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

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ASIA PACIFIC

Explosives import certificate amendment fee

2021-05-31

Changes to existing import certificates may now be subject to an additional application fee. This is dependent on the type and number of changes required and is at the discretion of the EPA.

[Read about hazardous substances application fees](#)

[Read EPA guidance on importing explosives into NZ](#)

New Zealand EPA, 31 May 2021

<https://www.epa.govt.nz/news-and-alerts/>

Reassessment of methyl bromide

2021-05-31

Stakeholders in Methyl Bromide Reduction Inc (STIMBR) have applied for a reassessment of methyl bromide.

The application, formally received on 9 April 2019, is to amend the controls on the use of methyl bromide, particularly the control that required that operators recapture methyl bromide from October 2020.

A remote hearing for this application was held from 11–17 August 2020. It was adjourned so that the Decision-making Committee (DMC) could deliberate its decision, based on the information presented before and during the hearing.

Latest update – 24 May 2021

In its Direction and Minute WGT032, the DMC directed parties to the reassessment to comment on additional information provided by the applicant, the Environmental Protection Authority, and WorkSafe New Zealand. This feedback is now available.

In Direction and Minute WGT035, the DMC directed modelling experts to review the EPA Update Report 2. These reviews are now available.

In the 30th Memorandum of Counsel, the applicant asked for time to be able to provide their comments on the additional information. The DMC

Changes to existing import certificates may now be subject to an additional application fee.

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gave until 5pm on 21 May for the applicant to provide their comments, in its Direction and Minute WGT036.

New Zealand EPA, 31 May 2021

<https://www.epa.govt.nz/public-consultations/in-progress/reassessment-of-methyl-bromide/>

APVMA Gazette

2021-06-04

- 4 June 2021 - [PDF \(603.18 KB\)](#) | [DOCX \(90.02 KB\)](#)

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Content last updated:

4 June 2021

Content last reviewed:

4 June 2021

APVMA, 4 June 2021

<https://apvma.gov.au/node/86511>

AMERICA

Macaroni and cheese with a side of regulation

2021-05-26

Every day in the United States, two million boxes of macaroni and cheese are sold. As COVID-19 leaves many Americans homebound, demand for this all-American comfort food has hit record levels.

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But as consumers empty grocery store aisles, the U.S. Food and Drug Administration (FDA) continues to face mounting pressure from health and consumer advocacy groups worried about the lasting effects of the macaroni craze.

In 2017, the Coalition for Safer Food Processing and Packaging, an alliance of public health, environmental, and consumer advocacy groups, published a report that found high concentrations of phthalate chemicals in ten varieties of macaroni and cheese powders currently on the market.

Phthalates are a broad class of chemicals that are used to make plastic, and they have been historically detected in a wide variety of consumer products including nail polish, perfume, shampoo, detergent, and vinyl flooring. Phthalates have been called “everywhere chemicals” due to their presence in such a vast spectrum of products on the market.

Although not all phthalates pose substantial health risks, the phthalate found in macaroni and cheese, DEHP, is considered by some advocacy groups to be the “most widely banned phthalate around the world.” These bans stem from some research linking DHEP exposure to blocked production of testosterone, fertility complications, and even cancer.

[Read More](#)

The Regulatory Review, 26 May 2021

<https://www.theregreview.org/2021/05/26/leibson-macaroni-cheese-with-side-of-regulation/>

EPA should protect America’s children by further revisions of the Lead and Copper Rule

2021-05-27

Lead poisoning, sometimes dubbed a “silent pandemic,” causes a variety of tough-to-diagnose, widespread effects on humans (particularly children) including reduced IQ, memory loss, and brain, heart, and kidney damage. The lead pipes and lead solder in community water systems are a major cause of lead exposure in the United States. Despite decades of mitigation efforts, recent lead-water crises have afflicted Washington, DC in 2002, Pittsburgh, Pa. in 2012, Flint, Mich. in 2014, and Newark, N.J. in 2016. Particularly in Flint, large-scale lead-leaching was unnecessarily prolonged and caused documented increases in children’s blood lead levels. Poor, minority communities have suffered more from such crises, making lead contamination in drinking water an important environmental justice

The lead pipes and lead solder in community water systems are a major cause of lead exposure in the United States.

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issue. The Biden administration's infrastructure proposal includes \$45 billion for nationwide replacement of lead pipes, but even if this legislation survives congressional criticisms, many Americans would remain at risk for years if not decades while such measures are complete—unless our lead regulations are immediately and effectively improved.

The EPA's Lead and Copper Rule (LCR) of 1991 aims to protect Americans from lead contamination in water, but these recent lead crises have been attributed to its shortcomings and poor enforcement. In the aftermath of the Flint water crisis, in 2016 the EPA began a multi-year Lead and Copper Rule Revisions process, which was finalized by the Trump administration in December 2020. The Biden administration has announced plans to begin implementation of the updated form of the revised rule beginning on June 17, 2021, after a public comment period.

A study by Princeton researchers based on 20 years of data concluded that public comments have a near-zero impact on policy-making in the US, so inviting comments from the public is extremely unlikely to result in substantive changes to the revised rule. Because the revised Lead and Copper Rule remains deeply flawed and dangerous to America's children, the EPA should instead go back to the drawing board to drastically revamp it.

To improve the near-term protection of the public, the EPA needs to make fundamental changes in the rule's provisions for water sampling, action thresholds and timetables, and oversight.

Inadequate samplings. Ineffective sample collection and under-reporting of lead concentrations played a fundamental role in the initial masking of the Flint crisis. Although the Lead and Copper Rule revisions provides for a few improvements in sample collection and reporting methods, it is still inadequate. The revisions continue to require the collection of a very small number of samples for estimating lead levels in certain water systems. For instance, for a water provider serving a 10,000 to 100,000 population living in thousands of homes, only 60 samples are required every six months to represent lead levels in the entire system. The rule revisions leave site selection largely to local governments and water utilities, with minimal oversight of the selection of sampling sites. The laissez-faire approach to site selection along with inadequate sample density creates opportunities for selective sampling. (While in theory the rule supposedly steers sampling towards high-risk homes, in practice it has been easy for water systems to avoid areas with suspected high concentrations of lead.) So the system allows under-representation of lead levels. Further, proper

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Regulatory Update

JUN. 18, 2021

water lead-sampling methodology should include multiple consecutive water samples. While initial samples from a given tap tend to better represent leaded particulates, later samples better represent dissolved-lead concentrations, and both should be measured.

[Read More](#)

The Bulletin, 27 May 2021

<https://thebulletin.org/2021/05/epa-should-protect-americas-children-by-further-revisions-of-the-lead-and-copper-rule/>

High levels of arsenic and lead found in vinegar products, particularly balsamics

2021-06-01

- On May 24, 2021, the consumer protection groups Food & Water Watch and Empire State Consumer Project, Inc. (ESCP) requested (via letter) that the FDA take action to address the allegedly high levels of arsenic and lead found in many vinegar products.
- ESCP tested 24 samples of major brands of vinegars or vinegar reductions or glazes and found that 11 contained arsenic or lead and 7 contained both. And, of the 11 products, 10 were balsamic products and all were imported from Italy, Greece, or Spain. Arsenic levels in contaminated products ranged from 70 parts per billion (ppb) to more than 1,040 ppb, which means at maximum levels, one tablespoon serving of vinegar would exceed FDA's maximum allowable level of 0.01 mg arsenic in one liter of drinking water (equivalent to 10 ppb arsenic). Lead levels ranged from 68.6 to 127 ppb, which exceeded the 34 ppb safe harbor level for balsamic vinegars under California's Proposition 65.
- Citing to the dangers of arsenic and lead exposure, particularly to developing fetuses, the letter requests FDA to perform product testing and establish limits and warnings addressing lead and arsenic in vinegars and vinegar reductions or glazes.
- This letter comes in the wake of the fallout from the Congressional report on heavy metals (including arsenic and lead) in baby foods, which has prompted FDA's Closer to Zero Plan as well as proposed legislation in Congress, both aimed at reducing heavy metals levels in baby foods. Keller and Heckman will continue to monitor any developments in the regulation of heavy metals in food.

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JUN. 18, 2021

[Read More](#)

The National Law Review, 1 June 2021

<https://www.natlawreview.com/article/high-levels-arsenic-and-lead-found-vinegar-products-particularly-balsamics>

EUROPE

UK supermarkets to phase out forever chemicals, PFAS, from food packaging

2021-06-01

New details published by environmental charity, **Fidra**, show 5 out of 10 major UK supermarkets are taking voluntary action to reduce or remove PFAS from own brand food packaging, 2 aiming to be PFAS-free by the end of 2021.

Environmental charity, Fidra, have been calling for the removal of PFAS, chemicals of health and environmental concern, since testing revealed widespread use in UK food packaging. In February 2021, Fidra delivered almost 12,000 signatures to the CEO's of Aldi, ASDA, Co-op, Iceland, Lidl, Morrisons, Marks and Spencer, Tesco, Sainsbury's and Waitrose, urging action to remove these highly persistent chemicals from food packaging.

