus should be used to avoid inhalation of the product.

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- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

United States [3]

NIOSH: The National Institute for Occupational Safety & Health has established a Recommended Exposure Limit (REL) for nitric acid of TWA 2 ppm (5 mg/m³) and short-term concentrations of 4 ppm (10 mg/m³)

OSHA: The Occupational Safety and Health Administration has set a Permissible Exposure Limit (PEL) for nitric acid of TWA 2 ppm (5 mg/m³)

Australia [2]

Safe Work Australia: Safe Work Australia has established a time weighted average concentration of less than 5.2 milligrams per cubic metre of air in an 8-hour period. Short-term exposure over a 15-minute period of no more than 10 mg/m³ air is recommended.

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Tiny, fast lasers are unlocking the mysteries of photosynthesis

2023-03-27

Renewable energy is easy for plants. These green organisms take water, sunlight and carbon dioxide and make their own fuel. The magic happens within teeny molecular structures too small for the human eye to perceive.

But while this process is a breeze for plants, truly understanding what happens is surprisingly hard for humans. Scientists know that it involves electrons, charge transfers, and some atomic-level physics, but the specifics of what happens and when are a bit hazy. Efforts have been made to decipher this mystery utilizing a range of tools from nuclear magnetic resonance to quantum computers.

Enter an approach that shoots laser pulses at live plant cells to take images of them, study author Tomi Baikie, a fellow at the Cavendish Laboratory at Cambridge University, explained to Earther. Using this tech, Baikie and his colleagues delved into the reaction centers of plant cells. Their findings were published this week in the journal Nature.

The technique they used allowed the researchers to carefully watch what the electrons are doing, and “follow the flow of energy in the living photosynthetic cells on a femtosecond scale – a thousandth of a trillionth of a second,” according to a press release from University of Cambridge.

Being able to have such a close eye on the electrons enabled the scientists to be able to make observations such as where the protein complex could leak electrons, and how charges move down the chain of chemical reactions. “We didn’t know as much about photosynthesis as we thought we did, and the new electron transfer pathway we found here is completely surprising,” Jenny Zhang, who coordinated the research, said in the statement.

Knowing the intricacies behind how this natural process functions “opens new possibilities for re-wiring biological photosynthesis and creates a link between biological and artificial photosynthesis,” the authors wrote in the paper. That means they could one day use this knowledge to help reengineer plants to tolerate more sun, or create new formulas for cleaner, light-based fuel for people to use.

Although the possibilities of “hacking” photosynthesis is more speculative, the team is excited about the potential of ultrafast spectroscopy itself, seeing how it can provide “rich information” on the “dynamics of living

Seeing the process in fractions of a blink could provide insights for clean fuel and more climate-sturdy plants.

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systems." As PopSci previously reported, "using ultrashort pulses for spectroscopy allows scientists to peer into the depths of molecules and atoms, or into processes that start and finish in tiny fractions of a blink."

Popular Science, 27 March 2023

<https://popsci.com>

Glass beads on moon's surface may hold billions of tonnes of water, scientists say

2023-03-28

Tiny glass beads strewn across the moon's surface contain potentially billions of tonnes of water that could be extracted and used by astronauts on future lunar missions, researchers say.

The discovery is thought to be one of the most important breakthroughs yet for space agencies that have set their sights on building bases on the moon, as it means there could be a highly accessible source of not only water but also hydrogen and oxygen.

"This is one of the most exciting discoveries we've made," said Mahesh Anand, a professor of planetary science and exploration at the Open University. "With this finding, the potential for exploring the moon in a sustainable manner is higher than it's ever been."

More than half a century after humans last walked on the moon, Nasa and other space agencies are preparing for a return. Nasa's Artemis mission aims to put the first woman and the first person of colour on the moon, while the European Space Agency has plans for a moon village. Both expect to draw on lunar materials to sustain their off-world bases.

Anand and a team of Chinese scientists analysed fine glass beads from lunar soil samples returned to Earth in December 2020 by the Chinese Chang'e-5 mission. The beads, which measure less than a millimetre across, form when meteoroids slam into the moon and send up showers of molten droplets. These then solidify and become mixed into the moon dust.

Tests on the glass particles revealed that together they contain substantial quantities of water, amounting to between 300m and 270bn tonnes across the entire moon's surface.

Finding from lunar soil samples is important breakthrough for hopes of building bases on the moon

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"This is going to open up new avenues which many of us have been thinking about," said Anand. "If you can extract the water and concentrate it in significant quantities, it's up to you how you utilise it."

Hints that the moon might not be an entirely arid wasteland have emerged from previous missions. In the 1990s, Nasa's Clementine orbiter found evidence for frozen water in deep, steep-sided craters near the moon's poles. In 2009, India's Chandrayaan-1 spacecraft spotted what appeared to be a thin layer of water bound up in the surface layer of moon dust.

The latest research, published in Nature Geoscience, points to fine glass beads as the source of that surface water. Unlike frozen water lurking in permanently shaded craters, this should be far easier to extract by humans or robots working on the moon.

"It's not that you can shake the material and water starts dripping out, but there's evidence that when the temperature of this material goes above 100C, it will start to come out and can be harvested," Anand said.

The water appears to form when high-energy particles streaming from the sun – the so-called solar wind – strike the molten droplets. The solar wind contains hydrogen nuclei, which combine with oxygen in the droplets to produce water or hydroxyl ions. The water then becomes locked in the beads, but it can be released by heating the material.

Further tests on the material showed the water diffuses in and out of the beads on the timeframe of a few years, confirming an active water cycle on the moon.

According to Prof Sen Hu, a senior co-author of the study at the Chinese Academy of Sciences in Beijing, such impact glasses could store and release water on other airless rocks in the solar system.

"This work adds to the growing consensus that the moon is more water-rich than previously thought," said Ian Crawford, professor of planetary science and astrobiology at Birkbeck, University of London.

"This additional reservoir of lunar water could prove a useful resource in areas that are distant from the presumed polar ice deposits, but we should not over-estimate the amount of water present, which is at most 130 ml per cubic metre of lunar soil."

The Guardian, 28 March 2023

<https://theguardian.com>

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Promising Alzheimer's therapy and related drugs shrink brains

2023-03-28

A class of Alzheimer's drugs that aims to slow cognitive decline, including the antibody lecanemab that was granted accelerated approval in the United States in January, can cause brain shrinkage, researchers report in a new analysis. Although scientists and drug developers have documented this loss of brain volume in clinical trial participants for years, the scientific review, published yesterday in *Neurology*, is the first to look at data across numerous studies. It also links the brain shrinkage to a better known side effect of the drugs, brain swelling, which often presents without symptoms.

"We don't fully know what these changes might imply," says Jonathan Jackson, a cognitive neuroscientist at Massachusetts General Hospital. But, "These data are extremely concerning, and it's likely these changes are detrimental."

The analysis, which found that trial participants taking these Alzheimer's drugs often developed more brain shrinkage than when they were on a placebo, alarmed Scott Ayton, a neuroscientist at the Florey Institute of Neuroscience and Mental Health in Melbourne, Australia, who led the work. "We're talking about the possibility of brain damage" from treatment, says Ayton, who was invited by Eisai to join an advisory board on lecanemab's rollout in Australia if the drug is approved there. "I find it very peculiar that these data, which are very important, have been completely ignored by the field."

A spokesperson for Eisai suggested there are benign theories for the brain shrinkage, too. The company said that although participants in its pivotal trial did experience "greater cortical volume loss on lecanemab relative to placebo," those reductions may be due to antibody clearing the protein beta amyloid from the brain, and reducing inflammation.

But that's sheer speculation, some scientists worry. "We don't know what it means" that more brain shrinkage occurs in treated participants than in people on placebo, says Lon Schneider, director of the California Alzheimer's Disease Center at the Keck School of Medicine of the University of Southern California. "When we see volume loss on MRI, we tend to think that's not good," Schneider continues. It's crucial to "try to seriously understand this."

As full approval of anti-amyloid antibody looms, scientists want more study of brain changes triggered by such drugs.

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Ayton and two colleagues identified 31 published clinical trials of so-called anti-amyloid Alzheimer's drugs. All aim to eliminate beta amyloid, whose buildup many consider a driver of the disease. The drugs fell into two categories. One, secretase inhibitors, are traditional small-molecule drugs that target an enzyme that produces beta amyloid from a larger protein. These compounds have largely been abandoned because they didn't pan out in trials. The second category included monoclonal antibodies like lecanemab that directly target various forms of beta amyloid. Another anti-amyloid antibody in the analysis, aducanumab, was approved in 2021 amid much controversy, and still others are in trials. Sixteen of the 31 trials Ayton and his colleagues analyzed involved these lab-generated immune proteins.

Alzheimer's disease frequently causes the brain to shrink as the illness progresses. But the researchers found both types of anti-amyloid drugs generally caused clinical trial participants to lose more brain volume than what was seen in Alzheimer's patients on a placebo. Lecanemab and another antibody, donanemab, made by Eli Lilly and Company and currently in late-stage trials, both "accelerated whole brain volume loss," Ayton and colleagues write. People in two large lecanemab trials on the highest drug dose—which is the one the U.S. Food and Drug Administration (FDA) approved—recorded, on average, a 28% greater brain volume loss relative to placebo after about 18 months. This translated to a loss of an extra 5.2 milliliters (mL) in brain matter.

