CHEMWATCH

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ASIA PACIFIC

Indians consuming salt are ingesting microplastics from waste dumped in seas

2023-04-10

Plastic pollution is a significant concern for ocean ecosystems. Although the amount of plastic discarded into the ocean is hard to measure conclusively, estimates reveal that at least 14 million tons of plastic make their way to oceans every year. Without immediate action, the amount of plastic is projected to substantially increase in the next two decades.

The pervasive nature of plastic contamination in the marine world has come into widespread focus in recent times, with the detection of microplastics (plastic particles smaller than 5 mm) in various marine organisms, including fish, mussels, and crustaceans. Now, several studies have detected the presence of microplastics even in Indian sea salts, adding a new layer to the discourse on plastic's omnipresence in our world.

Although considered virtually indestructible, plastic in the environment does undergo fragmentation due to exposure to ultraviolet radiation and external forces resulting in mechanical and biological degradation, creating smaller plastic particles. Based on the size, these particles are classified as macro, meso and microplastics.

The presence of microplastics has been analyzed in sea salt samples across the country by various research groups, emphasizing the need to rapidly address plastic pollution while keeping a check on marine-derived products.

Read More

Quartz, 10-04-23

https://qz.com/indians-using-salt-ingest-microplastics-from-sea-dumps-1850318139

China to Add 59 Items to List of Dangerous Goods

2023-03-31

59 items (i.e., UN0510 ~ UN0513, UN3496 ~ UN3550) are proposed to be added to the List of dangerous goods.

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China's National Public Service Platform for Standards Information issued a notice on March 1, 2023, seeking public comments on draft revisions to two national mandatory standards, including:

- GB 6944 Classification and code of dangerous goods
- GB 12268 List of dangerous goods

These two standards were first released in 2005 and revised in 2012. They help standardize the system for dangerous goods transportation, storage, distribution, and other related activities in China. To align with the UN Recommendations on the Transport of Dangerous Goods – Model Regulations (Rev. 22), the UN Manual of Tests and Criteria (Rev. 7), and other relevant regulations and technical standards in China, the authority drafted the revisions to solicit public feedback. The period for comments will end on May 8, 2023. Once adopted, the revised standards are expected to take effect 12 months after publication and replace their 2012 versions.

Read More

REACH24H, 31-03-23

https://www.reach24h.com/en/news/industry-news/chemical/59-list-of-dangerous-goods-china.html

Japan ISHL: Japan to Subject 1,469 Substances for Mandatory SDS and Labeling Requirements

2023-03-31

Two batches of 1,469 hazardous substances are proposed to mandate SDS and labelling requirements under Japan ISHL.

The Japanese Ministry of Health, Labor and Welfare (MHLW) will listen to overseas stakeholders' opinions from March 14, 2023, on the second and third batches of candidate substances subject to mandatory SDS and labeling requirements under the Industrial Safety and Health Act (ISHL). The two batches of candidate substances include:

- Second batch: 651 substances identified in category 1 of hazard classes other than carcinogenicity, germ cell mutagenicity, reproductive toxicity (CMR) and acute toxicity, to be implemented from April 1st, 2025, and
- Third batch: 818 substances with health hazards in category 2 and below, or chemicals without health hazards but with physical-chemical hazards, to be implemented from April 1st, 2026.

Read More

REACH24H, 31-03-23

https://www.reach24h.com/en/news/industry-news/chemical/japan-ishl-japan-to-subject-1469-substances-for-mandatory-sds-and-labeling-requirements.html

AMERICA

National Drinking Water Standard for PFAS

2023-04-04

On March 14, 2023, the Biden-Harris administration announced its proposal for a first-ever National Primary Drinking Water Regulation (NPDWR) for six per- and polyfluoroalkyl substances (PFAS). The legally proposed enforceable limits are 4 parts per trillion (ppt) for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). If finalized as proposed, public water systems (PWSs) have 3 years to bring their systems into compliance.

PFAS, also known as "forever chemicals" due to a strong chemical bond that makes them hard to break down, are a category of manufactured chemicals that can cause serious health problems, including cancer, if people are exposed to them over a long period of time. When drinking water is contaminated with PFAS, it can be a significant portion of a person's total PFAS exposure.

"PFAS tend to co-occur with each other," according to the EPA PFAS website. "This regulation will also remove many other PFAS when they co-occur with these six regulated PFAS. EPA is following recent peer-reviewed science that indicates that mixtures of PFAS can pose a health risk greater than each chemical on its own. Concurrent with the proposed PFAS NPDWR, which was published in the Federal Register on March 29, 2023, the EPA also announced it is making preliminary regulatory determinations for [perfluorononanoic acid (PFNA)], GenX Chemicals, [perfluorohexane sulfonate (PFHxS)], and [perfluorobutanesulfonic acid (PFBS)] in accordance with the Safe Drinking Water Act regulatory development process. EPA proposes to regulate PFNA, GenX Chemicals, PFHxS, and PFBS using a Hazard Index formula."

If finalized, the proposed rule would establish:

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1. Maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) for PFOS and PFOA;
2. A Hazard Index for PFHxS, GenX chemicals, PFNA, and PFBS;
3. Monitoring requirements for PWSs;
4. Reporting requirements for PWSs that are community water systems; and
5. Treatment requirements for reducing PFAS levels for PWSs.

MCLGs and MCLs

"MCLGs are non-enforceable public health goals," states the EPA Fact Sheet on the proposal. "MCLGs consider only public health, not the limits of detection and treatment technology effectiveness. Therefore, they are sometimes set at levels which water systems cannot meet because of technological limitations. For example, if a contaminant is a known or likely carcinogen, EPA sets the MCLG at 0. MCLGs also consider adverse health risks to sensitive groups, including infants, children, the elderly, and immuno-compromised individuals. Once the MCLG is established, EPA determines the MCL. MCLs are enforceable standards. An MCL is the maximum level of a contaminant allowed in drinking water, which can be delivered to users of a [PWS]. For this rule proposal, EPA evaluated available methods and treatment technologies, that are shown to measure and remove these six PFAS and set the proposed MCLs as close as possible to the MCLGs. EPA also evaluated costs and benefits in determining the proposed MCLs."

Read More

EHS Daily Advisor, 04-04-23

https://ehsdailyadvisor.blr.com/2023/04/national-drinking-water-standard-for-pfas/

East Palestine isn't alone: Communities around the country grapple with toxic chemical exposure

2023-04-09

A February train derailment in East Palestine, Ohio, shone a spotlight on the impact of toxic chemicals. But communities who are exposed to such chemicals on a more routine basis say they're still waiting for the same level of recognition.

"We're glad that East Palestine is getting the attention that they're getting, but we also need attention here in Louisiana," said Shamell Lavigne, an

activist with local environmental justice organization Rise St. James, which operates in the state's infamous "Cancer Alley."

The derailment in East Palestine released a number of chemicals, including a carcinogen known as vinyl chloride, which is used to make polyvinyl chloride (PVC) plastic.

While officials have said it is safe to return to the area, locals have reported health issues and the incident has provoked widespread outcry from residents, environmentalists and leaders, including in Washington.

However, the East Palestine community is not the only one facing exposure to vinyl chloride and the risks that come with it.

According to the Environmental Protection Agency's (EPA) Toxic Release Inventory — a list of self-reported toxic chemical emissions — more than 428,000 pounds of vinyl chloride was released into the air by 38 industry facilities last year.

Read More

The Hill, 09-04-23

https://thehill.com/policy/energy-environment/3939919-east-palestine-isnt-alone-communities-around-the-country-grapple-with-toxic-chemical-exposure/

'Chemical recycling' or hot garbage? Michigan proposal cooks up controversy

2023-04-04

Just months after Michigan lawmakers exempted a suite of plastic-reprocessing technologies dubbed "chemical recycling" from state solid waste regulations, two companies are prompting controversy with plans to deploy the technology in Newaygo.

California-based Clean-Seas, Inc. is partnering with Michigan building and recycling company American Classic to launch the $20 million facility, which promises to turn plastic trash into fuel that could be blended with diesel or used to make new plastic products.

Backers of the west Michigan proposal laud its potential to keep waste out of landfills through a process called pyrolysis, which involves superheating plastic in an oxygen-free environment to break its chemical bonds.

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"We see ourselves as part of the puzzle" in dealing with the hundreds of millions of tons of plastic waste generated each year, said John Yonce, vice president of business development for Clean-Seas. "We're not the only solution by any means, but we think we serve a really important role."

The chemical recycling industry is attracting scrutiny from environmentalists and some lawmakers who say the techniques often use massive amounts of energy to turn plastic into combustible fuels, while producing relatively little recycled plastic.

"Taking low grade, single-use plastic and burning it is not recycling," said Christy McGillivray, political and legislative director for the Sierra Club's Michigan chapter.

Democrats who took control of the state Capitol in January say they are crafting legislation that could stop the plant from opening.

Read More

Bridge Michigan, 04-04-23

https://www.bridgemi.com/michigan-environment-watch/chemical-recycling-or-hot-garbage-michigan-proposal-cooks-controversy

States Consider Ban on Cosmetics With 'Forever Chemicals'

2023-04-11

A growing number of state legislatures are considering bans on cosmetics and other consumer products that contain a group of synthetic, potentially harmful chemicals known as PFAS.

In Vermont, the state Senate gave final approval this week to legislation that would prohibit manufacturers and suppliers from selling or distributing any cosmetics or menstrual products in the state that have perfluoroalkyl and polyfluoroalkyl substances, as well as a number of other chemicals.

The products include shampoo, makeup, deodorant, sunscreen, hair dyes and more, said state Sen. Terry Williams, a Republican, and member of the Senate Committee on Health and Welfare.

"Many known toxic chemicals are used in or found as contaminants in personal care products, including PFAS, lead and formaldehyde," Williams said in reporting the bill to Senate colleagues.

California, Colorado and Maryland passed similar restrictions on cosmetics that go into effect in 2025. Other proposals are under consideration in Washington and Oregon while bills have also been introduced in Illinois, Rhode Island and Georgia.

According to the U.S. Environmental Protection Agency, studies have linked PFAS exposure to increased cancer risk, developmental delays in children, damage to organs such as the liver and thyroid, increased cholesterol levels and reduced immune functions, especially among young children.

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Insurance Journal, 11-04-23

https://www.insurancejournal.com/news/national/2023/04/11/716109.htm

EPA Aims to Limit Air Emissions From Carcinogenic Sterilizer

2023-04-12

The Environmental Protection Agency announced a proposal for updated hazardous air pollutant rules on Tuesday, targeting worker and resident protections for commercial sterilizer plants using ethylene oxide, or EtO.

The Clean Air Act proposal would require 86 commercial sterilizers across the US to adopt tighter rules and advanced control technology that would reduce emissions of the carcinogenic chemical by 80%, according to the agency.

This action—and another for chemical manufacturing plants announced last week— comes after a nine-month review of elevated cancer risk in communities that surround EtO facilities.

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Bloomberg Law, 12-04-23

https://news.bloomberglaw.com/environment-and-energy/epa-aims-to-limit-air-emissions-from-carcinogenic-sterilizer

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CT's public water systems may soon need to treat for 'forever chemicals'. It will cost millions.

2023-04-11

Public water utilities throughout Connecticut may soon be required to install millions of dollars in new treatment technology to help remove "forever chemicals" from the tap water that tens of thousands of people drink every day.

Those upgrades will be necessary to comply with a new federal regulation that seeks to limit people's exposure to the chemicals, known as perfluoroalkyl and polyfluoroalkyl substances — PFAS for short.

The newly proposed rule would, for the first time, establish an enforceable limit on some of the most common types of PFAS in public drinking water systems — a step that environmental advocates have been demanding for years.

Environmental studies have shown that PFAS contamination is prevalent throughout the United States and the rest of the world.

Nearly every American has some level of the compounds in their bodies. The chemicals have been found in rivers, ponds, soil, aquifers and many drinking water systems throughout the country.

That includes traces that have been found in some of Connecticut's largest public water systems.

Read More

Hartford Courant, 11-04-23

https://www.courant.com/2023/04/09/cts-public-water-systems-may-soon-need-to-treat-for-forever-chemicals-it-will-cost-millions/

New federal regulations in the works for chemical plants

2023-04-06

The federal government announces new rules in the works to protect the air and communities around chemical plants.

The head of the Environmental Protection Agency made the announcement Thursday during a visit to St. John the Baptist Parish.

About 50 chemical plants, many located in the river parishes, will be affected by this new rule that EPA Administrator Michael Regan calls a game changer.

"We have a lot of pollution here," Dr. Beverly Wright, the executive director for the Deep South Center for Environmental Justice," said. "We have been poisoned, and we are sick."