New details published on Fidra's PFAS free website show 5 out of the 10 supermarkets approached are now actively working with suppliers to reduce PFAS use, with both Morrisons and Marks and Spencer aiming to remove PFAS from own brand food packaging by the end of 2021, and Iceland already free of PFAS across all own brand products.

PFAS have many different uses, including providing water and grease repellency to paper, board and compostable food packaging. With the food sector heavily focused on moving away from single-use plastic, the market share of these alternative forms of packaging is likely to increase dramatically. Fidra have been working with UK supermarkets to ensure the benefits of plastic reduction are not undermined by an increase in harmful and persistent environmental pollutants, PFAS.

PFAS (Per and Poly-fluoroalkyl Substances) are a group of highly persistent industrial chemicals, associated with a wide range of health and environmental issues, from cancer in humans to neurological problems in animals. There is also mounting scientific evidence linking PFAS exposure

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to immune system suppression, reduced vaccine efficacy, and an increased risk of developing severe COVID-19 symptoms.

PFAS are known as the 'forever chemicals' because some are known to take over 1,000 years to breakdown. As such, almost all the PFAS ever produced are still in our environment today, and concentrations are growing. PFAS are in air, oceans, soil and wildlife, all across the globe. They are building to dangerous levels in European drinking waters, can be taken up by crops, and are contaminating our food chains. 99% of people tested have been found to have PFAS in their blood, with intake levels for infants and young children approximately double that of adults. Babies are now born with PFAS already in their bodies.

[Read More](#)

Envirotech, 1 June 2021

<https://www.envirotech-online.com/news/environmental-laboratory/7/fidra/uknbspsupermarketsnbspto-phasenbspout-lquooforevernbspchemi calsrduonbsppfasnbspfromnbspfood-packaging/55459>

British, Australian food standard differences causing angst in free trade deal

2021-06-11

The differences in food and agriculture standards between the United Kingdom and Australia are emerging as issues of concern in the coming free trade deal.

British farmers, environmentalists and consumers fear imports from Australia will compromise the UK's high animal welfare and food standards.

The differences range from the use of hormones to pesticides and more recently, regulations around farming methods that address climate change.

As the two nations get closer to a deal, Charlotte Smith, who presents BBC program Farming Today, said British farmers were nervous about the impending trade deal.

"That's because there are more than 20 agricultural chemicals and certain farming practices, which are perfectly acceptable in Australia but are banned here."

British farmers, environmentalists and consumers fear imports from Australia will compromise the UK's high animal welfare and food standards.

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"I think the perception is that there are things that Australian farmers are allowed to do that British farmers are not allowed to do."

So, what are the differences in food and agriculture standards and will a free trade deal compromise Britain's food standards or see higher standards imposed on Australian exports?

Hormone treatment

Hormonal growth promotants (HGP) are used widely in Australia, while they have been banned in the EU and, therefore the UK since 1998.

Around 40 per cent of cattle in Australia are given HGPs, which are used to accelerate weight gain, according to Food Standards Australia New Zealand (FSANZ)

A small implant is placed under the skin on the back of the ear, slowly releasing a low dose over 100 to 200 days.

Studies have shown that cattle treated with HGPs have an increased weight gain of between 10–30 per cent.

The European Commission considers hormone treatment as carcinogenic, posing a risk to human health, but Australian authorities and other countries say the science doesn't back up that claim.

There are fears that the UK will reverse its standard on the practice in this trade deal and open the door to hormone-reared beef from other countries like the US.

Australia currently exports some meat to the EU, through a system whereby farmers can be EU accredited as hormone-free.

But there are strict guidelines, with the entire farm's grounds needing to be free of HGP products, treated animals and an annual audit takes place to maintain the status.

Read More

ABC, 11 June 2021

<https://www.abc.net.au/news/2021-06-11/british-australian-food-standard-differences-causing-angst/100205024>

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'Worrying, but not surprising': Paucity of UK chemical compliance testing revealed

2021-06-10

So far this year, the EU regime had recorded 991 product defects and dangers – often related to the risk of electrocution due to bad wiring.

Data bear out environmental groups' warnings that the UK was effectively acting as a free rider on the EU system, conducting little product testing itself. Last year, Unchecked UK found that only half of British local authorities had performed any at all within the past three years, failing to uphold their statutory duty.

Introduced in January, Unsafe Product Reports system, run by the Office for Product Safety and Standards (OPPS) is the post-Brexit successor to the EU's Safety Gate, which collates reports from EU member state authorities.

So far this year, the EU regime had recorded 991 product defects and dangers – often related to the risk of electrocution due to bad wiring. A total of 264 reports concern chemical risks, many of them Chinese-made plastic toys containing the banned phthalate plasticiser DEHP, with 20 specifically concerning chemical products, such as hand gel and tattoo ink.

Over the whole of 2020, there were 2,220 reports of all kinds, 525 of them related to chemical risks.

A quarter of all chemical reports were for banned phthalates, with the presence of lead, boron (often found in 'slime' toys), nickel and cadmium taking up another quarter.

An analysis of last year's results by European results by chemicals industry group Cefic, published yesterday, noted the shadow of the pandemic. Dozens of hand sanitisers were found to breach the Biocidal Products Regulation or classification, labelling and packaging rules, through containing methanol rather than ethanol, or having an insufficient amount of ethanol to destroy viruses.

It also identified that mercury-based so-called skin-lightening products, often imported from west Africa or Pakistan, are a "growing issue". In 2019, they accounted for only 4% of reports for illegal cosmetics. The figure was 18% in 2020.

No such issues have been detected by UK authorities this year, though there is no reason to suspect that the country is immune from them.

So far this year, the EU regime had recorded 991 product defects and dangers – often related to the risk of electrocution due to bad wiring.

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Only five products in breach of chemical rules have been reported: two examples of leather gloves containing carcinogenic chromium VI, above the limit specified under REACH, a silver cross with 10 times the permitted amount of lead, and DEHP-laden dolls.

It also included Ecover laundry liquid. The latter contained, “potassium hydroxide at hazardous levels that can cause the bottle to leak. Contact with the liquid could result in harm to skin and eyes, including causing skin burns or eye damage,” warned the notice.

“As an organisation that lives and breathes clean, we are deeply disappointed and apologise for this issue. We are resolved to working as hard as we can to make this right for our consumers so we can confidently continue together in our clean world revolution,” the firm said in a statement made in January, when it issued a recall for the affected product.

[Read More](#)

ENDS Report, 10 June 2021

<https://www.endsreport.com/article/1718786/worrying-not-surprising-paucity-uk-chemical-compliance-testing-revealed>

INTERNATIONAL

Ten tips for sustainability professionals in the fashion & textiles industry

2021-06-09

Increased focus on sustainability and environmental stewardship is changing the legal and regulatory landscape affecting the fashion and textiles industry, providing new challenges for textile and garment manufacturers, distributors, and retailers. This article provides ten tips for sustainability professionals to navigate compliance issues throughout their supply chains. At a minimum, it is critical to know the materials used in your products and the details of your supply chain to effectively identify applicable environmental rules, regulations, and requirements—as well as track changes as they occur. Particularly for the fashion and textiles industry, with its significant environmental footprint, a clear understanding of product components and corresponding legal requirements form the necessary foundation to ensure compliance and minimize environmental enforcement risk.

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1. Identify All the Materials Used in Your Product.

It is important for textile manufacturers to have a thorough understanding of the materials used in the manufacture and construction of their products. Chemical composition laws and regulations, responsible sourcing requirements, and recycled content mandates impose restrictions on textile manufacturers, distributors, and retailers that use or sell articles containing certain minerals or compounds. For example, the European Union (EU) restricts several chemicals that may be included in textile articles. The EU Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) law, the EU’s primary chemical regulation, limits the use of phosphates, phosphin oxides, biphenyls, and several other compounds applied in the development of textile articles, with heightened restrictions for chemicals that come into contact with skin. EU REACH also restricts the use of the widely found Perfluorooctanoic acid (PFOA) chemical and its salts in articles with certain exemptions. In addition, the United States (U.S.) and the EU also have conflict mineral disclosure obligations for certain minerals that are used by the fashion industry in finishing details, embellishments, and jewelry, such as gold, diamonds, and mica. On top of these restrictions, recycled content mandates and labeling requirements are becoming increasingly common both in the United States and globally.

2. Conduct Due Diligence to Minimize Supply Chain Risks.

Responsible sourcing is a growing focus for both U.S. and international regulators. For example, alleged human rights abuses within the Xinjiang Uyghur Autonomous Region (XUAR) in China have recently prompted enforcement actions concerning products imported into the U.S. The U.S. Customs and Border Protection agency issued Withhold Release Orders for a number of goods coming from the XUAR on human rights grounds, such as cotton and cotton products, prohibiting their release from U.S. ports. Other countries have enacted or are seriously considering due diligence and modern slavery laws to try to address human rights abuses within supply chains. Accordingly, it is important for companies with complex supply chains to conduct due diligence to identify and eliminate human rights and modern slavery risks. Such due diligence also provides companies with documentation to present to regulators in the event that regulators bring an enforcement action.