The authors also reported that the anti-amyloid antibodies—but not the secretase inhibitors—led to an increase in the size of brain ventricles, indicating they were filling with extra fluid. This can happen when nearby brain tissue atrophies. In people taking the now-approved dose of lecanemab, brain ventricle size increased by 36% more than it did in people on placebo—or an additional 1.9 mL.

Ayton's group then studied whether a type of brain swelling and bleeding called amyloid-related imaging abnormalities (ARIA), a well-documented side effect of the antibodies, was associated with the other brain changes. ARIA occurred in 21% of the 898 people taking lecanemab in Eisai's pivotal trial (as well as 9% on a placebo); most had no symptoms, but some did become severely ill and at least two died after extensive brain swelling and bleeding. Ayton and his colleagues found the experimental therapies with a higher rate of ARIA also generated a bigger average increase in the size of the ventricles.

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"I was just shocked when we put these data together," Ayton says. To him, there's a logic behind this, though the connections haven't been proved. ARIA shows up on brain scans as inflammation, and generally, "it's not controversial that neuroinflammation would lead to neurodegeneration." It's possible, he theorizes, that patients who develop ARIA—which tends to happen early in treatment—may later develop brain volume loss and ventricles that take on more fluid.

Last year, Eisai's pivotal trial of lecanemab in 1795 early Alzheimer's patients revealed that the antibody slowed the rate of cognitive decline by 27% after 18 months compared with people on a placebo. Alzheimer's experts agreed the benefit was modest, but many celebrated the results because it's been so difficult to find drugs that stall the devastating loss of cognition.

FDA officials who approved Eisai's application for lecanemab noted the brain volume changes. Like the company, though, they weren't unduly concerned. A lead FDA reviewer "questions the clinical relevance of the changes to whole brain volume and total ventricular volume," FDA wrote in its summary review of the drug, in part because the drug met its goal of slowing cognitive decline.

But researchers say the picture could be a lot more complicated. The publicly available information on brain volume loss and increase in ventricle size are averages across a trial population, and therefore make it hard to glean whether some people have more brain changes and how they fare. As Madhav Thambisetty, a neurologist at Johns Hopkins University and chief of the clinical and translational neuroscience section at the National Institute on Aging, says, "The published results do not provide any information on whether brain volume loss and increase in ventricular volume are associated with worsening clinical and cognitive outcomes" in individual patients. The "incomplete reporting of results ... is very concerning to me."

Ayton shares the sentiment. "The lack of information increases my worry," he says, calling on companies, including Eisai, and drug regulators to examine this issue and share additional information from the trials. "You have more data—tell us why we shouldn't be concerned."

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FDA is planning an advisory committee meeting by July to consider whether to grant lecanemab full approval.

Science, 28 March

<https://science.org>

The most detailed life cycle analysis of food waste ever offers eye-popping revelations

2023-03-24

Food loss and waste contributes half of the annual emissions arising from the whole global food system. This enormous figure was recently revealed in a Nature Food study—which, among other revelations, highlighted the role of just four nations in generating almost half that amount, along with the surprisingly high emissions toll of lentils and wheat.

Several studies have drawn up estimates of food system emissions. But this study provides the most holistic and thorough estimate of food loss and waste emissions to date.

To get there, the study authors mapped the emissions associated with any food loss or waste across nine lifecycle stages in 2017, spanning food's journey from farm to plate (or bin). They did this at the country level, and looked at four major food groups containing 54 types of food.

First of all, this revealed a staggering 9.3 gigatons of carbon dioxide-equivalent associated with food loss and waste: that's around half the total gob of carbon released by the global food system each year. It's also double the estimates made in previous research.

Digging into this considerable figure produced a wealth of insights. Firstly, the so-called 'supply-embodied emissions' of food—emissions linked to unintentional food loss or wastage on the farm, during storage, transport, processing, retail, and in the final stages of food consumption—generated around 6 of those 9 gigatons in 2017. That's a huge share, equivalent to two months-worth of emissions generated by burning fossil fuels.

Food transport and processing associated with lost or wasted food are major sources. But in particular, the researchers highlight the impact at the consumer stage, which generates 35% of those embodied emissions. That's more than from the wholesale, trading, and retail stages combined, which contributed 11%. In fact, reducing just one-third of the consumer-stage emissions in China and the United States would be comparable to

Food waste contributes half of the annual carbon released by the entire global food system—a staggering 9.3 gigatons, double previous estimates

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the emissions produced during the processing and transport stages of the food system globally, the researchers calculate.

The remainder of food loss and waste emissions—2.84 gigatons of CO₂-equivalent, or about one-third—occur at the end-of-life stage, which comes down to how the wasted food is disposed of, and how well it's managed after that.

Looking at the lifecycle is just one way to visualize where emissions occur: this is also influenced by food type. Meat, as might be expected, had a far greater overall emissions impact than plant-based foods when lost or wasted, largely due to the higher impact of production at the farm stage. Yet, this didn't hold across all lifecycle stages. In fact, rather surprisingly, cereals and pulses like lentils and wheat accounted for the largest share—up to 75%—of all emissions when wasted or lost at the end-of-life stage.

That's partly due to the large amount that's consumed and therefore also wasted globally compared to meat, but also because these foods have a comparatively high carbohydrate content, which emits large amounts of carbon and methane.

Geography matters in this equation too. The study found that four nations—the United States, China, Brazil, and India—account for a whopping 44% of all supply-embodied emissions, and 38% of total emissions at end-of-life, mainly due to large populations and greater production and consumption of meat in these regions.

Socioeconomic factors and the degree of technological development also determine how much food gets wasted or lost in individual countries, or how it's dealt with when it is. For example, more developed nations or those with a higher relative GDP may show reduced emissions on the end-of-life stage, because they're better equipped with innovative technologies like anaerobic digestion to reduce and capture these emissions in place.

These facts and figures are just a sampling of the many discoveries that the study made, which is its strength: the detailed, comprehensive picture it paints of food loss and waste may help pinpoint where changes need to happen to bring emissions down, the researchers hope. At the very least, it reveals that there are many routes to action.

One broad brush measure could be to halve food waste and loss outright, which would cut 4.65 gigatons of CO₂-equivalent emissions from the global picture each year, or a quarter of emissions from food production

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overall, they found. Interestingly, almost exactly the same amount could be cut by halving global meat consumption.

Significant, and perhaps in the short term more realistic, reductions could also be achieved by awareness-raising about food waste to reduce the huge contribution that consumers make. Or, by increasing the global spread of waste-management techniques like composting and anaerobic digestion. In fact, the study finds that a 50% increase in the market share of emissions-busting technologies would curtail food waste emissions by 15%.

The challenge is undoubtedly huge. But perhaps the study's biggest takeaway is that this huge emissions problem is avoidable. With coordinated action, new technologies, and dietary flexibility, we may be able to turn food loss into a win.

Zhu et. al. "Cradle-to-grave emissions from food loss and waste represent half of total greenhouse gas emissions from food systems." *Nature Food*. 2023.

Anthropocene, 24 March 2023

<https://www.anthropocenemagazine.org>

Zapping Microplastics Out of Our Waterways With Pulsing Ultrasound Waves

2023-03-29

Colorful particles of plastic drift along under the surface of most waterways, from headwater streams to the Arctic Ocean. These barely visible microplastics — less than 5 mm wide — are potentially harmful to aquatic animals and plants, as well as humans. So, researchers are devising ways to remove them and to stop them at their source. Today, a team reports a two-stage device made with steel tubes and pulsing sound waves that removes most of the plastic particles from real water samples.

The researchers will present their results at the spring meeting of the American Chemical Society (ACS). ACS Spring 2023 is a hybrid meeting being held virtually and in-person March 26–30, and features more than 10,000 presentations on a wide range of science topics.

"The idea came from a discussion with a colleague who said that we need new ways to collect microplastics from water," says Menake Piyasena, Ph.D., the project's principal investigator. "Because acoustic forces can

Researchers have developed a two-stage device using steel tubes and pulsing sound waves to effectively remove most plastic particles from water samples.

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push particles together, I wondered if we could use them to aggregate microplastics in water, making the plastic easier to remove.”

Filtration is the most commonly used technique for removing these materials from water. For example, washing machine outlet filters can keep fibers that slough off clothes during washing from entering wastewater. But this method can be costly on a large scale, requiring regular cleaning of the filters, which can get clogged.

Another option could be concentrating plastic particles in flowing water with acoustic forces, or sound waves, that transfer energy to nearby particles, causing some of them to vibrate and move. Just think of a speaker playing loud music that shakes the ground, bouncing flecks of dust and dirt toward each other. Scientists have already been using this phenomenon to separate biological particles from liquids, such as red blood cells from plasma.