Community advocates in St. John the Baptist Parish have pleading their case for years, and now the federal government is stepping in.

Last month, the EPA and the Department of Justice filed a legal action to address an endangerment to public health in the river parishes, but that's not all.

"That's why I'm proud to announce today that EPA is building on our commitment and proposing a regulation that would reduce more than 6,000 tons of highly toxic chemicals each and every year," Regan said.

The regulation will drastically cut back the emissions of more than 80 highly toxic chemicals, including chloroprene and ethaline oxide, which can cause cancer.

The rule will also require the plants to monitor the pollution at their fence lines.

"Today, we demonstrate, with this administrate who demonstrated in his actions, that we can make the necessary changes to save lives to make communities safer," Louisiana Rep. Troy Carter said.

Read More

News5, 06-04-23

https://www.wkrg.com/state-regional/new-federal-regulations-in-the-works-for-chemical-plants/

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EUROPE

Towards harmonisation of testing of nanomaterials for EU regulatory requirements on chemical safety – A proposal for further actions

2023-03-30

Over the recent years, EU chemicals legislation, guidance and test guidelines have been developed or adapted for nanomaterials to facilitate safe use of nanomaterials.

This paper provides an overview of the information requirements across different EU regulatory areas. For each information requirement, a group of 22 experts identified potential needs for further action to accommodate guidance and test guidelines to nanomaterials. Eleven different needs for action were identified, capturing twenty-two information requirements that are specific to nanomaterials and relevant to multiple regulatory areas.

These were further reduced to three overarching issues: 1) resolve issues around nanomaterial dispersion stability and dosing in toxicity testing, in particular for human health endpoints, 2) further develop tests or guidance on degradation and transformation of organic nanomaterials or nanomaterials with organic components, and 3) further develop tests and guidance to measure (a)cellular reactivity of nanomaterials. Efforts towards addressing these issues will result in better fit-for-purpose test methods for (EU) regulatory compliance.

Moreover, it secures validity of hazard and risk assessments of nanomaterials. The results of the study accentuate the need for a structural process of identification of information needs and knowledge generation, preferably as part of risk governance and closely connected to technological innovation policy.

Read More

Science Direct, 30-03-23

https://www.sciencedirect.com/science/article/pii/S0273230023000284?via%3Dihub

INTERNATIONAL

Plastics touching our food may be making us gain weight

2023-04-07

Hormone-disrupting chemicals are entering our bodies. We eat 44lbs of plastic in our lifetimes

When it comes to keeping off extra pounds, watching what we eat may not be enough – we have to keep an eye on our food's packaging, too.

Rates of obesity among US adults have increased from 14% in 1980 to 42% today, and half the world is expected to be overweight or obese by 2035, with children and teens facing the sharpest increase in obesity and its consequences. Because data doesn't support the idea that overeating and lack of exercise are squarely to blame, the scientific community is exploring other factors that may contribute – including metabolic disruption caused by eating products packaged in plastic.

For a study published last year, researchers at the Norwegian University of Science and Technology set out to determine what chemical compounds exist in 34 common plastic items that touch things we eat, such as yogurt cups, juice bottles, styrofoam meat trays, gummy-candy packages, and plastic wrap used for produce and cheese, as well as items often found in kitchens, like polyurethane placemats and sponges.

Of the 55,000 chemicals the researchers found in these items, only 629 were identifiable, with 11 being known metabolic disruptors such as phthalates and bisphenols, which interfere with our bodies' ability to regulate weight, among other troubling health effects. However, when exposed to in vitro human cell cultures (studies have not used human or animal test subjects), far more chemicals than the identified 11 metabolic disruptors triggered adipogenesis – the process underlying obesity, in which cells proliferate and accumulate an excess of fat.

"[W]e're quite certain [that] there are many chemicals in plastic products that disrupt metabolism, but we just couldn't identify all of them," Martin Wagner, a study co-author said. Strikingly, Wagner and his colleagues found that a third of all the common products they tested contain chemicals that trigger the adipogenic process. Although we are exposed to them daily, most of these mystery chemicals are unknown, unstudied and unregulated.

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Read More

The Guardian, 07-04-23

https://www.theguardian.com/commentisfree/2023/apr/07/plastic-packaging-obesity-hormone-disruption

On Vinyl A brief history of East Palestine's toxic train disaster

2023-04-11

The train that derailed near the Ohio-Pennsylvania border in February 2023 was hauling mixed frozen vegetables. It was hauling malt liquor and semolina flour as well as chemicals used to make plastics. Chemicals like vinyl chloride monomer. Think of vinyl chloride like metaphorical railcars. When coupled end-on-end-on-end, they make up the long-haul train that is polyvinyl chloride (PVC) plastic, which the manifest suggests other cars on the actual ill-fated train were also carrying.

PVC is garden hoses. Is water pipes. Is shower curtains. Is siding and decking and flooring and toys. It is medical tubing and IV bags. And for the audiophiles among you, it is records, also called vinyl, even when sometimes pressed from polystyrene.

Vinyl chloride is a carcinogen. Burning vinyl chloride, like burning PVC plastic, creates the conditions to form even more potent chemicals called dioxins.

Multiple companies make PVC plastics. The PVC on the derailed train was carried in cars tagged ROIX, which in railroad speak means the cars were owned by a company called Shintech. Shintech—"the world's largest producer of PVC"—is a wholly owned subsidiary of the Japanese firm, Shin-Etsu. In the U.S., it operates PVC plants in Freeport, Texas, and in Addis and Plaquemine, Louisiana.

Multiple companies make vinyl chloride. Norfolk Southern was carrying vinyl chloride in at least two cars traceable (the car ID, OCPX) to OxyVinyls, a division of OxyChem, which is a division of Occidental Petroleum. OxyVinyl's vinyl chloride plant is in Deer Park, Texas, near the Houston Ship Channel, where a tornado ripped through earlier this year, knocking the plant temporarily offline.

Sometimes vinyl chloride and PVC factories cluster together, says Jim Vallette of Material Research, who has mapped the industry. For example,

the companies Olin and Dow each supply vinyl chloride to Shintech's neighboring Louisiana and Texas PVC plants, Vallette told me.

Other times, the railroad is how vinyl chloride is ferried to distant PVC plants, and then how finished PVC gets to its molders and fabricators.

It is unclear what exact route the East Palestine train was traveling.

Chemical engineers, like train engineers, also speak of routes—the different pathways by which hydrocarbons can be coaxed toward the same destination.

There are multiple routes to making vinyl chloride.

All routes require chlorine.

Chlorine is bleach. Is white linens and white paper. Is disinfectant. Is the WWI-era war gas racing across the fields at Ypres before sinking down into the trenches and the lungs of unsuspecting soldiers.

No other industry uses more chlorine than PVC.

Chlorine is made from brine, which is to say salt, from which the chlorine must be split.

Read More

Orion, 11-04-23

https://orionmagazine.org/article/east-palestine-train-derailment-plastics-history/

International mercury regulations fail to protect the environment, public health: study

2023-04-13

- Mercury is one of the most concerning chemicals affecting public health and the environment. The chemical can enter local watersheds and poison flora and fauna, while leaving humans with memory loss, seizures, vomiting and lung damage, among other problems.
- A recent study found that data collection for mercury use is so inconsistent that it can't be relied on for understanding trends in artisanal and small-scale mining.
- The UN Minamata Convention on Mercury, which went into effect in 2017, requires countries to collect data on mercury use but doesn't say how that data should be collected, resulting in inconsistencies between countries.

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Around 15 million people across the globe are working at artisanal and small-scale gold mining sites, nearly a third of them women and children. Instead of operating advanced equipment supplied by formal mining companies subject to government oversight, they use basic tools, bulldozers and unregulated chemicals.

In many cases, miners vaporize mercury to separate gold from the soil, a process known as amalgamation. While it can be faster than other methods, the process also leads to serious environmental and public health consequences. Mercury is known to lead to memory loss, seizures, vomiting and lung damage, among other problems.

The World Health Organization considers mercury to be one of the top-ten chemicals of public health concern. Yet regulations on its use are still relatively new. The UN Minamata Convention on Mercury only went into force in 2017, an attempt by the international community to collaborate on mitigating mercury use. Nearly 140 countries have signed onto the treaty, with the UN saying that 84% of them have submitted some update on improved mercury regulation policy.

Read More

Mongaby, 13-04-23

https://news.mongabay.com/2023/04/international-mercury-regulations-fail-to-protect-the-environment-public-health-study/

ECHA recommends eight substances for REACH authorisation

2023-04-12

To protect workers and the environment, ECHA recommends that the European Commission adds eight substances, including lead, to the REACH Authorisation List. Once substances are added to the list, companies will need to apply for authorisation to continue using them.

Helsinki, 12 April 2023 – ECHA's 11th recommendation includes the following substances:

- Ethylenediamine;
- 2-(4-tertbutylbenzyl)propionaldehyde and its individual stereoisomers;
- Lead;
- Glutaral;
- 2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one;
- 2-benzyl-2- dimethylamino-4'-morpholinobutyrophenone;
- Diisohexyl phthalate; and
- Orthoboric acid, sodium salt.

ECHA has prioritised these substances from the Candidate List of substances of very high concern for this recommendation as they are of the highest priority, following the agreed approach of 2014.

The inclusion of lead in the draft recommendation published on 2 February 2022 generated many comments during the consultation. It led to an active discussion in ECHA's Member State Committee related to the best timing, its combination with other ongoing or planned regulatory activities as well as the expected workload for industry and authorities at the next stage.

Ofelia Bercaru, the Director for Prioritisation and Integration, said: "This recommendation brings lead metal to the same regulatory stage as other lead compounds with similar uses already recommended for inclusion to the Authorisation List. We are aware of the challenges and considered that balancing the risks posed by lead to workers and the environment with its continued use requires a policy decision by the Commission and EU Member States."

More information about the reasons for recommending these substances for authorisation and of their uses is available in the annex and in ECHA's recommendations.

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Background

ECHA has the legal obligation to regularly recommend substances from the Candidate List for the Commission to include in the Authorisation List. Before sending its recommendation to the European Commission, comments received during a three-month consultation and the opinion of the Member State Committee are taken into account.

The European Commission will decide which substances are included in the Authorisation List and what conditions apply for each substance. If a substance is included in the Authorisation List, it can only be placed on the EEA market or used after a given date, if an authorisation is granted for a specific use.

The authorisation process aims at enhancing substitution of substances of very high concern when technically and economically viable alternatives are available. Until this is achieved, the goal is to ensure proper control of risks for human health and the environment.

Read More

ECHA, 12-04-23

https://echa.europa.eu/-/echa-recommends-eight-substances-for-reach-authorisation

Janet's Corner

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Methods for Going to Space

2023-04-21

https://www.smbc-comics.com/comic/methods-for-going-to-space

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Engineered probiotic helps mice shake off alcohol buzz

2023-04-11

Researchers in China have created a probiotic specially designed to release an alcohol-metabolizing enzyme called ADH1. Then they fed the substance to mice and got them drunk. The results showed success in keeping the mice from getting too buzzed, and in helping them clear the alcohol from their systems faster. If the same results hold for humans, the probiotic could offer a way to not only shield us from the more unpleasant side effects of drinking, but it could also find use in treating liver disease.

When humans ingest alcohol, an enzyme known as alcohol dehydrogenase (ADH) is enlisted to help metabolize it. (Interestingly, ADH has also recently been shown to be a possible anti-aging substance, but we digress.)

While ADH is pretty effective at its job, research has shown that its cousin, ADH1B is even better. Found in Polynesian and East Asian populations, it is 100 times more effective at alcohol metabolism than regular ADH.

Using this form of the enzyme, a team of researchers from the Chinese Academy of Science's Institute of Zoology came up with an easy and harmless way of distributing it. They genetically altered the bacterium Lactococcus lactis to secrete ADH1B after ingestion. They then encapsulated it to ensure it could survive its trip through the harsh environment of the digestive tract, gave it to some mice, and got them drunk on wine.

Mice who didn't receive the probiotic got pretty tipsy as evidenced by the fact that when the researchers put them on their backs an hour after drinking, they couldn't turn themselves over. But for the mice who'd taken the pill, half could roll over after an hour, and a quarter never lost their ability to roll over at all.

Additionally, after two hours, the untreated mice were still seeing a climb in their blood alcohol levels, while in the mice that took the probiotics, BAC levels began to fall. If the treatment proves safe for humans – which is the next path of investigation for the researchers – a similar enzyme-expressing probiotic might be able to help us more quickly metabolize alcohol, and possibly shield us from the dreaded hangovers that come with overconsumption.