3. Track Changing Environmental Laws and Regulations in all Jurisdictions Where Your Business Operates.

This article provides ten tips for sustainability professionals to navigate compliance issues throughout their supply chains.

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Environmental laws and regulations can vary greatly between countries and even between regions within countries. To reduce risk exposure, it is critical to understand the environmental legal regimes in the countries and regions in which you operate. Further, with increasing global attention on climate change and sustainability, many countries and governing bodies are adopting or are in the process of adopting new domestic environmental laws and regulations, as well as international treaties and agreements. Per- and polyfluoroalkyl substances (PFAS), advanced recycling, microplastics, and microfibers are all emerging areas in which the industry is likely to see relevant, new environmental laws and regulations in the near future. To reduce enforcement risks, it is important to review periodically the environmental laws and regulations impacting your operations in key jurisdictions to proactively adapt to any changes.

[Read More](#)

National Law Review, 9 June 2021

<https://www.natlawreview.com/article/ten-tips-sustainability-professionals-fashion-textiles-industry>

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REACH Update

JUN. 18, 2021

Review of the Recommendation 2011/696/EU – Stakeholder consultation

2021-06-10

The European Commission has been performing a review of its Recommendation on the definition of nanomaterial. It is now launching an online targeted stakeholder consultation to update, test and verify the preliminary findings of this comprehensive review, gathering further evidence and feedback from a wide range of stakeholders who have a role in application of the harmonized regulatory definition of nanomaterial in the EU.

The online consultation is open until 30 June 2021.

The consultation aims to:

- Verify or complement the findings of the review
- Gather precise and structured technical feedback on the identified technical elements of the definition that could be addressed by changes to the definition
- Gather input on the impact of the changes under consideration: would they influence (different) classification of specific materials placed or emerging on the market?

It includes summary of the interim findings, links to relevant documents and reports and provides a short rationale with every question.

[Read More](#)

European Commission, 10 June 2021

https://ec.europa.eu/environment/chemicals/nanotech/review_en.htm

Chromium trioxide widely used in plating and surface treatment

2021-06-08

ECHA has received over 1 000 notifications from industrial sites using chromium trioxide in chrome plating and surface treatment in the EU. This follows two European Commission decisions in December 2020 granting authorisation to use the chemical until September 2024. Enforcement authorities can now carry out inspections as necessary.

Helsinki, 8 June 2021 – Notifications from 1 026 sites across Europe submitted by May 2021 confirm that chromium trioxide is still widely used

The online consultation is open until 30 June 2021.

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REACH Update

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in functional or hard chrome plating and surface treatment. The annual usage is estimated to be 7 000 tonnes. The substance of very high concern was placed on the Authorisation List in 2013 and its use has needed a specific authorisation in the EU since 2017.

By notifying the uses to ECHA, companies confirm that they follow the conditions for use set in the authorisation decisions granted to their suppliers. As part of the conditions, they must inform ECHA by the end of 2021 how their workers are exposed to chromium trioxide. This information will help companies to protect their workers even better by minimising their exposure to the carcinogen.

“This is an important step to further reduce exposure of workers to chromium trioxide across Europe. These notifications of use will help European authorities carry out joint enforcement on functional chrome plating and surface treatment,” says *Peter van der Zandt*, ECHA’s Director of Risk Management.

Given the increase in the number of notifications, ECHA has updated its downstream user notifications web page. It now contains searchable, public information from over 3 000 notifications covering 14 substances.

Background

REACH allows companies to apply for an authorisation to continue or start using and placing chemicals included in the Authorisation List on the market for a limited time. The authorisation, granted by the European Commission, can cover the uses of the applying company but also their customers (downstream users). Those companies that use a chemical based on an authorisation granted to an applicant up the supply chain, have to notify their use to ECHA within three months of the first delivery of the chemical taking place after the authorisation decision.

The European Commission granted authorisations for five uses of chromium trioxide in December 2020, including functional chrome plating and surface treatment. The current authorisations expire in September 2024, but authorisation holders can re-apply by submitting a review report to ECHA by March 2023.

Chrome plating and surface treatment are done in industrial settings, exposing workers to the harmful chemical that can cause cancer. These uses add a protective coating to metal parts and products and enhance the strength of the surface as well as wear and corrosion resistance. The treated surface does not contain chromium trioxide.

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The European Parliament took legal action against the Commission in March 2021 to annul the decision, saying it is in breach of EU regulation. The legal process is ongoing.

[Read More](#)

ECHA, 8 June 2021

<https://echa.europa.eu/-/chromium-trioxide-widely-used-in-plating-and-surface-treatment>

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Janet's Corner

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Mitochondria

2021-06-18

might-ochondria



definitely-chondria



<https://www.pinterest.com.au/pin/AW2dXi3bejs1EiCoAeu4bly7hwG5GcFZBkL-vHpWcemBfog4KRAfKyk/>

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Hazard Alert

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Ammonium sulphamate

2021-06-18

Ammonium sulphamate (or sulfamate) is a white crystalline (sand-like) solid, readily soluble in water with the chemical formula $H_6N_2O_3S$. [1]

USES [2,3]

Ammonium sulphamate is used for flame-retardant textiles and paper, and as herbicide. As a herbicide, ammonium sulphamate is used to control many types of woody plants, trees, herbaceous perennials, and annual broadleaf weeds and grasses. It is a contact herbicide, which means that it injures only those parts of the plant to which it is applied. It is used primarily to control undesired growth along rights-of-way and for general weed and poison ivy control around homes, commercial buildings and fruit orchards. In addition, ammonium sulphamate is used as a fertiliser. [2]

ROUTES OF EXPOSURE [4]

The routes of exposure for ammonium sulphamate are:

- inhalation
- skin contact
- eye contact

HEALTH EFFECTS [2,4]

Acute Health Effects

Acute health effects to ammonium sulphamate include irritation to the skin, eyes and nose, cough, gastrointestinal disturbances, respiratory stimulation, prostration, and death.

Chronic Health Effects

No signs or symptoms of chronic ammonium sulphamate exposure have been reported.

Carcinogenicity

- Has not been tested for its ability to cause cancer in animals.

Reproductive Hazards

- Has not been tested for its ability to affect reproduction.

Ammonium sulphamate (or sulfamate) is a white crystalline (sand-like) solid, readily soluble in water with the chemical formula $H_6N_2O_3S$.

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Hazard Alert

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SAFETY

First Aid Measures [5]

- Inhalation: Remove to fresh air. Get medical attention for any breathing difficulty.
- Ingestion: Give several glasses of water to drink to dilute. If large amounts were swallowed, get medical advice.
- Skin Contact: Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention if irritation develops.
- Eye Contact: Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

Workplace Controls and Practices [2]

Unless a less toxic chemical can be substituted for a hazardous substance, engineering controls are most effective means of reducing exposure. The best protection is to enclose operations and / or exhaust on the site spilled chemicals. Isolating operations can also reduce exposure. Use a respirator or protective equipment is less effective than the controls mentioned above, but it is sometimes necessary. Good work practices can help to reduce hazardous exhibitions. The following work practices are recommended:

- Workers whose clothing has been contaminated by ammonium sulphamate should quickly change into clean clothes.
- Do not take contaminated work clothes home. Family members could be exposed.
- Contaminated work clothes should be washed ensure workers have been informed of the risks of exposure to ammonium sulphamate.
- Eye wash fountains should be provided in the immediate work area in case of emergency.
- If the possibility of skin exposure, emergency showers should be provided.
- On skin contact with ammonium sulphamate, immediately wash or shower to remove the chemical.
- Do not eat, smoke, drink or when ammonium sulphamate handled, processed or stored, since the chemical can be ingested.

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- Wash hands thoroughly before eating, drinking, smoking or using the toilet.
- Use a vacuum or a wet method to reduce dust during cleanup up. Do not dry sweep.

Personal Protective Equipment [5]

- Personal Respirators (NIOSH Approved): For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
- Skin Protection: Wear protective gloves and clean body-covering clothing.
- Eye Protection: Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

REGULATION [4,6]

EXPOSURE LIMITS

United States

- OSHA: The Occupational Safety & Health Administration permissible exposure limits for ammonium sulphamate are 10mg/m³ (total dust) and 5mg/m³ (respirable fraction) as an 8 hour time weighted average concentration;
- NIOSH: The National Institute of Occupational Safety & Health has established a recommended exposure limit of 10mg/m³ (total dust) and 5mg/m³ (respirable fraction) as an 8 hour time weighted average;
- ACGIH: The American Conference of Governmental Industrial Hygienists has assigned ammonium sulphamate a threshold limit value of 10mg/m³ as a time weighted average for an 8-hour workday.

Australia

- Safe Work Australia: Safe Work Australia has established a time weighted average concentration of 10mg/m³ for ammonium sulphamate.

