CHEMWATCH

Bulletin Board

Contents

MAY. 19, 2023

(click on page numbers for links)

CONTACT US

subscribers@chemwatch.net
tel +61 3 9572 4700
fax +61 3 9572 4777

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

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

Contents

CURIOSITIES

TECHNICAL NOTES

CHEMWATCH
Bulletin Board

Regulatory Update

MAY. 19, 2023

ASIA PACIFIC

Nepal Govt prepares to ban use of printing paper for packaging street food

2023-05-02

Director general of the Department of Food Technology and Quality Control, Dr Matina Joshi Vaidhya said that since such papers contain chemicals that have a dangerous effect on health, a procedure is being prepared to impose a ban on the use of printing paper for packing street food.

Speaking at a food hygiene training program that started in Kathmandu from Tuesday, she mentioned that the use of street food is increasing because it is affordable and tasty, and also made it clear that the government wants to ban the use of printing paper to package street food.

Director General Vaidhya said that in order to keep the street food and vegetable and fruit markets clean, the federal government has also initiated public awareness programs in collaboration with the local governments.

She said, "Street foods are a good alternative as some cheap and delicious snacks. Not everyone can afford fine dining. So that street food will not cause food poisoning at all, it is very important to improve its hygiene. We should make a procedure for this from the department as well. And foods like chatpate and selroti packed in newspapers which are sold to customers should be immediately stopped. We can ban such harmful practices as per the Food Act by making them aware and gradually banning them."

The Department of Food Technology and Quality Control has also said that there will be strict monitoring of street food and fruit markets for food hygiene.

Read More

MyRepublica, 02-05-23

https://myrepublica.nagariknetwork.com/news/govt-prepares-to-ban-use-of-printing-paper-for-packaging-street-food/?categoryId=81

China's New Inspection Mode to Boost Safety of Imported Hazardous Chemicals

2023-05-11

Starting from April 13, 2023, the General Administration of Customs of China (GACC) will implement a new inspection mode, "Document Review + Port Inspection or Destination Inspection," for every batch of imported hazardous chemicals across the country. The inspection locations and percentages will be determined by the GACC based on the imported hazardous chemicals' properties and packaging types.

The GACC decided to reform the inspection process to standardize operational requirements and prevent false declarations and concealment. After a successful pilot in Shanghai and Guangzhou, the GACC decided to roll out this new inspection mode nationwide.

Specific Requirements

When declaring at customs, importers of hazardous chemicals should provide truthful information on the China International Trade Single Window, including:

- cargo attributes,
- project of inspection and quarantine,
- hazard class,
- UN number,
- packaging group level,
- UN markings, and
- inspection and quarantine department at the destination.

Additionally, importers should submit declaration materials required by GACC Announcement No. 129 of 2020, such as:

- Declaration of Conformity for Enterprises Importing Hazardous Chemicals,
- Chinese labels and SDS, and
- information on inhibitors and stabilizers.

Read More

REACH24H, 11-05-23

https://www.reach24h.com/en/news/industry-news/chemical/chinas-new-inspection-mode-to-boost-safety-of-imported-hazardous-chemicals.html

CHEMWATCH
Bulletin Board
Regulatory Update
MAY. 19, 2023

AMERICA

California considers regulating consumer products containing microplastics and PPD derivatives

2023-04-23

Safer Consumer Products Program proposes adding two chemical families to the menu of chemicals it may regulate, initiating a public process

SACRAMENTO – State regulators announced plans today for two additions to the list of chemicals that may be regulated under the state's Safer Consumer Products Program (SCP). The California Department of Toxic Substances Control (DTSC) proposes adding two groups of chemicals, microplastics and para-Phenylenediamine (PPD) derivatives, to its Candidate Chemicals List (CCL), based on their reported impacts on human health and the environment. This announcement begins a public process that will help inform a potential regulatory proposal.

Scientific evidence is increasingly showing that tiny particles of plastics, known as microplastics, may harm people or the environment. Once they are released, either directly or from the breakdown of larger plastic items, microplastics persist and move in the environment. In its 2021-2023 Priority Product Work Plan, DTSC named products that release microplastics to the environment as one of five policy priorities. At a November 2021 meeting of DTSC's Green Ribbon Science Panel, speakers affirmed that exposure to microplastics may result in broad and significant negative impacts to human health and the environment.

PPD derivatives are a family of chemicals used in a variety of industrial applications. 6PPD, a member of this family, is widely used in motor vehicle tires to prevent deterioration over time; it is the only PPD derivative currently included on the CCL. A 2020 study showed that exposure to 6PPD from tire and road wear particles kills certain species of salmon while they are attempting to spawn. DTSC is finalizing regulations that will add motor vehicle tires containing 6PPD to its Priority Product List, which will require tire manufacturers to identify and evaluate potential alternatives to 6PPD that ensure tire safety and performance while also preventing harm to salmon and other fish. Adding this chemical class to the CCL will ensure that manufacturers fully evaluate the tradeoffs before switching from 6PPD to another PPD derivative.

This announcement, and public workshops planned for June and July, are part of a public process to help inform a potential regulatory proposal.

Regulations that add chemicals to the CCL do not directly create any new requirements. They allow DTSC's SCP Program to select consumer products containing one or more of these chemicals for later evaluation and possible regulation under SCP regulations as a Chemical of Concern in a Priority Product. Manufacturers of a consumer product regulated by SCP must thoroughly evaluate the impacts of a Candidate Chemical before choosing it as a replacement for a Chemical of Concern.

Read More

California DTSC, 27-04-23

https://dtsc.ca.gov/2023/04/27/news-release_t-03-23/

Washington state now has the nation's strongest law against toxic cosmetics

2023-05-12

The legislation targets harmful chemicals that are often found in products marketed to women of color.

The Washington state Legislature has passed some of the country's strongest legislation to protect residents from hazardous chemicals in cosmetic products. Starting in 2025, the Toxics-Free Cosmetics Act will ban the manufacture, sale, and distribution of cosmetics containing nine chemicals and chemical classes, including formaldehyde and "forever chemicals."

The act, passed last month and expected to become law later this month, puts Washington "at the bleeding edge" of state-level efforts to clean up the cosmetics industry, said Laurie Valeriano, executive director of the nonprofit Toxic-Free Future. Compared to similar policies elsewhere in the country, she said, it covers more chemicals and does more to foster the transition to cleaner alternatives. "It's a huge success," she said.

The law comes amid growing concern about toxic chemicals in shampoo, deodorant, lipstick, and other products that come in direct contact with people's skin, hair, lips, and eyes. Repeated exposure to these chemicals can cause cancer and damage to the brain and nervous system, among other effects.

CHEMWATCH
Bulletin Board
Regulatory Update
MAY. 19, 2023

Read More

Grist, 12-05-23

https://grist.org/regulation/washington-state-just-passed-the-nations-strongest-law-against-toxic-cosmetics/

Court orders EPA to regulate perchlorate in drinking water

2023-05-11

The US Environmental Protection Agency must set a limit for perchlorate in drinking water, a federal appeals court ruled May 9. The ruling restarts the clock for the EPA to propose regulations to control the chemical under the Safe Drinking Water Act (SDWA).

The EPA determined in 2011 that perchlorate in drinking water should be regulated. The chemical, which is used to make rocket fuel, military weapons, and fireworks, inhibits the thyroid from taking up iodine. A lack of iodine during pregnancy is linked to abnormal brain development in the fetus, and iodine deficiency in lactating people is associated with neurodevelopmental problems in their children.

But the EPA never proposed a perchlorate drinking-water regulation. In 2020, under the administration of Donald J. Trump, the agency decided it didn't need to regulate the chemical.

The EPA has long faced pressure from other federal agencies, including the Department of Defense, the Department of Energy, and NASA, to not regulate perchlorate. Those agencies' activities have contaminated groundwater across the US with the chemical.

The Natural Resources Defense Council (NRDC), an environmental group, sued the EPA in 2020. The group claimed that the agency lacks authority to withdraw a regulatory determination under the SDWA.

Two out of three judges on a panel of the US Court of Appeals for the DC Circuit agreed with the NRDC, stating that the law does not permit the EPA to withdraw a regulatory determination for drinking water. The third judge agreed to strike down the EPA's decision for a different reason, saying the action was "arbitrary and capricious."

"The court ruled that EPA must regulate perchlorate-contaminated drinking water because the agency had found that it poses a health risk to millions of Americans," Erik Olson, senior strategic director for health

at the NRDC, says in a statement. "After more than a decade of delay and litigation, EPA now must issue a drinking water standard for this widespread and dangerous contaminant. It's about time."

Read More

C&N, 11-05-23

https://cen.acs.org/environment/pollution/Court-orders-EPA-regulate-perchlorate-drinking-water/101/web/2023/05

EUROPE

Reuse a 'big opportunity' to tackle packaging waste, advocates say

2023-05-09

The EU's draft packaging waste regulation, tabled in November last year, introduces a ban on single-use packaging for dine-in restaurants from 2030 and expands the use of reusable packaging for takeaway food consumption.

The draft is now being examined by the European Parliament and EU member states, which are considering amendments to the proposal before signing it into law.

But the proposal was met with strong pushback from the paper packaging industry, which funded a series of studies arguing that reuse targets will lead to a growth in plastic use, water consumption and CO2 emissions.

According to Jean-Pierre Schweitzer from the European Environmental Bureau, the industry studies must be taken with a pinch of salt. In particular, he said it was important to look into who has paid for the study and if the research has been peer-reviewed or not. "Half of them come from the food packaging sector," he remarked during a conference in the European Parliament on 26 April.

Schweitzer presented some peer-reviewed literature on the subject that shows, for instance, that reuse performs better than single-use after 15 rotations across all impacts, or that introducing reusable packaging could reduce emissions by 54%.

CHEMWATCH
Bulletin Board
Regulatory Update
MAY. 19, 2023

Besides, many environmental benefits of reusable packaging cannot be included in a lifecycle assessment, such as biodiversity, exposure to chemicals, microplastics, and land use, he continued.

"Even if we have a conclusion from a lifecycle assessment, we may not be considering all of the important factors from an environmental perspective," Schweitzer argued. For him, reuse represents a "big opportunity" to improve the sustainability of packaging and cut waste.

The Commission's impact assessment study that was published alongside its packaging regulation has been heavily criticised by the paper industry and some policymakers for being inaccurate.

However, according to Wolfgang Trunk, policy officer at the Commission's environment directorate, many people have challenged the impact assessment because it goes "against their own business interest".

"Those industries who will lose turnover, they're doing everything to fight this and this is often big industries, and they are very active in lobbying," he pointed out.

The current legislation failed to tackle the issue of packaging waste, but the new proposal will result in a significant decrease in waste and carbon emissions, Trunk argued.

Read More

Euractiv, 09-05-23

https://www.euractiv.com/section/energy-environment/news/reuse-a-big-opportunity-to-tackle-packaging-waste-advocates-say/

NGOs Warn EU's Plan to Ban Most Toxic Chemicals is Failing

2023-05-23

Environmental groups ClientEarth and the European Environmental Bureau (EEB) have warned that the European Union's (EU) plan to ban more harmful chemicals than anywhere else in the world is failing.

A year ago, the European Commission announced that it would rapidly ban thousands of the most notorious chemicals still found in consumer products and contributing to growing human infertility, serious illnesses and environmental harms. The roadmap promised bans of the most harmful flame retardants, all bisphenols, and all non-essential PFAS'

'forever chemicals'. A review of progress one year later shows a very different outcome is emerging, with officials having tabled bans of 14 chemical groups on schedule. However, eleven other groups cover only a small number of chemicals or their uses, allowing the vast majority of pollution and its impacts to continue.

The campaigners blame lobbying by the chemical industry, but most of the blame lies with officials, especially the European Commission. Chemical production is projected to triple by 2050 globally.

Read More

Chemycal, 08-05-23

https://chemycal.com/news/8135a17d-e8a6-47c7-bb4a-726e683de5d6/NGOs_Warn_EUs_Plan_to_Ban_Most_Toxic_Chemicals_is_Failing

INTERNATIONAL

An open invitation to help reduce plastic waste

2023-05-19

The world's plastic pollution problem is a large and complex challenge — more than 91% of plastic isn't even recycled and is left sitting in landfills or littering our oceans and communities. Reducing plastic waste requires entire industries to come together and take more meaningful action.

For us at Google, that means rethinking our approach to the way we source products, serve food and reduce our waste. We're looking to switch from using single-use disposable products in our onsite food service operations to more reusable solutions — whether it's snack wrappers or changes to packaging used during distribution and delivery. Reducing — and ultimately eliminating — single-use plastics will help stem the tide of plastic polluting our planet.

So, to help further reduce the plastic footprint across food services and shine a light on emerging solutions, we're launching our Single-Use Plastics Challenge. If you're a food and beverage company with single-use, plastic-free packaging solutions, we invite you to apply to the Challenge. You can find more information and apply here.

How you can help

The Single-Use Plastics Challenge — hosted in collaboration with premier food service management company Canteen and other food service

CHEMWATCH
Bulletin Board
Regulatory Update
MAY. 19, 2023

partners — will give food companies with packaging that is free of single-use plastic the opportunity to test their solutions in Google's U.S.-based cafes and MicroKitchens.

Products must meet U.S. federal, state and local food safety regulations and Google Food program standards for health, environmental, social and financial considerations. Finalists will have the opportunity to pitch their products to Google and leading global food operators to scale them across our U.S. offices.

Read More

Google, 19-05-23

https://blog.google/outreach-initiatives/sustainability/single-use-plastics-challenge/

Chemicals in Plastics - A Technical Reports

2023-05-03

The report provides state of knowledge on chemicals in plastics and based on compelling scientific evidence calls for urgent action to address chemicals in plastics as part of the global action on plastic pollution.

Overview of the report:

The "Chemicals in Plastics: A Technical Report" aims to inform the global community about the often-overlooked chemical-related issues of plastic pollution, particularly their adverse impacts on human health and the environment as well as on resource efficiency and circularity. Based on compelling scientific evidence, it further highlights the urgent need to act and outlines possible areas for action. It also aims to support the negotiation process to develop the instrument on plastic pollution based on United Nations Environment Assembly resolution 5/14. The report outlines a set of credible and publicly available scientific studies and initiatives focused on chemicals in plastics and the science-policy interface.

The report was developed by UNEP in cooperation with the Secretariat of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, and the Stockholm Convention on Persistent Organic Pollutants, with lead authors from the International Panel on Chemical Pollution, as well as contributions from key experts.