When humans ingest alcohol, an enzyme known as alcohol dehydrogenase (ADH) is enlisted to help metabolize it.

Considering that alcohol consumption has been linked to everything from cancer to accelerated aging to brain shrinkage, anything that helps us metabolize it better would be a welcome development.

Along those lines, the current study additionally showed that the treated mice also gathered fewer lipids and triglycerides in their livers, which means the pill could help mitigate some of the damage that alcohol can do to that organ.

"We believe that genetically engineered probiotics will provide new ideas for the treatment of liver diseases," said study co-author Meng Dong, Ph.D. "We are excited about the improvement of recombinant probiotics in acute alcohol-induced liver and intestinal damage."

The research has been published in the journal, Microbiology Spectrum.

New Atlas, 11 April 2023

https://newatlas.com

Findings are a step toward water-based batteries

2023-04-11

These batteries differ from lithium-ion batteries that contain cobalt. The group's goal of researching metal-free batteries stems from having better control over the domestic supply chain since cobalt and lithium are outsourced. This safer chemistry would also prevent battery fires.

Chemical engineering professor Jodie Lutkenhaus and chemistry assistant professor Daniel Tabor, both of Texas A&M University, report their findings about lithium-free batteries in Nature Materials.

"There would be no battery fires anymore because it's water-based," Lutkenhaus says. "In the future, if materials shortages are projected, the price of lithium-ion batteries will go way up. If we have this alternative battery, we can turn to this chemistry, where the supply is much more stable because we can manufacture them here in the United States and materials to make them are here."

Lutkenhaus says aqueous batteries consist of a cathode, electrolyte, and an anode. The cathodes and anodes are polymers that can store energy, and the electrolyte is water mixed with organic salts. The electrolyte is key to ion conduction and energy storage through its interactions with the electrode.

Researchers have discovered a 1,000% difference in the storage capacity of metal-free, water-based battery electrodes.

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"If an electrode swells too much during cycling, then it can't conduct electrons very well, and you lose all the performance," she says. "I believe there is a 1,000% difference in energy storage capacity, depending on the electrolyte choice because of swelling effects."

According to their article, redox-active, non-conjugated radical polymers (electrodes) are promising candidates for metal-free aqueous batteries because of the polymers' high discharge voltage and fast redox kinetics. The reaction is complex and difficult to resolve because of the simultaneous transfer of electrons, ions, and water molecules.

"We demonstrate the nature of the redox reaction by examining aqueous electrolytes of varying chao-/kosmotropic character using electrochemical quartz crystal microbalance with dissipation monitoring at a range of timescales," write the researchers in their article.

Tabor's research group complemented the experimental efforts with computational simulation and analysis. The simulations gave insights into the microscopic molecular-scale picture of the structure and dynamics.

"Theory and experiment often work closely together to understand these materials. One of the new things that we do computationally in this paper is that we actually charge up the electrode to multiple states of charge and see how the surroundings respond to this charging," Tabor says.

Researchers macroscopically observed if the battery cathode was working better in the presence of certain kinds of salts through measuring exactly how much water and salt is going into the battery as it is operating.

"We would like to expand our simulations to future systems. We needed to have our theory confirmed of what are the forces that are driving that kind of injection of water and solvent," Tabor says. "With this new energy storage technology, this is a push forward to lithium-free batteries. We have a better molecular level picture of what makes some battery electrodes work better than others, and this gives us strong evidence of where to go forward in materials design."

The project is funded by the US Department of Energy and the National Science Foundation through the Texas A&M Engineering Experiment Station.

Futurity, 11 April 2023

https://futurity.org

Baking Soda Saves the World: New Additive in Concrete Mix Could Slash Carbon Emissions

2023-04-11

Concrete's carbon footprint could be reduced by 15% if sodium bicarbonate is introduced during the early stages of mixing, according to MIT researchers. The addition of the common household ingredient helps to produce carbonates during mixing and pouring, which could dramatically reduce the amount of carbon dioxide released into the atmosphere during production. This process allows construction to be more productive, as form works can be removed earlier, reducing the time required to complete a building or bridge.

Despite the many advantages of concrete as a modern construction material, including its high strength, low cost, and ease of manufacture, its production currently accounts for approximately 8 percent of global carbon dioxide emissions.

Recent discoveries by a team at MIT have revealed that introducing new materials into existing concrete manufacturing processes could significantly reduce this carbon footprint, without altering concrete's bulk mechanical properties.

The findings are published on March 28 in the journal PNAS Nexus, in a paper by MIT professors of civil and environmental engineering Admir Masic and Franz-Josef Ulm, MIT postdoc Damian Stefaniuk and doctoral student Marcin Hajduczek, and James Weaver from Harvard University's Wyss Institute.

After water, concrete is the world's second most consumed material, and represents the cornerstone of modern infrastructure. During its manufacturing, however, large quantities of carbon dioxide are released, both as a chemical byproduct of cement production and in the energy required to fuel these reactions.

Approximately half of the emissions associated with concrete production come from the burning of fossil fuels such as oil and natural gas, which are used to heat up a mix of limestone and clay that ultimately becomes the familiar gray powder known as ordinary Portland cement (OPC). While the energy required for this heating process could eventually be substituted with electricity generated from renewable solar or wind sources, the other half of the emissions is inherent in the material itself: As the mineral mix is heated to temperatures above 1,400 degrees Celsius (2,552 degrees Fahrenheit), it undergoes a chemical transformation from calcium

Introducing additives to concrete manufacturing processes could reduce the sizeable carbon footprint of the material without altering its bulk mechanical properties.

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carbonate and clay to a mixture of clinker (consisting primarily of calcium silicates) and carbon dioxide — with the latter escaping into the air.

When OPC is mixed with water, sand, and gravel material during the production of concrete, it becomes highly alkaline, creating a seemingly ideal environment for the sequestration and long-term storage of carbon dioxide in the form of carbonate materials (a process known as carbonation). Despite this potential of concrete to naturally absorb carbon dioxide from the atmosphere, when these reactions normally occur, mainly within cured concrete, they can both weaken the material and lower the internal alkalinity, which accelerates the corrosion of the reinforcing rebar. These processes ultimately destroy the load-bearing capacity of the building and negatively impact its long-term mechanical performance. As such, these slow late-stage carbonation reactions, which can occur over timescales of decades, have long been recognized as undesirable pathways that accelerate concrete deterioration.

"The problem with these post-curing carbonation reactions," Masic says, "is that you disrupt the structure and chemistry of the cementing matrix that is very effective in preventing steel corrosion, which leads to degradation."

In contrast, the new carbon dioxide sequestration pathways discovered by the authors rely on the very early formation of carbonates during concrete mixing and pouring, before the material sets, which might largely eliminate the detrimental effects of carbon dioxide uptake after the material cures.

The key to the new process is the addition of one simple, inexpensive ingredient: sodium bicarbonate, otherwise known as baking soda. In lab tests using sodium bicarbonate substitution, the team demonstrated that up to 15 percent of the total amount of carbon dioxide associated with cement production could be mineralized during these early stages — enough to potentially make a significant dent in the material's global carbon footprint.

"It's all very exciting," Masic says, "because our research advances the concept of multifunctional concrete by incorporating the added benefits of carbon dioxide mineralization during production and casting."

Furthermore, the resulting concrete sets much more quickly via the formation of a previously undescribed composite phase, without impacting its mechanical performance. This process thus allows the construction industry to be more productive: Form works can be removed earlier, reducing the time required to complete a bridge or building.

The composite, a mix of calcium carbonate and calcium silicon hydrate, "is an entirely new material," Masic says. "Furthermore, through its formation, we can double the mechanical performance of the early-stage concrete." However, he adds, this research is still an ongoing effort. "While it is currently unclear how the formation of these new phases will impact the long-term performance of concrete, these new discoveries suggest an optimistic future for the development of carbon neutral construction materials."

While the idea of early-stage concrete carbonation is not new, and there are several existing companies that are currently exploring this approach to facilitate carbon dioxide uptake after concrete is cast into its desired shape, the current discoveries by the MIT team highlight the fact that the precuring capacity of concrete to sequester carbon dioxide has been largely underestimated and underutilized.

"Our new discovery could further be combined with other recent innovations in the development of lower carbon footprint concrete admixtures to provide much greener, and even carbon-negative construction materials for the built environment, turning concrete from being a problem to a part of a solution," Masic says.

Sci Tech Daily, 11 April 2023

https://scitechdaily.com

Astronomers have directly detected a massive exoplanet. The method could transform the search for life beyond Earth

2023-04-14

Finding life on other planets might well be the holy grail of astronomy, but the hunt for suitable host planets that can sustain life is a resource-intensive task.

The search for exoplanets (planets outside our Solar System) involves competing for time on Earth's biggest telescopes – yet the hit rate of this search can be disappointingly low.

In a new study published today in Science, I and my international team of colleagues have combined different search techniques to discover a new giant planet. It could change the way we try to image planets in the future.

Imaging planets is no small feat

The search for exoplanets (planets outside our Solar System) involves competing for time on Earth's biggest telescopes.

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To satisfy our curiosity about our place in the universe, astronomers have developed many techniques to search for planets orbiting other stars. Perhaps the simplest of these is called direct imaging. But it's not easy.

Direct imaging involves attaching a powerful camera to a large telescope and trying to detect light emitted, or reflected, from a planet. Stars are bright, and planets are dim, so it's akin to searching for fireflies dancing around a spotlight.

It's no surprise only about 20 planets have been found with this technique to date.

Yet direct imaging is of great value. It helps shed light on a planet's atmospheric properties, such as its temperature and composition, in a way other detection techniques can't.

HIP99770b: a new gas giant

Our direct imaging of a new planet, named HIP99770b, reveals a hot, giant and moderately cloudy planet. It orbits its star at a distance that falls somewhere between the orbital distances of Saturn and Uranus around our Sun.

With about 15 times the mass of Jupiter, HIP99770b is a real giant. However, it's also more than 1,000 , so it's not a good prospect for a habitable world.

What the HIP99770 system does offer is an analogy to our own Solar System. It has a cold "debris disk" of ice and rock far out from the star, akin to a scaled-up version of the Kuiper Belt in our Solar System.

The main difference is that the HIP99770 system is dominated by one high-mass planet, rather than several smaller ones.

Searching with the light on

We reached our findings by first detecting hints of a planet via indirect detection methods. We noticed the star was wobbling in space, which hinted at the presence of a planet in the vicinity with a large gravitational pull.

This motivated our direct imaging efforts; we were no longer searching in the dark.

The extra data came from the European Space Agency's Gaia spacecraft, which has been measuring the positions of nearly one billion stars since

2014. Gaia is sensitive enough to detect tiny variations of a star's motion through space, such as those caused by planets.

We also supplemented these data with measurements from Gaia's predecessor, Hipparcos. In total, we had 25 years' worth of "astrometric" (positional) data to work with.

Previously, researchers have used indirect methods to guide imaging that has discovered companion stars, but not planets.

It's not their fault: massive stars such as HIP99770 – which is almost twice the mass of our Sun – are reluctant to give up their secrets. Otherwise-successful search techniques can rarely reach the levels of precision required to detect planets around such massive stars.

Our detection, which used both direct imaging and astrometry, demonstrates a more efficient way to search for planets. It's the first time the direct detection of an exoplanet has been guided through initial indirect detection methods.

Gaia is expected to continue observing until at least 2025, and its archive will remain useful for decades to come.

Mysteries remain

Astrometry of HIP99770 suggests it belongs to the Argus association of stars – a group of stars that moves together through space. This would suggest the system is rather young, about 40 million years old. That would make it roughly one-hundredth of the age of our Solar System.

However, our analysis of the star's pulsations, as well as models of the planet's brightness, suggest an older age of between 120 million and 200 million years. If this is the case, HIP99770 might just be an interloper in the Argus group.

Now that it's known to host a planet, astronomers will aim to further unravel the mysteries of HIP99770 and its immediate environment.

The Conversation, 14 April 2023

https://theconversation.com

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Crazy ants have wacky genetics thanks to their never-before-seen way of reproducing

2023-04-13

It turns out that yellow crazy ants (Anoplolepis gracilipes), named after their erratic walking style, live up to their name in more ways than one.

Scientists have for the first time, discovered that males of this notoriously invasive species are "chimeras" – a phenomenon which is usually just a developmental accident, but in this case is due a mode of reproduction previously unknown to science.

Dr Hugo Darras, Assistant Professor at Johannes Gutenberg University Mainz (JGU) in Germany says the discovery was "highly unexpected."