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Boy gets burned by wet cement in rare case

2021-06-09

A 7-year-old boy who accidentally got wet cement all over his head and torso ended up in the emergency room after the cement mixture burned his skin, according to a new report.

A family member had been mixing and pouring cement when the boy, who was playing nearby, walked under the wet cement dispenser, according to the report, published June 2 in The Journal of Emergency Medicine.

A little while later, the boy experienced a burning pain, and his skin reddened. He was taken to a healthcare facility, where staff washed his skin with an organic substance called polyethylene glycol. Then, he was transferred to Vanderbilt University Medical Center in Nashville, Tennessee, for evaluation on whether his burns needed further treatment.

There, doctors noted the boy had superficial burns — or first-degree burns — on his head, neck and torso, according to the authors, from Vanderbilt University. They also saw that the cement mixture hadn't been completely washed off — visible particles still clung to his skin and hair.

Wet cement should never be left on the skin for very long — the substance can cause severe chemical burns.

That's because cement is made up mostly of the compound calcium oxide, and when it mixes with water, it becomes highly basic or alkaline, meaning it has a high pH, according to the National Capital Poison Center. A substance's pH is measured on a scale from 0 to 14 — substances with a low pH are acidic, while substances with a high pH are alkaline. Wet cement can have a pH as high as 14, the authors said. **PLAY SOUND**

Contact with wet cement doesn't immediately cause a chemical burn, but if someone has prolonged contact with the material (for instance, if they are kneeling in cement as they pour it), or the material is left on the skin for a long period, it can cause burns. The average time between exposure to wet cement and signs of a burn is six hours, the authors said. Because of this delay, people may not realize that cement caused their burn.

"Wet cement is often a poorly recognized cause of alkali burns," the study authors wrote. And when it is recognized, doctors most often see this type of injury in adults who've been working with cement. Wet cement burns are rarely seen in children, making the current case unique, the authors said.

Wet cement should never be left on the skin for very long — the substance can cause severe chemical burns.

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Treatment involves washing the skin with copious amounts of water to get the wet cement off, the authors said. Doctors sometimes use other solutions, including polyethylene glycol, to wash the skin, but there's no evidence that these are better alternatives to water, the authors said. If the burns are severe enough, patients may need surgery. In the current case, the boy's skin was irrigated with water until all the cement was completely removed. Then, he was evaluated by a burn specialist, who determined that the boy did not need further treatment. "Fortunately, the patient involved in this case was decontaminated early enough and no surgical intervention was required," the authors wrote. He was discharged from the hospital and made a full recovery, they said.

Originally published on Live Science.

[livescience.com](https://www.livescience.com), 9 June 2021

<https://www.livescience.com>

Mosquitoes armed with virus-fighting bacteria sharply curb dengue infections, hospitalizations

2021-06-09

A strategy for fighting dengue fever with bacteria-armed mosquitoes has passed its most rigorous test yet: a large, randomized, controlled trial. Researchers reported today dramatic reductions in rates of dengue infection and hospitalization in areas of an Indonesian city where the disease-fighting mosquitoes were released. The team expects the World Health Organization (WHO) to formally recommend the approach for broader use.

The findings are a "breakthrough" that brings the approach "much closer to ... being an official strategy to control dengue," says Ewa Chrostek, an infection biologist at the University of Liverpool who was not involved with the work. WHO estimates there are 100 million to 400 million infections per year with dengue, which can cause high fever and severe joint pain.

The bacterium *Wolbachia pipiensis* naturally inhabits many insects, though not *Aedes aegypti* mosquitoes, the main transmitter of dengue virus. In *A. aegypti* cells, the bacterium can block viruses, including dengue, from replicating, making the insects less likely to spread disease when they bite humans. That has made the microbe a promising strategy for fighting dengue. In tropical regions, where mosquito-borne viruses are common, other strategies such as insecticides have failed to fully control the disease.

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A few previous studies have found that areas where *Wolbachia* mosquitoes were released had lowered rates of dengue compared with nearby untreated areas, or with historical infection rates. But, "The global scientific community was looking for gold-standard evidence, and that means a randomized trial," says Cameron Simmons, an infectious disease researcher at Monash University, Melbourne, and an investigator with the nonprofit World Mosquito Program (WMP), which conducted the new study.

For that gold-standard trial, the researchers divided a 26-square-kilometer area in Yogyakarta, Indonesia—an urban area home to about 300,000 people—into 24 clusters. In 12 of those clusters, the team set out containers of *Wolbachia*-carrying mosquito eggs every 2 weeks for 18 to 28 weeks. The microbe eventually spread through the local mosquito population: Ten months after releases started, the prevalence of *Wolbachia* among mosquitoes in the treated clusters had climbed to 80% or higher.

The team then recruited study participants who came to primary care clinics in the city with a fever. Of the patients who lived in treated clusters, 2.3% tested positive for dengue virus, versus 9.4% of those from control areas—a 77% reduction in infections, the team reports today in *The New England Journal of Medicine*. Beyond the drop in infections, which WMP announced in August 2020, the researchers also found an 86% reduction in hospitalization for dengue among study participants.

"That's really the big thing," Simmons says. "It's the weight of hospitalization ... that really stretches health systems."

The paper offers other encouraging details, Chrostek says: The *Wolbachia* strain, known as wMel, was effective against all of the four main subtypes of dengue virus that infect humans. And computer models determined the more exposure a person had to *Wolbachia*-infected mosquitoes—calculated based on *Wolbachia* prevalence both near their home and in clusters where they had recently traveled—the lower their risk of dengue. *Wolbachia* infection gradually spread to mosquitoes in the nontreated clusters during the trial, and in January, after the trial had ended, WMP released *Wolbachia* mosquitoes in those clusters, aiming to further drive down or even eliminate dengue in the area.

In December 2020, WMP presented its data to a WHO advisory group, and the organization is now developing a recommendation for *Wolbachia* mosquitoes as a method of dengue control. WMP is also seeking a WHO "prequalification" that would make it eligible for investment from U.N. agencies to support future releases, Simmons says. He notes that the cost

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of the approach is already less than \$10 per person protected, and WMP aims to get that cost below \$1.

Still, Ary Hoffmann, a biologist at the University of Melbourne who worked with a predecessor of WMP on earlier Wolbachia releases in Yogyakarta, says it's important to keep monitoring levels of the bacterium and rates of dengue in the experimental areas. Wolbachia levels have remained high for 10 years at sites of some previous mosquito trials without releasing more insects. But Hoffmann notes that the genome of the mosquitoes, the bacterium, or the dengue virus could potentially evolve to reduce the level of protection Wolbachia confers. "This is a great technology," he says, "but we need to think about the longer run."

[sciencemag.org](https://www.sciencemag.org), 9 June 2021

<https://www.sciencemag.org>

New clues suggest people reached the Americas around 30,000 years ago

2021-06-09

Humans may have inhabited what's now southern Mexico surprisingly early, between 33,448 and 28,279 years ago, researchers say.

If so, those people arrived more than 10,000 years before folks often tagged as the first Americans (SN: 7/11/18). Other preliminary evidence puts humans in central Mexico as early as around 33,000 years ago (SN: 7/22/20).

The latest evidence comes from animal bones that biological anthropologist and archaeologist Andrew Somerville and two Mexican colleagues found stored in a Mexico City lab. The bones had been excavated in the 1960s at a rock-shelter called Coxcatlan Cave.

Radiocarbon analyses of six rabbit bones from the site's deepest sediment yielded unexpectedly old ages, the researchers report online May 19 in *Latin American Antiquity*. That sediment also contained chipped and sharp-edged stones regarded as tools by the site's lead excavator.

Higher sediment layers yielded clearer examples of stone tools and other remnants of human activity dating to nearly 9,900 years ago. Somerville, of Iowa State University in Ames, initially suspected that rabbit bones from the deepest sediment were perhaps around 12,000 years old. But analyses revealed they were much older, hinting humans were living in the cave roughly 30,000 years ago.

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Somerville will next determine whether other animal bones from the ancient sediment display butchery marks, breaks where marrow was removed or burned patches from cooking. He also wants to locate and study possible stone tools from that same sediment that may be stored in the same lab.

Based on additional radiocarbon dates and comparisons with stone-tool finds from other Mexican sites, Somerville suspects that a separate occupation of Coxcatlan Cave occurred between 13,500 and 9,900 years ago. Regional food and water sources may have dwindled when the last Ice Age peaked between 26,000 and 19,000 years ago, causing the earliest settlers to leave and delaying further occupations until conditions improved, Somerville speculates.

[sciencenews.org](https://www.sciencenews.org), 9 June 2021

<https://www.sciencenews.org>

CICADA-PALOOZA!

2021-06-13

I'm not terribly disappointed that, by moving from Washington D.C. to Georgia, I've missed the last two Brood X cicada invasions.