Some key findings:

- Based on the latest studies, more than 13,000 chemicals have been identified as associated with plastics and plastic production across a wide range of applications.
- Ten groups of chemicals (based on chemistry, uses, or sources) are identified as being of major concern due to their high toxicity and potential to migrate or be released from plastics, including specific flame retardants, certain UV stabilizers, per- and polyfluoroalkyl substances (PFASs), phthalates, bisphenols, alkylphenols and alkylphenol ethoxylates, biocides, certain metals and metalloids, polycyclic aromatic hydrocarbons, and many other non-intentionally added substances (NIAS).
- Chemicals of concern have been found in plastics across a wide range of sectors and products value chains, including toys and other children's products, packaging (including food contact materials), electrical and electronic equipment, vehicles, synthetic textiles and related materials, furniture, building materials, medical devices, personal care and household products, and agriculture, aquaculture and fisheries.

Read More

UNEP, 03-05-23

https://www.unep.org/resources/report/chemicals-plastics-technical-report

UV-328 listed as POP under the Stockholm Convention

2023-05-08

11th meeting of the Conference of the Parties to the Stockholm Convention lists UV absorber as Persistent Organic Pollutant (POP); first non-halogenated POP under the Convention; also listing of flame retardant dechlorane plus and pesticide methoxychlor in Annex A

From May 1-12, 2023 the Conference of the Parties to the Stockholm Convention (SC COP) held its 11th meeting in Geneva, Switzerland. According to reporting from the Philippine Daily Inquirer and an announcement from the Center for International Environmental Law, SC COP-11 negotiators agreed to list UV-328 (CAS 25973-55-1) under Annex A for global elimination of all production and use (with specific exemptions). UV-328 is the first substance listed under the Stockholm Convention that is not halogenated (i.e., does not contain any fluorine, chlorine, or bromine).

CHEMWATCH
Bulletin Board
Regulatory Update
MAY. 19, 2023

UV-328 is used as an UV absorber to protect against discoloration and degradation under UV/sunlight. It is mainly used in paints and coatings and as an additive in a variety of plastics, including applications in food contact. Scientists have demonstrated that the chemical damages the liver and kidneys in mammals, and has endocrine-disrupting effects (FPFreported).

As a consequence, the EU legally recognized UV-328 as a substance of very high concern (SVHC) in 2014, and in 2019 it was added to the REACH Authorization list. The continued use worldwide, led the Swiss government to submit a proposal to add UV-328 to the elimination list of the Stockholm Convention in May 2020. In January 2021, the Persistent Organic Pollutants (POP) Review Committee (POPRC) within the Convention officially recognized that UV-328 fulfills the screening criteria of POPs: (1) persistence, (2) bioaccumulation, (3) adverse effects, and (4) potential for long-range environmental transport (FPF reported). This resulted in pushback from the world's largest oil and chemical companies which perceived the ban as burdensome to their businesses (FPF reported). Scientists provided clarifications on plastic-driven long-range environmental transport of the chemicals (FPF reported). And, in the 17th and 18th meetings in January and September 2022, PORC agreed to move UV-328 onto the final step in the review process (FPF reported) and recommended its listing under Annex A, respectively (FPF reported).

Read More

Food Packaging Forum, 08-05-23

https://www.foodpackagingforum.org/news/uv-328-listed-as-pop-under-the-stockholm-convention

Current calls for comments and evidence

2023-05-10

Calls for comments and evidence allow interested parties to signal their interest and express their views and concerns in the preparatory phase of the restriction proposal. They also let interested parties comment on the different documents under preparation in ECHA in relation to restrictions, such as reports on substances in articles and guidelines on restriction entries.

Additional information to justify or support comments made is also welcomed. The information gathered will provide an input into developing Annex XV restriction dossiers or other documents. When we open a call for comments and evidence, we intend to give parties who otherwise might not have been identified and consulted a chance to submit information.

The calls for comments and evidence do not take the place of the public consultation on restriction proposals developed by Member States or ECHA, which forms a standard part of the restriction process.

Substance Details

Name

Substances which are classified as carcinogen, germ cell mutagen or reproductive toxicant category 1A or 1B in Part 3 of Annex VI to Regulation (EC) No 1272/2008

Start of consultation

10/05/2023

Deadline for providing input

07/06/2023

Subject of the call

Call for evidence on analytical methods to measure CMR substances in childcare articles

Objective of the call

The European Commission has requested ECHA to prepare a report on carcinogenic, mutagenic and reprotoxic substances (CMR) in childcare articles (see mandate). This work will support the Commission in the

CHEMWATCH
Bulletin Board
REACH Update
MAY. 19, 2023

preparation of a restriction proposal for CMR 1A or 1B substances in childcare articles on the basis of REACH Article 68(2).

In their mandate, the Commission requests information on availability of analytical methods to identify CMR 1A or 1B substances in different material types of childcare articles. This information will be useful to conclude about the enforceability of the restriction proposal.

This call for evidence aims to collect information on suitable analytical methods to measure CMR 1A or 1B substances in childcare articles.

Read More

ECHA, 10-05-23

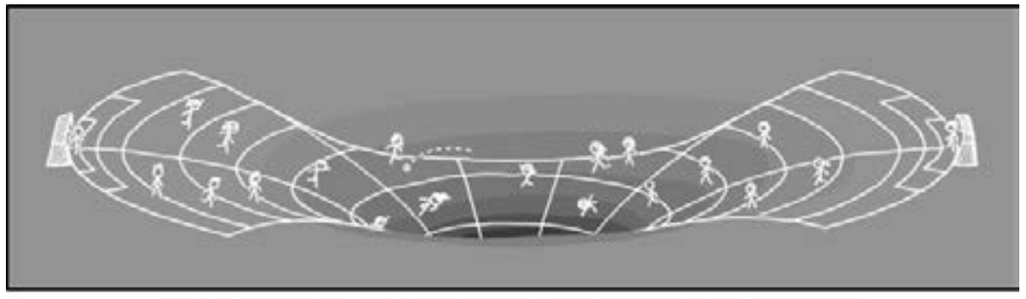
https://echa.europa.eu/calls-for-comments-and-evidence/-/substance-rev/73202/term

Janet's Corner

MAY. 19, 2023

Spacetime Soccer

2023-05-19



SPACETIME SOCCER GOT A LOT OF CRITICISM FOR HOW MANY PLAYERS FELL INTO THE GRAVITY WELL, BUT WHAT ULTIMATELY DOOMED IT WAS THE ADVANCED MATHEMATICS REQUIRED TO FIGURE OUT THE OFFSIDES RULE.

https://xkcd.com/2705/

undefined.

CHEMWATCH
Bulletin Board

Hazard Alert

MAY. 19, 2023

Dichloromethane

2023-05-19

Dichloromethane (DCM) — or methylene chloride — is an organic compound with the formula CH_2Cl_2. This colourless, volatile liquid with a moderately sweet aroma is widely used as a solvent. Although it is not miscible with water, it is miscible with many organic solvents. Dichloromethane does not occur naturally in the environment. [1,2]

USES [3]

Dichloromethane is predominantly used as a solvent in paint strippers and removers; as a process solvent in the manufacture of drugs, pharmaceuticals, and film coatings; as a metal cleaning and finishing solvent in electronics manufacturing; and as an agent in urethane foam blowing. In addition, it is used as a propellant in aerosols for products such as paints, automotive products, and insect sprays. Dichloromethane is used as an extraction solvent for spice oleoresins, hops, and for the removal of caffeine from coffee. However, due to concern over residual solvent, most decaffeinators no longer use it. Dichloromethane is also approved for use as a post harvest fumigant for grains and strawberries and as a degreening agent for citrus fruit. Dichloromethane's low boiling point allows the chemical to function as a heat engine that can extract movement from low-grade temperatures. It can also be used to weld certain plastics. Often sold as a main component of plastic welding adhesives, it is also used extensively by model building hobbyists for joining plastic components together — it is commonly referred to as "Di-clo." Dichloromethane is also used in the garment printing industry for removal of heat-sealed garment transfers, and its volatility is exploited in novelty items — bubble lights and jukebox displays. Furthermore, it is used in the material testing field of civil engineering; specifically it is used during the testing of bituminous materials as a solvent to separate the binder from the aggregate of an asphalt or macadam to allow the testing of the materials.

Dichloromethane (DCM) — or methylene chloride — is an organic compound with the formula CH2Cl2.

SOURCES & ROUTES OF EXPOSURE [2,4]

Routes of exposure to dichloromethane are:

- Inhalation: Most cases of human exposure to dichloromethane occur when people breathe vapours from paint strippers. When household water becomes contaminated, people can inhale vapours while showering, laundering, and cooking. When dichloromethane is used near an open flame, poisonous "phosgene" gas can be created. Phosgene can cause permanent lung damage at low levels.
- Ingestion: People can be exposed when they drink contaminated water or when they use it for preparing food.
- Dermal: Dichloromethane can be absorbed through the skin, but this is a minor route of exposure.

The principal route of human exposure to dichloromethane is inhalation of ambient air. Occupational and consumer exposure to dichloromethane in indoor air may be much higher, especially from spray painting or other aerosol uses. People who work in these places can breathe in the chemical or it may come in contact with the skin. Dichloromethane has been detected in both surface water and groundwater samples taken at hazardous waste sites and in drinking water at very low concentrations.

HEALTH EFFECTS [2,3]

Acute Effects

Case studies of dichloromethane poisoning during paint stripping operations have demonstrated that inhalation exposure to extremely high levels can be fatal to humans. Acute inhalation exposure to high levels of dichloromethane in humans has resulted in effects on the central nervous system (CNS) including decreased visual, auditory, and psychomotor functions, but these effects are reversible once exposure ceases. In addition, dichloromethane irritates the nose and throat at high concentrations. People exposed to dichloromethane may feel unsteady, dizzy, and have nausea and a tingling or numbness of your finger and toes. A person breathing smaller amounts of methylene chloride may become less attentive and less accurate in tasks requiring hand-eye coordination. Skin contact with methylene chloride causes burning and redness of the skin.

CHEMWATCH
Bulletin Board
Hazard Alert
MAY. 19, 2023

Chronic Effects

The major effects from chronic inhalation exposure to methylene chloride in humans are effects on the CNS, such as headaches, dizziness, nausea, and memory loss. Animal studies indicate that the inhalation of methylene chloride causes effects on the liver, kidney, CNS, and cardiovascular system. EPA has calculated a provisional Reference Concentration (RfC) of 3 milligrams per cubic meter (mg/m3) based on liver effects in rats. The Reference Dose (RfD) for dichloromethane is 0.06 milligrams per kilogram body weight per day (mg/kg/d) based on liver toxicity in rats.

Reproductive/Developmental Effects

No studies were found regarding developmental or reproductive effects in humans from inhalation or oral exposure. However, animal studies have demonstrated that dichloromethane crosses the placental barrier, and minor skeletal variations and lowered foetal body weights have been noted.

Cancer Risk

Several studies did not report a statistically significant increase in deaths from cancer among workers exposed to methylene chloride. Animal studies have shown an increase in liver and lung cancer and benign mammary gland tumours following inhalation exposure to dichloromethane. EPA considers dichloromethane to be a probable human carcinogen and has ranked it in EPA's Group B2.

SAFETY [5]

First Aid Measures

- Eyes: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical aid.
- Skin: In case of contact, flush skin with plenty of water. Remove contaminated clothing and shoes. Get medical aid if irritation develops and persists. Wash clothing before reuse.
- Ingestion: If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical aid.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Exposure Controls/Personal Protection

Engineering Controls

Facilities storing or utilising this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Personal Protective Equipment

- Eyes: Wear chemical goggles.
- Skin: Wear appropriate protective gloves to prevent skin exposure.
- Clothing: Wear appropriate protective clothing to prevent skin exposure.
- Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

CHEMWATCH
Bulletin Board
Hazard Alert
MAY. 19, 2023

REGULATIONS [6,7,8]

United States

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL) - General Industry See 29 CFR 1910.1052	25 ppm TWA 125 ppm STEL 12.5 ppm Action Level	HE1	Cancer
		HE3	Cardiac and liver toxicity
		HE7	Light-headedness, staggering, unconsciousness, decreased eye/hand coordination, numbness of the extremities
		HE8	Central nervous system effects/ narcosis
		HE14	Eyes, nose, throat, skin irritation
		HE17	Chemical anoxia (metabolic conversion to CO)

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA PEL - Construction Industry See 29 CFR 1926.1152	25 ppm TWA 125 ppm STEL 12.5 ppm Action Level	HE1	Cancer
		HE3	Cardiac and liver toxicity
		HE7	Light-headedness, staggering, unconsciousness, decreased eye/hand coordination, numbness of the extremities
		HE8	Central nervous system effects/ narcosis
		HE14	Eyes, nose, throat, skin irritation
		HE17	Chemical anoxia (metabolic conversion to CO)
OSHA PEL - Shipyard Employment See 29 CFR 1915.1052	25 ppm TWA 125 ppm STEL 12.5 ppm Action Level	HE1	Cancer
		HE3	Cardiac and liver toxicity
		HE7	Light-headedness, staggering, unconsciousness, decreased eye/hand coordination, numbness of the extremities
		HE8	Central nervous system effects/ narcosis
		HE14	Eyes, nose, throat, skin irritation
		HE17	Chemical anoxia (metabolic conversion to CO)

CHEMWATCH
Bulletin Board
Hazard Alert
MAY. 19, 2023

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) See Appendix A	Lowest feasible concentration Ca	HE1	Cancer
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2001) (Listed under dichloromethane)	50 ppm (174 mg/m3) TWA A3, BEI	HE4	Cardiovascular changes
		HE7	Neurological effects (headache, dizziness, loss of balance, memory difficulties, numbness in hands or feet)
		HE8	Central nervous system effects (narcosis)
		HE17	Asphyxiant, anoxiant
CAL/OSHA PELs See Section 5202	25 ppm (87 mg/m3) TWA 125 ppm (435 mg/m3) STEL		

Australia

- Safe Work Australia has set an allowable limit for workers to be exposed to 50 parts per million dichloromethane over an eight-hour workshift. It has determined that dichloromethane is a Category 3, suspected carcinogen. It is possible that there is no safe level of exposure to a carcinogen.
- Australian Drinking Water Quality Guidelines (NHMRC and ARMCANZ, 1996): 0.004 mg/L (i.e. 0.000004 g/L).

Europe

- Dichloromethane use is regulated under the Solvent Emissions Directive (1999/13/EC).

Scientists find a pheromone that controls cannibalism

2023-05-06

Researchers have identified the pheromone that prevents massive swarms of migratory locusts from devouring each other.