Recently, some teams have applied this approach to the separation of microplastics from samples they prepared in the lab with pure water. But this work was done with tiny volumes of water. They also used microplastics that were only tens of microns wide — smaller than the width of human hair, explains Nelum Perera, a graduate student in Piyasena’s lab at New Mexico Tech.

“I read that most of the microplastics in the environment are larger than that,” says Perera, who is presenting the work. “So, I wanted to develop a device that could be useful for most of the sizes and could be scaled up to meet real-world goals.”

To accommodate higher water flow rates, Perera created a proof-of-concept device with 8-mm-wide steel tubes connected to one inlet tube and multiple outlet tubes. Then she attached a transducer to the metal tube’s side. When the transducer was turned on, it generated ultrasound waves across the metal tube, applying acoustic forces onto microplastics as they passed through the system, making them easier to capture. The prototype device is relatively simple compared to traditional filtration methods, Piyasena explains, because it doesn’t clog as easily as a filter.

In initial experiments with polystyrene, polyethylene, and polymethyl methacrylate microplastics, the researchers discovered that smaller (6- to 180- μm -wide) particles behaved differently than the larger (180- to 300- μm -wide) ones in the presence of acoustic forces. Spiked into pure water, particles of both sizes arranged along the center of the channel, exiting through the middle outlet, while clean water flowed out the

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surrounding outlets. But if laundry detergent or fabric softener were added to the water, the larger particles focused toward the sides, exiting through the side outlets, and purified water out the middle outlet.

Based on these results, the researchers set out to develop a system that could take advantage of these differing movements. They connected two steel tubes in tandem: The first stage captured small microplastics less than 180 μm wide, and the water stream with the remaining larger microplastics went to the second stage to be cleaned. “We removed more than 70% of the small plastics and more than 82% of the large ones this way,” says Perera.

To show that the two-stage system could work for real-world applications, Perera and Piyasena collected water from a pond on the New Mexico Tech campus and from the Rio Grande River. They filtered all of the samples to remove large contaminants, leaving behind water that still contained dissolved substances that could have affected the separation. Next, they spiked the water with microplastics. When the environmental water samples went through the acoustics device, plastic particles were removed as effectively as from pure water. With this prototype, Perera estimates it would cost around 7 cents to operate the current device for an hour and take around an hour and a half to clean one liter of water.

The team’s next step is to develop a system with wider tubes, or bundles of multiple tubes, and to try it on unspiked real-world samples, including ocean water and wastewater from washing machines. “We have shown that acoustic forces can be used to concentrate a wide range of microplastic sizes,” says Piyasena. “And from here, we want to prove that this can be done on a larger scale with real samples that already have microplastics in them.”

Sci Tech Daily, 29 March 2023

<https://scitechdaily.com>

‘Astonishing’ molecular syringe ferries proteins into human cells

2023-03-29

Researchers have hijacked a molecular ‘syringe’ that some viruses and bacteria use to infect their hosts, and put it to work delivering potentially therapeutic proteins into human cells grown in the laboratory.

Technique borrowed from nature, and honed using artificial intelligence, could spur the development of better drug-delivery systems.

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"It's astonishing," says Feng Jiang, a microbiologist at the Chinese Academy of Medical Sciences Institute of Pathogen Biology in Beijing. "It is a huge breakthrough."

The technique, published in *Nature* on 29 March 1, could offer a new way to administer protein-based drugs, but will need more testing before it can be used in people. With further optimization, the approach might also be useful for delivering the components needed for CRISPR-Cas9 genome editing.

Difficult delivery

The medical applications of CRISPR are currently limited by the challenges of getting the reagents — the DNA-cutting Cas9 enzyme and a short piece of RNA that guides Cas9 to a specific region in the genome — into cells.

"One of the major bottlenecks for gene editing is delivery," says study co-author Feng Zhang, a molecular biologist at the Broad Institute of MIT and Harvard in Cambridge, Massachusetts, and an early pioneer of the CRISPR-Cas9 technique. Limited options have restricted most clinical trials to editing genomes in liver, eye or blood cells, because those cells can be reached using the current delivery methods, he says. "The reason we don't see brain or kidney diseases getting tackled is because we don't have good delivery systems."

While Zhang and his collaborators searched for ways of transporting proteins into human cells, microbiologists were learning more about an unusual group of bacteria that use molecular spikes to pierce a hole in the membranes of host cells. The bacteria then transport proteins through the perforation and into the cell, exploiting the host's physiology in their favour.

Last year, Jiang and his colleagues reported that they could manipulate this syringe-like system in the bioluminescent bacterium *Photobacterium luminescens*, loading proteins of their choosing from mammals, plants and fungi into the syringe. Normally, the bacterium lives inside nematodes and uses its syringe to transport a toxin into the cells of insects infected by the nematode. The toxin kills the insect, and the nematode eats the remains. "The bacterium can be viewed as a hired gun to kill this insect," says co-author Joseph Kreitz, a molecular biologist at the Massachusetts Institute of Technology in Cambridge.

In Zhang's lab, Kreitz and his collaborators were working on ways to engineer the *P. luminescens* molecular syringe so that it would recognize

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human cells. They focused on a region of the syringe called the tail fibre, which normally binds to a protein found on insect cells. Using the artificial-intelligence program AlphaFold, which predicts protein structures, the team designed ways to modify the tail fibre so that it would recognize mouse and human cells instead. "Once we had the image, it was very easy to modify it for our uses," says Kreitz. "That was the moment when it all came together."

They then loaded the syringes with various proteins, including Cas9 and toxins that could be used to kill cancer cells, and delivered them into human cells grown in the lab, and into the brains of mice.

Flexible system

The system was unable to transport the mRNA guide needed for CRISPR-Cas9 genome editing, but the team is developing ways to do this, says Kreitz. The fact that the system was able to ferry Cas9 into cells speaks to the technique's flexibility, he adds, given that the Cas9 protein is about five times larger than the syringes' usual cargo.

The syringe story is reminiscent of the way that researchers such as Zhang developed CRISPR-Cas9 — a system that many microorganisms rely on in nature to defend against viruses and other pathogens — for use as a genome-editing technique, says Asaf Levy, a computational microbiologist at the Hebrew University of Jerusalem. Similar to the early days of CRISPR-Cas9 research, the bacterial syringes are studied by only a handful of labs, and their roles in microbial ecology are only beginning to be understood.

Yet they could have a transformational effect on medicine, says Levy. "The evolution of this thing is quite amazing," he says. "The fact that you can engineer both the payload and the specificity is ultracool."

Nature, 29 March 2023

<https://nature.com>

Dying plants are 'screaming' at you

2023-03-30

While plants can't chat like people, they don't just sit in restful silence. Under certain conditions—such as a lack of water or physical damage—plants vibrate and emit sound waves. Typically, those waves are too high-pitched for the human ear and go unnoticed.

In the future, farmers might use ultrasound to listen to stressed plants vent.

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But biologists can now hear those sound waves from a distance. Lilach Hadany, a biologist at Tel Aviv University in Israel, and her colleagues even managed to record them. They published their work in the journal *Cell* today.

Hadany and colleagues' work is part of a niche but budding field called "plant bioacoustics." While scientists know plants aren't just inert decorations in the ecological backdrop—they interact with their surroundings, like releasing chemicals as a defense mechanism—researchers don't exactly know how plants respond to and produce sounds. Not only could solving this mystery give farmers a new way of tending to their plants, but it might also unlock something wondrous: Plants have senses in a way we never realized.

It's established that "the sounds emitted by plants are much more prominent after some kind of stress," says František Baluška, a plant bioacoustics researcher at Bonn University in Germany who wasn't a part of the new study. But past plant bioacoustics experiments had to listen to plants at a very close distance to measure vibrations. Meanwhile, Hadany and her colleagues managed to pick up plant sounds from across a room.

The study team first tested out their ideas on tomato and tobacco plants. Some plants were watered regularly, while others were neglected for days—a process that simulated drought-like conditions. Finally, the most unfortunate plants were severed from their roots.

Plants under idyllic conditions seemed to thrive. But the damaged and dehydrated plants did something peculiar: They emitted clicking sounds once every few minutes.

Of course, if you were to walk through a drought-stricken tomato grove with a machete, chopping every vine you see, you wouldn't hear a chorus of distressed plants. The plants emit sounds in ultrasound: frequencies too high for the human ear to hear. That's part of why researchers have only now perceived these clicks.

"Not everybody has the equipment to do ultrasound [or] has the mind to look into these broader frequencies," says ecologist Daniel Robert, a professor at the University of Bristol in the United Kingdom who wasn't an author of the paper.

The researchers were able to record similar sounds in other plants deprived of water, including wheat, maize, wine grapes, pincushion cactus, and henbit (a common spring weed in the Northern Hemisphere).

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Biologists think the clicks might come from xylem, the "piping" that transports water and nutrients through a plant. Pressure differences cause air bubbles to enter the fluid. The bubbles grow until they pop—and the burst is the noise picked up by scientists. This process is called cavitation.