"The results of previous genetic analyses of the yellow crazy ant have shown that the males of this species have two copies of each chromosome. Males usually develop from unfertilised eggs in ants, bees, and wasps – and therefore should only have one maternal copy of each chromosome," he says.

The extraordinary results are described in a new paper in Science.

Male yellow crazy ants are real-life chimeras.

Until now, it had been assumed that the males carried the same two sets of chromosomes in all cells of their bodies like other normal multicellular animals including humans. All the cells of our body (except gametes, sperm and eggs) contain copies of both our maternal and paternal chromosomes, so we're diploid.

Instead, the researchers found that the cells in the male crazy ant's body are actually a mixture of two different lineages – some contain copies of maternal chromosomes, while others contain the paternal ones, so they're haploid.

"We discovered that the male ants have maternal and paternal genomes in different cells of their body and are thus chimeras. To put it another way, all males have two genomes, but each cell of their bodies contains only one or the other of the two genomes," explains Darras, who is lead author of the study.

How is this possible?

Male crazy ants develop from fertilised eggs where the two parental gametes (the sperm and egg) do not fuse. Instead, they continue to divide

and multiply separately within the same egg, so that the resulting adult males have both parents' DNA, but in different cells in the body.

If the gametes were to fuse, this would result in either a queen or a worker developing. The mechanism that determines whether this fusion takes place or not is not yet known.

Chimeras are individual organisms whose cells contain different genetic materials. Normally, this occurs naturally in some species where separate individuals can merge to become one – like corals and angler fish.

They can also be found in humans and other placental mammals. During gestation small-scale exchanges of cells can occur between mother and fetus, so that the offspring usually has a few cells that contain the same genome as the mother, or between twins in the womb.

Cosmos, 13 April 2023

https://cosmosmagazin.come

Study reveals shocking link between dishwashers and chronic illnesses

2023-04-14

A new study by researchers at the Swiss Institute of Allergy and Asthma Research (SIAF), an associated institute of the University of Zurich (UZH), has revealed the toxic effect of one ingredient in commercial rinse agents on the gastrointestinal tract. The study's findings have implications for public health, as the toxic substance could trigger the onset of many chronic diseases.

Commercial dishwashers are widely used in various settings, from restaurants to barracks, to wash plates, glasses, and cutlery. A typical cycle in these machines involves circulating hot water and detergent for around 60 seconds at high pressure. In the second 60-second washing and drying cycle, water and a rinse agent are applied.

The study discovered that many appliances do not have an additional wash cycle to remove the remaining rinse aid, allowing potentially toxic substances to remain on the dishes, where they then dry in place. When these dishes are used again, the dried chemical residue can easily end up in the gastrointestinal tract.

The research team under Cezmi Akdis, UZH professor of experimental allergology and immunology and director of SIAF, investigated the effect

The researchers warn that the effect they found could mark the beginning of the destruction of the gut's epithelial layer and trigger the onset of many chronic diseases.

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of the components of commercial-grade detergents and rinse agents on the epithelial barrier in the gut.

The epithelial barrier is the layer of cells that lines the intestinal tract and controls what enters the body. A defect in this barrier is associated with conditions such as food allergies, gastritis, diabetes, obesity, cirrhosis of the liver, rheumatoid arthritis, multiple sclerosis, autism spectrum disorders, chronic depression, and Alzheimer's disease.

To conduct the study, the researchers used human intestinal organoids and intestinal cells on microchips, a newly developed technology. The tissue forms a three-dimensional clump of cells that is very similar to the intestinal epithelium in humans.

The team used various biomolecular methods to analyze the effect that commercial detergents and rinse aids have on these cells. They diluted these substances to reflect the amounts that would be present on dry dishes (1:10,000 to 1:40,000).

The study found that high doses of rinse agents killed the intestinal epithelial cells, and lower doses made it more permeable. Researchers also observed the activation of several genes and cell signaling proteins that could trigger inflammatory responses. A more detailed analysis showed that one component of the rinse agent – alcohol ethoxylates – was responsible for this reaction.

The researchers warn that the effect they found could mark the beginning of the destruction of the gut's epithelial layer and trigger the onset of many chronic diseases. Akdis calls for an immediate response: "It is important to inform the public about this risk, since alcohol ethoxylates seem to be commonly used in commercial dishwashers."

The rinse aid decreased TEER and increased PF in differentiated Caco-2 cells. A, C, and E, TEER was measured every 24 hours for 9 days for cells treated with detergent and rinse aid alone or as a mixture. B, D, and F, PF was measured in response to 72 hours of exposure to the detergent and rinse aid alone or as a mixture. (CREDIT: The Journal of Allergy and Clinical Immunology)

The connection between defective epithelial barriers and chronic illnesses has been explored in numerous studies. As Akdis explains, many additives and chemicals that we encounter in everyday life can damage these layers.

"We assume that defective epithelial barriers play a role in triggering the onset of two billion chronic illnesses," he says. This connection is explained

by the epithelial barrier hypothesis, which Akdis has helped develop during his more than 20 years of research in this field.

The findings of the study have significant implications for public health, as commercial dishwashers are widely used in various settings. The toxic effect of one ingredient in commercial rinse agents on the gastrointestinal tract could trigger the onset of many chronic diseases. It is, therefore, crucial to inform the public about this risk and take immediate action to prevent the negative health effects of these substances.

The Brighter Side of News, 14 April 2023

https://www.thebrighterside.news

Be excited about EPR, even if it's not a silver bullet

2023-04-14

Extended producer responsibility (EPR) legislation is popping up in more U.S. states. There's a lot of energy around these policies, which require producers to contribute to the costs associated with recycling the packaging they put into the market.

TerraCycle operates in 20 countries, many of which have federal EPR programs in place. In Germany, we're partly owned by one of the main administrators of Der Grüne Punkt, the first EPR scheme introduced. There, and elsewhere, we've had a firsthand look at the benefits and shortcomings of EPR.

Why do we need policy in the first place?

In the current U.S. recycling system, the main actors — manufacturers, retailers, consumers and waste management companies — are not mandated to adopt circular actions or business models. In other words, manufacturers don't have to make their products and packaging easy to recycle or include recycled content in production. Retailers can sell anything they want. The consumer that buys the product has no legal obligation to recycle it (considering it's recyclable), and even if someone does put something in a recycling bin, the waste management company isn't legally required to recycle it either.

In such an "open loop," what drives each actor is cost (economics) and convenience (a derivative of cost). This is where policy can help.

How does policy help?

The bottom line is that a money flow is needed to improve recycling rates, and extended producer responsibility contributes to that.

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There are a few ways policy is being leveraged to make the recycling loop less open and more closed. Most of these interventions are pointed at manufacturers, but here's a sense of the current landscape.

Manufacturers: Policies typically fall into the following categories.

- Regulations that prevent them from creating certain items. Single-use plastic bans are an example. The U.S. has no federal single-use plastic bans, but several states, plus Washington D.C., do regulate items such as plastic bags and straws.
- Requirements that mandate certain actions, like using a portion of post-consumer recycled (PCR) content in production. Washington state enacted a PCR law in 2021, following in California's footsteps.
- Mandatory deposit return systems. This forces brands to put a deposit on their product (which increases the price of that product at retail). Consumers get this deposit back when they return the package, typically at a retailer in a "reverse vending machine." In the U.S., we call such legislation a "bottle bill," and examples exist in 10 states (and Guam). Every time a deposit return system go into effect, recycling rates increase.
- Taxes on products and packaging they put on the market. The money is then pooled and used to fund recycling infrastructure and processing. This is EPR. It can be administered at a country level (as in Germany) or at a regional level (as is the case in the U.S.)

Retailers: Some precedent exists for mandates on retailers. In several U.S. states, grocery stores of a certain size are legally mandated to offer plastic shopping bag recycling front-of-store.

Consumers: In the U.S., there's still no legal obligation for consumers to recycle instead of disposing of a recyclable item, although some countries, such as Germany, fine households for improper recycling. Isn't it interesting that we are fined for littering but not for sending recyclable items to landfills?

Recyclers: Recycling companies still don't have to worry about any federal orders to recycle what they collect. The only enforcement they may have is from their clients (which may be municipalities or private companies).

Why EPR is amazing but not a silver bullet

EPR can be effective because it creates a new flow of money to help subsidize recycling. However, it doesn't make everything recyclable, because EPR schemes don't address the underlying economics of waste.

The pooled taxes paid by producers make items that are profitable to recycle more profitable (and thus their rates of recycling increase). But items that have not been profitable to recycle often remain below the line of profitability and as such still do not get recycled (even if the manufacturer of those items is paying its EPR fees). In other words, expensive-to-recycle items, such as cosmetic packaging, will still not get recycled, while aluminum cans will be recycled at an even higher rate because they're even more profitable than before. (See Figure 1.)

You can see this in action with Germany's EPR system. The country is often lauded for its 65 percent recycling rate, the best in the world. But more than 60 percent of what is collected through German "recycling" is actually incinerated because it's still not profitable to recycle it.

So, if you're a producer of aluminum packaging, you benefit from EPR. But if you make snack chip bags, you might not. The tax you're paying will help fund the recycling of items further up the chain, like that aluminum can, instead of your packaging.

The "perfect" EPR scenario would involve producers being taxed based specifically on the waste they create with their products and packaging. Producers of very hard-to-recycle packaging would pay the most, and producers of already profitable-to-recycle packaging might pay nothing (or even get a credit). This is what TerraCycle does, although on a voluntary instead of mandated basis. We call it voluntary producer responsibility (VPR), where a producer funds what it actually costs to collect and recycle the item, minus whatever the recycled outputs are worth. (See Figure 2.)

Mandating that the collection and processing of every item be fully funded in a fair way could incentivize producers to move into higher-quality packaging forms (from polypropylene to PET). (See Figure 3.)

So perhaps "traditional" EPR isn't perfect, and "perfect" EPR is expensive for producers, but the bottom line is that a money flow is needed to improve recycling rates, and EPR contributes to that.

It's quickly ramping up in the U.S. Four states — Maine, Oregon, Colorado and California — have already passed laws. And in 2022, 40 related bills received consideration across 18 states. A silver bullet EPR may not be, but all of this progress is still something to celebrate.

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With all that said, the true solution is to stop waste at the source. We all need to vote for a better future by buying less.

GreenBiz, 14 April 2023

https://www.greenbiz.com

Revolutionary protein kills cancer cells and boosts the body's immunity

2023-04-15

Tumor cells typically alter their energy metabolism and increase glucose uptake to support their rapid division and spread. This limits glucose availability for immune cells and therefore dampens the body's anti-cancer immune response.

By searching for proteins that both regulate the metabolism of cancer cells and affect immune cells in tumors, a team led by investigators at Massachusetts General Hospital (MGH) recently identified a potential target for therapies that could simultaneously drain tumors of energy and boost the immune response against them.

New anti-cancer therapies could simultaneously deplete tumors of energy and boost the body's immune response against them.

For the research, which is published in Cancer Discovery, Keith T. Flaherty, MD, the director of Clinical Research at the MGH Cancer Center and a professor of medicine at Harvard Medical School, and his colleagues developed a new computational tool called BipotentR that can identify targets that block immune activation and also stimulate a second user-defined pathway (in this case, metabolism).

When applied to gene expression data from patients with cancer who were treated with immunotherapy, as well as from cell lines and animal models, the tool identified 38 cancer cell–specific immune-metabolic regulators.

Artificial intelligence techniques showed that the activity level of these regulators in tumors predicted patients' outcomes after receiving immunotherapy.

The topmost identified regulator, ESRRA (Estrogen Related Receptor Alpha), was activated in immunotherapy-resistant tumors of many types. Inhibiting ESRAA killed tumors by suppressing energy metabolism and activating two immune mechanisms involving different types of immune cells.

ESRRA inhibition was safe when tested in mice, and its effects on energy metabolism were focused on cancer cells.

The scientists also demonstrated that BipotentR can be applied to other survival mechanisms used by cancer cells, such as their ability to promote blood vessel formation to increase their blood supply.

Therefore, BipotentR, available at http://bipotentr.dfci.harvard.edu, provides a resource for discovering single drugs that can act through one cancer-related pathway while simultaneously stimulating an immune response.

"These findings provide a simple biomarker to predict response/non-response to immunotherapy, and they support ERRA as a therapeutic target," says Flaherty.

Key Takeaways

- By developing a new computational tool, researchers have identified a potential target for anti-cancer therapies that could simultaneously deplete tumors of energy and boost the body's immune response against them
- The target, called Estrogen Related Receptor Alpha, may also represent a marker to predict which patient will benefit from immunotherapy

Additional MGH co-authors include Phillip Munson, Dejan Juric, and David E. Fisher.