Until now, scientists have long suspected that cannibalism amongst locust swarms contributes to their swarming behaviour, with individuals constantly on the fly to evade members of the same species (called conspecifics) eager to take a bite out of them.

A new study in the journal Science has identified a pheromone named phenylacetonitrile, or PAN, that locusts produce under crowded conditions to deter other locusts, and the olfactory receptor that recognises it.

Because cannibalism has a major impact on locust swarm dynamics, these finding opens up new possibilities for controlling the insects that wreak havoc on crops and threaten food security.

"If you inhibit the production of PAN or the function of the [PAN] receptor, you could get the locusts to behave more cannibalistically and potentially control themselves in that way," says study leader Professor Bill Hansson, Director of the Department of Evolutionary Neuroethology at the Max Planck Institute, Germany.

Why do locusts swarm?

Under certain circumstances, migratory locusts become more abundant and experience changes in their morphology and behaviour that lead to swarming.

"In most cases, locusts are in the solitary phase, where they avoid physical contact with conspecifics and eat comparatively little food," explains first author Dr Hetan Chang, a postdoctoral researcher at Max Planck Institute for Chemical Ecology.

"If the population density increases due to rainfall and sufficient food, the locusts change their behaviour within a few hours; they can smell, see, and touch each other. These three types of stimulation increase serotonin and dopamine levels in the locust brain, causing solitary locusts to become aggressive gregarious locusts that are very active and have a large appetite.

"They also release aggregation pheromones, which eventually leads to swarming and poses a huge threat to agricultural production. Cannibalism does only occur in the gregarious phase."

Researchers have identified the phero-mone that prevents massive swarms of mi-gratory locusts from devouring each other.

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

Pheromones are chemical signals secreted by organisms for communicating with members of the same species. They can trigger an immediate effect on behaviour or can affect physiology and produce an effect after a period of time.

"We wondered how these insects influence each other's behaviour within huge swarms, and whether olfaction plays a role," says Hansson.

In a series of behavioural experiments with the migratory locust Locusta migratoria, the team showed that the rate of cannibalism increased with the number of gregarious locusts kept together in a cage.

By analysing and comparing all of the odours emitted by solitary and gregarious juvenile locusts, they identified that, of the 17 odours produced solely in in the gregarious phase, only PAN deterred other locusts.

"We showed that as population density increased, not only did the level of cannibalism rise, but the animals also produced more PAN," says Chang.

"Using genome editing, we were able to knock out an enzyme responsible for the production of this compound. This allowed us to confirm its strong anti-cannibalistic effect, because cannibalism was again significantly increased when the animals were no longer able to produce the compound."

The most challenging part of the whole process was actually identifying the olfactory receptor responsible for recognising PAN – since locusts have more than 140 olfactory receptor genes. Tests on 49 different olfactory receptors, using more than 200 relevant odours, eventually revealed the olfactory receptor OR70a.

Genetically modifying locusts so that their OR70a receptor was no longer functional resulted in a much greater rate of cannibalism because they could no longer perceive the anti-cannibalism signal.

In their paper, the researchers suggest that "the system is very likely to be of major importance in locust population ecology, and our results might therefore provide opportunities in locust management".

Cosmos, 6 May 2023

https://cosmosmagzine.com

Molecular Magic – Researchers Develop Lightweight 2D Material Stronger Than Steel

2023-05-05

Scientists from Rice University and the University of Maryland lead efforts to overcome a major barrier.

Despite being recognized as some of the strongest substances on Earth, utilizing 2D materials to their full potential has proven to be a difficult task.

2D materials, which are finer than even the thinnest onionskin paper, have garnered significant attention due to their remarkable mechanical attributes. However, these properties dissapate when the materials are layered, thus restricting their practical applications.

"Think of a graphite pencil," says Teng Li, Keystone Professor at the University of Maryland's (UMD) Department of Mechanical Engineering. "Its core is made of graphite, and graphite is composed of many layers of graphene, which has been found to be the world's toughest material. Yet a graphite pencil isn't strong at all—in fact, graphite is even used as a lubricant."

Now, Li and collaborators at Rice University and the University of Houston have found a way to overcome this barrier, by carefully tweaking the molecular structure of 2D polymers known as covalent organic frameworks (COFs). The findings are detailed in a new study published in Proceedings of the National Academy of Sciences.

"It's a very exciting starting point," said Rice University materials science and nanoengineering professor Jun Lou, who led the Rice team.

Using molecular-level simulations, the researchers studied different functional groups—that is, arrangements of molecular elements—and then designed two COFs with minute differences in structure. They then studied how the COFs behaved when stacked into layers. It turned out that the tiny structural differences led to significantly different results.

The first COF, like most 2D materials, showed only a weak interaction among layers, and both strength and elasticity drained away as more layers were added. Not so with the second COF, which "exhibits strong interlayer interaction and retains its good mechanical properties even as multiple layers are added," said Rice University doctoral student Qiyi Fang, a co-lead author of the PNAS paper.

Researchers have developed a method to retain the mechanical properties of 2D polymers called covalent organic frameworks (COFs) when stacked in multiple layers.

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

According to the researchers, this phenomenon is most likely due to hydrogen bonding. "We found from our simulations that the strong interlayer interactions in the second type of COF result from the significantly enhanced hydrogen bonding among its special functional groups," said co-lead author Zhengqian Pang, a UMD post-doctoral researcher and a member of Li's research group.

Applying their findings, the research team then produced a lightweight material that not only is several times stronger than steel, but preserves its 2D properties even when stacked into multiple layers.

The potential applications are many. "COFs could make excellent filtration membranes," said Rice's Lou. "For a filtration system, the functional group structure at the pore will be very important. As you have, say, dirty water traveling through a COF membrane, the functional group at the pore will capture the impurities only and allow the desired molecule to pass. In this process, the mechanical integrity of that membrane will be very important. Now we have a way to design very strong, very fracture-resistant, multilayer 2D polymers that could be very good candidates for membrane filtration applications."

"Another potential application is for upgrading batteries: Replacing the graphite anode with a silicon one would greatly increase the storage capacity of current lithium-ion battery technologies," he said.

Insights from the research could also lead to advances in designing a broad range of materials, including ceramics and metals, said Li. Ceramics, for instance, depend on ionic bonding that forms at very high temperatures, which is why a broken coffee mug can't be easily fixed. Metals, likewise, require forging at high temperatures. With the molecular tweaking being explored by the researchers, similar products could conceivably be manufactured and repaired without turning up the heat.

"Although the immediate context is 2D materials, more generally we're pioneering ways to exploit the advantageous properties of materials without the constraints these materials present," Li said.

Sci Tech Daily, 5 May 2023

https://scitechdaily.com

Scientists develop self-monitoring metamaterial concrete for smart infrastructure systems.

Metamaterial Concrete: Reinventing the Most Widely Used Construction Material

2023-05-06

Engineers at the University of Pittsburgh are bringing concrete into the 21st century by reimagining its design. Concrete, which has its roots dating back to the Roman Empire, remains the most widely utilized material in the construction industry.

A new study presents a concept for the development of smart civil infrastructure systems with the introduction of metamaterial concrete. The research presents a concept for lightweight and mechanically-tunable concrete systems with integrated energy harvesting and sensing capabilities.

"Modern society has been using concrete in construction for hundreds of years, following its original creation by the ancient Romans," said Amir Alavi, assistant professor of civil and environmental engineering at Pitt, who is the corresponding author on the study. "Massive use of concrete in our infrastructure projects implies the need for developing a new generation of concrete materials that are more economical and environmentally sustainable, yet offer advanced functionalities. We believe that we can achieve all of these goals by introducing a metamaterial paradigm into the development of construction materials."

Alavi and his team have previously developed self-aware metamaterials and explored their use in applications like smart implants. This study introduces the use of metamaterials in the creation of concrete, making it possible for the material to be specifically designed for its purpose. Attributes like brittleness, flexibility, and shapeability can be fine-tuned in the creation of the material, enabling builders to use less of the material without sacrificing strength or longevity.

"This project presents the first composite metamaterial concrete with super compressibility and energy harvesting capability," said Alavi. "Such lightweight and mechanically tunable concrete systems can open a door to the use of concrete in various applications such as shock absorbing engineered materials at airports to help slow runaway planes or seismic base isolation systems."

Not only that, but the material is capable of generating electricity. While it cannot produce enough electricity to send power to the electrical grid, the generated signal will be more than enough to power the roadside sensors. The electrical signals self-generated by the metamaterial concrete under

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

mechanical excitations can also be used to monitor damage inside the concrete structure or to monitor earthquakes while reducing their impact on buildings.

Eventually, these smart structures may even power chips embedded inside roads to help self-driving cars navigate on highways when GPS signals are too weak or LIDAR is not working.

The material is composed of reinforced auxetic polymer lattices embedded in a conductive cement matrix. The composite structure induces contact-electrification between the layers when triggered mechanically. The conductive cement, which is enhanced with graphite powder, serves as the electrode in the system. Experimental studies show that the material can compress up to 15% under cyclic loading and produce 330 μW of power.

Sci Tech Daily, 6 May 2023

https://scitechdaily.com

How a Human Smell Receptor Works Is Finally Revealed

2023-05-01

After decades of frustration, researchers have determined how an airborne scent molecule links to a human smell receptor.

or the first time, researchers have determined how a human olfactory receptor captures an airborne scent molecule, the pivotal chemical event that triggers our sense of smell.

Whether it evokes roses or vanilla, cigarettes or gasoline, every scent starts with free-floating odor molecules that latch onto receptors in the nose. Multitudes of such unions produce the perception of the smells we love, loathe or tolerate. Researchers therefore want to know in granular detail how smell sensors detect and respond to odor molecules. Yet human smell receptors have resisted attempts to visualize how they work in detail — until now.

In a recent paper published in Nature, a team of researchers delineated the elusive three-dimensional structure of one of these receptors in the act of holding its quarry, a compound that contributes to the aroma of Swiss cheese and body odor.

"People have been puzzled about the actual structure of olfactory receptors for decades," said Michael Schmuker, who uses chemical informatics to study olfaction at the University of Hertfordshire in England. Schmuker was not involved in the study, which he describes as "a real breakthrough."

He and others who study our sense of smell say that the reported structure represents a step toward better understanding how the nose and brain jointly wring from airborne chemicals the sensations that warn of rotten food, evoke childhood memories, help us find mates and serve other crucial functions.

The complexity of the chemistry that the nose detects has made olfaction particularly difficult to explain. Researchers think that human noses possess about 400 types of olfactory receptors, which are tasked with detecting a vastly larger number of odoriferous "volatiles," molecules that vaporize readily, from the three-atom, rotten-egg-smelling hydrogen sulfide to the much larger, musky-scented muscone. (One recent estimate put the number of possible odor-bearing compounds at 40 billion or more.)

"In my mind, one of the most amazing things about olfaction is our ability to detect and discriminate such a wide array of volatiles," said Hiroaki Matsunami, an olfaction researcher at Duke University and an author of the new study.

Caught in the Act

Perched on the surface of neurons in the nose, olfactory receptors change shape when they snag odor molecules. This reconfiguration prompts the neurons to send signals to the odor-processing parts of the brain. Researchers have long sought to see in detail how the interaction between receptor and odor molecule plays out.

A study published in 2021 gave them a glimpse of that process in insects: A group at Rockefeller University determined the structure of an olfactory receptor in the jumping bristletail, as well as the basis for the receptor's ability to recognize molecules with divergent chemistry. However, that discovery didn't tell researchers much about human olfaction because insect olfactory receptors work fundamentally differently from ours.

Human olfactory receptors belong to an enormous family of proteins known as G-protein-coupled receptors (GPCRs). Situated within cell membranes, these proteins contribute to a vast array of physiological processes by detecting all kinds of stimuli, from light to hormones.

Over the past two decades, researchers have determined detailed structures for an ever-expanding number of GPCRs — but not for the olfactory receptors among them. To get enough receptors for these studies, researchers must produce them in cultured cells. However,

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

olfactory receptors generally refuse to mature properly when grown outside olfactory neurons, their natural habitat.

To overcome this problem, Matsunami and Claire de March, who was a research associate in Matsunami's lab, began exploring the possibility of genetically altering olfactory receptors to make them more stable and easier to grow in other cells. They joined forces with Aashish Manglik, a biochemist at the University of California, San Francisco, and Christian Billesbølle, a senior scientist in Manglik's lab.

Although this effort was progressing, the team decided to give the extraction of a natural receptor one more shot. "It'll probably fail just like everybody else has," Manglik recalled thinking. "[But] we should try it anyway."

They improved their odds by picking an odor receptor, OR51E2, that is also found outside the nose — in the gut, the kidney, the prostate and other organs. Through Billesbølle's meticulous efforts, they managed to obtain enough OR51E2 to study. They then exposed the receptor to an odor molecule that they knew it detected: propionate, a short fatty acid produced by fermentation.

To generate detailed images of the receptor and propionate locked together, the interaction that triggers a sensory neuron to fire, they used cryo-electron microscopy, an advanced imaging technique that captures snapshots of proteins that have been rapidly frozen.

The team found that within the structure of the interlocked molecules, the OR51E2 had trapped propionate within a small pocket. When they enlarged the pocket, the receptor lost much of its sensitivity to propionate and to another small molecule that normally activates it. The tweaked receptor preferred larger odor molecules, which confirmed that the size and chemistry of the binding pocket tunes the receptor to detect only a narrow set of molecules.

The structural analysis also uncovered a small, flexible loop atop the receptor, which locks down like a lid over the pocket once an odor molecule binds inside it. The discovery suggests that this highly variable looping piece may contribute to our ability to detect diverse chemistry, according to Manglik.

The Underlying Logic of Scent

OR51E2 may still have other secrets to share. Although the study focused on the pocket that holds propionate, the receptor may possess other

binding sites for other odors, or for chemical signals it might encounter in tissues outside the nose, the researchers say.

Also, the microscopy images revealed only a static structure, but these receptors are in fact dynamic, said Nagarajan Vaidehi, a computational chemist at the Beckman Research Institute of the City of Hope who also worked on the study. Her group used computer simulations to visualize how OR51E2 probably moves when it's not frozen.

For de March, who has moved to France's National Center for Scientific Research, the map of OR51E2 turned years of speculation into reality. She noted that she has been studying theoretical models of odorant receptors throughout her career: The new findings were "the first time I had the answers to everything I was wondering when I was working on these theoretical models," she said.

Other human olfactory receptors, especially those closely related to OR51E2, likely function similarly, Matsunami said. He and other researchers see the identification of the functional structure as a step toward understanding the underlying logic that guides the operation of our sense of smell.

But they have a long way to go. Scientists have at best an inkling of which molecules activate only about a quarter of the human olfactory receptors.