Most people who study cavitation aren't biologists; they're typically physicists and engineers. For them, cavitation is often a nuisance. Bursting bubbles can damage pumps, propellers, hydraulic turbines, and other devices that do their work underwater. But, on the other hand, we can put cavitation to work for us: for instance, in ultrasound jewelry cleaners.

Although it's known cavitation occurs in plants under certain conditions, like when they're dehydrated, scientists aren't sure that this process can entirely explain the plant sounds they hear. "There might not be only one mechanism," says Robert.

The authors speculate that their work could eventually help plant growers, who could listen from a distance and monitor the plants in their greenhouse. To support this potential future, Hadany and her colleagues trained a machine learning model to break down the sound waves and discern what stress caused a particular sound. Instead of being surprised by wilted greens, this type of tech could give horticulturists a heads-up.

Robert suspects that—unlike people—animals might already be able to hear plant sounds. Insects searching for landing spots or places to lay their eggs, for instance, might pick and choose plants by listening in and selecting a plant based on their health.

If there is an observable quality like sound (or light or electric fields) in the wild, then some organisms will evolve to use it, explains Robert. "This is why we have ears," he says

If that's the case, perhaps it can work the other way—plants may also respond to sounds. Scientists like Baluška have already shown that plants can "hear" external sounds. For example, research suggests some leaf trichomes react to vibrations from worms chewing on them. And in the laboratory, researchers have seen some plants' root tips grow through the soil in the direction of incoming sounds.

If that's the case, some biologists think plants may have more sophisticated "senses" than we perhaps believed.

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“Plants definitely must be aware of what is around because they must react every second because the environment is changing all the time,” says Baluška. “They must be able to, somehow, understand the environment.”

Popular Science, 30 March 2023

<https://popsci.com>

A popular underground pipe fix is making people sick: Here's what we learned from our investigation.

2023-04-01

It's relatively cheap.

It's more convenient than traditional pipe rehabilitation projects.

And it's already been used to repair hundreds of millions of miles of underground infrastructure in the United States alone.

Cured-in-place pipe lining is an increasingly popular method of repairing old and damaged sewer and stormwater pipes without having to dig up streets, reroute traffic or haul away debris.

But there's a catch: Noxious fumes created during the process can escape the job site and sicken people in their homes, schools and businesses.

Here are five key takeaways from our recent investigation into the cured-in-place pipe industry that you need to know.

How the CIPP process works

Cured-in-place pipe lining creates a new pipe inside an old one when workers insert a soft, resin-soaked liner into a damaged pipe, inflate it with pressurized air, then heat it with steam, hot water or UV light so it hardens.

During the heating process, volatile organic compounds in the resin mixture are released as a chemical plume that can escape from manholes and travel through the lateral connections linking the main pipe to the properties it serves.

Plumbing fixtures called P-traps are supposed to block these fumes from entering a building through sinks, toilets and drains. But they're not a failsafe. The emissions can also seep through cracks in the foundation, doors, windows and air intakes.

What happens to people

Cured-in-place pipe lining is an increasingly popular method of repairing old and damaged sewer and stormwater pipes without having to dig up streets, reroute traffic or haul away debris.

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People exposed to these fumes have described an odor similar to that of epoxy or model airplane glue. Many said it irritates their eyes and throats. Some have experienced nosebleeds. Other common complaints include dizziness, headaches, slowed reaction times, loss of balance, nausea and unconsciousness.

Dozens of incidents from coast to coast have landed people in the hospital, triggered evacuations and sparked lawsuits claiming injuries and even death.

Several people told USA TODAY their symptoms lasted weeks. In some cases, they never went away. At least three workers in two pipe-lining incidents have died after exposure to the chemicals. In October, a Florida woman settled a lawsuit with a contractor she blamed for her 71-year-old mother's death.

What the industry says

The industry claims these fumes are safe and notes that a key compound in the emission – styrene – is found in nature. Mailers, door hangers and FAQs issued by cured-in-place contractors and the cities that hire them tend to omit, deny or downplay the potential health threats.

The National Association of Sewer Service Companies, whose membership includes cured-in-place pipe contractors, has adopted voluntary guidelines to control worksite emissions. It also vigorously rejects evidence of widespread public health risks. In 2017, the association publicly denounced a peer-reviewed study that determined the process releases noxious emissions into the air.

What the research has found

Inside the chemical plume released from cured-in-place pipe projects lurk compounds like styrene, benzene, methylene chloride and phenol, along with bits of uncured resin, partially cured plastic and hazardous air pollutants, according to scientific research funded by the U.S. National Science Foundation and cited by the Centers for Disease Control and Prevention.

A 2017 California Department of Health safety alert noting that the emissions contain potentially toxic chemicals and advising that cities and contractors “should not tell residents the exposures are safe.”

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"Persons who detect an odor and experience health symptoms near CIPP installation sites should contact their medical provider and local health department," the alert said.

Nobody is regulating it

Despite these risks, the cured-in-place pipe-lining industry is completely unregulated when it comes to public health. No state or federal agency actively monitors work sites or requires safety protocols to eliminate or prevent harmful emissions from leaking into the environment.

The U.S. Environmental Protection Agency, in charge of protecting the public from harmful emissions, does not regulate "temporary sources of air pollution" such as that produced during a pop-up operation like a cured-in-place pipe project.

"It's sort of the Wild West," said Matt Belcher, a Chicago-based attorney who represented the family of a cured-in-place pipe worker who died on the job in 2017. "Nobody is policing these things."

USA Today, 1 April 2023

<https://usatoday.com>

3D-printable glass is made from proteins and biodegrades

2023-03-30

Researchers have transformed amino acids and peptides — the building blocks of proteins — into glass, according to a study published in *Science Advances*¹. Not only is the biomolecular glass transparent, but it can be 3D printed and cast in moulds. The paper suggests that the glass biodegrades pretty quickly, but wouldn't be suitable for applications such as drinks bottles because the liquid would cause it to decompose.

"Nobody ever tried this with biomaterials in the past," says Jun Liu, a materials scientist at the University of Washington in Seattle. "It's a good discovery."

Standard glass is made using inorganic molecules, mainly silicon dioxide. The ingredients are melted down at high temperatures and then rapidly cooled. Glass can be recycled easily, but despite this, a substantial amount ends up in landfill, where it can take thousands of years to break down.

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But amino acids are readily broken down by microorganisms, meaning that instead of sitting for years in a dump, the nutrients in biomolecular glass could, in principle, rejoin the ecosystem.

"The development of renewable, benign and degradable materials is highly appealing for a sustainable future," says Xuehai Yan, a co-author of the study and a chemist at the Chinese Academy of Sciences in Beijing.

Typically, when amino-acid chains, known as peptides, are heated, the molecules start to split up before they melt. Yan and his colleagues modified the ends of the amino acids to change how they assemble and stop them from breaking up. After melting these modified amino acids, the researchers rapidly supercooled them — a process that takes molecules to below their freezing point while allowing them to retain its liquid arrangement. The researchers then further cooled the substance to solidify it into glass. It stayed solid when it returned to room temperature.

This method prevents the amino acids and peptides from forming a crystalline structure when they solidify, which would make the glass cloudy, although the authors note that in some cases the glass was not completely colourless.

When the researchers exposed the biomolecular glass to digestive fluids and compost, it took between a few weeks and several months to break down, depending on the chemical modification and amino acid or peptide used.

The glass is just a lab curiosity at this stage: "This is a very fundamental study," says Ting Xu, a materials scientist at the University of California, Berkeley. However, she says it opens a new path for materials researchers to explore.

Because it can biodegrade, the glass would not be appropriate for use in environments that are very humid or wet, Xu says. Organic chemical bonds tend to be weaker than inorganic bonds, so she speculates that the peptide glass would be less rigid than standard glass. But she says that this property could be beneficial in flexible, miniature devices, such as the lenses of a microscope.

Nature, 30 March 2023

<https://nature.com>

Chemically modifying the ends of the molecules opens the door to glass that could decompose with organic waste.

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Facelift for T. rex: analysis suggests teeth were covered by thin lips

2023-03-30

The fearsome maw of the iconic Tyrannosaurus rex has had a makeover. According to a study published today in *Science*¹, the dagger-like teeth of theropod dinosaurs such as T. rex would not have been visible when their mouths were closed. Instead, they would have been concealed behind thin, scaly lips.

Reconstructions of large theropods — whether in Hollywood films or scientific texts — often depict the prehistoric predators as having jaws full of exposed teeth, even when their mouths are shut. Palaeontologists had reasoned that theropod teeth were probably exposed because the teeth are so big, and because the closest living relatives of theropods, alligators and crocodiles, have toothy grins.

But when Kirstin Brink was a graduate student at the University of Toronto, Canada, in the 2010s, she and fellow students Thomas Cullen and Derek Larson got talking over a few beers about whether that depiction was accurate. “It just looks so weird when the T. rex mouth is closed, and you can see the teeth,” she says.

Brink, now a vertebrate palaeontologist at the University of Manitoba in Winnipeg, Canada, notes that modern-day lizards, such as iguanas and Komodo dragons, have lips that hide their teeth.