Let's get a few things straight: The "X" in "Brood X" is a Roman number, so just say "Brood Ten." But that means calling the noisy ones "X-Men" doesn't work (ATTN: TV Newsreaders). And they don't dig out from their 17-year hiatus until the ground temperature reaches 64°F (17.8°C). The best concise description of Brood X/Ten I found is at this page from the National Park Service.

And a final dirty human secret about the Brood Ten cicadas: Their range only covers portions of a few mid-Atlantic states and D.C. But that means they're enabled to disrupt every outdoors live shot from every TV reporter in Washington D.C.

The clinchers came on Wednesday, when President Biden battled off a cicada on his departure to Europe, some of the six-legged assailant's hench-insects delayed the White House press corps plane by six hours when they lodged themselves in an auxiliary engine.

Which affirms a dirty not-so-secret about what many consider an East Coast media bias: What happens in Washington or New York speaks for the entire country.

But that means they're enabled to disrupt every outdoors live shot from every TV reporter in Washington D.C.

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In this case, the speaking was done by the wings of countless male cicadas, looking to get back in the breeding game after 17 years literally underground. The cicadas should be quiet by the end of the month, to return in 2038. The resident population of alleged East Coast media bias will probably be waiting for them.

Asian carp

So enough about insects and journalists. Fish and journalists, anyone?

If you think TV folks love cicada stories, try Asian carp. The fish were brought to the U.S. in the mid-20th century to control algae blooms near sewage treatment plants and fish farms. One species, the silver carp, made its way from Mississippi Delta catfish farms upriver to Illinois, outcompeting native fish all the way.

But these fish have a quirky defensive behavior that's also fabulous slapstick comedy. When threatened or alarmed, silver carp can breach up to 15 feet in the air. I've watched video of fishermen rejoicing as fish fulfill an old myth by literally jumping into the boat; a wildlife biologist hit full in the trousers by an airborne carp; or a TV reporter striking theatrical paydirt when hit upside the head with a frightened fish.

Noodling for catfish

And finally, I can't leave the topic of human-wildlife interaction without giving a shout-out to the sport of noodling—also known as handgrabbing.

The last time I checked, noodling was legal (sometimes with restrictions) in 11 states. It involves the catching of catfish by unconventional means: allowing an enormous flathead or channel catfish to mistake your arm for a meal, then running a rope through the channel cat's mouth and gills. Or, for expediency and on smaller (maybe 20 lbs.) cats, ditch the rope and just run your hand through the mouth and out the gills.

Either way, hobbying hazards from having a giant fish try to swallow your arm can include infections, broken bones, injured muscles and tendons and scar tissue up to the elbow. Whooppee!

This 13-minute video from father-daughter YouTube noodling sensations Jeff and Hannah Barron will change your life.

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Or not.

ehn.org, 13 June 2021

<https://www.ehn.org>

Teflon and 'forever chemicals:' The hidden toxins in your body

2021-06-11

What do raincoats, pizza boxes, frozen vegetable packaging and nonstick frying pans have in common? They all contain perfluorinated alkylated substances (PFAS). Known as "forever chemicals" by experts, they could be damaging human health.

Roland Weber, an environmental consultant with the United Nations, describes them as "one of the most threatening chemicals ever invented."

Some 4,500 human-made substances fall under the PFAS designation, and residues from this family of chemicals are now found across the globe — in soil, drinking water, food, animals and even inside the human body.

Do I have PFAS in my body?

Some 98% of US Americans have PFAS in their blood. Studies from India, Indonesia and the Philippines found the toxic substances in nearly all breastmilk samples tested. Every child in Germany has forever chemicals inside them, and in a fifth of those cases, concentrations exceed critical levels.

This made me wonder about the levels of forever toxins in my own body. Finding out is not easy as there are very few specialist labs in Germany able to perform the necessary tests. But I managed to locate one, IPASUM, in the southern city of Erlangen.

I sent them a blood sample. It was analyzed for PFOA and PFOS — the best-known forever chemicals — which can cause liver and kidney damage, decrease male fertility, and affect the weight of newborn babies as well as the effectiveness of vaccines. In high concentrations, they can lead to cancer. New studies have also indicated a link between the chemicals and severe cases of COVID-19.

The lab found 4 nanograms of PFOA and PFOS per liter of my blood. That's around a thousandth of the weight of a grain of sand and means I'm well below critical levels and in line with the German average.

Roland Weber, an environmental consultant with the United Nations, describes them as "one of the most threatening chemicals ever invented."

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Thomas Göen, a professor at IPASUM, who carried out the analysis, told me these concentrations present no risk according to current scientific knowledge. But the results didn't put my mind at ease because the substances are persistent and can accumulate in the body.

"And that's the main problem," Göen said, "that in the end they may accumulate in a dose, which might be a problematic concentration."

Forever chemicals are so stable that they don't biodegrade in nature, and the human body excretes them very slowly. Scientists are looking for ways to break them down, but any methods are still in their infancy.

How do forever chemicals end up in nature and in us?

But it's exactly this stability that makes PFAS so useful. Water, fat and dirt resistant, they are deployed in practically every industry and found in a diverse range of products, including artificial leather, photographic paper, pesticides, the foam in fire extinguishers, dyes and airplanes.

Humans ingest most PFAS in their food. Fish, meat, milk, eggs and vegetables from contaminated regions can contain particularly high rates of these chemicals.

Most sewage treatment plants can't filter out the chemical residues, which then enter the environment through landfills, industrial waste, and by washing outdoor clothing. PFAS have been found in the remote mountains of Patagonia, snow in Antarctica and the Altai Mountains in Central and East Asia, as well as inside polar bears, birds and dolphins.

Some animals with high PFAS concentrations experience changes in their hormone levels as well as to their liver and thyroid function. There has been little research on their impact on ecosystems.

From the atom bomb to the kitchen cupboard

In 1938, US chemicals concern DuPont invented PTFE, one of the first PFAS chemicals. As it was able to protect metal from corrosion at incredibly high temperatures, they used it in the first atomic bomb.

PTFE soon appeared in households around the globe as a durable coating on frying pans under the brand name "Teflon." It was a huge commercial success.

But in 1998, the nonstick brand found itself in a sticky situation when a livestock farmer said his cows grazing near a Teflon production plant in Parkersburg West Virginia were wasting away and dropping dead.

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Robert Bilott, environmental lawyer and longtime defender of the livestock farmer in his legal battle against DuPont, said his client "could see white foaming water coming out of a landfill next to his property." It soon came out that thousands of people in the region had been contaminated with PFAS through sewage from the DuPont factory and leaking landfill waste.

Documents show that DuPont — unlike state authorities — had known of the danger for decades but continued to discharge the toxic substance into the environment.

Studies suggest that high PFAS levels in the area are connected to increased cases of kidney and testicular cancer. In 2017, DuPont agreed to pay victims \$671 million (€554 million) in compensation for bodily harm.

Industry gets creative with legal loopholes

Other countries, including The Netherlands, Belgium and Italy, have seen cases of PFAS contaminating drinking water and the environment.

Some of these forever chemicals are now being phased out in the EU, the USA and Japan, and the amount detected in the population has steadily decreased. In Germany, the average has more than halved since 1990.

In response to the crackdown, the chemicals industry is manufacturing a new generation of PFAS that differ very little from their predecessors, but don't fall under the ban for now.

How can I protect myself?

What am I supposed to take from all this? I'm a bit stumped. It feels impossible to avoid something found in so many things but which isn't flagged on labels or packaging.

For now, I've said goodbye to nonstick pans and I'm considering buying a water filter to get rid of any PFAS in my drinking water. It looks like takeaway and convenience food, which I've never been a fan of anyway, will slip even further down the menu, so I can keep away from PFAS-laden disposable packaging. But I'll never be able to turn down a box of frozen spinach — a childhood favorite of mine.

On a global level, the pressure to dispense with PFAS is growing. Following a Greenpeace campaign, outdoor clothing manufacturers Vaude, Paramo and Rotauf committed to detoxing their garments. Swedish furniture giant Ikea says it has also banned the substances, while countries such as

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Germany, Denmark, Norway and Sweden are pushing for an EU-wide ban on all PFAS by 2030.

This article was adapted from German.

dw.com, 11 June 2021

<https://www.dw.com>

Earth's fifth ocean just confirmed

2021-06-15

The Earth has finally attained popular recognition for its fifth ocean, with a decision by the National Geographic Society to add the Southern Ocean around Antarctica to the four it recognizes already: the Atlantic, Pacific, Indian and Arctic oceans.

Although the designation of the frigid waters around the icy southern continent as a separate ocean has kicked around for almost 100 years and is widely used by scientists, until now it has not had popular backing.

But on June 8 — World Oceans Day — the society announced it would henceforth be labeling the Southern Ocean as the fifth ocean on its maps of our planet.

"The Southern Ocean has long been recognized by scientists, but because there was never agreement internationally, we never officially recognized it," the society's official geographer Alex Tait told the National Geographic website. "It's sort of geographic nerdiness in some ways."

One of the biggest impacts would be on education, he said: "Students learn information about the ocean world through what oceans you're studying. If you don't include the Southern Ocean, then you don't learn the specifics of it and how important it is."