Still, with more structures like that of OR51E2, it may be possible to open the biological black box of olfaction, said Joel Mainland, an olfactory neuroscientist at the Monell Chemical Senses Center who was not involved in the new research. With more insights into how the neural coding for olfaction works, "the hope is that now we'll be able to make confident models about what odors will bind to given receptors," he said.

The question of how receptors selectively respond to airborne chemicals is only a piece of the bigger puzzle of smell, however. To fully understand the sense, researchers also need to figure out how the brain translates the incoming information about receptor activity into a perception, said Matt Wachowiak, an olfactory neuroscientist at the University of Utah who was not involved in the study.

In the real world, almost everything we smell contains a mix of many chemicals, at varying concentrations. "Somehow we recognize that

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

pattern, generally very quickly, and in different situations," he said. "The real challenge is figuring out: How does the brain do that?"

Quanta Magazine, 1 May 2023

https://quantamagazine.org

Amazonian dark earth could bring life back to decimated forestland

2023-05-05

Even though the Amazon is still a powerhouse of plant and animal life, about 18% of it has been cut down since the 1970s. Seeking ways to help get some of that lost forestland back, researchers have turned to a rich soil created by the activities of the Amerindians thousands of years ago.

About 2,000 years ago, as the Amerindian people were living their lives in what is now Amazonia, they inadvertently created an incredibly rich soil. Known as Amazonian dark earth (ADE) or terra preta, this soil was formed as the charcoal from campfires combined with other bits of daily life like animal bones, broken pottery pieces, compost and manure. Not only does the soil contain these ancient components of human life, but it has been found to harbor a rich microbiome as well.

The research aims to find a way to restore some of the thousands of acres of Amazonian rainforest that have been cut down throughout the last several decades.

Curious to know if ADE could help restore some of the Amazon's rich rainforests, researchers at São Paulo University in Brazil undertook a simulation. They filled containers with three different types of soil: as a control, they used soil from Amazonian cropland, then they created a mix of the cropland soil with 20% ADE in one container, and placed 100% pure ADE in another.

Next, they sowed grass in each of the containers. Once the grass reached maturity, they cut it down, leaving the roots in place, and planted a variety of trees in the containers. This process simulated what would happen naturally when cropland is left untended and converts first to grassland, and then to forest.

The researchers found that after the trees had grown for 90 days, all soils had fewer nutrients because they had been taken up by the plants, but the ADE soils retained more than the control soil. Both ADE soils also had a greater biodiversity of bacteria and other microbes than the control.

"Microbes transform chemical soil particles into nutrients that can be taken up by plants," said joint lead author Anderson Santos de Freitas. "Our data showed that ADE contains microorganisms that are better

at this transformation of soils, thus providing more resources for plant development. For example, ADE soils contained more beneficial taxa of the bacterial families Paenibacillaceae, Planococcaceae, Micromonosporaceae, and Hyphomicroblaceae."

Most impressive is the fact that when grown in this rich microbial soil, the harvested dry mass of the grass was 3.4 times greater in the 20% ADE mixture and a whopping 8.1 times greater in the 100% ADE soil. The trees also fared better. The 20% mixture yielded trees that grew 2.1 and 5.2 times taller by species than in the control soil, and an impressive 6.3 times taller in the 100% ADE soil. One tree species known as Abay pumpwood wouldn't even grow in the control medium, but grew just fine in both ADE soils.

The research team cautions against using actual ADE in reforestation strategies, but says that creating soil rich with the same microbes found in ADE could yield much the same effects, thereby helping to encourage depleted cropland to grow new forests.

"ADE has taken thousands of years to accumulate and would take an equal time to regenerate in nature if used," said senior study author Siu Mui Tsai. "Our recommendations aren't to utilize ADE itself, but rather to copy its characteristics, particularly its microorganisms, for use in future ecological restoration projects."

The research has been published in the journal, Frontiers in Soil Science.

New Atlas, 5 May 2023

https://nawatlas.com

An unprecedented view of gene regulation

2023-05-08

Much of the human genome is made of regulatory regions that control which genes are expressed at a given time within a cell. Those regulatory elements can be located near a target gene or up to 2 million base pairs away from the target.

To enable interactions, the genome loops itself in a 3D structure that brings distant regions close together. Using a new technique, MIT researchers have shown that they can map these interactions with 100 times higher resolution than has previously been possible.

"Using this method, we generate the highest-resolution maps of the 3D genome that have ever been generated."

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

"Using this method, we generate the highest-resolution maps of the 3D genome that have ever been generated, and what we see are a lot of interactions between enhancers and promoters that haven't been seen previously," says Anders Sejr Hansen, the Underwood-Prescott Career Development Assistant Professor of Biological Engineering at MIT and the senior author of the study. "We are excited to be able to reveal a new layer of 3D structure with our high resolution."

The researchers' findings suggest that many genes interact with dozens of different regulatory elements, although further study is needed to determine which of those interactions are the most important to the regulation of a given gene.

"Researchers can now affordably study the interactions between genes and their regulators, opening a world of possibilities not just for us but also for dozens of labs that have already expressed interest in our method," says Viraat Goel, an MIT graduate student and one of the lead authors of the paper. "We're excited to bring the research community a tool that help them disentangle the mechanisms driving gene regulation."

MIT postdoc Miles Huseyin is also a lead author of the paper, which appears today, May 8, in Nature Genetics.

High-resolution mapping

Scientists estimate that more than half of the genome consists of regulatory elements that control genes, which make up only about 2 percent of the genome. Genome-wide association studies, which link genetic variants with specific diseases, have identified many variants that appear in these regulatory regions. Determining which genes these regulatory elements interact with could help researchers understand how those diseases arise and, potentially, how to treat them.

Discovering those interactions requires mapping which parts of the genome interact with each other when chromosomes are packed into the nucleus. Chromosomes are organized into structural units called nucleosomes—strands of DNA tightly wound around proteins—helping the chromosomes fit within the small confines of the nucleus.

Over a decade ago, a team that included researchers from MIT developed a method called Hi-C, which revealed that the genome is organized as a "fractal globule," which allows the cell to tightly pack its DNA while avoiding knots. This architecture also allows the DNA to easily unfold and refold when needed.

To perform Hi-C, researchers use restriction enzymes to chop the genome into many small pieces and biochemically link pieces that are near each other in 3D space within the cell's nucleus. They then determine the identities of the interacting pieces by amplifying and sequencing them.

While Hi-C reveals a great deal about the overall 3D organization of the genome, it has limited resolution to pick out specific interactions between genes and regulatory elements such as enhancers. Enhancers are short sequences of DNA that can help to activate the transcription of a gene by binding to the gene's promoter—the site where transcription begins.

To achieve the resolution necessary to find these interactions, the MIT team built on a more recent technology called Micro-C, which was invented by researchers at the University of Massachusetts Medical School, led by Stanley Hsieh and Oliver Rando. Micro-C was first applied in budding yeast in 2015 and subsequently applied to mammalian cells in three papers published in Molecular Cell in 2019 and 2020 by researchers including Hansen, Hsieh, Rando and others at University of California at Berkeley and at UMass Medical School.

Micro-C achieves higher resolution than Hi-C by using an enzyme known as micrococcal nuclease to chop up the genome. Hi-C's restriction enzymes cut the genome only at specific DNA sequences that are randomly distributed, resulting in DNA fragments of varying and larger sizes. By contrast, micrococcal nuclease uniformly cuts the genome into nucleosome-sized fragments, each of which contains 150 to 200 DNA base pairs. This uniformity of small fragments grants Micro-C its superior resolution over Hi-C.

However, since Micro-C surveys the entire genome, this approach still doesn't achieve high enough resolution to identify the types of interactions the researchers wanted to see. For example, if you want to look at how 100 different genome sites interact with each other, you need to sequence at least 100 multiplied by 100 times, or 10,000. The human genome is very large and contains around 22 million sites at nucleosome resolution. Therefore, Micro-C mapping of the entire human genome would require at least 22 million multiplied by 22 million sequencing reads, costing more than $1 billion.

To bring that cost down, the team devised a way to perform a more targeted sequencing of the genome's interactions, allowing them to focus on segments of the genome that contain genes of interest. By focusing on regions spanning few million base pairs, the number of possible genomic sites decreases a thousandfold and the sequencing costs decrease a

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

millionfold, down to about $1,000. The new method, called Region Capture Micro-C (RCMC), is therefore able to inexpensively generate maps 100 times richer in information than other published techniques for a fraction of the cost.

"Now we have a method for getting ultra-high-resolution 3D genome structure maps in a very affordable manner. Previously, it was so inaccessible financially because you would need millions, if not billions of dollars, to get high resolution," Hansen says. "The one limitation is that you can't get the whole genome, so you need to know approximately what region you're interested in, but you can get very high resolution, very affordably."

Many interactions

In this study, the researchers focused on five regions varying in size from hundreds of thousands to about 2 million base pairs, which they chose due to interesting features revealed by previous studies. Those include a well-characterized gene called Sox2, which plays a key role in tissue formation during embryonic development.

After capturing and sequencing the DNA segments of interest, the researchers found many enhancers that interact with Sox2, as well as interactions between nearby genes and enhancers that were previously unseen. In other regions, especially those full of genes and enhancers, some genes interacted with as many as 50 other DNA segments, and on average each interacting site contacted about 25 others.

"People have seen multiple interactions from one bit of DNA before, but it's usually on the order of two or three, so seeing this many of them was quite significant in terms of difference," Huseyin says.

However, the researchers' technique doesn't reveal whether all of those interactions occur simultaneously or at different times, or which of those interactions are the most important.

The researchers also found that DNA appears to coil itself into nested "microcompartments" that facilitate these interactions, but they weren't able to determine how microcompartments form. The researchers hope that further study into the underlying mechanisms could shed light on the fundamental question of how genes are regulated.

"Even though we're not currently aware of what may be causing these microcompartments, and we have all these open questions in front of us, we at least have a tool to really stringently ask those questions," Goel says.

In addition to pursuing those questions, the MIT team also plans to work with researchers at Boston Children's Hospital to apply this type of analysis to genomic regions that have been linked with blood disorders in genome-wide association studies. They are also collaborating with researchers at Harvard Medical School to study variants linked to metabolic disorders.

Medical Xpress, 8 May 2023

https://medicalxpress.com

Gut bacteria linked to Parkinson's, paves way for targeted treatment

2023-05-07

A new study has found that a species of gut bacteria cause the destructive nerve cell 'clumps' that are a hallmark of Parkinson's disease. The discovery opens the door to the development of targeted treatments for this debilitating disease.

More than 10 million people worldwide live with Parkinson's disease (PD), an incurable neurodegenerative disorder characterized by tremors, muscle stiffness, hindered movement, and impaired balance and coordination.

When the protein alpha-synuclein (alpha-syn), predominantly found in nerve cells, clumps together, it forms Lewy bodies. The presence of alpha-syn/Lewy bodies in the brain and throughout the nervous system is a hallmark of PD. Clumped alpha-syn has also been found in the gut, and it's thought that a gut-based pathogen may cause the aggregation, which then travels to the brain.

In an effort to better understand what causes PD, researchers from the University of Helsinki in Finland have closely examined the role that a species of bacteria – Desulfovibrio (DSV) – might play.

They'd looked at the link between DSV and PD in 2021 when they found the bacteria were more prevalent in people with the disease. They also found that, in people with PD, having more of these bacteria correlated with the severity of symptoms seen.

However, in the previous study, the way DSV contributed to the development of PD was not explored. Now, the researchers turned to science's favorite worm, Caenorhabditis elegans (C. elegans), to examine whether DSV strains contributed to alpha-syn aggregation and PD.

A new study has linked a species of gut bacteria to the development of Parkinson's disease.

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

The researchers recruited 20 participants: 10 with PD and 10 healthy individuals. The healthy individuals just happened to be the spouses of the PD participants. Each participant provided fecal samples, which were analyzed for the presence of DSV.

DSV strains found in either group were fed to C. elegans worms whose heads were imaged under a microscope. They also looked at whether the C. elegans' survival was affected by the bacteria. The researchers fed strains of the bacteria Escherichia coli (E. coli) to worms that acted as a control group.

The researchers found that worms fed DSV bacteria from individuals with PD had significantly more and larger alpha-syn aggregates than worms fed from healthy individuals or worms fed E. coli strains. They also found that the worms who received DSV strains from people with PD died in significantly higher quantities than worms fed E. coli.

As a result of their findings, the researchers concluded that DSV strains from people with PD, as opposed to healthy people, appear more toxic and can cause more alpha-syn aggregation. They say the study's findings point to the important role that environmental factors play in the development of PD.

"Our findings are significant, as the cause of Parkinson's disease has gone unknown despite attempts to identify it throughout the last two centuries," said Per Saris, a co-author of the study. "The findings indicate that specific strains of Desulfovibrio bacteria are likely to cause Parkinson's disease. The disease is primarily caused by environmental factors, that is, environmental exposure to the Desulfovibrio bacterial strains that cause Parkinson's disease. Only a small share, or roughly 10%, of Parkinson's disease is caused by individual genes."

Their findings, they say, suggest that DSV bacteria contribute to the development of PD by causing the aggregation of alpha-syn, opening the door to new treatments that specifically target these bacteria.

"Our findings make it possible to screen for the carriers of these harmful Desulfovibrio bacteria," Saris said. "Consequently, they can be targeted by measures to remove these strains from the gut, potentially alleviating and slowing the symptoms of patients with Parkinson's disease."

Further studies could uncover the differences between the DSV strains seen in people with PD and healthy people, something that couldn't be done in the current study.

The study was published in the journal Frontiers in Cellular and Infection Microbiology.

New Atlas, 7 May 2023

https://newatlas.com

New Details on Rare Immune Disease Uncovered by NIH Researchers in 11-Year Study

2023-05-08

In an 11-year study, researchers at the National Institutes of Health (NIH) have further characterized idiopathic CD4 lymphocytopenia (ICL), a rare immune deficiency that leaves people vulnerable to infectious diseases, autoimmune diseases, and cancers. Researchers observed that people with the most severe cases of ICL had the highest risk of acquiring or developing several of the diseases associated with this immune deficiency. This study, published on May 4 in the New England Journal of Medicine, was led by Irini Sereti M.D., M.H.S. and Andrea Lisco, M.D., Ph.D. of the HIV Pathogenesis Section in the Laboratory of Immunoregulation at the National Institute of Allergy and Infectious diseases (NIAID), part of NIH, and conducted at the NIH Clinical Center.