Other palaeontologists have also wondered whether extinct theropods smiled like a crocodile or had lips like lizards. But Brink, Cullen, Larson and their colleagues are the first team to examine the skulls and teeth of theropods and their living relatives to settle the debate.

Brink says that the tooth enamel in theropods points to them having lips that cover the teeth. “Enamel needs to stay hydrated,” she says, otherwise it is prone to cracking.

In crocodiles, the enamel is thick and stays hydrated because they live in the water. Even so, crocodile teeth bear the signs of cracks and damage on their outer surface. That’s not the case in theropods, she says. Theropod teeth are covered by just a thin layer of enamel, indicating that these dinosaurs probably had lips to keep the teeth protected and coated in saliva when their mouths were closed.

Gummy dragons

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Brink and her colleagues also compared theropods with Komodo dragons (*Varanus komodoensis*), one of the few living reptiles with teeth shaped like those of theropods. “Komodo dragons are weird though, because they have these gigantic gums,” says Brink. There’s no evidence that theropods had such gummy mouths, but it’s possible, she says.

“These authors have given T. rex a facelift,” says Steve Brusatte, a vertebrate palaeontologist at the University of Edinburgh, UK. The work is “the single strongest case for lippy tyrannosaurs yet,” he says.

Soichiro Kawabe, a vertebrate palaeontologist at Fukui Prefectural University in Eiheiji, Japan, says he has long suspected that theropod enamel was too thin for the teeth to be exposed. “So I am happy that the scientific data has now been presented,” he says. “It looks less monstrous and more natural,” he adds. Kawabe would like to see similar work to be done in other prehistoric creatures, such as toothy pterosaurs, for which the facial morphology is less known than for the well-studied T. rex.

T. rex wouldn’t have been able to purse its lips like humans do because it wouldn’t have had the necessary muscles. “Dinosaur lips would have been scales and keratin, and some soft bits covering the teeth from the outside, not the big fleshy and pouty lips of humans,” says Brusatte.

“I doubt it will be the final word in this contentious debate,” he says. “Ultimately, we need to find a fossil T. rex mummy with skin and muscles and scales still preserved on the head,” he says. “That would tell us once and for all whether there were lippy tissues covering the teeth, or whether the teeth were more exposed.”

Nature, 30 March 2023

<https://nature.com>**Crocodiles and Komodo dragons provide evidence to support the idea of a scaly cover over the teeth of dinosaur Tyrannosaurus rex.**

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Genetic Welding: Unleashing Evolution's Future or Playing With Ethical Fire?

2023-03-28

With CRISPR-Cas9 technology, humans can now rapidly change the evolutionary course of animals or plants by inserting genes that can easily spread through entire populations. Evolutionary geneticist Asher Cutter proposes that we call this evolutionary meddling "genetic welding." In an opinion paper published today (March 28) in the journal *Trends in Genetics*, he argues that we must scientifically and ethically scrutinize the potential consequences of genetic welding before we put it into practice.

"The capability to do genetic welding has only taken off in the last few years, and much of the thinking about it has focused on what can happen in the near term," says Cutter of the University of Toronto. "Ethically, before humans apply this to natural populations, we need to start thinking about what the longer-term consequences might be on a time scale of hundreds or thousands of generations."

In classical Mendelian genetics, we think about genes having a 50:50 chance of getting passed from parent to offspring, but this isn't always the case. In a natural phenomenon known as "genetic drive," some genes are able to bias their own transmission so that they are much more likely to be inherited.

Genetic welding is the human-mediated version of this: introducing genes that have an unfair advantage when it comes to heritability into natural populations. Because these genes spread easily and rapidly through populations, they result in much faster evolutionary change than the usual slow plod that we see from natural and artificial selection. Also, in contrast to natural selection, genetic drives and genetic welding can perpetuate genes that don't necessarily benefit the organisms that carry them, making them an attractive potential method to control problematic/invasive/disease-bearing species.

Genetic welding in this way has been proposed as a tool for controlling disease-bearing mosquito populations and invasive species. It could also be used to genetically engineer endangered species to be resistant to infectious pathogens that threaten them with extinction. "It raises the question of how much should humans intervene into processes that are normally beyond our control," says Cutter.

"If ethicists, medical practitioners, and politicians decide that it is acceptable in some cases to edit the germ line of humans, then that

"Genetic welding" is the use of CRISPR-Cas9 technology to alter the evolutionary course of organisms by inserting easily-spread genes.

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would open the possibility that genetic welding could be used as a tool in that regard," says Cutter. "This would open a much bigger can of worms by virtue of the fact that genetic welding could change the entirety of a population or species, not just a few individuals that elected to have a procedure."

Though it might be difficult to experimentally assess the long-term implications of genetic welding, Cutter says that thought experiments, mathematical theory, computer simulations, and conversations with bioethicists could all play important roles, as could experiments in organisms with short lifespans and rapid reproduction.

Sci Tech Daily, 28 March 2023

<https://scitechdaily.com>

Could grinding up lithium batteries help to recycle them?

2023-03-29

Grinding up old batteries might lead to a low-energy way to recycle the lithium and other metals used in them.

Lithium-ion batteries are in all our personal technology — such as phones, laptops and wireless headphones — and they power electric vehicles. Without them, our lives would look very different.

The lithium in rechargeable batteries is currently recycled by either heating them to high temperatures or treating them with concentrated acids and organic solvents. Estimates for how much lithium is recycled vary, but calculations by lithium-battery consultant Hans Eric Melin suggest that perhaps 15% of the metal in batteries is recovered.

Oleksandr Dolotko, a materials scientist at Karlsruhe Institute of Technology, Germany, and his colleagues used mechanochemistry — the initiation of a chemical reaction by mechanical force from grinding or milling — to recover lithium from lithium-ion batteries.

Such batteries contain lithium compounds and other metals, such as cobalt or nickel. Although the supply of these metals is not critically running low, recycling them is becoming more important because battery-powered devices are becoming more prevalent as part of the transition away from fossil-fuel energy. The European Union has set a target of 80% lithium recovery for all batteries by 2031.

Researchers use 'mechanochemistry' to recover the metal from batteries at a small scale.

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Dolotko's team developed two extraction methods, with varying success. They first took the cathode material from a lithium cobalt oxide battery and combined it with the same amount of aluminium foil. Real-life batteries contain aluminium, which they use as a 'current collector' to allow electrons to move out of the battery. The researchers mixed the compounds using a grinder called a ball miller. After 3 hours, the aluminium had reacted with the cathode material and produced a mixture of insoluble aluminium oxides, as well as metallic cobalt and water-soluble lithium oxides.

A separation method known as water-based leaching and further purification produced the recycled lithium compound: lithium carbonate, which can be used to make more batteries.

But these reactions recovered only 30% of the metal. "Somewhere there was a loss of lithium," says Dolotko. So Dolotko's team tweaked their experiment. The second version had fewer steps — they heated the mixture that came out of the ball milling with water. This prevented the formation of insoluble lithium aluminium oxides, which lock up the lithium.

The team tested both processes with different cathode materials used in batteries, as well as a mixture of the cathodes. The improved process recovered 75% of the lithium from a mix of cathode materials.

Mechanochemistry is not typically used in commercial chemical processes, and exactly how mechanical force initiates chemical reactions isn't completely understood, says Dolotko. "It is really hard to say how it happens," he says. Perhaps the temperature increases at specific points in the process, or friction produces some intermediate products, he suggests. But the milling did prompt the aluminium to act as a reducing agent, as he expected.

This mechanochemical recycling process is a demonstration, at the scale of a small laboratory, and as such is a proof of principle rather than a game-changing technology, says Melin, director of Circular Energy Storage, a London-based consultancy focused on the lithium-ion-battery end-of-life market. He points out that battery recycling is more complicated than simply developing a new technique, and is as much about the economics of the raw materials and the take-up of technologies that use batteries, such as electric vehicles.

"We are in a situation where we don't really know today where the lithium we need in 2030 will come from," Melin says.

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Dolotko says that there are opportunities to refine the process, and he is also working to extract other metals from batteries at the same time, including cobalt and nickel.

Nature, 29 March 2023

<https://nature.com>

What can't bees do? Unique study of urban beehives reveals the secrets of several cities around the world

2023-03-30

Bees provide myriad benefits to humanity, including pollination services, honey production, food security and crop pollination, artistic inspiration and even career opportunities.

But what if bees could also provide insights into human and city health? A new study published today in Environmental Microbiome shows how honeybee hives reveal information about human health, pathogens, plant life and the environment of different cities.

Our living cities

The United Nations predicts nearly 70% of the human population will reside in cities by 2050.

While cities are planned and built with humans in mind, they also act as complex, adaptive ecosystems hosting a diversity of other living organisms. Human health and wellbeing in urban areas can be affected by our interactions with the many invisible things we share our cities with.

It is therefore important to understand what biotic (living organisms such as plants, animals, and bacteria) and abiotic (non-living components such as soil, water and the atmosphere) parts make up our cities. However, to collect such samples from across the city, we need lots of volunteers, time and intensive labour.