This work was supported by the Adelson Medical Research Foundation.

The Brighter Side of News, 15 April 2023

https://www.thebrighterside.news

'Forever chemicals': Eating the fish you catch can be harmful to your health

2023-04-16

Although the touting of Ohio fishing reasonably ramps up this time of year, like cigarette packaging it probably should come with a health warning.

In keeping with the spirit of World Earth Day that arrives Saturday, consider what follows as that absent warning: Catching and releasing fish in Ohio waters can be a fun, challenging and diverting pastime; eating caught fish can be harmful to health.

Virtually everyone on Earth is contaminated, and no level of contamination by certain PFAS and PFOS is thought to be without risk.

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So concludes a report based on research sampling issued earlier this year by The Environmental Working Group (EWG), a Washington-based lobbying and education organization, on the prevalence nationwide of "forever chemicals" in freshwater fish.

Nationwide obviously includes Ohio, where fish samples taken at 30 or so locations that included the Ohio River, Lake Erie and tributaries of both turned up measurable levels of the chemicals, known as PFAS and PFOS.

PFAS and PFOS, short for per- and polyfluoroalkyl substances, are described by the U.S. Centers for Disease Control as a widespread "group of chemicals used to make fluoropolymer coatings and products that resist heat, oil, stains, grease and water."

Developed during the 1940s at least partly to bolster World War II needs, the chemicals afterward became commercially important. Their thousands of permutations are included in a long list of everyday products such as Teflon, fire retardants, Scotchgard, wire sheathing, plastics, tents, outdoors apparel, shampoos and cosmetics.

In short, the chemicals were put to various profit-making uses, many of them welcome. For decades nobody paid much attention, including federal and state regulators that generally aren't tasked with determining the safety of introduced chemicals until they show harm.

That harm could be wrought by particular "forever chemicals" was determined some years after a 1999 lawsuit was brought in federal court on behalf of a sickened group of West Virginia residents by the Ohio-based law firm of Taft Stettinius & Hollister. The suit successfully linked the group's various maladies, some of them lethal, to a DuPont chemical plant in Parkersburg, West Virginia, where millions of pounds of a Teflon component were leaked into nearby water, including the Ohio River.

What has been determined since is that "very low exposure to some PFAS has been linked to cancer, thyroid disease, weakened childhood immunity and many other health problems," the EWG reports.

Those "other" problems tied to PFAS and PFOS, the Taft law firm reports, include "high cholesterol, changes in liver enzymes, decreased immune response to vaccination, thyroid disorders, pregnancy-induced hypertension and preeclampsia."

Almost two decades after the confirmation of a link to human illness, work is being done to eliminate the production of the chemicals identified as toxic.

However, "forever chemicals," which have been detected atop Mt. Everest and in the deepest ocean trenches, don't disappear but persist in living organisms. Longer-lived species that eat other animals are most likely to accumulate PFAS and PFOS at high levels.

Those include fish. A Lake Erie walleye, for example, can live 20 years while having eaten scads of smaller, loaded fish.

Virtually everyone on Earth is contaminated, and no level of contamination by certain PFAS and PFOS is thought to be without risk.

What seems worth considering, the EWG report says, is "eating just one PFAS-contaminated freshwater fish per month could be the equivalent of drinking a glass of water with very high levels of PFOS or other forever chemicals."

The Ohio Department of Health offers a downloadable, 36-page booklet entitled, Ohio Sport Fish Advisory 2022, that offers recommendations for eating fish while staying within recognized safe limits. However, the limits to date account for mercury and PCB levels, not for PFAS and PFOS.

The Columbus Dispatch, 16 April 2023

https://dispatch.com

Marking Time

2023-04-13

One thousand years ago, according to Viking sagas, intrepid seafarers sailed west from Greenland to a coast they called Vinland. There they set up camps, harvested wild grapes, and skirmished with local people. At an archaeological site in a coastal town in Newfoundland called L'Anse aux Meadows, remnants of structures laid out like Viking longhouses and artifacts such as a bronze cloak pin and iron nails record their presence—likely the first Europeans to set foot in North America. Yet pinning down exactly when Vikings came to Vinland was impossible, until researchers discovered a kind of cosmic timestamp preceding their arrival.

In 2021, Margot Kuitems and Michael Dee of the University of Groningen obtained pieces of timber from a longhouse with visible tree rings and intact bark. Kuitems, an archaeologist, and Dee, a radiocarbon expert, were hoping to find a tree ring with an unusually large amount of carbon-14 (14C): the signature of a barrage of high-energy particles from outer space known to have occurred in 993–94 C.E. "It was a bit of a shot in the dark," Kuitems says. But 28 rings in from the bark, they found the telltale 14C

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Radiocarbon time-stamps left in ancient tree rings by cosmic ray bombardments can date historical events with unprec-edented precision

spike: persuasive evidence that Vikings had felled the fir and juniper trees used to build the longhouse in 1021 C.E.

The timing of the Viking foothold at L'Anse aux Meadows heralds a revolution in archaeology: a newfound ability to whittle the age of wooden artifacts from decades down to single years. The breakthrough paving the way for such precision came in 2012, when Japanese physicist Fusa Miyake revealed that a massive influx of cosmic rays caused a big uptick in 14C in a tree ring dated to 774–75 C.E. Since then, at least seven more confirmed spikes, known as Miyake events, have been found so far. The earliest well-supported spike dates to 7176 B.C.E.

These chronological lighthouses are now guiding a growing cadre of scientists as they work to date ancient ruins, natural disasters, and other historic turning points. "If we're able to start pinning things down to the year," Dee says, "we can start analyzing early history, perhaps even prehistory, with the sort of rigor that previously we could only apply to modern history."

The technique "is phenomenally cool," says Charlotte Pearson, a dendrochronologist and radiocarbon scientist at the University of Arizona's Laboratory of Tree-Ring Research. "These are eureka moments, and we're about to have a lot more of them."

Even scribes in the early Middle Ages noticed the cosmic assault that produced Miyake's first event. In 774 C.E., the Anglo-Saxon Chronicle, a collection of manuscripts that recounts key moments in Anglo-Saxon history, recorded the appearance in the sky, after sunset, of a "red crucifix." Astronomers have speculated that the sighting may have been atmospheric dust scattering light from a nearby supernova, or an especially vivid aurora borealis triggered by a giant solar flare.

That same year, thousands of kilometers to the east, as Japan's Emperor Kōnin struggled with a succession crisis, a Japanese cedar on Yaku Island off the nation's southern coast was sucking up carbon dioxide (CO2) through its short, bristled needles. The tree converted some of the CO2 into sugar and deposited that in the outermost layer of its wood. As empires rose and fell, the cedar added ring after ring of annual growth—succumbing only in 1956, at the venerable age of 1900 or so, to the blades of Yaku forestry managers. A half-century later, Miyake, then a graduate student at Nagoya University, cut a cross-section of the cedar's stump.

Each of its rings held a trace of 14C. The radioactive isotope forms continuously in the upper atmosphere as cosmic rays—high-energy

particles from space—collide with gas molecules, spawning neutrons. When one of these neutrons knocks out a proton in a nitrogen atom, that nitrogen is transformed into 14C. As it inhaled CO2, the cedar had incorporated the 14C into its wood.

All green plants take up 14C and pass it on to the animals they sustain; it can be detected in fossils and other preserved tissues going back tens of thousands of years. Its mostly predictable decay rate is the basis of standard radiocarbon dating. Using methods such as mass spectrometry, scientists can analyze organic remains to determine how much 14C has decayed since the life form that absorbed it died. That value is then compared against the 14C values of items with a known age—usually based on tree rings—giving the sample's age to within a few decades under ideal circumstances. (Because the isotope has a half-life of about 5700 years, samples from earlier than about 50,000 years ago contain too little for dating.)

But Miyake wasn't trying to date the tree. She was looking for anomalous 14C spikes left by violent space weather events—solar flares, other outbursts from the Sun, and exploding stars—that unleash short, exceptionally intense showers of high energy particles.

Using techniques developed in part by Lukas Wacker, a physicist at ETH Zürich, she zeroed in on a period toward the end of the 8th century C.E., where previous radiocarbon scientists had detected an anomalous hump. Working ring by ring, she sliced out tiny wood chips from the cedar and ran them through an accelerator mass spectrometer to determine the ratio of 14C to stable carbon isotopes. In the ring corresponding to 774–75 C.E., she saw a 12% jump in 14C: an increase 20 times larger than ordinary cosmic ray oscillations produce. Other teams confirmed the spike in samples from a German oak and a New Zealand kauri tree.

Later that year, Miyake and her colleagues published a paper in Nature attributing the 14C spike to a massive bombardment of cosmic rays, perhaps from the Sun or a gamma ray burst from a distant star. In 2013, they found a second, slightly smaller 14C spike in the same Yaku cedar at 993–94 C.E. Other scientists started calling the phenomena Miyake events.

When Wacker read about Miyake's 774–75 C.E. and 993–94 C.E. spikes, he recognized the radiocarbon beacon's untapped potential. He trained it on a chapel in Müstair, Switzerland, supposedly built by the first Holy Roman Emperor, Charlemagne, on a site where he and his party had survived a horrendous blizzard. Another team of scientists had dated the chapel to 785 C.E. by meticulously analyzing the widths of tree rings in a

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wooden beam—wider rings often indicate wetter years—then matching the patterns with more recent timber from the area until they had an unbroken record stretching from the present back to the beam.

Wacker knew that if his team could find the 14C spike from the 774–75 C.E. Miyake event in the beam, they could simply count to its outer edge to obtain a precise date. They did just that, confirming in 2014 the 785 C.E. date. "That was pioneering work," Miyake says. "I was really happy to see that kind of application was made possible because of our findings."

WHILE WACKER PURSUED the Holy Cross Chapel work, Dee and colleagues began exploring other ways that Miyake events might illuminate historical timelines confused or obscured by the passage of time. Reliable written records—chronicles listing the exact years of of empires and wars, and more mundane archives of taxes, trade receipts, births and deaths—go back only some 2500 years, Dee says, and only in societies that kept written records. Radiocarbon dates, with their decades or centuries of uncertainty, may help reconstruct history in broad strokes, but key historical moments often play out over shorter timescales. "One couldn't examine the political events of the 20th century if you only had decadal resolution," Dee says. "If the First World War and the Second World War had been in 1914 B.C. and 1939 B.C., we wouldn't be able to tell those two things apart."

In 2020, Kuitems and Dee used the technique to clear up a longstanding mystery surrounding rectangular ruins on a lake island in southern Siberia. Despite decades of archaeological work, nobody knew for sure how old the Por-Bazhyn site is, who built it, or what its purpose was. Por-Bazhyn lacked any sign of occupation such as trash heaps or charcoal from hearths, suggesting it was abandoned soon after construction. But the 774–75 C.E. spike was present in an outer ring of a beam, indicating the source tree had been felled in 777 C.E. That was during the reign of Tengri Bögü Qaghan, a Uyghur monarch who converted to Manichaeism, a religion that views existence as an epic struggle between good and evil. Most likely, Kuitems says, Bögü Qaghan built Por-Bazhyn as a Manichaean monastery.

Por-Bazhyn's precise age points to the apparent reason it was never occupied. In 779 C.E., rebels opposed to Manichaeism killed Bögü Qaghan. "So at the moment this whole building was finished, it immediately became useless," Kuitems says. Dee also contributed to work by German colleagues that used the same Miyake spike to date another ancient fortress, on an island in Lake Āraiši in central Latvia. "These were questions

that people couldn't answer for decades, and now we could with this method," Kuitems says.

In the wake of their headline-grabbing Vinland success, the Groningen team is tackling another alluring set of historical puzzles: "floating" chronologies, or ancient, internally consistent timelines that are untethered to specific dates. For instance, Dee has long hoped to moor the floating timelines of ancient Egypt's pharaohs to our modern calendar. Radiocarbon dating has pegged the Egyptian chronology to within a couple hundred years; scientists have tried to use ancient observations of known astronomical events, such as star and planet alignments, to narrow dates further. But timelines remain blurry. Egypt's Old Kingdom era, for example, encompasses dozens of pharaohs who reigned from approximately 2700 to 2200 B.C.E. "The calendrical dates are not even really known to the century," Dee says.

Many native Egyptian tree species don't produce annual growth rings, complicating the quest for Miyake events there. But the Egyptians imported conifers—which builders often preferred for their straightness and strength—from Lebanon and Syria. The pandemic and laws restricting the export of Egyptian artifacts have slowed his team's work, Dee says. But he has his sights set on discovering a precise date for the construction of the Great Pyramid, which was built by the Old Kingdom Pharaoh Khufu. "There is an old Arab proverb which goes, 'Man fears time; time fears the Pyramids,'" Dee says. "If this structure, and his reign, could be precisely dated, that would solve a mystery that has endured since antiquity itself."