ICL is a condition marked by too few CD4+ T-cells, which are a type of white blood cell. The clinical definition of ICL is a CD4+ T-cell count of less than 300 cells per cubic millimeter (mm^3) of blood for at least six weeks, in the absence of any disease or therapy associated with reduced white blood cells. Unlike HIV, a virus that suppresses the immune system if left untreated, there is no evidence that ICL is transmitted from person to person, and it has no known cause. There are limited therapeutic options for ICL.

In this observational study, the NIAID researchers quantified immune cells and noted the presence of opportunistic infections—infections that typically only affect people with suppressed immune systems—and other clinical conditions among 91 participant volunteers with ICL. The most prevalent opportunistic infections were human papillomavirus-related diseases (in 29% of participants), cryptococcosis (24%), molluscum contagiosum (9%), and mycobacterial diseases other than tuberculosis (5%). Participants with CD4+ T-cell counts below 100 cells per mm^3 had a more than five-fold higher risk of opportunistic infections than those with CD4+ T-cell counts above 100 cells. Cancer risk was also higher in

NIH researchers characterize ICL, a rare immune deficiency, linking severe cases to higher risk of infections and cancers.

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

individuals with the lowest CD4+ T-cell counts, but the risk of autoimmune disease was lower.

These findings further support the inverse correlation between CD4+ T-cell count and susceptibility to viral, fungal, and mycobacterial infections, as well as certain cancers, according to the authors. NIAID continues to pursue research on the natural history of rare conditions such as ICL to understand disease progression, as well as potential therapeutic interventions.

Sci Tech Daily

https://scitechdaily.com

Recycling plants spew a staggering amount of microplastics

2023-05-08

An unsettling report released barely a year ago painted a grim picture of the plastics industry—only about 5 percent of the 46 million annual tons of plastic waste in the US makes it to recycling facilities. The number is even more depressing after realizing that is roughly half of experts' previous estimates. But if all that wasn't enough, new information throws a heaping handful of salt on the wound: of the plastic that does make it to recycling, a lot of it is still released into the world as potentially toxic microplastics.

According to the pilot study recently published in the Journal of Hazardous Materials Advances focused on a single, modern facility, recycling plants' wastewater contains a staggering number of microplastic particles. And as Wired explained on Friday, all those possibly toxic particulates have to go somewhere, i.e. potentially city water systems, or the larger environment.

The survey focusing on one new, unnamed facility examined its entire recycling process. This involves sorting, shredding, and melting plastics down into pellets. During those phases of recycling, however, the plastic waste is washed multiple times, which subsequently sheds particles smaller than 5 millimeters along the way. Despite factoring in the plant's state-of-the-art filtration system designed to capture particulates as tiny as 50 microns, the facility still produced as many as 75 billion particles per cubic meter of wastewater.

For the tiny amount of waste that ends up recycled, a new pollution problem arises.

The silver lining here is that without the filtration systems, it could be much worse. Researchers estimated facilities that utilized filters cut down their microplastic residuals from 6.5 million pounds to around 3 million pounds per year. Unfortunately, many recycling locations aren't as equipped as the modern plant used within the study. On top of that, the team only focused on microplastics as small as 1.6 microns; particles can get so small they actually enter organisms' individual cells. This implies much more plastic escapes these facilities than previously anticipated.

"I really don't want it to suggest to people that we shouldn't recycle, and to give it a completely negative reputation," Erina Brown, a plastics scientist at the University of Strathclyde, told Wired. "What it really highlights is that we just really need to consider the impacts of the solutions."

Most experts agree that the most important way to minimize coating the entire planet in microplastics is to focus on the larger issue—reducing society's reliance on plastics in general, and pursuing alternative materials. In the meantime, recycling remains an important part of sustainability, as long as both facilities do everything they can to minimize microscopic waste.

Popular Science

https://popsci.com

Magnetic bacteria: Microorganisms can help to extract dangerous heavy metals from wastewater

2023-05-09

A research team at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) has managed to purify water containing uranium using a special kind of bacteria known as magnetotactic bacteria. The name derives from their ability to react to magnetic fields. They can accumulate dissolved heavy metal in their cell walls. These research findings also shed new light on the interaction between uranium and bioligands.

"Our experiments are geared towards potential industrial applications in the field of microbiological remediation of water, especially when it is contaminated with heavy metals of the type you find in mine drainage water in the old uranium mines," explains Dr. Evelyn Krawczyk-Bärsch of HZDR's Institute of Resource Ecology. "For this project we sought help from a very special group of living creatures: the magnetotactic bacteria," her colleague, Dr. Johannes Raff, adds and continues, "Due to their structure, they are positively predestined for such a task."

These research findings also shed new light on the interaction between uranium and bioligands.

CHEMWATCH
Bulletin Board
Gossip
MAY. 19, 2023

Because they exhibit a feature that differentiates them from other bacteria, magnetotactic bacteria form nanoscopic magnetic crystals within the cell. They are arranged like a row of beads and so perfectly formed that humans would currently be unable to reproduce them synthetically. Each individual magnetic crystal is embedded in a protective membrane.

Together, the crystals and membrane form the so-called magnetosome which the bacteria use to align themselves with the Earth's magnetic field and orientate themselves in their habitat. It also makes them suitable for simple separation processes.

Magnetotactic bacteria can be found in almost any aqueous environment from fresh water to saltwater, including environments with very few nutrients. Microbiologist Dr. Christopher Lefèvre has even discovered them in the hot springs of Nevada. It was from him and his colleague Dr. Damien Faivre of the French Alternative Energies and Atomic Energy Commission (CEA) that the Rossendorf scientists acquired their bacteria strain, not to mention expert advice on how best to preserve them—because despite being fairly common, cultivating them requires some specialist knowledge.

Stable heavy metal collectors in a hostile environment

Magnetotactic bacteria can survive at neutral pH values, even in aqueous solutions containing higher concentrations of uranium. Over a wide pH range, they bind the uranium almost exclusively in their cell walls—an excellent basis for dealing with the conditions found in water associated with mining. None of the uranium penetrates into the interior of the cell in the process, nor is it bound by the magnetosome.

It was already known that different types of bacteria could bind heavy metals in their cell walls despite being potentially quite differently structured. In the case of magnetotactic bacteria the cell walls are formed of a peptidoglycan layer, a macromolecule composed of sugars and amino acids which is the main component of the cell walls of many bacteria, which is only four nanometers thick.

The cell walls of magnetotactic bacteria are surrounded by an external membrane composed of sugars and fat-like components: potential docking sites for uranium.

"Our results show that in magnetotactic bacteria peptidoglycan plays the main role in absorbing uranium. This knowledge is new and unexpected in this type of bacteria," says Krawczyk-Bärsch. The team even managed

to identify three specific uranium peptidoglycan species and confirm their findings with reference samples. These new insights were only possible thanks to a combination of microscopy and various spectroscopic techniques, a combination that is rarely found anywhere else in the world.

"By cooperating with the Institute of Ion Beam Physics and Materials Research at HZDR, for example, we were able to use the electron microscope. The proximity of our institutes at the site and the expertise of our colleagues are a major advantage for our work," Raff says.

Significance for purifying contaminated water

Thanks to their magnetic properties, magnetotactic bacteria can be easily separated from water using magnets. "It's conceivable this could be done on a large scale by carrying out the treatment right in the surface water or by pumping water from underground mines and directing it to pilot treatment plants," Krawczyk-Bärsch explains.

Using magnetotactic bacteria could be an effective alternative to expensive, conventional chemical treatments—because magnetotactic bacteria are undemanding in terms of upkeep; implementing other biomass-based solutions, by contrast, regularly fails due to the costs involved in increased nutrient and energy requirements.

And another detail has sparked the researchers' interest in these bacteria: their proteins can stabilize divalent and trivalent iron so that the magnetite stored in the magnetosomes can be synthesized. "So, we are really asking ourselves how these microorganisms interact with radionuclides in various oxidation states. In particular, we are thinking of plutonium," explains Raff.

This is because, unlike uranium, it is conceivable that its chemical similarity to iron means it uses other routes into the cell. How does this influence the migration behavior of plutonium in nature, and could this also be a way of removing plutonium from wastewater? Thus, the topic is also of relevance to repository research: any results could then be incorporated into the safety assessment.

The findings are published in the Journal of Hazardous Materials.

Phys Org, 9 May 2023

https://phys.org

Why Are There So Few Insects in the Ocean? Japanese Scientists May Have Solved the Mystery

2023-05-06

Scientists from Tokyo Metropolitan University have proposed a hypothesis for why insects are so rare in marine environments. They previously showed that insects evolved a unique chemical mechanism to harden their shells which uses molecular oxygen and an enzyme called multicopper oxidase-2 (MCO2). Now, they argue that this gives them a disadvantage in the sea, while it confers advantages that help them on land, placing MCO2 at the heart of insect eco-evolution.

Insects are some of the most successful organisms on the planet. They are said to make up the most biomass of all terrestrial animals and have a significant impact on the global ecosystem. However, their abundance is matched by their startling rarity in the sea. Very few insects call the sea home, even though their biological ancestors came from there. It is a pervading mystery of science, one that scientists have been trying to answer for many years.

Now, researchers from Tokyo Metropolitan University led by Assistant Professor Tsunaki Asano have proposed a solution based on evolutionary genetics. The latest in molecular phylogenetics has taught us that both crustaceans and insects are part of the same family, Pancrustacea, and that insects were a branch that left the sea and adapted to the land. They share an important feature, an exoskeleton consisting of a wax layer and hard cuticle.

New hypothesis says it's to do with how they harden their shells.

In previous work, the same team showed that when insects adapted to terrestrial environments, they evolved a unique gene that creates an enzyme called multicopper oxidase-2 (MCO2) that helps them harden their cuticles using oxygen. MCO2 mediates a reaction where molecular oxygen oxidizes compounds called catecholamines in the cuticle, turning them into agents that bind and harden the surface. This is in contrast to crustaceans who harden their cuticles using calcium from seawater instead. The team's claim is that this makes the land far more suitable for insects due to the abundance of oxygen. The sea is now a harsh environment due to both the lack of oxygen and the abundance of better-adapted organisms.

But it is not just that the sea is not as hospitable for insects anymore. The hardening and drying of the cuticle via the MCO2 pathway lead to a biomaterial that is not only protective, but also lightweight. They postulate

that this may be why insects gained the ability to climb plants, glide, and eventually fly. This allowed them to migrate and occupy previously empty niches in the ecosystem, a strong driving force that led to their sheer numbers. Again, this is in contrast to crustaceans, whose shells are significantly denser, with a strong correlation between density and the degree of calcification.

Of course, insects are hardly the only arthropods to adapt to the land, so it's clear that MCO2 is not strictly necessary for success in "terrestrial niches." However, the nature of insect cuticles speaks volumes about their success in the terrestrial environment. In fact, the team believes that MCO2 might be a defining feature of insects: "no MCO2, no insects." Their work promises an entirely new highlight on the role that cuticle hardening might play in insect evolution and terrestrialization.

Sci Tech Daily, 6 May 2023

https://scitechdaily.com

Stone Age Molecules Resurrected From Ancient Dental Plaque

2023-05-07

Reconstructing the bacterial genomes recovered from the calcified plaque of human and Neanderthal remains has offered new insights into previously undescribed Pleistocene bacterial metabolites, researchers report. The approach expands researchers' ability to study microbial natural products, which has otherwise been mostly limited to studying living bacteria.

Bioactive small molecules produced by microbes, often called natural products, have been an important source of diverse functional compounds for industry and medicine, including many antimicrobials. Characterizing the natural products encoded in biosynthetic gene clusters (BGCs) once produced by the microbiota of the ancient microbiome would provide valuable insight into previously unknown metabolites, as well as their role in the nutrition and health of early hominins.

Although recent advances in paleogenomics have illuminated past genomic diversity in humans, the functions and biosynthetic capabilities of this rapidly growing paleome remain elusive.

Martin Klapper and colleagues searched for biosynthetic gene clusters in metagenomic datasets extracted from calcified dental plaque, or dental

Scientists reconstructed ancient bacterial genomes from human and Neanderthal dental plaque.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

calculus, from ancient human and Neandertal remains spanning roughly the past 100,000 years.

They reconstructed 459 bacterial metagenome-assembled genomes (MAGs). Some of the MAGs were more than 90,000 years older than the previously oldest reconstructed MAGs. Within this sample, Klapper et al. discovered a previously undescribed Pleistocene-era bacterial species within the genus Chlorobium, which contained a BGC shared by seven Middle and Upper Paleolithic individuals.

Using heterologous expression techniques to reconstruct the biosynthetic action of these ancient BGCs, the authors found that they produced previously unreported metabolites, namely 5-alkylfuran-3-carboxylic acid products that the authors dub paleofurans.

According to the authors, the findings demonstrate the paleobiotechnological approach's potential in future natural product exploration in ancient metagenomes.

"By merging metagenomics, genome mining, gene synthesis, and metabolic analyses with the field of [ancient DNA] research, we chart a path for the discovery of ancient natural products to gain evolutionary insights on their formation and origin, as well as to inform their potential future applications," write Klapper et al.

Sci Tech Daily, 7 May 2023

https://scitechdaily.com

New cellular 'organelle' discovered inside fruit-fly intestines

2023-05-04

Phosphate is essential to life. Now, researchers have discovered a tiny structure inside animal cells that acts like a reservoir of phosphate, helping to regulate levels of the nutrient inside cells and triggering processes that maintain tissues when it is in short supply1. The researchers classify the structure as a new type of organelle — fundamental structures in cells, such as the nucleus, mitochondria and the membrane, that function as miniature organs in its body.

"This is one of the first studies to actually find phosphate storage in an animal cell," says Rebekka Wild, a structural biologist at the French national research agency CNRS in Grenoble, who was not involved in the research. "It's really exciting."

Fruit-fly cells use previously unknown complex cellular structures to store phosphate, a molecule essential to life

In plants, bacteria and yeast, phosphate is important for cell growth and helps cells to communicate and generate energy. Although it is known to be essential in animal tissues and cells, few studies had explored its specific functions. Charles Xu, a geneticist at the Rockefeller University in New York City, was curious about what part phosphate played in regulating tissue renewal in the fruit-fly gut, a useful model for studying how diseases affect cells in the human intestine. "That's not really well known, especially in animal cells," says Xu.

Fruit-fly findings

Xu and his colleagues fed fruit flies (Drosophila melanogaster) phosphonoformic acid (PFA), which inhibits absorption of phosphorous in cells. When the researchers stained and imaged cells from the flies' intestinal lining, they noticed that the lack of phosphate led to a spike in cell numbers. This rapid cell multiplication also occurred when Xu and his colleagues fed the flies food that contained 10% less phosphate than standard levels, indicating that the phosphate did indeed have an impact on cell numbers.