Honeybee hives maintained by urban beekeepers could provide a new, more efficient way to sample the urban microbiome – a collection of the local microbes, such as bacteria, fungi, viruses, and their genes.

Honeybees as collaborators

Honeybees often live in hives of 60,000–80,000 individuals. When a bee reaches a certain age in the hive (roughly 21 days), they become a forager. Foragers leave the hive in search of nectar, pollen and other resources.

Honeybee hive debris could provide a snapshot of the microbial landscape of cities.

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Researchers enlisted the help of honeybees as data collectors in five cities: New York in the United States, Tokyo in Japan, Venice in Italy, and Melbourne and Sydney. In urban areas, honeybee foragers typically travel approximately 1.5km from the hive to visit flowers.

During these flights they can interact with many biotic and abiotic components of the environment, carrying traces of these interactions back to the hive. In each city, the team took samples of one or more of the following: hive materials including honey, bee bodies, hive debris (accumulation of material under or at the bottom of the hive) and swabs of the hive itself.

The 'genetic signature' of a city

The researchers found some unexpected materials in the hives, alongside less surprising results. Hive materials showed plant DNA that varied between cities. In Melbourne, the sample was dominated by eucalyptus, while samples from Tokyo contained plant DNA from lotus and wild soybean, as well as the soy sauce fermenting yeast *Zygosaccharomyces rouxii*.

Samples from Venice were dominated by fungi related to wood rot and date palm DNA. The samples also contained bee-related microorganisms, indicating both healthy hives and hives with pathogens or parasites, such as *Varroa destructor*.

The more surprising discoveries included genetic data in the Sydney sample from a bacterial species that degrades rubber, *Gordonia polyisoprenivorans*. DNA from a pathogen spread to humans via cat fleas called *Rickettsia felis* was also found in samples, and showed up in Tokyo hives over time.

How do we interpret these results?

The study offers a new and interesting use of honeybee hives in cities – the potential to monitor human health and urban pollution. However, there were some limitations to the work. The differences in microbiomes across cities were based on small sample sizes – one hive in Venice, three in New York, two in Melbourne, two in Sydney and 12 in Tokyo.

Due to these constraints, differences between cities could potentially be attributed to variation in hives and their genetics. Future work using longer-term studies with more hives would help to uncover whether the unique genetic signatures were due to differences amongst cities or between hives or even time periods.

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The authors have suggested that honeybee hive debris could provide a snapshot of the microbial landscape of cities. In the future, they argue such methods could even help to monitor antibiotic resistance and the spread viral diseases, but much more sampling and validation will be needed to achieve these goals.

The Conversation, 30 March 2023

<https://theconversation.com>

Deadly weed may actually help us look younger, heal faster

2023-03-29

If you're on a hike, you'd be best steering well clear of the cocklebur weed. While the stalky green plants with curious-looking spiky burs don't appear particularly deadly, this noxious plant is a killer.

In 2007, 76 villagers fell ill in northeastern Bangladesh after consuming the plant's seedlings, and a quarter of those died. The toxin present in the seedlings and burs (also often called their fruit and their seeds), carboxyatractyloside, can cause nausea, palpitations, drowsiness, hallucinations and multiple organ dysfunction leading to death.

It can also cause acute liver failure in pigs, cattle, sheep, poultry, horses and other ruminants.

However, the deadly plant is of increasing interest to scientists for its array of potential health benefits. Already studied for cancer-fighting and arthritis-treating properties, researchers have also discovered compounds with anti-aging and wound-healing potential.

New research has found that the fruit of the cocklebur plant – scientifically, *Xanthium strumarium* – has antioxidant and anti-inflammatory properties that could be used by humans as an effective skin protectant.

Research out of Myongji University in South Korea detailed how in clinical trials on tissues and cells, compounds extracted and isolated from the burs reduced damage from UVB exposure, accelerated wound healing and stimulated collagen production.

"We found that cocklebur fruit has the potential to protect the skin and help enhance production of collagen," said Eunsu Song, a doctoral candidate at Myongji University. "In this regard, it could be an attractive ingredient for creams or other cosmetic forms. It will likely show a

The plant has been used for thousands of years in traditional Chinese herbal medicine, treating everything from headaches to fungal infections.

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synergistic effect if it is mixed with other effective compounds, such as hyaluronic acid or retinoic acid, against aging.”

The plant has been used for thousands of years in traditional Chinese herbal medicine, treating everything from headaches to fungal infections. Scientists have since identified around 170 of its compounds for use in medical research.

Cocklebur proliferation, its hardiness and the rate at which it grows could provide an economical and sustainable source of cosmetic and pharmaceutical skincare development. However, the researchers caution that their results are preliminary and that more studies are needed to evaluate safety.

“In its burrs, cocklebur fruit also has a toxic constituent, carboxyatractyloside, which can damage the liver,” said Song. “Cocklebur showed a potential as a cosmetic agent by increasing collagen synthesis; however, it showed negative results with higher concentrations. Therefore, finding the proper concentration seems very important and would be key to commercializing cocklebur fruit extracts in cosmetics.”

The research was presented at the ASBMB annual meeting #DiscoverASBMB in Seattle.

New Atlas, 29 March 2023

<https://newatlas.com>

Saturn's rings have been slowly heating up its atmosphere

2023-03-31

Nothing can really stay a secret forever, and this otherworldly mystery has evaded astronomers for four decades. Saturn's signature ring system is heating the planet's upper atmosphere. According to NASA, this phenomenon has never been seen in the solar system, and the unexpected interaction between Saturn and its vast rings could provide a tool for predicting if the planets around other stars have ring systems like Saturn's.

The findings were published March 30 in the Planetary Science Journal.

The evidence that caused Saturn to spill its secrets is an excess of ultraviolet radiation that is seen as a spectral line of hot hydrogen in Saturn's atmosphere. This bump in radiation indicates that something

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is heating and contaminating the planet's upper atmosphere from the outside.

According to the paper, the most feasible explanation is that icy ring particles raining down onto Saturn's atmosphere cause this heating. A few things could be driving this shower of particles, including the impact of micrometeorites, bombardments with particles from solar wind, solar ultraviolet radiation, or electromagnetic forces picking up electrically charged dust. Additionally, Saturn's gravitational field is pulling particles into the planet while this is all occurring.

In 2017, NASA's Cassini probe plunged into Saturn's atmosphere and measured the atmospheric constituents, confirming that many particles are indeed falling in from the rings. This new discovery used that Cassini data in addition to observations from NASA's Hubble Space Telescope, the Voyager 1 and 2 spacecraft, and the retired International Ultraviolet Explorer mission.

“Though the slow disintegration of the rings is well known, its influence on the atomic hydrogen of the planet is a surprise. From the Cassini probe, we already knew about the rings' influence. However, we knew nothing about the atomic hydrogen content,” astronomer and co-author Lotfi Ben-Jaffel of the Institute of Astrophysics in Paris and the Lunar & Planetary Laboratory, said in a statement.

“Everything is driven by ring particles cascading into the atmosphere at specific latitudes. They modify the upper atmosphere, changing the composition,” said Ben-Jaffel. “And then you also have collisional processes with atmospheric gasses that are probably heating the atmosphere at a specific altitude.”

To come to this conclusion, Ben-Jaffel pulled together archival ultraviolet-light (UV) observations from four different space missions that studied the ringed planet. During these missions spaced out over 40 years, astronomers dismissed the measurements as noise in the detectors. By 2004, when the Cassini mission arrived on Saturn, it also collected UV data on the atmosphere over a period of several years. Some of the additional secret-cracking data came from Hubble and the International Ultraviolet Explorer, an international collaboration between NASA, the European Space Agency, and the United Kingdom's Science and Engineering Research Council that launched in 1978.

The lingering question among decades of data was whether all of it could be illusory or actually reflect a true phenomenon on Saturn.

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The key turned out to be Ben-Jaffel's decision to use measurements taken by the Hubble's Space Telescope Imaging Spectrograph (STIS). These precision observations of Saturn helped calibrate the archival UV data from all four of the other space missions that have observed Saturn. He compared the STIS UV observations of Saturn to the distribution of light from multiple space missions and instruments.

"When everything was calibrated, we saw clearly that the spectra are consistent across all the missions. This was possible because we have the same reference point, from Hubble, on the rate of transfer of energy from the atmosphere as measured over decades," said Ben-Jaffel. "It was really a surprise for me. I just plotted the different light distribution data together, and then I realized, wow—it's the same."

Forty years of UV data covers multiple solar cycles and helps astronomers study the sun's seasonal effects on Saturn. Bringing this data together and calibrating it helped Ben-Jaffel find that there was no difference in the level of UV radiation. The UV level of radiation can be followed at "at any time, any position on the planet," which points to the steady ice rain coming from Saturn's rings as the best explanation.

Some of the next goals for this research include seeing how it can be applied to planets that orbit other stars.

Popular Science, 31 March 2023

<https://popsci.com>

Fish know to stop the spread of misinformation

2023-03-31

Many social animals rely on each other for survival – for example, alerting one another when danger is present.