Another floating chronology Dee's team hopes to anchor is the Mesoamerican Long Count timekeeping system. Used by the Maya, Aztec, and other Mesoamerican civilizations, the system counts the days linearly from a supposed day of the world's creation. While there have been several attempts to correlate the Long Count with the Gregorian calendar, academics are still debating the precise creation date. Finding a Miyake event in wood from a Mesoamerican structure—such as a lintel in the Maya temple Tikal in Guatemala, whose construction is recorded in the Long Count—would settle the matter.

Miyake events also promise to date natural disasters that have altered the course of human history. "This technique can help answer questions about the rise and fall of civilizations," Pearson says.

In 2017, Clive Oppenheimer, a volcanologist at University of Cambridge, teamed up with Wacker and others to use a Miyake event to date a larch tree buried in ash by the so-called Millennium eruption of Mount Paektu,

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a volcano straddling the border of China and North Korea. Radiocarbon dates pegged the eruption—one of the biggest in the past 10,000 years—to sometime during the ninth to 11th centuries. Some historians hypothesized that the blast led to the fall in 926 C.E. of the Bohai Kingdom, which encompassed parts of the Korean Peninsula, Northeast China, and Russia's Far East. Oppenheimer and colleagues used the 774–75 C.E. Miyake event to date the larch's demise to 946 C.E., exonerating the eruption in the kingdom's collapse. "Thanks to the Miyake event, we could really nail it," Oppenheimer says. "With anything that kills trees—earthquakes, fires, biological pests—there's now the potential to date that very, very precisely."

Pearson is hoping to replicate a version of that success in a tree that was downwind of the volcano Thera when it erupted around 3500 years ago on the island of Santorini, possibly contributing to the fall of the Minoan civilization. The widespread devastation would have disrupted commerce throughout the Mediterranean and sent refugees scrambling for new homes. A 14C spike centered on 1528 B.C.E.—so far unconfirmed as a Miyake event—confirms that in 1562 B.C.E, plus or minus 1 year, an abrupt chemical signal shows up in the tree's rings, possibly caused by sulfate from the eruption.

Miyake events may even shed light on potential future cataclysms. Dendrochronologist Bryan Black, also at the Arizona treering lab, recently used the 774–75 C.E. Miyake event to date two mass tree deaths separated by more than 80 kilometers in the Puget Sound region of the U.S. Pacific Northwest. The forests grew along two distinct shallow faults near present-day Seattle, and geological evidence shows they died more than 1000 years ago. Sediments record the upheaval, as do oral traditions of the indigenous Salish people. Earth scientists have wondered whether both faults ruptured separately, or at once in a single massive earthquake. Black found these trees all died during the same season between 923 and 924 C.E., suggesting the faults could conspire again to produce a massive earthquake. "It takes the current worst-case scenario of these shallow faults and raises it to the next level," he asserts.

Radiocarbon scientists are scouring tree ring archives for more Miyake events. Kuitems hopes to firm up one in the sixth millennium B.C.E., which may allow her to precisely date an undisclosed Neolithic site in Europe. Other researchers have spotted a possible Miyake cluster in 1261 C.E., 1268 C.E., and 1279 C.E. Several different labs are aiming to verify these and other 14C spikes in trees from around the world.

"It's like a sort of jigsaw puzzle," Dee says. "In the end, if we have enough spikes, we'll be able to put together a lot of this history of the Holocene in absolute time."

Ice core data can also confirm Miyake events. Cosmic rays spawn two other radioisotopes—beryllium-10 and chlorine-36—in the upper atmosphere. Rather than lodging in living tissue, these isotopes are washed to the surface in rain and snow, and they can end up in the annual layers of polar ice sheets. Like 14C in tree rings, sharp spikes of beryllium-10 and chlorine-36 in the ice have been correlated to known Miyake events. At a radiocarbon conference in Zürich last year, physicists Andrew Smith and David Fink of the Australian Nuclear Science and Technology Organisation reported isotopic spikes at 774–75 C.E. and 993–94 C.E. in Antarctic ice cores. Continued analysis of the cores could reveal other, previously unknown Miyake events that dendrochronologists could follow up on.

Miyake, too, is continuing her quest to find more of the events that bear her name. She has joined forces with Arizona's Laboratory of Tree Ring Research, whose 700,000 tree ring samples–the largest collection in the world–offer an unparalleled record of past climate and cosmic events. There, Miyake and her Arizona colleagues, along with colleagues around the world, are aiming to patch together from recently deceased and long-dead trees a complete radiocarbon record stretching back 12,000 years. Filling in the gaps between Miyake events is also important, says Pearson, as they contain solar patterns that can be matched with tree-ring and ice-core records to improve radiocarbon dating. Pearson and Wacker are preparing to submit another 1100 years' worth of data from California's bristlecone pines, which can live for more than 4000 years, to an international radiocarbon calibration repository. Miyake is looking to samples of other long-lived trees from Russia, Finland, and Japan, and has already spotted several as-yet unpublished Miyake events, she says.

Miyake's pioneering analysis of the cedar continues to ripple through studies of the past, colleagues say. "She trusted her instincts and was so confident in what she had that she was able to convince us all that there was a real effect," Dee says. "And the rest, as they say, is history."

Science, 13 April 2023

https://science.org

"Runaway" supermassive black hole creates new stars in its wake

2023-04-10

Astronomers have spotted a bizarre sight out in the cosmos unlike anything they've ever seen before. A supermassive black hole has been ejected from its host galaxy, leaving a streak of light almost twice as wide as the Milky Way in its wake as the shockwaves create new stars.

Telescope images often need a little cleaning up to confirm that things they see exist out in space and aren't just artifacts of light, like lens flares, reflections or cosmic ray interference. So when astronomers first saw a long streak of light on some images from the Hubble Space Telescope, they assumed it would disappear after the usual image processing was applied.

But to their surprise it didn't, indicating that what they were looking at was in fact a 200,000-light-year-long line stretching out of a galaxy roughly 7 billion light-years away. This space oddity wasn't something astronomers had ever seen before, so the team studied it closer to figure out what it was.

And the origin story they came up with is an incredible one. A supermassive black hole with the mass of about 20 million Suns was violently ejected from its galaxy, leaving a bright wake trailing back to its former home.

The evidence for this story starts at the leading edge of the line, farthest from the galaxy, where a bright lump of light seems to be coming from ionized oxygen. The team suggests this is a shockwave in intergalactic gas as the black hole zips through the cosmos.

Although we might be inclined to associate black holes with destruction, this one is actually engaging in a spectacular act of creation. Traveling at speeds of about 1,600 km (1,000 miles) per second, the black hole is moving way too fast to slurp up much matter. Instead, it's shocking and compressing gas, which then cools and coalesces into brand new stars behind it. The wake, then, is a thin corridor of baby stars stretching all the way back to the galaxy.

So what would cause a supermassive black hole to fly out of its home galaxy? Only other supermassive black holes, the team says. The hypothesis goes that two galaxies merged about 50 million years earlier, creating a binary system of black holes at the center of this new galaxy.

Although we might be inclined to associate black holes with destruction, this one is actually engaging in a spectacular act of creation.

This remained stable for a further 10 million years or so, before a third galaxy joined the party, complete with its own supermassive black hole. But of course, three's a crowd, and the more complex gravitational interactions sent one of the black holes flying out of the galaxy.

Intriguingly, there's some circumstantial evidence for this story, the team says. Such a calamity would have ejected the other two black holes in the opposite direction – and so far there doesn't seem to be any sign of an active black hole remaining at the center of the galaxy. A strange feature seen on the exact opposite side of the galaxy could be where the other two are now hiding.

To confirm the hypothesis, or figure out what's really going on, further observations will be needed. The plan is to examine the system with the James Webb Space Telescope and Chandra X-ray Observatory in the near future.

The research was published in the Astrophysical Journal Letters.

New Atlas, 10 April 2023

https://newatlas.com

The ultra-absorbent feathers of this African bird might inspire next gen water bottles

2023-04-12

Male desert-dwelling sandgrouses have a truly extraordinary ability to gather water in their specially-adapted belly feathers, hold and safely transport it during flight and release it to their chicks back at the nest.

Now, engineers have taken an extremely close look at these special feathers to finally reveal exactly how they can hold so much water.

The feather's unique architecture, described in The Royal Society Interface, could inspire the next generation of absorbent materials.

"It's super fascinating to see how nature managed to create structures so perfectly efficient to take in and hold water," says co-author Jochen Mueller, an Assistant Professor in the Department of Civil and Systems Engineering at Johns Hopkin University in the US.

"From an engineering perspective, we think the findings could lead to new bio-inspired creations."

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These fluffy birds can hold 15% of their body weight in water!

Sandgrouse (Pteroclidae) are a family of sixteen species of ground-dwelling birds found in Asian and African deserts.

African sandgrouse need to nest as far as 32 kilometres away from watering holes, to stay safe from predators, and the male sandgrouse's ability to absorb and retain water in his feathers keeps most of it safe over the roughly half hour flight.

Engineers zeroed in on the microstructures of the belly feathers from a single male adult Namaqua sandgrouse (Pterocles namaqua) using scanning electron microscopy, microcomputed tomography (which uses x-rays to produce 3D images), light microscopy, and 3D videography.

They observed the feathers while dry, wet, and then, in an imitation of a sandgrouse at a watering hole, while dry feathers were dunked in water, pulled out, and then resubmerged.

"When you do that type of work, you can't even breathe or else you blow it away," says Mueller.

They found that the shafts of the feathers are just a fraction of the width of a human hair and contain even tinier individual barbules – coiled hairlike extensions on the feather that expand to soak up water like a sponge.

The feather's structure is optimised to hold and retain water in a few different ways. For instance, curled barbules near the top of the feather act almost like caps to keep water held in the forest of barbules close to the shaft. This is possible thanks to tubular structures on the barbules that capture water, and the way that the barbules form protective tentlike clusters when wet.

"That's what excited us, to see that level of detail," says Mueller, who specialises in smart materials and design.

"This is what we need to understand in order to use those principles to create new materials."

These findings will underpin the designs of new materials for the controlled absorption, secure retention, and easy release of liquids. Potential future applications include netting for collecting water from frog and dew in desert regions, medical swabs that efficiently soak up liquids and easily release it, and even a water bottle designed to prevent annoying swinging and sloshing.

Mueller is contemplating a design that includes an inner feather-like system that keeps water from sloshing around while someone moves with it, such as a hydration pack or water bladder for runners.

Cosmos, 12 April 2023

https://cosmosmagazine.com

How octopuses taste with their arms

2023-04-12

Octopuses and squids both use the suckers on their limbs to grapple with their prey and to taste their quarry at the same time. Now, a pair of studies describes how these animals 'taste by touching' — and how evolution has equipped them with the perfect sensory ability for their lifestyles1,2. The papers were published in Nature on 12 April.

The research details the structure of the receptors that stud the animals' suckers. These receptors transmit information that enables the creature to taste chemicals on a surface independently from those floating in the water.

Armed with brains

Cephalopods — the group that includes octopuses and squids — have long fascinated neuroscientists because their brains and sensory systems are unlike those found in any other animals. Octopuses, for instance, have more neurons in their arms than in their central brain: a structure that allows each arm to function independently as if it has its own brain3. And researchers have long known that the hundreds of suckers on each arm can both feel the environment and taste it4.

Molecular biologist Nicholas Bellono at Harvard University in Cambridge, Massachusetts, and his group were studying the California two-spot octopus (Octopus bimaculoides) when they came across a distinctive structure on the surface of the animal's tentacle cells. Bellono suspected that this structure acted as a receptor for chemicals in the octopus's environment. He contacted neurobiologist Ryan Hibbs at the University of California San Diego, who studies receptors that are architecturally similar to the octopus structures found by Bellono's team: both types consist of five barrel-like proteins clustered to form a hollow tube.

When the researchers looked at the octopus genome, they found 26 genes for these barrel-shaped proteins, which could be shuffled to create millions of distinct five-part combinations that detect various tastes1.

Ultra-specialized proteins enable octopuses and squids to taste surfaces with their suckers — and these proteins are tailored to each animal's way of life.

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The researchers found that the octopus receptors tend to bind to 'greasy' molecules that don't dissolve in water, suggesting that they are optimized for detecting chemicals on surfaces such as a fish's skin, the sea floor or the octopus's own eggs.