To find out how phosphate was having this effect, Xu and his team investigated whether low phosphate levels affected gene expression. A gene that the authors call PXo is similar to a mammalian gene that encodes a phosphate-sensing protein. Xu and colleagues found that PXo's expression was weaker when cells were deprived of phosphate. This reduced gene expression also kicked cell division into overdrive. However, cell division slowed down when the researchers tweaked the gene to overexpress the PXo protein.

The researchers labelled the PXo protein with a fluorescent tag and noticed that it was associated with an array of oval-shaped structures in the cells that did not seem to be any of the known organelles.

Phospholipid reservoirs

"These were quite visible, and we wondered what they were," says Xu. When the scientists took a closer look at the mysterious structures, they saw they had several membrane layers, and the PXo protein was transporting phosphate across them. Once inside the unfamiliar organelles, the phosphate was converted to phospholipids, the main building blocks of cellular membranes.

When the fly cells were deprived of phosphate, the organelles broke apart and released the stored phospholipids into each cell, indicating that

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

they function like reservoirs, says Xu. This breakdown activated cellular machinery known as Cka, triggering a stress signal that increased the production of new cells. This could be a way for the intestinal lining to keep phosphate levels stable, because the increased number of cells can absorb more of the nutrient, says Xu. "It's beneficial for the organism to regenerate more of these healthy [cells]," he says.

Wild says that the findings lay the groundwork for exploring whether there are similar phosphate-storing organelles in other animals, including humans. She adds that it could be useful to take a deeper look at the structure of the PXo protein, to unravel how it transports phosphate into the organelles. "This would be very interesting, especially for people who come from the structural-biology side," she says.

Xu says a next step could be to investigate how these phosphate-storing organelles interact with other organelles, and how their dynamics change over time. "It's opened the door to many other questions," he says.

The discovery of a new organelle in animal cells also highlights how much there is still to learn about cell physiology, adds Xu. "The beauty is there, it's just waiting for us to discover it," he says.

Nature, 4 May 2023

https://nature.com

Why champagne bubbles fizz straight up

2023-05-04

New research explains why bubbles in Champagne fizz up in a straight line while bubbles in other carbonated drinks, like beer or soda, don't.

The findings are based on a series of numerical and physical experiments, including, of course, pouring out glasses of Champagne, beer, sparkling water, and sparkling wine.

The results not only explain what gives Champagne its line of bubbles but may hold important implications for understanding bubbly flows in the field of fluid mechanics.

"This is the type of research that I've been working out for years," says Roberto Zenit, engineering professor at Brown University and senior author of the study in the journal Physical Review Fluids.

"Most people have never seen an ocean seep or an aeration tank but most of them have had a soda, a beer, or a glass of Champagne. By talking about Champagne and beer, our master plan is to make people understand that fluid mechanics is important in their daily lives."

Bubble Chains

The team's goal was to investigate the stability of bubble chains in carbonated drinks. Part of the signature experience of enjoying these beverages is the tiny or large bubbles that form when the drink is poured, creating a visible chain of bubbles and fizz. Depending on the drink and its ingredients, the fluid mechanics involved are all different.

When it comes to Champagne and sparkling wine, for instance, the gas bubbles that continuously appear rise rapidly to the top in a single-file line and keep doing so for some time. This is known as a stable bubble chain. With other carbonated drinks, like beer, many bubbles veer off to the side, making it look like multiple bubbles are coming up at once. This means the bubble chain isn't stable.

The researchers set out to explore the mechanics of what makes bubble chains stable and if they could recreate them, making unstable chains as stable as they are in Champagne or prosecco.

The results of their experiments indicate that the stable bubble chains in Champagne and other sparkling wines occur due to ingredients that act as soap-like compounds called surfactants. These surfactant-like molecules help reduce the tensions between the liquid and the gas bubbles, making for a smooth rise to the top.

"The theory is that in Champagne these contaminants that act as surfactants are the good stuff," Zenit says. "These protein molecules that give flavor and uniqueness to the liquid are what makes the bubbles chains they produce stable."

Size Matters

The experiments also showed the size of the bubbles themselves affect the stability of the bubbles. They found that the chains with large bubbles have a wake similar to that of bubbles with contaminants, leading to a smooth rise and stable chains.

In beverages, however, bubbles are always small. It makes surfactants the key ingredient to producing straight and stable chains. Beer, for example, also contains surfactant-like molecules but, depending on the type of beer, the bubbles can rise in straight chains or not. In contrast, bubbles in carbonated water are always unstable since there are no contaminants helping the bubbles move smoothly through the wake flows left behind by the other bubbles in the chain.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

"This wake, this velocity disturbance, causes the bubbles to be knocked out," Zenit says. "Instead of having one line, the bubbles end up going up in more of a cone."

The results in the new study go well beyond understanding the science that goes into celebratory toasts, the researchers say. The findings provide a general framework in fluid mechanics for understanding the formation of clusters in bubbly flows, which have economic and societal value.

Technologies that use bubble-induced mixing, like aeration tanks at water treatment facilities, for instance, would benefit greatly from researchers having a clearer understanding of how bubbles cluster, their origins and how to predict their appearance. In nature, understanding these flows may help better explain ocean seeps in which methane and carbon dioxide emerges from the bottom of the ocean.

Champagne Bubbles vs. Beer Bubbles

The experiments the research team ran were relatively straightforward—and some could even be run in any local pub. To observe the bubble chains, the researchers poured glasses of carbonated beverages including Pellegrino sparkling water, Tecate beer, Charles de Cazanove champagne, and a Spanish-style brut.

To study the bubble chains and what goes into making them stable, they filled a small rectangular plexiglass container with liquid and inserted a needle at the bottom so they could pump in gas to create different kinds of bubble chains.

The researchers then gradually added surfactants or increased bubble size. They found that when they made the bubbles larger, they could make unstable bubble chains become stable, even without surfactants. When they kept a fixed bubble size and only added surfactants, they found they could also go from unstable chains to stable ones.

The two experiments indicate that there are two distinct possibilities to stabilize a bubble chain: adding surfactants and making bubbles bigger, the researchers explain in the paper.

The researchers performed numerical simulations on a computer to explain some of the questions they couldn't explain through the physical experiments, such as calculating how much of the surfactants go into the gas bubbles, the weight of the bubbles and their precise velocity.

They plan to keep looking into the mechanics of stable bubble chains in an effort to apply them to different aspects of fluid mechanics, especially in bubbly flows.

"We're interested in how these bubbles move and their relationship to industrial applications and in nature," Zenit says.

Additional coauthors are from the University of Toulouse in France and Brown.

Futurity, 4 May 2023

https://futurity.org

Researchers Assemble Pathogen "Tree of Life"

2023-05-04

A groundbreaking online resource for plant pathogens has been developed, aimed at assisting researchers worldwide in identifying, detecting, and monitoring species of Phytophthora. These pathogens have caused various plant diseases, from the catastrophic Irish potato famine in the 1840s to the ongoing sudden oak death affecting West Coast oaks.

This innovative "tree of life" for pathogens offers extensive information on over 192 officially recognized species, such as their evolutionary history and interrelationships within groups. Additionally, it covers more than 30 informally identified taxa. The tool incorporates genetic sequence data from multiple sites within each species' genome, as well as crucial details like the global locations of each species, their plant hosts, and the locations where the pathogens reside in or on the host plants.

"We're taking all known Phytophthora species and putting them into a living 'tree of life' using the Tree-Based Alignment Selector (T-BAS) toolkit that was developed by my colleague Ignazio Carbone," says Jean Ristaino, William Neal Reynolds Distinguished Professor of Plant Pathology at North Carolina State University and corresponding author of a paper in the journal PLOS ONE that describes the tool. "Researchers can place emerging threat species into the open-access tree and look at which groups are expanding and evolving."

The new tool will allow researchers to update plant disease information in real time.

"The real key to preventing disease outbreaks is to grab the signals before the outbreak occurs," said Ristaino, who directs NC State's Emerging Plant

A first-of-its-kind online tool enables global researchers to identify, detect, and monitor Phytophthora species, providing real-time updates on plant diseases and aiding in disease surveillance.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

Disease and Global Food Security cluster. "T-BAS could be useful as a tool for disease surveillance and for figuring out the next new lineage that might emerge. Researchers can query this database and the tree will incorporate the new species."

The first species in the genus Phytophthora, or "plant destroyer," was described and named in 1876. Phytophthora are present in the air, soil, and water and can cause disease on food crops, ornamental plants, and trees.

"About 150 new Phytophthora species have been identified since 2000," says NC State Ph.D. student Allison Coomber, who developed the tool with the team.

"This is an unusually large number of plant pathogen species," Ristaino said. "Many Phytophthora species have broad host ranges, so they can 'move' over wider areas."

Ristaino, who published a paper in Nature in 2001 identifying the strain of Phytophthora infestans that caused the Irish potato famine, hopes to eventually integrate physical maps with the T-BAS data to help provide better pathogen monitoring between states or countries.

"We have mined all published data on Phytophthora," Ristaino said. "Collaboration and sharing data makes much more sense than being secretive."

Ristaino added that the Phytophthora T-BAS Tool is housed in the DeCIFR web portal available through NC State's Center for Integrated Fungal Research, which explores fungi and the roles they play in agricultural, animal, environmental, and human health systems. Further information on access to the tool can be found on the Ristaino Lab website.

Sci Tech Daily, 4 May 2023

https://scitechdaily.com

Need to keep your picnic cool? Try mushrooms instead of dry ice

2023-05-05

"Cool as a cucumber" might be better phrased as "cool as a mushroom." A research team has found that mushrooms and other fungi, including yeast and molds, stay cooler than their surroundings—and has also explained how they stay so chill. The contain a lot of water—just think how

Researchers document a remarkable cooling ability in yeast, mold, and mushrooms, thanks to evaporation.

mushrooms shrink when cooked—and gradually release it in a fungal form of sweating that lowers their temperature, the microbiologists report this week in the Proceedings of the National Academy of Sciences.

"It's kind of a neat finding," says Christopher Still, an ecophysiologist at Oregon State University who was not involved with the work. Mostly for fun, the team even built a picnic cooler powered by mushrooms.

Walking in the woods during the COVID-19 pandemic, Johns Hopkins University microbiologist Radamés Cordero was trying out his lab's new thermal camera, which records infrared—heat—as images. He and his colleague Arturo Casadevall planned to use the camera to see how the dark pigments of some fungi influence their surface temperature. During his hikes, Cordero imaged about 20 kinds of wild mushrooms, and all—regardless of color—were cooler than their surroundings.

Following up in the lab, the researchers found that some species, such as the brown American star-footed amanita, were just 1°C or 2°C cooler than their surroundings, but the oyster mushroom Pleurotus ostreatus was almost 6°C cooler. Moreover, 19 kinds of molds and yeast, including Brewer's yeast, the mold that makes penicillin, and a few human pathogens, were also cool, particularly near the center of their colonies. Even at air temperatures close to freezing, the colonies were about 1°C colder.

The temperatures of the single-cell fungi were a surprise, because compared with mushrooms they have much less surface area per volume, even when grouped into colonies, for losing heat. But the work suggests "this phenomenon is a widespread feature of the fungal kingdom," Cordero says. (Only after his team's initial research did he discover that another team showed more than 20 years ago that at least one kind of cultivated mushroom keeps its cool.)

By dehydrating mushrooms or measuring their cooling ability at different air humidities, the researchers determined that the chilling effect stems from water evaporating from the fungi—the equivalent of sweating on a hot day. The complex gill architectures on the undersides of mushroom caps increase the surface area for such cooling. Plant leaves similarly cool themselves, by releasing water through pores, but their method is usually not as effective.

How the fungi benefit from staying so cool is unclear. It might aid in the development or release of spores from the mushroom caps, or "it may just

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

be that this kingdom prefers a lower temperature," Casadevall says. "That would be a neat thing to explore," Still says.

In the meantime, the cool mushrooms can be put to work. Cordero and Casadevall put two air holes in a small Styrofoam packing box containing less than a half-kilogram of button mushrooms, installed a computer exhaust fan in one hole to draw air through it, and put the box into a larger Styrofoam container. With the fan on, the larger container's temperature dropped 10°C within 40 minutes and stayed there for half an hour. "You are not going to freeze water," through mushroom cooling, Casadevall says. But the prototype could easily keep a six-pack and lunch chilled for a quick picnic, he says, "and you can eat the [mushrooms] afterwards."

Science, 5 May 2023

https://science.org

How technology is helping farmers grow more food with less chemicals

2023-05-07

Jon Walz's century-old farm in Stapleton, Nebraska, has 300 head of cattle, corn fields, and other crops, including oats and rye. On a recent morning in April, the whole farm seemed to need his attention after temperatures abruptly swung from frigid winter lows to sweltering summer highs.

Walz brought a sick calf and its mother into a corral, attended to several pieces of irrigation equipment that needed maintenance, and started setting up an herbicide sprayer. "There's just a lot of things happening on the farm right at the moment," he said while checking to see if any of his other cows were giving birth.

As part of a recent push to make the farm more sustainable, Walz has added another item to his to-do list. He's testing several technologies that promise to reduce his use of nitrogen fertilizer and the associated environmental impacts.

Last year, working with researchers at the University of Nebraska-Lincoln, Walz attached a sensor to his tractor that measured the greenness of his crops as he drove over them. The sensor identified which parts of his field already had enough nutrients. By applying less fertilizer in those areas, he cut his nitrogen use by 32%.

Regulators, consumers, and farmers want to use less chemicals to grow food; chemical companies are changing their business models in response.

"Sometimes it's expensive," Walz says of the technology. "But I think the opportunity to be more efficient using that technology, as long as it's reasonably priced, is there."

The overuse of agricultural chemicals, such as fertilizers, herbicides, and other pesticides, cuts into farmers' incomes, generates tons of greenhouse gas emissions, and represents a major source of water pollution. Regulators are pushing farmers to cut their chemical use, but farmers also need to grow more—at least 35% more than they did in 2010 if they are to meet the food needs of the world's population in 2050, according to one recent analysis published in the journal Nature Food (2021, DOI: 10.1038/s43016-021-00322-9). Some farmers are now trying to grow more food with less chemicals by adopting technologies that apply them only when and where they are necessary. Like Walz, many growers are using in-field sensors or aerial imagery to map the nutrients a crop needs and apply them more judiciously. Others are using sprayers equipped with cameras that can pinpoint weeds and kill them with a targeted shot of herbicide rather than a blanket of it.