But what happens when there is a false alarm?

False alarms are the most common kind of misinformation among wild animals. An example of this is when an individual in a group produces an alarm signal or makes a run for it when no real danger is present.

Such actions in an individual can be perceived by others in the group as an indication of threat. It can result in a cascade of escape responses spreading erroneously.

Previous studies have shown how behavioural responses in an individual help control flawed decision making in such scenarios. But it hasn't

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been clear until now how groups of animals control their exposure to misinformation.

A new study of foraging fish takes this question up and shows that such misinformation is quickly stopped from spreading.

Researchers on French Polynesian reefs placed cameras to record the behaviour of wild foraging fish of different species.

The scientists analysed the footage, comparing it to reconstructions of the sensory information available to the fish before, during and after escape events. They then modelled the fish's decision-making process to assess whether the animal responded or not.

No more than a few individual foraging fish usually took the misinformation bait according to the results, despite escape events occurring frequently in the absence of predators. The researchers found that the animals form dynamic information networks of visual cues between each other.

"These networks are surprisingly robust to false alarms that occur when one individual flees in the absence of a true shared threat," says Ashkaan Fahimipour, an assistant professor at Florida Atlantic University. "By reconstructing visual sensory inputs to each animal, we show that this robustness to misinformation about threats inherits from a specific property of their decision-making strategy: dynamic adjustments in sensitivity to socially acquired information. This property can be achieved through a simple and biologically widespread decision-making circuit."

Escape responses in fish are controlled by specialised neural circuits that process sensory stimuli before passing the information on to premotor neurons in the brain. These neurons, also called "mirror neurons" are active when the individual is performing an action, or when observing another individual performing that same activity.

It's thought, then, that escape responses are triggered by visual cues produced when individuals in the group move.

The study's results match up with previous thinking that animals pool the behavioural cues from neighbours to make decisions. The fish were able to dynamically adjust their response given the information available from others nearby.

"It will be interesting to investigate whether the mechanisms revealed here also are important in driving individual decision-making and

Misinformation rarely spreads to more than a few individual fish.

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misinformation spread in other biological and social systems," Fahimipour adds.

The study is published in the Proceedings of the National Academy of Sciences journal.

Cosmos, 31 March 2023

<https://cosmosmagazine.com>

How Ants Took Over the World

2023-04-01

Ants are pretty much everywhere. There are more than 14,000 different species, spread over every continent except Antarctica, and researchers have estimated that there are more than four quadrillion individual ants on Earth — that's 4,000,000,000,000,000. But how ants evolved to take over the world is still a mystery. In a new study in the journal *Evolution Letters*, scientists used a combination of fossils, DNA, and data on the habitat preferences of modern species to piece together how ants and plants have been evolving together over the past 60 million years. They found that when flowering plants spread out from forests, the ants followed, kicking off the evolution of the thousands of ant species alive today.

"When you look around the world today, you can see ants on nearly every continent occupying all these different habitats, and even different dimensions of those habitats — some ants live underground, some live in the canopies of trees. We're trying to understand how they were able to diversify from a single common ancestor to occupy all these different spaces," says Matthew Nelsen, a research scientist at the Field Museum in Chicago and lead author of the paper.

Scientists already knew that ants and flowering plants, or angiosperms, both originated around 140 million years ago and subsequently became more prevalent and spread to new habitats. Nelsen and his colleagues wanted to find evidence that the two groups' evolutionary paths were linked.

To find that link, Nelsen and his co-authors (Corrie Moreau at Cornell University, Kevin Boyce at Stanford University, and Richard Ree at the Field Museum) compared the climates that 1,400 modern ant species inhabit, including data on temperature and precipitation. They coupled this information with a time-scaled reconstruction of the ant family tree, based on genetic information and ant fossils preserved in amber. Many ant

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behaviors, like where they build their nests and what habitats they live in, appear to be deeply ingrained in their species' lineages, to the point that scientists are able to make pretty good guesses about prehistoric ants' lives based on their modern relatives. These data, when paired with similar information about plants, helped bring the early ants' world into focus.

About 60 million years ago, ants lived primarily in forests and built their nests underground. "Around this time, some of the plants in these forests evolved to exhale more water vapor out through tiny holes in their leaves— they made the whole place a lot wetter, so the environment became more like a rainforest," says Nelsen. In this wetter environment, some of the ants began moving their nests out from underground and up into the trees. (They weren't the only ones moving to the trees, either— frogs, snakes, and epiphytic plants, similar to the bromeliads and air plants we have today, also took to the trees around this time, helping create new arboreal communities.)

Some of the flowering plants living in these forests began to spread outward, inching their way into more arid regions and adapting to thrive in drier conditions. Nelsen and his colleagues' work suggests that when flowering plants left the forests, some of the ants followed. The plants may have provided an incentive for the ants in the form of food. "Other scientists have shown that plants in these arid habitats were evolving ways of making food for ants— including things like elaiosomes, which are like fleshy appendages on the seeds," says Nelsen. And when ants take the seeds to get the elaiosomes, they help disperse them: a win for the parent plants.

The researchers say that by showing how plants helped shape the evolution and spread of ants is especially important in light of the climate and biodiversity crises we're facing.

"This study shows the important role that plants play in shaping ecosystems," says Nelsen. "Shifts in plant communities— such as those we are seeing as a consequence of historic and modern climate change— can cascade and impact the animals and other organisms relying on these plants."

Sci Tech Daily, 1 April 2023

<https://scitechdaily.com>

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What's the Future of Gas Stations in an EV World?

2023-03-30

A new forecast says the number of public fast-charging ports for electric vehicles will increase by 60-fold between 2022 and 2050 in the United States and Canada.

That growth rate, from the research firm Wood Mackenzie, is notable on its own. But it begs a question: What kinds of businesses will be hosting all of those fast chargers?

Will we be going to convenience stores like the kind that now sell gasoline? Or, will they be something new?

Before I go on, some basics:

There are three main levels of EV charging. Level 1 chargers can plug into an outlet in your house, and they may take a day or longer to charge an EV. Level 2 systems are an upgrade from a typical outlet, and they can charge an EV in a few hours; they can be installed at home with an outlet much like that of a clothes dryer, and also are common in public charging stations. Level 3 chargers, also called fast chargers, can do their work in the time it takes to eat lunch; they are mainly found in public stations like Tesla's Supercharger network.

Most of the growth in public charging ports is going to be fast chargers, of which there are now about 30,000. Level 2 systems also will grow, but at a slower rate.

"Gas stations will exist, but will have a different kind of model," said Amaiya Khardenavis, a Wood Mackenzie analyst.

And many of today's gas stations will evolve into EV charging stations.

"Gas stations are prime real estate locations, so they are excellent candidates for installing charging infrastructure," he said.

Nick Esch, a Wood Mackenzie analyst, described some of the competition taking place as companies try to secure the best locations.

"As EV charging networks are expanding their footprints, it's important to realize this is not just a land grab, but a capacity grab," he said.

By that, he means that fast chargers require a lot of grid capacity. A charger developer needs to work with the local utility to reserve enough capacity to be able to operate a station. If another developer wants to set

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up a competing station across the street, they may need to pay for grid upgrades to be able to have enough capacity.

While charging stations may occupy some of the same land as today's gas stations and have other similarities, I don't want to minimize the scale of the change that will be taking place.

The availability of charging at home and work means that the customers at charging stations will be less of a general population, and more people with specific needs. The main two categories would be people on long trips and those who don't have access to charging at home or work.

Charging stations that serve people on long trips will be located along highways and clustered with restaurants, much like the patterns of development for existing gas stations. One difference is that a fast charger takes 20 minutes to an hour to get a vehicle to about 80 percent charge, which is a lot longer than it takes to fill up a tank with gasoline. So customers will have some more time on their hands and it would make sense if we begin to see more mall-like travel centers to serve people who are making longer stops.

The needs would be different in cities, where a variety of businesses are looking at neighborhood-based options, including chargers alongside public streets, to serve people who don't have garages. One example is FLO, a charging company building curbside stations in New York City.

Tesla dominates today's market for public fast charging, with about 17,000 ports in the United States and Canada, many of which are located on the grounds of other businesses, including convenience stores. Right now, the ports can only be used by Tesla vehicles, but the company said in February that it will open the network for use by other brands by the end of 2024.

The second-largest operator of fast chargers is Electrify America, a Volkswagen subsidiary, which has about one-fifth as many ports as Tesla.

EVgo ranks third, but is poised for major growth. The California-based company announced a deal with General Motors last year and the companies are working together to expand a network of charging stations, including at Pilot and Flying J truck stops.

Meanwhile, convenience store companies are making investments in EV charging systems that they own and operate. Alimentation Couche-Tard Inc., the Canada-based owner of Circle K stores, said last year that it plans to add EV charging at 200 locations in North America. Texas-based 7-Eleven said this month that it is starting a charging station network to

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operate at its stores; the company didn't give specifics on a timetable or how many locations would initially get the charging hardware.