Antarctic current

National Geographic began making maps in 1915, but the society had only formally recognized just four oceans, which they defined by the continents that bordered them.

In contrast, the Southern Ocean is defined not by the continents that surround it, but by the Antarctic Circumpolar Current (ACC) that flows from west to east. Scientists think the ACC was created 34 million years ago when the continent of Antarctica separated from South America, allowing water to flow unimpeded around the "bottom" of the world.

"It's sort of geographic nerdiness in some ways."

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Today, the ACC flows through all waters that surround Antarctica until about 60 degrees south, except for the Drake Passage and the Scotia Sea, which are both roughly between South America's Cape Horn and the Antarctic Peninsula.

The waters of the ACC — and therefore most of the Southern Ocean — are colder and slightly less salty than the ocean waters to the north.

The ACC pulls in water from the Atlantic, Pacific and Indian oceans to help drive a global "conveyor belt" that carries heat around the planet, while the cold dense water of the ACC sinks and helps to store carbon in the deep ocean. And thousands of marine species live only within the ACC, according to National Geographic.

Antarctic waters

Exactly what constitutes an ocean is not agreed, other than that they are the largest bodies of water. A common definition split the global ocean into four or five parts, according to the continents that surrounded them.

Nevertheless, the term "Southern Ocean" had been used to describe the waters at the bottom of the world since they were first seen by the Spanish explorer Vasco Núñez de Balboa early in the 16th century, and its use continued as oceans became vital routes for international communications and trade in the centuries that followed.

By the 19th century, many maritime nations had established "hydrographic" authorities to publish information on the oceans for their navies and merchant vessels, and the term "Southern Ocean" appeared in the early publications of the International Hydrographic Organization (IHO) that they formed in 1921.

But according to the book "Southern Ocean: Oceanographers Perspective" (Ice Press, 2015), the IHO rescinded the designation in 1953: "The majority of opinions received ... are to the effect that there exists no real justification for applying the term Ocean to this body of water," the IHO wrote in the guidelines it published that year.

Scientists didn't agree, however, and the term has been increasingly used, as the importance and uniqueness of the Southern Ocean became more clear. The U.S. Board on Geographic Names started using it in 1999, and the National Oceanic and Atmospheric Administration (NOAA) officially began using it this year.

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The original “ocean” on Earth was, in fact, a river — named by the ancient Greeks after the titan Oceanus, a river god who was the son of Uranus and Gaia and the brother and husband of Tethys, the goddess of the primal waters that nourished the Earth. .

This river “Ocean” was originally thought to encircle the world, which the early Greeks imagined ended somewhere just west of Europe and east of Asia. Eventually, the term would become used to describe the different parts of the global ocean.

The related term “Seven Seas,” meanwhile, is much older than many modern oceans. No one knows where the concept originated, but the term appears in the ancient writings of the Greeks, Romans, Arabs, Hindus, Persians and Chinese, although it often described entirely different seas — some of them mythical — for different people.

According to the World Atlas website, the Seven Seas today are considered the seven largest oceanic bodies of water: the Arctic, North Atlantic, South Atlantic, Indian, North Pacific, South Pacific, and Southern or Antarctic Ocean

Originally published on Live Science.

[livescience.com](https://www.livescience.com), 15 June 2021

<https://www.livescience.com>

Scientists convert used plastic bottles into vanilla flavouring

2021-06-15

Plastic bottles have been converted into vanilla flavouring using genetically engineered bacteria, the first time a valuable chemical has been brewed from waste plastic.

Upcycling plastic bottles into more lucrative materials could make the recycling process far more attractive and effective. Currently plastics lose about 95% of their value as a material after a single use. Encouraging better collection and use of such waste is key to tackling the global plastic pollution problem.

Researchers have already developed mutant enzymes to break down the polyethylene terephthalate polymer used for drinks bottles into its basic units, terephthalic acid (TA). Scientists have now used bugs to convert TA into vanillin.

Currently plastics lose about 95% of their value as a material after a single use.

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Vanillin is used widely in the food and cosmetics industries and is an important bulk chemical used to make pharmaceuticals, cleaning products and herbicides. Global demand is growing and in 2018 was 37,000 tonnes, far exceeding the supply from natural vanilla beans. About 85% of vanillin is currently synthesised from chemicals derived from fossil fuels.

Joanna Sadler, of the University of Edinburgh, who conducted the new work, said: “This is the first example of using a biological system to upcycle plastic waste into a valuable industrial chemical and it has very exciting implications for the circular economy.”

Stephen Wallace, also of the University of Edinburgh, said: “Our work challenges the perception of plastic being a problematic waste and instead demonstrates its use as a new carbon resource from which high value products can be made.”

About 1m plastic bottles are sold every minute around the world and just 14% are recycled. Currently even those bottles that are recycled can only be turned into opaque fibres for clothing or carpets.

The research, published in the journal Green Chemistry, used engineered E coli bacteria to transform TA into vanillin. The scientists warmed a microbial broth to 37C for a day, the same conditions as for brewing beer, Wallace said. This converted 79% of the TA into vanillin.

Next the scientists will further tweak the bacteria to increase the conversion rate further, he said: “We think we can do that pretty quickly. We have an amazing roboticised DNA assembly facility here.” They will also work on scaling up the process to convert larger amounts of plastic. Other valuable molecules could also be brewed from TA, such as some used in perfumes.

Ellis Crawford, of the Royal Society of Chemistry, said: “This is a really interesting use of microbial science to improve sustainability. Using microbes to turn waste plastics, which are harmful to the environment, into an important commodity is a beautiful demonstration of green chemistry.”

Recent research showed bottles are the second most common type of plastic pollution in the oceans, after plastic bags. In 2018, scientists accidentally created a mutant enzyme that breaks down plastic bottles,

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and subsequent work produced a super-enzyme that eats plastic bottles even faster.

theguardian.com, 15 June 2021

<https://www.theguardian.com>

A deep look at a speck of human brain reveals never-before-seen quirks

2021-06-09

A new view of the human brain shows its cellular residents in all their wild and weird glory. The map, drawn from a tiny piece of a woman's brain, charts the varied shapes of 50,000 cells and 130 million connections between them.

This intricate map, named H01 for "human sample 1," represents a milestone in scientists' quest to provide ever more detailed descriptions of a brain (SN: 2/7/14).

"It's absolutely beautiful," says neuroscientist Clay Reid at the Allen Institute for Brain Science in Seattle. "In the best possible way, it's the beginning of something very exciting."

Scientists at Harvard University, Google and elsewhere prepared and analyzed the brain tissue sample. Smaller than a sesame seed, the bit of brain was about a millionth of an entire brain's volume. It came from the cortex — the brain's outer layer responsible for complex thought — of a 45-year-old woman undergoing surgery for epilepsy. After it was removed, the brain sample was quickly preserved and stained with heavy metals that revealed cellular structures. The sample was then sliced into more than 5,000 wafer-thin pieces and imaged with powerful electron microscopes.

Computational programs stitched the resulting images back together and artificial intelligence programs helped scientists analyze them. A short description of the resulting view was published as a preprint May 30 to bioRxiv.org. The full dataset is freely available online.

For now, researchers are just beginning to see what's there. "We have really just dipped our toe into this dataset," says study coauthor Jeff Lichtman, a developmental neurobiologist at Harvard University. Lichtman compares the brain map to Google Earth: "There are gems in there to find, but no one can say they've looked at the whole thing."

"In the best possible way, it's the beginning of something very exciting."

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But already, some "fantastically interesting" sights have appeared, Lichtman says. "When you have large datasets, suddenly these odd things, these weird things, these rare things start to stand out."

One such curiosity concerns synapses, connection spots where signals move between nerve cells. Usually, most message-sending axons touch a message-receiving dendrite just once. In the new dataset, about 90 percent of the connections were these one-hit contacts. Some pairs of cells have slightly more contacts. But every so often, researchers spotted cells that connect multiple times, including one pair that were linked by a whopping 19 synapses.

Multiple connections have been spotted in mouse brains, though not quite as abundantly as in this human sample. And fly brains can also have many connections between cells, though they're more dispersed than the newly described human connections, says neuroscientist Pat Rivlin of Howard Hughes Medical Institute's Janelia Research Campus in Ashburn, Va. There, Rivlin works on the FlyEM Project, which aims to create detailed maps of the fruit fly nervous system.

The large dataset on the human brain provides a breakdown of just how common these types of connections are, says Reid. And that raises the question of what these extraordinarily strong synapses might be doing in the brain.

These cells might be able to compel their target cell into action in a powerful way, Lichtman speculates. Perhaps rote information, such as knowing 5 times 5 is 25 or knowing to stop at a red light, relies on these powerful inputs that efficiently drive information through the brain.

Molecular neuroscientist Seth Grant at the University of Edinburgh points out that although the map is a valuable tool, it shows only the anatomy of the brain. Other research will help clarify the function and composition of molecules that drive brain behavior. For now, the map is "very much an exploratory tool," he says.