These techniques are also transforming the companies that make fertilizers and pesticides. In the future, instead of selling as many tons of chemicals as possible, companies say they will provide farmers with a suite of software, machinery, and chemical products to maximize a farm's profitability.

That's a monumental and difficult shift for an industry that for nearly a century has made money by discovering, manufacturing, and selling large volumes of chemicals. And it will likely require a new business model, one based on how much these new tools help the farmer, says Niall Mottram, who leads Cambridge Consultants' agricultural technology business. "Rather than selling pounds of fertilizer, they're wanting to sell outcomes."

For Walz, technology is only one part of a strategy to transition his farm toward more regenerative agricultural practices. In addition to mapping how much fertilizer his fields need, he's using more cover crops—plants that improve the soil but aren't harvested—to add nitrogen and suppress weeds. Walz believes that combining these approaches will make his farm much less reliant on chemicals.

"We've got a few fields where we haven't used Roundup for several years," he says of the ubiquitous herbicide. "That's the direction that we're going to be pushing. I think it's more than possible."

Fertile ground

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

Synthetic nitrogen fertilizers were introduced on US farms in the middle of the 20th century, and their use increased steadily until the 1980s. Since then, they've been applied consistently to nearly all the corn grown in the US. Those extra nutrients significantly boost farmers' yields, but they can harm ecosystems and human health when excess leaches into the environment.

Each summer, fertilizer runoff contributes to a massive oxygen-poor zone in the Gulf of Mexico that's unable to support marine life. One recent study published in Environmental Health estimates that 5.6 million people in the US drink water with dangerous levels of nitrates, partly because of pollution from fertilizers (Environ. Health 2019, DOI: 10.1186/s12940-018-0442-6). The production of nitrogen fertilizers in particular is also a major source of greenhouse gas emissions.

Part of the problem is that farmers typically apply the same amount of nitrogen to every part of their land, even though the nutrient needs within a field usually aren't uniform. That means some parts of a field receive too much nitrogen, while other parts don't get enough. Farmers also apply phosphorus and potassium fertilizers, but these nutrients can build up in soil over time, so precision is less important.

"Being more surgical and efficient with our nutrient applications means less of that impact on our water supply and in our aquatic systems and fisheries," says Steven Mirsky, a US Department of Agriculture research ecologist who studies agricultural technology.

Ninja Ag uses images captured by drones or satellites to measure the normalized difference vegetation index (NDVI), a ratio between red and near-infrared light reflected off the field. Higher values, shown in green, typically represent greener plants, while lower values, shown in red, may represent yellowing plants, bare ground, or very wet areas. The company uses these data to identify which parts of a field need fertilizer.

The challenge is figuring out exactly how much fertilizer each part of a field needs and when to apply it. In 2018, a group of agricultural researchers from Oklahoma State University formed the start-up Ninja Ag to help farmers answer those questions using aerial imagery.

The company, which started operating commercially in 2021, first asks farmers to apply an ample amount of fertilizer to one strip of a field, which will serve as a reference point for the healthiest possible plants. Ninja Ag then analyzes an aerial image of the farm captured by drones or satellites, comparing a measure of greenness—a proxy for chlorophyll and thus

plant health—from the reference strip with that measure from the rest of the field. Farmers use a handheld greenness sensor in a few areas to calibrate the readings from satellites or drones, making the data more precise.

The data are loaded into a formula that considers the farm's location, the weather that season, and how big and green the crop is. The formula generates a map recommending the best way to apply fertilizer.

As proof that Ninja Ag can help farmers apply nitrogen more efficiently, CEO Courtney Arnall points to Brent Rendel, a farmer in Oklahoma who says the system reduced his overall fertilizer use on his most recent winter wheat crop.

Without Ninja Ag's system, Rendel says, he would have used far too much nitrogen in multiple fields. There were also areas of his fields where the system said his typical flat rate of nitrogen wouldn't have been enough. "I had fields that needed almost nothing and fields that needed a lot," he says.

Other companies are getting closer to the plants to measure how much fertilizer a field needs. The start-up Autonomous Pivot mounts nitrogen sensors on irrigation pivots, the rotating metal scaffolds that arc over a field and drip liquid fertilizer and water on crops.

The company divides the field into slices and recommends how much fertilizer to apply in each one. While dripping fertilizer from above, the pivot moves faster over slices that need less and slower over slices that need more. The system is already available for potato farmers, and the company hopes to move into corn next. CEO Yuval Aviel estimates that the system can reduce fertilizer use by 10–20% without cutting into yield, compared to conventional fertilizer management.

Another company, Arable, gets even closer to the crop. It sells a device that looks like a lamppost rising above a field. The post is packed with sensors. A camera on the underside looks down on the crop and measures greenness, while a sensor in the ground monitors soil moisture and temperature.

CEO James Ethington says having a sensor positioned directly above a crop at all times helps farmers spoon-feed their plants fertilizer throughout the growing season rather than apply a large amount at the beginning of the season, when it's more likely to be wasted.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

Farmers without the tools to determine exactly how much fertilizer their crops need will generally apply more than they think is necessary as a form of insurance, Ethington says. Applying extra fertilizer costs farmers more, but it protects them from the risk of using too little fertilizer and missing out on a huge harvest. "We'll put better tools in the hands of the farmer so that they can better see and decide what they actually need," he says.

Right now, Arable's devices are used mostly by large food companies that operate their own farms and by big chemical companies, which use them to monitor field trials for new varieties of seeds or pesticides. The company hopes to start selling more devices to traditional growers.

Laura Thompson, a researcher at the University of Nebraska–Lincoln, says such systems can help farmers save significant amounts of fertilizer, but each farm is different. There's no one-size-fits-all approach, she says, and it's important for farmers to find the technology that's most appropriate for their land.

"We would expect more benefit from these technologies when we're in fields that are more variable, compared to a uniform field where a farmer's traditional, uniform, flat management would be fine," Thompson says. In some cases, a new technology could recommend the same overall amount of fertilizer as the farmer would have otherwise used, she says, but it might recommend distributing it in a different way to increase production.

Smart sprayers

In the US, most corn, soybean, and cotton farmers apply a blanket of herbicides to crops that have been genetically modified to tolerate them. Many farmers love the simplicity of this system, but it also means that most of the herbicide they're spraying is simply wasted on the dirt.

In addition to damaging native plant life and threatening water sources, the overuse of herbicides has led to the evolution of weeds that can tolerate these chemicals. These herbicide-resistant plants have forced farmers to use more chemicals to control weeds, increasing the chances that new herbicide-resistant weeds will emerge. Farmers are desperate for new herbicides to escape this vicious cycle, but some companies say making smarter machinery to apply the chemicals is another way out.

"I think if you go out in 20 years and say, 'We were spraying contact herbicides even where there weren't weeds,' people will think, 'Why were you ever doing that?'" says Matt Leininger, who leads the North American division of One Smart Spray.

The equipment manufacturer Bosch and the chemical company BASF formed One Smart Spray as a joint venture in 2021 to create a tractor-mounted sprayer that precisely applies herbicides to weeds located by onboard cameras.

An artificial intelligence program analyzes images from the cameras in real time. It instructs nozzles to open when they are directly above a weed and stay closed when there are no weeds to spray. In field trials, the company showed that its sprayer used 70% less herbicide than a conventional broadcast sprayer. In April, equipment maker Agco announced that it would incorporate the technology in some of its tractors next year.

Greeneye Technology's sprayer uses artificial intelligence to identify weeds and then applies a targeted shot of herbicide to kill them.

Several start-ups are developing similar technologies. Greeneye Technology is already selling a sprayer that can be attached to a farmer's tractor. CEO Nadav Bocher says the arm's cameras can identify the species of a weed and send that information back to farmers. In the company's first commercial season, customers reduced their use of in-season contact herbicides by 88%.

"That's a game changer for farmers," Bocher says. "It's not only how much product you can save, but it's also about the [herbicide] products you can use, which were not affordable prior to this technology because they were too expensive to broadcast across the entire field."

Precision AI, which recently won the Cooperative Ventures Innovation Challenge at the World Agri-Tech Innovation Summit, is about to commercialize a drone that scours fields for weeds and records their precise locations on a digital map. Later, farmers load the data onto a tractor-mounted sprayer that sprays only the weeds identified on the map.

Precision AI uses a fixed-wing drone rather than one with only downward-facing rotors to avoid disturbing the air underneath the machine. That makes it easier to spray herbicides while flying.

The company is already testing the next generation of the technology: a drone that both spots weeds and automatically sprays them with a blast of herbicide from above. CEO Daniel McCann envisions a future in which farmers have a "hive" of drones that wake up once a week to scan the farm and spray any chemicals that are needed, with little human intervention.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

"It sounds superfuturistic, but at the pace technology and AI is developing, I actually think it's going to be shockingly closer than people think," he says.

Until recently, this type of spot treatment simply wasn't feasible, but advancements in cameras, computer chips, and artificial intelligence have made it possible.

Mottram, the analyst with Cambridge Consultants, says the first smart sprayers deployed on farms will be expensive, but prices will fall as the underlying technology improves. At the same time, Mottram says the cost of agricultural chemicals has been rising, strengthening the argument that this technology is a good return on investment. "Imaging technologies and hardware will keep getting cheaper," he says.

Big business

If smart-spraying machines and systems to optimize the use of nutrients start spreading through the farm belt, they could chip away at the volume of chemicals needed to grow food. Combined with the impact of stricter regulations, the use of these tools has the potential to upend the crop protection industry's long-standing business model of selling as much fertilizer and pesticide as possible.

"Chemical companies cannot follow the same path as they have been doing for the past 70 or 100 years: research, find a chemical, sell it, and keep selling it," says Tim Appachanda, an agricultural analyst with Lux Research.

Rachel Rama, head of small molecules at Bayer Crop Science, says her company is starting to move toward a model in which farmers pay for the outcome, such as a field free of weeds, rather than a specific chemical. "You are not selling the liquid in the bottle anymore," she says. "You are selling the results in the field."

Like Bocher, Rama says applying lower volumes of herbicides more precisely could also open the door to products, such as biological herbicides or molecules with new modes of action, that are too expensive to use in a conventional, indiscriminate sprayer. "You can have a quite expensive product because at the end, the cost per hectare is going to be OK," Rama says.

Other companies are taking the same approach. BASF, Corteva Agriscience, FMC, and Syngenta have all released software to help farmers use pesticides more efficiently. Bayer's digital tools were used on more

than 80 million hectares in 2022, but Mottram doubts that companies are generating a profit from such initiatives. "I don't think anyone's making huge dollar out of that today. But it's definitely the route of travel," he says.

Justin Gayliard, head of digital farming in North America for BASF, says the company has struggled to get farmers in North America to use its software. But the company is investing heavily in the program and still views it as a pillar for long-term growth.

"Our future is: How can we help agronomists use tools and technology to bring better decision-making to the farmer?" Gayliard says.

Fertilizer companies are experimenting with different business models as well. Nutrien is piloting a program that pays farmers to use less fertilizer. The company makes recommendations about how to reduce fertilizer use and measures how much those actions shrink each farmer's carbon footprint. Nutrien hopes to sell the resulting carbon credits. The company "became the platform for trading carbon credits . . . which compensates for the lower purchase of inputs by farmers," says Appachanda, who wrote a case study on the program.

Markus Braaten, market development director for digital agronomy at the fertilizer company Yara, says his company is increasingly focused on how much food its products help farmers grow rather than how much fertilizer it sells. But he says everyone in the industry is still calculating how to make money this way.

"Our current business model is not really designed for that. The entire agricultural value chain really isn't designed for that," he says. "We have to figure out how to create alignment in what we value across the value chain."

Slow adoption

The companies developing technologies to use pesticides and fertilizers more efficiently are promising to make farming more sustainable and break agriculture's dependence on expensive chemicals. But these tools won't have any impact if farmers don't use them.

Machines that apply fertilizer according to how much a certain area needs have been around since GPS became widely available, in the 1990s. After 3 decades, this method of fertilizer application is still used on only 28% of the corn grown in the US, according to a USDA report.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

Many farmers say flashy equipment often fails to live up to lofty claims from marketing materials, and they can be skeptical that it will provide a good return on investment. That group includes Walz, who says the sensor he mounted on his tractor did reduce fertilizer costs, but it was difficult to use, and he wasn't impressed with the manufacturer's technical support.

With so many other tasks clamoring for his attention, it was hard to justify fiddling with a finicky piece of hardware, so he's trying another approach. This year, he's working with Sentinel Fertigation, which uses satellite imagery to recommend how much fertilizer to apply, which he's hoping will be less work.

Even if it can occasionally be frustrating, Walz is hopeful that this kind of precise technology will help him apply even less fertilizer. "I feel like it has a place," he says.

C&En, 7 May 2023

https://cen.acs.org

Popular Explanation Is Wrong – Researchers Discover New Clues Regarding the Origin of Earth's Continents

2023-05-08

New experiments have called into question a popular explanation for the properties that give rise to dry land.

Despite being a crucial factor in making Earth a hospitable place for life compared to other planets in the solar system, the origins and unique characteristics of continents, massive segments of the planet's crust, remain largely enigmatic.

A recent study conducted by Elizabeth Cottrell, a research geologist and rock curator at the Smithsonian's National Museum of Natural History, and Megan Holycross, formerly a Peter Buck Fellow and National Science Foundation Fellow at the museum and now an assistant professor at Cornell University, has advanced our knowledge of Earth's crust by testing and disproving a widely held theory regarding the lower iron content and higher oxidation levels of continental crust compared to oceanic crust.

The iron-poor composition of continental crust is a major reason why vast portions of the Earth's surface stand above sea level as dry land, making terrestrial life possible today.

The study, recently published in the journal Science, uses laboratory experiments to show that the iron-depleted, oxidized chemistry typical of Earth's continental crust likely did not come from crystallization of the mineral garnet, as a popular explanation proposed in 2018.

The building blocks of new continental crust issue forth from the depths of the Earth at what are known as continental arc volcanoes, which are found at subduction zones where an oceanic plate dives beneath a continental plate. In the garnet explanation for continental crust's iron-depleted and oxidized state, the crystallization of garnet in the magmas beneath these continental arc volcanoes removes non-oxidized (reduced or ferrous, as it is known among scientists) iron from the terrestrial plates, simultaneously depleting the molten magma of iron and leaving it more oxidized.

One of the key consequences of Earth's continental crust's low iron content relative to oceanic crust is that it makes the continents less dense and more buoyant, causing the continental plates to sit higher atop the planet's mantle than oceanic plates. This discrepancy in density and buoyancy is a major reason that the continents feature dry land while oceanic crusts are underwater, as well as why continental plates always come out on top when they meet oceanic plates at subduction zones.