The transition to EVs is a source of trepidation for the convenience store industry, which stands to lose revenue and customer traffic that it now gets from selling gasoline. But it's also an opportunity for the businesses that can figure out how best to sell products to the people waiting for their vehicles to charge.

I spoke with Eva Strasburger, who is closely monitoring this shift. She is a Texas-based veteran of the convenience store industry who co-founded the Vision Group Network, an organization that holds meetings to discuss major issues facing the industry.

"There (used to be) a lot of concern about how to entertain people while they are waiting to charge," she said. "Several years ago, the question was would we be putting in nail salons and meditation centers and coffee shops. The reality, when we look at what people are doing, is that people get out, get something to drink, go back to their car and then they're on their phones to catch up on emails."

Her group hosted an event in January in which convenience store corporate leaders talked about the changes that the transition to EVs will bring.

"Nobody's predicting that (the transition to EVs) doesn't happen," said Doug Haugh, former president of Parkland USA, a convenience store chain, at the event. "Everybody's just arguing about the schedule. So, the schedule matters, because whether it's 20 or 30 years or 40 versus 10 makes a hell of a lot of difference for all of us."

"What we have to figure out is, how can we replicate, at least to some degree, that same level of convenience and service that our services provide today?" he asked.

Inside Climate News, 30 March 2023

<https://insideclimatenews.com>

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First Peoples' knowledge of 'mysterious fairy circles' in Australian deserts has upended a long-standing science debate

2023-04-04

What are "fairy circles"? They are polka dots of bare earth, regularly scattered across arid grasslands. Scientists first described fairy circles in Namibia in the 1970s and sparked a global debate in the scientific community about the causes of the phenomenon.

In 2016, a group of international scientists concluded that, in the Australian Pilbara, "fairy circles" arose from spinifex plants competing for water and nutrients – a similar explanation to the one they proposed for fairy circles in Namibia. These stories were amplified by the media, but the voices of Aboriginal desert people were not reported.

In a study published in *Nature Ecology & Evolution* today, we show what our Aboriginal coauthors have always known – that fairy circles in the Western Deserts of Australia are flat, hard "pavements" inhabited by spinifex termites (*Drepanotermes* species).

Knowing the Country

Aboriginal people have lived in Australia's Western Desert, including the Pilbara, for at least 50,000 years and know their Country deeply. We are grateful to be part of a cross-cultural team of researchers that include Western Desert people and scientists.

Our starting points included open-minded curiosity. Some of us knew little about spinifex grassland ecosystems. None of us knew about "fairy circles" or the international science debate. However, we all wanted to learn, and were interested in learning together. As our research unfolded, the more we learned, the more we realised we didn't know. We learned things that were new even to those who've lived in and studied deserts for a lifetime.

We saw similarities between patterns in specific Aboriginal artworks and aerial views of the pavements. We found paintings that tell deep and complex stories about termites and the activities of termite Jukurrpa (Dreaming) ancestors.

Western Desert Martu people call the fairy circle pavements linyji and the fat-rich flying termites Warturnuma. We learned that the hard surfaces of linyji are used to thresh seed and flying termites are prized foods. Martu colleague Gladys Karimarra Bidu stated:

Scientists first described fairy circles in Namibia in the 1970s and sparked a global debate in the scientific community.

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Termites as kin

This knowledge about pavements and termites is shared and passed down through generations by Martu and other Indigenous groups. Our Australian Wildlife Conservancy colleagues Alice Nampijinpa Michaels and Lee Nangala Wayne describe their feelings for flying spinifex termites in this video. Alice said:

Why such strong feelings? Spinifex termites are kin to them. Those that live in the pavements are like the krill of desert ecosystems – they are super-abundant. Most people think of above-ground termite mounds, but here is a whole community that lives mostly below the soil surface, only emerging to eat dead spinifex or to fly to reproduce.

Most Australians consider spinifex grasslands to be “rubbish country”. A pastoralist even said so while we were excavating into termite pavements. He was about to set fire to the spinifex (and potentially us). Termites, including those that live in the spinifex, are often maligned and poisoned by Australians. However, these vast tracts of land and their termites are deeply important to Aboriginal people in ways that were invisible to some of our team.

New science findings from Aboriginal knowledge

Our cross-cultural research has led to unexpected findings. Termite pavements hold water after big rains, which was unknown to scientists until we recognised clues in the stories and art of Aboriginal country folk. Purungu Desmond Taylor, Martu interpreter and co-author, remembered the Mulyamiji, great desert skink, and describes breeding behaviour not previously reported by scientists:

Aboriginal people have refined their encyclopaedic knowledge while living continuously on this continent for thousands of generations. Listening to Aboriginal desert voices improved our understanding of how ubiquitous, but often overlooked, desert Country works.

We learnt that the flat, hard linyji are used to prepare foods, they can become ephemeral sources of water and support the breeding of Mulyamiji, they provide abundant and rich sources of food, and have deep spiritual significance.

This year, Australians will be asked to recognise Australia’s First Nations People in our constitution. In our experience, we strengthen our

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connections with Country and each other when we nurture relationships, listen well and share together, work equitably and two-ways.

The Conversation, 4 April 2023

<https://theconversation.com>

Recreating the double-slit experiment that proved the wave nature of light in time, instead of space

2023-04-03

Imperial physicists have recreated the famous double-slit experiment, which showed light behaving as particles and a wave, in time rather than space.

The experiment relies on materials that can change their optical properties in fractions of a second, which could be used in new technologies or to explore fundamental questions in physics.

The original double-slit experiment, performed in 1801 by Thomas Young at the Royal Institution, showed that light acts as a wave. Further experiments, however, showed that light actually behaves as both a wave and as particles—revealing its quantum nature.

These experiments had a profound impact on quantum physics, revealing the dual particle and wave nature of not just light, but other “particles” including electrons, neutrons, and whole atoms.

Now, a team led by Imperial College London physicists has performed the experiment using “slits” in time rather than space. They achieved this by firing light through a material that changes its properties in femtoseconds (quadrillionths of a second), only allowing light to pass through at specific times in quick succession.

Lead researcher Professor Riccardo Sapienza, from the Department of Physics at Imperial, said, “Our experiment reveals more about the fundamental nature of light while serving as a stepping-stone to creating the ultimate materials that can minutely control light in both space and time.”

Details of the experiment are published today (April 3) in Nature Physics.

The original double-slit setup involved directing light at an opaque screen with two thin parallel slits in it. Behind the screen was a detector for the light that passed through.

These experiments had a profound impact on quantum physics, revealing the dual particle and wave nature of not just light, but other “particles”.

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To travel through the slits as a wave, light splits into two waves that go through each slit. When these waves cross over again on the other side, they “interfere” with each other. Where peaks of the wave meet, they enhance each other, but where a peak and a trough meet, they cancel each other out. This creates a striped pattern on the detector of regions of more light and less light.

Light can also be parceled up into “particles” called photons, which can be recorded hitting the detector one at a time, gradually building up the striped interference pattern. Even when researchers fired just one photon at a time, the interference pattern still emerged, as if the photon split in two and traveled through both slits.

In the classic version of the experiment, light emerging from the physical slits changes its direction, so the interference pattern is written in the angular profile of the light. Instead, the time slits in the new experiment change the frequency of the light, which alters its color. This created colors of light that interfere with each other, enhancing and canceling out certain colors to produce an interference-type pattern.

The material the team used was a thin film of indium-tin-oxide, which forms most mobile phone screens. The material had its reflectance changed by lasers on ultrafast timescales, creating the “slits” for light. The material responded much quicker than the team expected to the laser control, varying its reflectivity in a few femtoseconds.

The material is a metamaterial—one that is engineered to have properties not found in nature. Such fine control of light is one of the promises of metamaterials, and when coupled with spatial control, could create new technologies and even analogs for studying fundamental physics phenomena like black holes.

Co-author Professor Sir John Pendry said, “The double time slits experiment opens the door to a whole new spectroscopy capable of resolving the temporal structure of a light pulse on the scale of one period of the radiation.”

The team next want to explore the phenomenon in a “time crystal,” which is analogous to an atomic crystal, but where the optical properties vary in time.

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Co-author Professor Stefan Maier said, “The concept of time crystals has the potential to lead to ultrafast, parallelized optical switches.”

Phys Org, 3 April 2023

<https://phys.org>

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(NOTE: OPEN YOUR WEB BROWSER AND CLICK ON HEADING TO LINK TO SECTION)

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[The variable associations between PFASs and biological aging by sex and reproductive stage in NHANES 1999-2018](#)

[Leaching of herbicides mixtures from pre-exposed agricultural plastics severely impact microalgae](#)

[Correlation Between Toxic Elements and Pesticide Residues in Medicinal Herbs Available in Pharmaceutical Market](#)

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ENVIRONMENTAL RESEARCH

[Phthalates contamination in the coastal and marine sediments of Rio de Janeiro, Brazil](#)

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PHARMACEUTICAL/TOXICOLOGY

[A cross-sectional analysis of ambient fine particulate matter \(PM2.5\) exposure and haemoglobin levels in children aged under 5 years living in 36 countries](#)

OCCUPATIONAL

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