One curiosity to explore further is the team's observation of two nerve cells, or neurons, that appeared to be entwined in a symmetrical dance. The images also revealed message-sending axons of neurons forming elaborate coils, unusual and mysterious whorls that look like coiled snakes. "We had just never seen anything like it," Lichtman says. Once the researchers knew how to look for these coils, more and more turned up.

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These extremely detailed brain maps are a culmination of years of research, says Reid, who is working on maps of mouse and human brains at the Allen Institute (SN: 8/7/19). "It's this magical time in history" when the map-making tools, such as computational methods, machine learning and powerful microscopes, are all available, Reid says. "This work is just beginning to see the light of day."

What these maps will ultimately reveal is still anybody's guess. Lichtman is circumspect about whether these maps will lead to a deep understanding of the brain. "I think the best we can do is describe," he says. "I hope that at some point, we will get to a place where we are no longer surprised by what we see."

sciencenews.org, 9 June 2021

<https://www.sciencenews.org>

Research on ocean plastic surging, U.N. report finds

2021-06-10

Plastic winds up everywhere—from the top of Mount Everest to remote corners of Antarctica. Every year, millions of tons of discarded plastic also wash into the ocean. Some of it floats in giant garbage patches, whereas other bits drop to the sea floor, even turning up in the hindguts of crustaceans in deep ocean trenches.

Research about ocean plastic is swelling, too, from just 46 papers in 2011 to 853 in 2019, according to a U.N. report published today on the state of global science. This year's edition of the report, which UNESCO publishes every 5 years, found that the growth in ocean plastic research outstripped that of the other 55 development-related topics it tracked (see chart, below). "It has really skyrocketed in recent years," says Erik Van Sebille, an oceanographer and climate scientist at Utrecht University who uses plastic particles as tracers to study the ocean's dynamics.

Carmen Morales, an ecotoxicologist at the University of Cádiz's Marine Litter Lab, says plastic is more conspicuous than contaminants such as metals or organic compounds, and it draws more attention from the public and policymakers. "It's an eyesore to have all this plastic on beaches," adds Bart Koelmans, an aquatic ecologist at Wageningen University. "For many people, that is enough to be concerned." Scientists are delving into where the plastic comes from, where it goes, and how it affects the environment and human health.

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But gaps remain in the research. Journals "still get many papers dealing with exactly the same topics: the presence of plastic on beaches, on the seabed, or in animals, but not [many] about sources or solutions," says Ángel Borja, a marine ecologist at the AZTI research centre in Pasaia, Spain.

In a study published today, Morales pinned down sources by combining data from scattered studies into an inventory of 12 million litter items larger than 2 centimeters. Her team found that takeout food and drink packaging was the most pervasive: Single-use bags, bottles, containers, and wrappers accounted for 44% of all waste across environments.

Researchers are also trying to understand the ecological effects of plastic pollution. Plastic itself is inert, but often contains toxic additives such as flame retardants, pigments, or chemicals to make plastic more flexible and durable. "These additives are what we're worried about," Morales says. Other harmful substances, such as polycyclic aromatic hydrocarbons, can enter ecosystems by sticking to drifting plastic.

Microplastic particles eroded from larger objects can end up the same size as plankton, so marine animals eat them without deriving any nutrition. Smaller, nanoplastic particles may be the most harmful: They can be tiny enough to penetrate tissues, where their shape may make a difference, Koelmans says: Fibrous particles seem to cause more inflammation than spherical ones. Yet the overall ecotoxicological effects of plastic are poorly understood; it's difficult for labs to reproduce the cocktail of particles that organisms are exposed to in the environment.

To stem the buildup of debris, many countries have moved to phase out single-use plastics; as of 2018, 127 had passed legislation to regulate plastic bags, UNESCO says. But given low recycling rates, the report says, bans will not be enough: Biodegradable alternatives will be needed.

Research into such materials, derived from plant-based hydrocarbons, is also growing fast, if slower than studies describing the problem. Publications on eco alternatives to plastics almost tripled from 404 in 2011 to 1111 in 2019, the U.N. report found. "I'm happy [to see the figures] because it means I made the right decision to change my research focus," says Carla La Fuente, a postdoc chemical engineer at the University of São Paulo, Piracicaba, who is developing green methods to make biodegradable plastic from cassava starch.

Oceanographer Tiffany Straza, the report's deputy editor at UNESCO, sees parallels between plastic pollution and the problem of nuclear waste. "There was this idea that our scientific knowledge and solutions for waste

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disposal would catch up while we chased after this advanced technology," she says. Yet practices for disposing of nuclear waste lagged while nuclear power burgeoned. "I'm not convinced that we've fully learned that lesson," she says. "Are we going to do the same with plastics?"

sciencemag.org, 10 June 2021

<https://www.sciencemag.org>

New discovery could help take down drug-resistant bacteria

2021-06-11

Scientists have found a new way to kill antibiotic-resistant bacteria. The new approach disarms their natural defense mechanism, making existing antibiotics more lethal.

The study, conducted in lab dishes and mice, offers a promising strategy for taking down so-called superbugs without needing to make brand-new antibiotics.

"You want to make the already existing antibiotics with good safety profiles more potent," and with the help of a few newfound chemicals, the research team did just that, said senior author Evgeny Nudler, a professor of biochemistry at the New York University Grossman School of Medicine and an investigator with the Howard Hughes Medical Institute.

In the new study, published Thursday (June 10) in the journal *Science*, the team took aim at *Staphylococcus aureus* and *Pseudomonas aeruginosa*, two bacteria that show pervasive resistance to multiple drugs and rank among the leading causes of hospital-acquired infections. These bacteria rely on an enzyme called cystathionine gamma-lyase (CSE) to counter the toxic effects of bactericidal antibiotics, drugs that kill bacteria rather than just slowing their growth. **PLAY SOUND**

Specifically, the enzyme produces hydrogen sulfide, a compound that shields bacteria from oxidative stress, or an accumulation of free radicals. So the team sifted through more than 3 million small molecules to find chemicals that would block CSE without interacting with mammalian cells, and they found three strong candidates.

In lab dishes, the newfound molecules made bactericidal antibiotics two- to 15-fold more potent against the microbes, depending on the antibiotic being used and the bacterial strain being targeted. One of the small

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molecules also improved the survival of antibiotic-treated mice that had been infected with either *S. aureus* or *P. aeruginosa*.

Given that the study was conducted in rodents in the lab, "moving on into a human system is, you know, that huge next step," said Thien-Fah Mah, a professor and director of the Microbiology Graduate Program at the University of Ottawa who was not involved in the research. And, as with any new drug-like molecules, more studies will be needed to pin down what dose and administration route would be the safest and most effective in people, Mah told Live Science.

But given that most bacterial species use this defense tactic, taking aim at hydrogen sulfide production could be a "true game changer" in the fight against antibiotic resistance, Mah wrote in a commentary, also published June 10 in the journal *Science*.

Long road to discovery

The road to the current study began years ago, when a 2007 report in the journal *Cell* introduced the idea that all bactericidal antibiotics might trigger cell death in the same way, Mah said. "At that point ... it kind of blew the lid off of what all of us were thinking," because each class of bactericidal antibiotics targets different parts of the bacterial cell, so it's counterintuitive to think they work the same way to ultimately kill microbes, she said.

For example, some bactericidal drugs target a cell's outer wall, while others disrupt its protein-building factory, the ribosome. But the 2007 paper suggested that, after hitting their primary targets, all these drugs trigger a common secondary effect: They push bacteria to produce "reactive oxygen species," also known as free radicals, highly reactive molecular wrecking balls that can seriously damage DNA and proteins if not promptly defused.

Following this work, Nudler and his colleagues discovered one of bacteria's natural defense mechanisms against reactive oxygen species: hydrogen sulfide. According to their report, published in 2011 in the journal *Science*, the team scoured the genomes of hundreds of bacteria and found that they shared common genes that code for hydrogen sulfide-producing enzymes, with *S. aureus* and *P. aeruginosa* primarily using CSE. They reported that hydrogen sulfide boosted production of antioxidant enzymes in the bacteria, which transform free radicals into non-toxic molecules, while also suppressing the production of reactive oxygen species.

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They also found that deleting or disabling the enzymes in bacteria made them “highly sensitive” to a wide range of antibiotics. These sensitized bacteria died from oxidative stress caused by a buildup of reactive oxygen species. At that point, the team wanted to find “inhibitors” that could bind and disable bacterial enzymes in an infected person.

“If we combined those inhibitors with antibiotics ... we could make those antibiotics more potent,” Nudler told Live Science. However, “it was very tricky to find those inhibitors targeting these enzymes that were specific to bacteria,” he noted.

Mammalian cells also produce hydrogen sulfide, meaning human cells also rely on the compound; in humans, hydrogen sulfide acts as a signalling molecule and interacts with many tissues, from the brain to smooth muscle. Both human cells and bacterial cells use CSE to make hydrogen sulfide, but the human and bacterial CSE come in slightly different flavors. The team wanted to find molecules that would show a strong preference for the bacterial CSE, both to ensure that the chemicals would be potent against bacteria and to avoid any unintended side effects on mammalian cells.