The authors think that having a wide variety of molecules in the suckers could allow an octopus to quickly determine what it is tasting, without having to send this information to the brain for processing.

A bitter pill

In the second study in Nature, Bellono, Hibbs and their colleagues studied how these chemical receptors arose in cephalopods2. The receptors seem to have evolved from those that many other organisms use to send signals through the nervous system.

The researchers compared the octopus receptors with those found in the tentacle suckers of striped dumpling squid (Sepioloidea lineolata) and found that the squid receptors responded to molecules that would produce a bitter taste. This suggests that a squid might choose to accept or reject its prey based on this particular taste.

Analysing the squid and octopus genomes showed that the receptors had evolved independently after squid and octopus ancestors diverged around 300 million years ago, acquiring new properties over time. The need for different types of receptors makes sense: squids float in the water, see their prey and shoot out tentacles to capture it, meaning that their suckers don't taste a fish until they touch it. But for octopuses, which tend to sit on the sea floor and feel their way around for prey, having a variety of sensitive tentacle suckers is crucial.

"To have so much insight so quickly is really exciting," says Cliff Ragsdale, an evolutionary biologist at the University of Chicago, Illinois. He says that the findings raise many questions, including how the suckers send sensory information to the octopus's brain and how the brain interprets it.

Nature, 12 April 2023

https://nature.com

Now we know why hibernating bears don't get blood clots

2023-04-13

As anyone who's taken a long flight knows, sitting still for too long is a major pain. It can also present a serious health hazard, as inactivity can lead to blood clots in leg veins and the lungs. Yet this risk doesn't affect hibernating bears, which lay still for months at a time. Now researchers know why: Hibernating bears produce less of a protein that researchers just learned helps blood to clot, the team reports today in Science.

Understanding more about this protein could have major implications for human health. When it comes to cardiovascular disorders, only heart attacks and strokes kill more people than these blood clots, which lead to a condition called deep vein thrombosis, explains Marc Rodger, a hematologist at McGill University who was not involved with the work. Current treatments and preventatives are only partially effective and involve blood thinners, he adds, which can lead to uncontrolled bleeding. "If you can develop a way to control this protein, it could be important" to treating these blood clots in humans, says Mirta Schattner, a physiologist at the National Scientific and Technical Research Council's (CONICET's) Institute of Experimental Medicine who was also not involved with the work.

To better understand how bears avoid dangerous blood clotting, a pair of cardiologists at the Ludwig Maximilian University of Munich, Tobias Petzold and Manuela Thienel, teamed up with a Scandinavian team and other researchers to study hibernating brown bears in Sweden.

For two winters, the researchers trekked through the snow to dig out sleeping brown bears wearing GPS collars. They tranquilized 13 bears, took blood samples, then returned the bears to their dens to finish their winter naps. The following summers, they tracked the same bears and took more blood samples. Collaborators at the Max Planck Institute of Biochemistry looked for seasonal differences in the bears' blood that might explain why it did not clot in the winter. "It was brilliant to look at brown bears," Schattner says. "I would never have thought of it."

The researchers noticed a protein called HSP47 was abundant in the bears' blood during the summer, but virtually disappeared in the winter, Thienel and her colleagues report today.

Previous work by Jon Gibbins, a cell biologist at the University of Reading, in mice had revealed that in addition to other functions, this protein sits

Understanding the biochemistry behind it could help prevent people from deadly clotting

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on the surface of blood platelets involved in clot formation. Working with mice bred to lack this protein, Gibbins and his colleagues determined that platelets with less HSP47 were less likely to attract and bind to infection-fighting white blood cells called neutrophils—a key step in clot formation. "This study shows the importance of HSP47 in platelet activation," says Nigel Mackman, who studies venous thrombosis in cancer and other diseases at the University of North Carolina, Chapel Hill.

The HSP47 on the platelets activate neutrophils, causing them to form a "net" that traps proteins, pathogens, and cells, leading to blood clots. Because hibernating bears produce less HSP47, their blood is less likely to form these nets and therefore less likely to clot, Theinel says.

Next, the researchers looked at HSP47 in people with spinal cord injuries, who—like hibernating bears—don't seem to develop blood clots very frequently, despite being immobile for long periods of time. They found these people, too, had relatively little HSP47 compared with others who were more mobile. That suggests their bodies were toning down the production of this protein in response to being immobilized. To test that hypothesis, 10 healthy volunteers spent 27 days on bed rest while researchers monitored their HSP47 levels. Sure enough, the protein levels dropped over time. "We were really surprised that we got such a hit [with HSP47] and that it was relevant to humans," Thienel says.

She wonders whether decreasing platelet HSP47 in people who suddenly find themselves immobilized might reduce their risk of clots until their bodies start naturally reducing the protein. But others are not yet sure of biomedical applications.

"It would be good to have these observations independently confirmed by other groups," Mackman says.

Nonetheless, Rodger is impressed that HSP47 seems to play the same role in both bears and people, as the work suggests this clotting mechanism evolved long ago in mammals. "It's a fascinating finding of a potential novel mechanism" to prevent clots, he points out. It may also help cancer, surgery, and trauma patients, who are at greater risk of developing clots, he adds.

"The ideal treatment for deep vein thrombosis would prevent blood clots from forming where they aren't supposed to, while not preventing your body's normal blood clotting machinery" as current drugs do, says Kim

Martinod, a biomedical scientist at KU Leuven. "This has the potential to be just that."

Science, 13 April 2023

https://science.org

Scientists identify new benchmark for freezing point of water at -70 C

2023-04-14

Scientists have discovered yet another amazing aspect of the weird and wonderful behavior of water—this time when subjected to nanoscale confinement at sub-zero temperatures.

The finding that a crystalline substance can readily give up water at temperatures as low as -70 °C, published in the journal Nature on April 12, has major implications for the development of materials designed to extract water from the atmosphere.

A team of supramolecular chemists at Stellenbosch University (SU), consisting of Dr. Alan Eaby, Prof. Catharine Esterhuysen and Prof. Len Barbour, made this discovery while trying to understand the peculiar behavior of a type of crystal that first piqued their interest about ten years ago.

"Scientists are currently adept at designing materials that can absorb water," Barbour explains. "However, it is much harder to get those materials (we call them 'hydrates') to then release the water without having to supply energy in the form of heat. As we all know, energy is expensive and seldom completely 'green.'"

The chemical compound in question was originally synthesized by Prof. Marcin Kwit, a specialist in organic stereochemistry at Adam Mickiewicz University in Poland. It was then crystallized and brought to Barbour's lab for further study by postdoctoral fellow Dr. Agnieszka Janiak. This was mainly because of Barbour's interest in ring-shaped molecules and how they form channels when packed together in crystals.

Janiak noticed that the crystals were yellow on some days and red on others. It didn't take her long to figure out that the crystals would only turn red on days with humidity levels higher than 55%. When humidity levels fell below this level, the crystals would go back to being yellow.

Crystal hydrates are not supposed to release water at such low temperatures.

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"Not only was this behavior rather unusual," Barbour explains, "it was also happening very fast. It seems the crystals were absorbing water as fast at high humidity as it was losing it again at low humidity. While we are familiar with materials designed to absorb water, it is highly unusual for a material that absorbs water easily to lose it equally easily."

Why do these crystals have such special properties? This question started a nearly ten-year investigation, which initially focused on explaining the mechanism behind the color change. Theoretical modeling by Esterhuysen and MSc student Dirkie Myburgh showed that water uptake causes slight changes in the electronic properties of the crystals, causing them to turn red. With such remarkable properties, Barbour was convinced that the crystals would also have other interesting properties.

That is when Ph.D. student Alan Eaby started dabbling with the material. Initially he had focused on room temperature studies for his MSc research but would later turn his attention to measuring properties at lower temperatures when he embarked on his Ph.D. three years ago. He wanted to know how the crystals would behave when subjected to different temperatures and humidity levels: "I was intrigued by the color change and wanted to explore what was happening at the atomic scale," he explains.

Having learned about developing instruments and methods from Barbour, he embarked on employing non-standard techniques to understand the mechanisms of water uptake and release in the material.

One day, he observed something strange happening at temperatures below zero degrees Celsius. "I noticed that the crystal still changed color at sub-zero temperatures. Initially I thought that there was something wrong with the experimental setup or the temperature controller, as crystal hydrates are not supposed to release water at such low temperatures," he explains.

After lots of conversations and coffee breaks with Barbour and Esterhuysen, and tweaking the experimental setup several times, they realized that Alan's observations could be explained by the narrowness of the channels in the material. The channels in the crystal are only one nanometer wide—one thousandth the diameter of a human hair.

It was already known that, at the nanoscale, water can remain mobile within channels at temperatures below 0°C. However, this study showed for the first time that such channels can also allow the uptake and release of water at temperatures far below its normal freezing point.

To understand this process, Eaby undertook an extensive, systematic series of X-ray diffraction studies of the red and yellow crystals at different temperatures and humidities. This allowed him to construct a computer-generated "movie," with atomic-scale resolution, of what happens to the channels upon cooling or heating, and in the presence or absence of water. These animations indicated that water molecules in the nanochannels move about freely until cooled to -70 °C, whereupon they undergo a "reversible structuring event" to resemble a glassy state. This "glass transition" ultimately causes the water to become trapped in the material at temperatures below -70°C.

Were it not for the color-changing behavior of the crystals in the first place, they would not have become aware of the ultralow temperature water loss capability. "Who knows," says Barbour, "there may be many other materials out there with the ability to absorb and release water at very low temperatures, such as metal-organic frameworks and covalent organic frameworks.

"We simply do not know about it because we have not been able to visualize it. Now that we do know that such behavior is possible, it opens a whole new field of research and potential applications. Researchers can use this new information to identify other materials with similar properties, and also use the principles we've developed to fine tune the low-temperatures release of water. This could lead to dramatic reductions in the energetic costs of atmospheric water harvesting, with implications for society and the environment," he concludes.

Phys Org, 14 April 2023

https://phys.org

Can you take the cow out of milk without losing texture and flavour?

2023-04-15

Demand is growing for animal-free milk alternatives, but most plant-based milks, such as oat, soy and almond milk, don't contain the same nutrients as dairy, nor do they taste the same.

This is why Australia's oldest dairy cooperative, Norco, has teamed with the CSIRO to back the development of an animal-free dairy product.

It's a challenge the CSIRO set itself to more than a decade ago. Now its solution is about to undergo the ultimate taste test.

If biology can make nature-identical building blocks without the animal it would lower the cost with less environmental impact.

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If it looks like milk, tastes like milk and has the same nutrients as milk – will it sell like milk?

"It's a fairly close representation, much better than the plant milk available at the moment," says Norco CEO Michael Hampson.

He doesn't see animal-free milk alternative Eden Brew as competition. Instead, he sees the Werribee-based startup as a sustainable way to expand the industry at a time when meeting increased global demand is proving a problem.

Not only are suitable pastures and affordable irrigation under pressure from an unstable climate and population growth, the global carbon offset market only has so much capacity.

Eden Brew launched in July 2021 and hopes to have its first ice-cream ready for sale this year.

CEO and co-founder Jim Fader says the global demand for protein will double by 2050.

"While there are numerous milk alternatives, they cannot sustainably meet future demand and don't achieve the sensory or processability properties of cow's milk," says Fader.

This can be done through fermentation – a process with a millennia-long association with the dairy industry. It's used to make cheese, yoghurt and beer.

The exact process is a trade secret. But the general outline has been offered up by the CSIRO.

It first mapped the genetics of cow's milk. Then it explored ways of precision-fermenting yeasts. The resulting casein and whey proteins are the same as those found in cow's milk. And it's these that give milk its creamy texture, frothy surface, and core nutrients.

"The proteins form the base which we combine with minerals, sugars, fats and flavours to create a glass of 'milk'," the CSIRO explains, adding that it is also lactose-free and "cholesterol friendly".

"When we build with biology, we can make nature-identical building blocks without the animal – at lower cost with less environmental impact and still meet surging protein demand," Eden Brew chair Phil Morle added.

The product can also be treated like milk.

"We can heat, pasteurise and UHT-process our [milk] to extend shelf life for dairy products of all kinds," an Eden Brew fact sheet explains. "This will leverage existing milk and dairy production techniques and infrastructure without needing to reinvent the udder."

About 14 per cent of Australian greenhouse gas emissions come from the agricultural sector. More than three-quarters of that comes from livestock.

Cosmos, 15 April 2023

https://cosmosmagazine.com

Inspired by the sea and the sky, a biologist invents a new kind of microscope

2023-04-14

Anyone who's ever owned a telescope has probably tried looking through the wrong end to see whether it works in reverse—that is, like a microscope. Spoiler alert: It doesn't.