The garnet explanation for the iron depletion and oxidation in continental arc magmas was compelling, but Cottrell said one aspect of it did not sit right with her.

"You need high pressures to make garnet stable, and you find this low-iron magma at places where the crust isn't that thick and so the pressure isn't super high," she said.

In 2018, Cottrell and her colleagues set about finding a way to test whether the crystallization of garnet deep beneath these arc volcanoes is indeed essential to the process of creating continental crust as is understood. To accomplish this, Cottrell and Holycross had to find ways to replicate the intense heat and pressure of the Earth's crust in the lab, and then develop techniques sensitive enough to measure not just how much iron was present, but to differentiate whether that iron was oxidized.

To recreate the massive pressure and heat found beneath continental arc volcanoes, the team used what are called piston-cylinder presses in the museum's High-Pressure Laboratory and at Cornell. A hydraulic piston-cylinder press is about the size of a mini fridge and is mostly made of incredibly thick and strong steel and tungsten carbide. The force applied by a large hydraulic ram results in very high pressures on tiny rock samples, about a cubic millimeter in size. The assembly consists of electrical and thermal insulators surrounding the rock sample, as well as a cylindrical furnace. The combination of the piston-cylinder press and heating assembly allows for experiments that can attain the very high pressures and temperatures found under volcanoes.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

In 13 different experiments, Cottrell and Holycross grew samples of garnet from molten rock inside the piston-cylinder press under pressures and temperatures designed to simulate conditions inside magma chambers deep in Earth's crust. The pressures used in the experiments ranged from 1.5 to 3 gigapascals—that is roughly 15,000 to 30,000 Earth atmospheres of pressure or 8,000 times more pressure than inside a can of soda. Temperatures ranged from 950 to 1,230 degrees Celsius, which is hot enough to melt rock.

Next, the team collected garnets from Smithsonian's National Rock Collection and from other researchers around the world. Crucially, this group of garnets had already been analyzed so their concentrations of oxidized and unoxidized iron were known.

Finally, the study authors took the materials from their experiments and those gathered from collections to the Advanced Photon Source at the U.S. Department of Energy's Argonne National Laboratory in Illinois. There the team used high-energy X-ray beams to conduct X-ray absorption spectroscopy, a technique that can tell scientists about the structure and composition of materials based on how they absorb X-rays. In this case, the researchers were looking into the concentrations of oxidized and unoxidized iron.

The samples with known ratios of oxidized and unoxidized iron provided a way to check and calibrate the team's X-ray absorption spectroscopy measurements and facilitated a comparison with the materials from their experiments.

The results of these tests revealed that the garnets had not incorporated enough unoxidized iron from the rock samples to account for the levels of iron depletion and oxidation present in the magmas that are the building blocks of Earth's continental crust.

"These results make the garnet crystallization model an extremely unlikely explanation for why magmas from continental arc volcanoes are oxidized and iron-depleted," Cottrell said. "It's more likely that conditions in Earth's mantle below continental crust are setting these oxidized conditions."

Like so many results in science, the findings lead to more questions: "What is doing the oxidizing or iron depleting?" Cottrell asked. "If it's not garnet crystallization in the crust and it's something about how the magmas arrive from the mantle, then what is happening in the mantle? How did their compositions get modified?"

Cottrell said that these questions are hard to answer but that now the leading theory is that oxidized sulfur could be oxidizing the iron, something a current Peter Buck Fellow is investigating under her mentorship at the museum.

Sci Tech Daily, 8 May 2023

https://scitechdaily.com

Scientists warn of disinfectant dangers: Study

2023-05-09

Disinfectants have had a moment since the COVID-19 pandemic began — and scientists are warning that this widespread use is spurring health problems, antimicrobial resistance and harming the environment.

"It's ironic that the chemicals we're deploying in vain for one health crisis are actually fueling another," Erica Hartmann, a co-author of a new study examining the dangers of disinfectants and an associate professor of civil and environmental engineering at Northwestern University, said in a statement.

Hartmann and colleagues' new study, published today in Environmental Science & Technology, examines quaternary ammonium compounds, or quats, which are used in disinfectants and personal care products. They reviewed the existing environmental and human health science on quats, which have been used much more since the pandemic began, and found that the compounds are linked to asthma, dermatitis, inflammation, infertility, birth defects and other problems. They can also harm aquatic life and cause antimicrobial resistance, which can make drug-resistant viruses and bacteria.

"Antimicrobial resistance was already contributing to millions of deaths per year before the pandemic, Hartmann said. "Overzealous disinfection, especially with products containing [quats], threaten to make it worse."

Quat use and exposure

Quats can be found in disinfectants, baby wipes, eye drops, hair conditioners, fabric softeners and other products. There was a spike of disinfectant use when the COVID-19 pandemic began, increasing exposure, and researchers saw an associated spike in quats in people. People are mostly exposed via their skin and breathing quats in, but food and water could be other potential sources of exposure. Certain professions, including housekeepers, food or medical equipment

"It's ironic that the chemicals we're deploying in vain for one health crisis are actually fueling another."

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

preparation, dental assistants and nurses, are more highly exposed. Children and teachers may also have elevated exposure.

"Disinfectant wipes containing [quats] are often used on children's school desks, hospital exam tables and in homes where they remain on these surfaces and in the air," Courtney Carignan, a co-author and assistant professor at Michigan State University's Center for Research on Ingredient Safety, said in a statement.

The most common quat is benzalkonium chloride, but if you see ingredients on labels that end in "ammonium chloride," there are probably quats in the product. The authors point out that U.S. regulation varies — pesticides, for example, list quats, while paints do not. Most quats are unregulated, and so are not tested for health impacts. This makes it a challenge to tease out how much people are exposed or what the health impacts are.

While the feds haven't tested the compound, academic researchers have linked the chemicals to multiple health problems, and the authors point out that there is evidence going back more than 70 years that the chemicals spur antimicrobial resistance.

"Antimicrobial resistance was already contributing to millions of deaths per year before the pandemic. Overzealous disinfection, especially with products containing [quats], threaten to make it worse," Hartmann said.

Using safer cleaning products

The authors recommend not using quat-containing compounds when the chemicals are unnecessary. Soap and water usually do the trick — and if you need a disinfectant, University of Massachusetts Lowell has a guide to safer products.

Environmental Health News, 9 May 2023

https://ehn.org

Fortified with Coconuts, 'Living' Shorelines Are Stopping Coastal Erosion

2023-05-05

Along South Riverside Drive in Neptune, New Jersey, until last fall, at high tide on the Shark River, water almost lapped the edge of the road, yards away from a row of houses.

From New Jersey to Texas, a nature-nurturing alternative to concrete sea walls is protecting America's coastline.

"It used to flood all the time," says Al Modjeski, habitat restoration program director of the American Littoral Society. "The tide comes right up." Neptune is less than three miles from the Atlantic Ocean, into which the Shark River feeds.

To strengthen the shoreline, the organization led a project to build up the riverside dune and expand and raise the beach with new sand. To encourage marsh vegetation to grow at the water's edge, teams also installed shaggy logs made of a fiber that you're more likely to see in Bali than along the Jersey Shore: shredded coconut husk.

Coir, as the material is known, is a common ingredient in an approach to combating coastal erosion through habitat restoration. An increasingly popular alternative to hard barriers like concrete bulkheads, these so-called "living shorelines" utilize natural elements like rocks, reefs and plants to fortify the shore against erosion. Biodegradable yet sturdy, coconut fiber frequently plays a role as a temporary buffer that can help build up soil layers and give vegetation a stable place to take root.

Mitigating coastal erosion is an urgent matter for communities in New Jersey and beyond in the face of rising sea levels and stronger storms. Shoreline habitat like salt marshes can improve resiliency. But those habitats have diminished, in part the consequence of centuries of changes to the waterfront to accommodate agriculture, shipping and development.

In the past, a common approach to protecting coastal property was to build a bulkhead, like a wall, to deflect waves. However, Modjeski explains, those structures have limited lifespans. "You're not really absorbing wave energy," he says. "You're reflecting it."

Sea walls are tough on local ecosystems, too. One assessment found biodiversity is 23 percent lower along hardened coastlines, and there are fewer plants and animals.

Living shorelines, in contrast, aim to encourage the development of coastal ecosystems that are naturally resilient to erosion. Benefits of restoring habitat at the water's edge go beyond reducing erosion; the projects also are found to improve water quality, benefit fisheries and sequester carbon. According to the National Oceanic and Atmospheric Administration, a square mile of salt marsh can annually "store the carbon equivalent of 76,000 gallons of gas."

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

Modjeski's team adapts each living shoreline project to the particularities of a location, layering in elements like stone breakwaters, and bags of shells to form reefs. The plans often include expanding marsh vegetation, which can trap sediment and absorb the force of waves. That's where coir comes in.

When the stiff, reddish-brown material is secured along coastal areas, it captures silt and sediment to build up the floor elevation, and offers a stable environment for plants and organisms to move in. The American Littoral Society uses it in different ways, sometimes in lines to stabilize dunes and a beach, like in Neptune. In other projects, like Thompson's Marsh in New Jersey, coir logs were stacked on top of each other to form a yard-tall wall that was infilled with sediment from a nearby channel. The fibers will decompose, usually in between two and five years, but by the time it's gone, the vegetation has taken over.

"It provides you that temporary time to have plants establish," Modjeski says.

Coir, fibers stripped from coconut shells, has gained popularity as an alternative to plastic geotextiles in watershed erosion control and shoreline stabilization around the world. A pilot in Indonesia used coconut husks and fishing nets to construct an "eco-sea wall." In India, matting made of coconut fiber was found to stabilize embankments around ponds while vegetation grew up. The coir Modjeski typically uses is sourced from India and Indonesia, and bound into logs with fiber after it arrives in the US.

As more US states turn to nature-based erosion solutions, coir is in the toolkit for both salt and freshwater.

In Texas, Andrew Clamann with Austin's Watershed Protection Department used coir logs to protect the shores of a reservoir on the Colorado River. Recreation on the long, narrow Lake Austin can be what Clamann described as "extreme." Wake from power boats eats away at the sand and silt shore, he explains.

"We have basically ocean energy on the banks of what used to be just a little river," he says.

Clamann set up a small trial area along the lake's edge in 2009, making bays out of coir logs and experimenting with planting vegetation. The team went to great lengths to keep the coir in place, using rebar and zip ties.

Three of the four trial areas succeeded, according to Clamann's analysis. Fourteen years later, they are still flourishing.

"The places went from no plants to like a dozen different species, thick and verdant and wonderful," Clamann says. "I have a feeling that that area is stabilized in perpetuity."

Inspired by the success of the first effort, Clamann initiated another project along more than a quarter mile of the shore. This time, rather than repeating the intensive measures to secure the coir in a grid, the team installed rows of logs.

"Pretty much 100% of it all failed," he says. Clamann takes the experience as a lesson. "It's better to put more effort in a smaller thing than it is to put half the effort in a bigger thing."

Coir needs to be well secured in order to serve as a matrix where plants and organisms can establish and grow. Weighing the logs down by dripping sediment over them can help, he says.

Clamann also found the logs can easily fall apart if the outer layer is broken. Though instructions direct securing the logs by driving a stake through them, he says that allowed the fibers to escape long before plants could start to grow.

Coir is not suited for every shoreline environment. Virginia Institute of Marine Science coastal geologist Scott Hardaway says in his experience working on the shores of Chesapeake Bay, coconut fiber doesn't hold up in areas where wave energy is more intense.

"We found it very limited, simply because it doesn't last very long," Hardaway says. "After a couple of years they fall apart and so the energies that were working on a shoreline before are still there."

Hardaway says coir tends to perform better in river systems or up creeks, where the surface of the water is narrow so there is not much space for wave energy to pick up.

Often, coir is one strategy among several to create multifaceted living shoreline projects.

Native Shorelines, a company based in North Carolina, uses coir in almost every project they do, according to director Mary-Margaret McKinney. The company predominantly works with waterfront homeowners, offering an alternative to hardened shorelines.

CHEMWATCH
Bulletin Board
Curiosities
MAY. 19, 2023

Instead of building a tall wall at the water's edge, they install lower standing structures a short distance offshore, which can serve as habitat for oysters and clams if those species are present. That hard structure then blunts the force of the incoming water, giving an opportunity for marsh to develop closer to shore.

"That marsh is arguably the most important thing any homeowner can have," McKinney says.

Most Native Shorelines projects begin with laying down a layer of coir matting, she explains. Because they're often working on mucky, silty areas, the coconut fiber mat keeps the structure from sinking in while the shellfish reef and the marsh starts to develop.

Coir matting is relatively affordable, and easy to work with, she says. Since the ultimate goal is to improve shoreline ecosystems, it's a much better choice than plastic alternatives.

"Obviously we do not want to put a plastic woven geotextile fabric on miles upon miles of shoreline that we're trying to make more environmentally friendly," says McKinney.

In Neptune, New Jersey, the changes to the waterfront are starting to show. Plants are starting to grow. The beach is noticeably broader. Fiddler crabs are emerging on the sand. Modjeski says there are more steps ahead for the project. Volunteers will soon be replanting some parts.

"The two biggest words as a restoration practitioner are 'adaptive management.' You build it, you stick by it, you monitor it," he says. "You may have to tweak it again and again."

Reasons to be Cheerful, 5 May 2023

https://reasonstobecheerful.world

CHEMWATCH

Bulletin Board

Technical Notes

MAY. 19, 2023

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

CHEMICAL EFFECTS

Three years of wastewater surveillance for new psychoactive substances from 16 countries

Critical review on uranium and arsenic content and their chemical mobilization in groundwater: A case study of the Malwa region Punjab, India

Perceptions, beliefs, and current practices regarding neonatal skin care and emollient use in eastern Uganda: a qualitative study

ENVIRONMENTAL RESEARCH

Association of multiple air pollutants with oxygen saturation during sleep in COPD patients: Effect modification by smoking status and airway inflammatory phenotypes

PHARMACEUTICAL/TOXICOLOGY

Effectiveness and safety of anticoagulants among venous thromboembolism cancer patients with and without brain cancer

Effectiveness and Safety of Rivaroxaban and Low Molecular Weight Heparin in Cancer-Associated Venous Thromboembolism

Overhauling the ecotoxicological impact of synthetic pesticides using plants' natural products: a focus on Zanthoxylum metabolites

OCCUPATIONAL

Associations between prenatal phthalate exposure and childhood epigenetic age acceleration

Ultraviolet radiation exposure in cannabis growing facilities

Prenatal DEHP exposure predicts neurological disorders via transgenerational epigenetics