Now, a team of researchers inspired by the strange eyes of a sea creature has figured out a way to do it. By flipping the mirrors and lenses used in certain types of telescopes, they have created a new kind of microscope that can be used to image samples floating in any type of liquid—even the insides of transparent organs—while retaining enough light to allow for high magnification. The design could help scientists achieve high enough magnification to study tiny structures such as the long, skinny axons that connect neurons in the brain or individual proteins or RNA molecules inside cells.

"It's nice to see even something as basic as a lens could still bring interest and there's still room there to do some work that would help a lot of people," says Kimani Touissant, an electrical engineer at Brown University. He says the design could be useful in his work, in which he uses lasers to etch patterns into gels that mimic collagen and act as scaffolds for cells.

At very high magnification, light trained on a sample can scatter around it, blurring and dimming the image. To get around that problem, scientists using traditional, lens-based microscopes cover their sample with a thin layer of oil or water, then dip their device's lens into the liquid, minimizing the degree of light scattering. But this technique requires instruments to have different lenses for different types of liquid, making it an expensive, finicky process and limiting the ways that samples can be prepared.

The device can achieve clear images using samples suspended in any kind of liquid.

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Enter Fabian Voigt, a molecular biologist at Harvard University and inventor of the new design. He was reading a book about animal vision when he encountered the odd case of scallops' eyes. Unlike most animals, whose eyes feature retinas that send images to the brain, scallops have mantles covered with hundreds of tiny blue dots, each of which contains a curved mirror at its back. As light passes through each eye's lens, its inner mirror reflects the light back onto the creature's photoreceptors to create an image that then allows the scallop to respond to its environment.

An amateur astronomer since he was a teenager, Voigt realized the scallop's eye design resembled a kind of telescope invented nearly 100 years ago called the Schmidt telescope. The Kepler Space Telescope, which orbits Earth, uses a similar curved mirror design to magnify far-away light from exoplanets. Voigt realized that by shrinking the mirror, using lasers for light, and filling the space between the mirror and the detector with liquid to minimize light scattering, the design could be adapted to fit inside a microscope.

So, Voigt and colleagues built a prototype based on those specs. Light enters from the top, passes through a curved plate that corrects for the mirror's curvature, then bounces off a mirror to hit a sample and magnify it. The curved mirror can magnify the image much like a lens, Voigt says. It allows researchers to look at samples suspended in any kind of liquid, simplifying the process. Voigt says the design could be particularly useful for researchers who study organs or even entire organisms, such as mice or embryos, that have been made completely transparent by artificially removing their pigment.

The researchers tested their prototype by shining a laser onto transparent samples including the muscles in a tadpole's tail, a mouse brain, and an entire chicken embryo. These images, the researchers reported last month in Nature Biotechnology, were as clear as those that could be achieved with conventional optical microscopes, despite using a simpler design, and providing more flexibility in the way researchers prepare samples.

The mirror design could prove useful to researchers aiming to trace the path of a mouse's axons that wind throughout the brain, says Adam Glaser, an engineer at the Allen Institute for Neural Dynamics who is working on brain mapping. Axons can be dozens of millimeters in length but only nanometers in width, which makes mapping the entire mouse brain a herculean task. It's also expensive to do using commercially available microscopes, which require numerous lenses and are finicky to operate. The new design, by contrast, could be easier to use because it requires

only one mirror and, because it can image through any kind of liquid, allows researchers to be more flexible in how they prepare their brain samples.

Glaser adds that the new microscope could also aid researchers looking at RNA molecules within the neurons that could reveal what genes each cell is expressing. "Borrowing from astronomy is a wonderfully efficient and creative way to do science," he says.

Science, 14 April 2023

https://science.org

Do wildfires spur bird and mammal biodiversity?

2023-04-13

"There's a fair amount of biodiversity research on fire and plants," says study lead author Max Moritz, a wildfire specialist with UC Cooperative Extension, who is based at the University of California, Santa Barbara's Bren School of Environmental Science & Management.

Research has shown that in ecosystems where fire is a natural and regular occurrence, there can be more species of plants—a greater "species richness"—due to a variety of factors, including fire-related adaptations. But, Moritz says, there hasn't been nearly as much research in the way of animal biodiversity and fire.

"If you look at how fire operates across the planet, fire actually eats plant productivity," Moritz says.

Productivity, which is a measure of how quickly biomass is generated within a given ecosystem, is also a driver of species richness at broad spatial scales. "When fires occur they can take a bite out of that bottom line," he adds.

If wildfire regularly consumes some of the base of an ecosystem's food chain, how does that ripple up to affect the biodiversity at higher levels?

For several years, Moritz and collaorators Enric Batllori from Universitat de Barcelona and Benjamin M. Bolker from McMaster University in Canada combed through global datasets on various factors such as plant biomass, fire observations, and species richness patterns.

While it might be natural to assume that plant biomass regularly consumed by fire would in turn lead to lower animal biodiversity, they

Wildfires may seem like purely destructive forces, but a new study reminds us that they're also generative forces.

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found that for birds and mammals, fire is associated with increased diversity.

In fact, they say, the effect of wildfire on biodiversity in the case of birds rivals that of the ecosystem's productivity. And in the case of mammals, fire's influence was even stronger than that of productivity.

"It's counterintuitive," Moritz says. In the short term, fire's consumption of plant material (also known as "net primary productivity") could result in less food for the animals that consume plants and make it more difficult to survive and reproduce. But in the longer term, he says, there may be evolutionary effects that unleash adaptations and formations of new species.

The researchers also looked at the effect of fire on amphibian species, however, the connection between fire and biodiversity in their case was difficult to make, possibly because amphibians live in wetter environments where fires may not be a regular occurrence.

So what accounts for the net positive effects of fire on mammal and bird diversity? The study is a correlative one, Moritz says, so more granular examinations have to be made to find out for sure.

But it's likely that fire selects for species that can adapt to and quickly recover from a burn, and fire often creates environmentally complex habitats that meet different species' requirements.

"We know that fire creates a lot of heterogeneity and opens up all these niches," Moritz says, and this resource availability might create favorable environments for some organisms to flourish alongside or over others.

For example, animals that have strategies to survive fires or reproduce faster might do better in a fire-prone environment, as could those that make use of different habitats that emerge in the wake of a blaze.

Despite the connection between fire and species richness, the authors are careful to point out it does not mean fire is good for all ecosystems. In places where fire is not a natural occurrence, its presence "is more of a modern threat than an important process to maintain," they says. And for places where fire is a natural part of the ecosystem, climate change-driven and intentional deforestation fires "may be quite different from natural fire regimes."

Nevertheless, they say, these findings indicate that fire plays an underappreciated role in the generation of animal species richness and

biodiversity conservation. Furthermore, the study adds nuance to the Latitudinal Biodiversity Gradient, a global pattern of terrestrial biodiversity in which the world's most biodiverse areas are located nearest to the equator, with levels of biodiversity generally decreasing toward the poles.

"This is a pattern that people have known for decades and have argued quite a bit about in terms of what drives it," Moritz says. "And it turns out, it's hard to figure out. And it looks like fire plays a far more important role than we've ever really understood."

The study appears in Ecology Letters. UC Santa Barbara's National Center for Ecological Analysis & Synthesis supported the work.

Futurity, 13 April 2023

https://futurity.org

Sound can successfully remove microplastics from water

2023-04-17

There's no debate that microplastics present an ever-increasing ecological and health threat, with scientists just starting to understand the extent of these tiny particles and their impact on organisms, from marine life to humans. A 2019 study revealed that we're even ingesting about 5 grams of microplastic, the weight of a credit card, each week.

The challenge now, however, is to find methods to successfully remove microplastics (MPs) from water and the atmosphere – no easy task when these tiny pieces of plastic measure just 1 micrometer to 5 millimeters in size.

A team of scientists out of Shinshu University has turned to sound to make it happen, experimenting with acoustic filtering to push MPs into a central channel, with branched sections filled by MP-free water that can be then released.

"Our proposed microfluidic device, which is designed based on a hydraulic-electric analogy, has three 1.5 mm-wide microchannels connected via four serial 0.7-mm-wide trifurcated junctions," explained lead researcher Professor Yoshitake Akiyama of the Department of Mechanical Engineering and Robotics at the Faculty of Textile Science and Technology at Shinshu University. "The MPs are aligned at the center of the middle microchannel using a bulk acoustic wave of 500-kHz resonance

Filtering microplastic out of water is a huge challenge for scientists.

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frequency. As a result, a 3.2-fold enrichment of MPs must occur at each junction, resulting in a 105-fold overall enrichment in the device."

In other words, ultrasonic waves travel through the water and push the MPs to the center of a fluid stream, where they can then be collected, or filtered out, as MP-free water filters into the branches off the main central path of the device. Traditionally, MPs are collected by mesh filters, which can get clogged up easily and are limited in what they collect by the size of the mesh.

This device instead using microfluidic technology, an emerging science that manipulates the behavior of water with channels on a micro level. When conducting separate experiments on grouped MPs, the collection rate for those sized 10 µm, 15 µm , 25 µm, 50 µm and 200 µm was more than 90%. Further tests mixing up particle size (25–200 µm and 10-25 µm) saw a collection rate of around 80%.

It's not the first acoustic filtering model the scientists have developed, having earlier produced a device made for and tested on laundry wastewater. The team believes the progress it's made shows the device has further-reaching applications, such as filtering wastewater from industrial-scale production before it's sent down the drain.

"This proposed microfluidic device based on acoustic focusing can efficiently, rapidly, and continuously collect 10–200 µm MPs without recirculation after pre-filtration of larger MPs through a mesh," said Akiyama. "It can be installed in washing machines, factories, and other sources of MPs for efficiently enriching and removing various-sized MPs from laundry and industrial wastewater. This will make it possible to prevent the discharge of MPs to the environment."

While there were issues with the device, such as some MPs slowing down and clogging the microchannel walls, the researchers believe tweaks in the pre-filtration process and the 2D focusing could iron this out.

The study was published in the journal Separation and Purification Technology.

New Atlas, 17 April 2023

https://newatlas.com

Hat trick: Newly discovered shape solves 60-year mathematical mystery

2023-04-17

A new shape has been discovered which would make for a pretty unique set of bathroom tiles. Nicknamed "the Hat," the 13-sided shape can tesselate with itself without ever repeating a pattern, solving a 60-year-old mathematical mystery.

This very niche milestone was made possible by David Smith, a self-proclaimed tiling enthusiast from Yorkshire, England. Along with many others in the community, Smith had been hunting for a specific kind of shape called an aperiodic monotile or an "einstein." That name has nothing to do with the famous physicist but is instead a play on the German words ein (meaning one) and stein (meaning stone).

This "one stone" is a formerly hypothetical shape that could tile a plane without any overlaps or gaps, and even if it was stretched out over an infinite space would never repeat the same pattern – and physically can't be made to repeat. Smith's Hat is the first such shape found to fit the bill.

It might not sound like a big deal for many people, but mathematicians have been searching for a puzzle piece with these properties since the mid-1960s. That's when the first set of shapes to exhibit aperiodic (non-repeating) tiling was discovered, but the toolbox required over 20,000 different shapes to ensure the pattern never repeated. Further work over the next decade whittled that number down smaller and smaller, until Sir Roger Penrose got it right down to just two, forming arrangements now known as Penrose tilings.

"Those two shapes in Penrose's solution had enough structure that they forbid periodicity," said Professor Craig Kaplan, a researcher on a study describing the new shape. "But for almost 50 years mathematicians have been wondering, can we get down to just one shape? Can we do this with a monotile? That's the problem we solved. We found a single shape that does what all these earlier sets of multiple shapes are able to do."

Smith had originally been experimenting with paper cutouts of shapes, but there's only so much you can test with a finite plane. To confirm the Hat's special abilities, he got in contact with Kaplan, who had recently developed software that could check a given shape on larger scales. For example, it can identify all the different ways the shape can be arranged into small groupings or "neighborhoods," and then work out if these can exist in a larger tiling without breaking the rules.

A tiling of a 13-sided shape called the Hat, the first known example of a shape that can be tiled without gaps or overlaps, and without repeating a pattern even across an infinite plane.

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The Hat might not be the only possible aperiodic monotile, either. The team says that technically, it's part of a family of very similar shapes with slight tweaks that still follow the same rules.

"The more interesting question is are there fundamentally different aperiodic monotiles?" said Kaplan. "My answer is that there's no reason to suspect otherwise and every reason to suspect there ought to be others."

Research describing the new shape is available on the preprint server ArXiv.

New Atlas, 17 April 2023

https://newatlas.com

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