To do so, they extensively studied the structure of human, bacterial and other versions of CSE to find an attractive target for their molecules to latch onto. Ultimately, they found a “nice pocket” on the bacterial CSE that a small molecule could slip into and change the activity of the enzyme, Nudler said.

“What they’ve done is, they actually identified something that’s unique to the bacterial enzyme and is not present in the human enzyme ... so this is specific for bacteria,” Mah said. Having found a bull’s-eye to aim at, the team set to work crafting their weapons. They ran a virtual screen of about 3.2 million commercially available small molecules to determine which would fit into their chosen pocket. Three stood out as promising choices and made it to the next round of experiments.

By tamping down hydrogen sulfide production, the inhibitors not only boosted the effects of antibiotics against the bugs but also suppressed a phenomenon known as “bacterial tolerance.”

Unlike antibiotic resistance, in which bacteria evolve in ways that make them less susceptible to drugs, tolerance describes when bacteria turn down their metabolisms in the face of stress and enter a somewhat dormant state. In this state, the cells stop multiplying and reduce their energy use. Because many antibiotics work by causing bacteria to short-

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circuit while multiplying, tolerance keeps the bacteria alive until the antibiotics are gone. This means some bacteria cells can linger even after an infected person completes a full course of antibiotics, and if their immune system isn’t equipped to deal with the leftovers, chronic infection can set in, Nudler said.

But in their experiments, the authors found that the inhibitors stopped many bacteria from switching into this protective state. “We demonstrate that hydrogen sulfide, clearly, makes a huge impact on tolerance,” Nudler said. Currently, “there is no drug specifically targeting ... this tolerance phenomenon,” he added, suggesting this could be a new avenue for treatment.

That said, “from a mechanistic point of view, it is still not entirely clear how inhibition of hydrogen sulfide leads to the various effects observed,” said Dr. Dao Nguyen, an associate professor in the department of microbiology and immunology at McGill University in Montreal, who was not involved in the study. Echoing the sentiment, Nudler noted that he and his colleagues plan to further investigate the role of hydrogen sulfide in tolerance.

The team also needs to determine whether they need to tweak the molecules to make them optimally effective for humans, not just mice, and to determine the best route of administration, Nguyen said. “If the inhibitors could be developed into safe and effective drugs, one could imagine that they would be used in combination with existing antibiotics to treat ... chronic infections where current antibiotics are not very effective,” she said.

Originally published on Live Science.

[livescience.com](https://www.livescience.com), 11 June 2021

<https://www.livescience.com>

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Hunks of oceanic crust are wedged inside Earth's mantle

2021-06-09

In Geology 101, Earth's interior is divided into neat layers, like a sugar-coated jawbreaker. But it turns out that parts of the planet's middle layer might be more like peanuts in a sea of caramel. Seismic data reveal that there may be hunks of oceanic crust stuck deep within the planet's liquid mantle, creating big lumps in one of those smooth layers.

The authors of a new study discovered those "peanut chunks" inside the gooey mantle beneath East Asia. Their findings, besides being deliciously intriguing, could have implications for models of how the oceanic crust forms and moves.

How did those chunks of oceanic crust get into that layer? The lithosphere is Earth's rigid outer layer, encompassing a cracked crust and hot upper mantle. The hot mantle churns and circulates, moving the crust at the surface, causing the oceanic crust to dive into its depths — a process called subduction — and triggering the upwelling of vast plumes of magma toward Earth's surface.

"Earth is energetic, manifested by the tectonic movement of the lithosphere and underlying convection in the deep mantle," said Jikun Feng, lead author of the study and a postdoctoral researcher at the University of Science and Technology of China.

PLAY SOUND

But geologists know very little about how the deeper regions of the mantle behave, despite its likely impact on mantle circulation.

The team wanted to create a more detailed picture of the structure and composition of the mantle and how it relates to mantle circulation, especially in the transition zone between the upper and lower mantle. Feng and colleagues focused on an area under China, where the North China crust sits atop a piece of oceanic Pacific crust that is buried deep within the mantle. This region of the Pacific tectonic plate is considered "stagnant" because it doesn't sink past the transition zone, and instead seems to float within the mantle. They wanted to better understand what happens at the transition zone within the mantle, and how stagnant slabs might affect circulation.

Traditionally, seismologists studied the structure of the mantle using seismic waves (waves that travel through Earth) produced by large earthquakes, Feng said. However, these earthquakes don't happen

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everywhere, all the time. To get around this limitation, Feng's team used an existing array of more than 200 seismometers to record ambient seismic noise, or small, everyday vibrations not tied to specific temblors.

Seismic waves can reveal "the footprint of deep mantle circulation," Feng told Live Science. That's because seismic waves travel differently through materials of various densities and properties. And these properties can change or be changed by other phenomena, such as the descent of oceanic slabs. Rising mantle plumes also disturb Earth's interior and result in different seismic measurements.

In the new study, the researchers stacked the seismometer readings from those instruments to see how seismic waves behaved in the mantle at the transition zone, where the upper and lower mantle meet. (The lower mantle is hotter, deeper and under more pressure than the upper mantle.)

They found a sharp discontinuity, or change in the speed of seismic waves, within the mantle at a depth of 410 miles (660 kilometers), or the bottom of the transition zone between the upper and lower mantle. Based on those waves, they concluded that some of the oceanic slab had "bunched up" at the base of this zone and prevented the Pacific plate from diving further. The team hypothesized that as the oceanic slab meets denser rock at that depth, it ceases its descent into the mantle and instead spreads laterally within the transitional mantle. The stuck slab then separates chemically into differing mineral compositions. This chemical separation creates a "chunky" region of the mantle with a complex structure, which differs slightly from the rest of the mantle material, which is pyrolite (a rock that is about three parts peridotite and one part basalt).

"Our findings provide direct evidence of segregated oceanic crust trapped within the mantle transition zone," Feng said.

The new work provides insight into mantle circulation, including how stagnant slabs might behave within the transition zone, Feng said. He noted that understanding the nature of mantle heterogeneities "can provide critical insights into the mantle circulation process and finally the evolution of our planet."

Their findings were published May 5 in the journal Nature Communications.

Their findings, besides being deliciously intriguing, could have implications for models of how the oceanic crust forms and moves.

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Originally published on Live Science.

livescience.com, 9 June 2021

<https://www.livescience.com>

Are advertisers coming for your dreams?

2021-06-11

If you've ever crammed for an exam just before bedtime, you may have tried something dream researchers have been attempting for decades: coaxing knowledge into dreams. Such efforts have had glimmers of success in the lab. Now, brands from Xbox to Coors to Burger King are teaming up with some scientists to attempt something similar: "Engineer" advertisements into willing consumers' dreams, via video and audio clips. This week, a group of 40 dream researchers has pushed back in an online letter, calling for the regulation of commercial dream manipulation.

"Dream incubation advertising is not some fun gimmick, but a slippery slope with real consequences," they write on the op-ed website EOS. "Our dreams cannot become just another playground for corporate advertisers."

Dream incubation, in which people use images, sounds, or other sensory cues to shape their nighttime visions, has a long history. People throughout the ancient world invented rituals and techniques to intentionally change the content of their dreams, through meditation, painting, praying, and even drug use. Greeks who fell ill in the fourth century B.C.E. would sleep on earthen beds in the temples of the god Asclepius, in the hopes of entering enkoimesis, an induced state of dreaming in which their cure would be revealed.

Modern science has opened a whole new world of possibilities. Researchers can now identify when most people enter the stage of sleep where much of our dreaming takes place—the rapid eye movement (REM) state—by monitoring brain waves, eye movements, and even snoring. They have also shown that external stimuli such as sounds, smells, lights, and speech can alter dreams' content. And this year, researchers communicated directly with lucid dreamers—people who are aware while they are dreaming—getting them to answer questions and solve math problems as they slept.

"People are particularly vulnerable [to suggestion] when asleep," says Adam Haar, a cognitive scientist and Ph.D. student at the Massachusetts Institute of Technology who co-authored the letter. Haar invented a glove that tracks sleep patterns and guides its wearers to dream about specific

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subjects by playing audio cues when the sleeper reaches a susceptible sleep stage. He says he has been contacted by three companies in the past 2 years, including Microsoft and two airlines, asking for his help on dream incubation projects. He helped with one game-related project, but says he wasn't comfortable participating in any advertising campaigns.

Work by Harvard University dream researcher Deirdre Barrett has also attracted corporate attention. In a 1993 study, she asked 66 college students taking a class on dreams to select a problem of personal or academic relevance, write it down, and think about it each night for at least a week before going to bed. At the end of the study, nearly half reported having dreams related to the problem. Similar work published in 2000 in *Science*, in which Harvard neuroscientists asked people to play several hours of the computer game Tetris for 3 days, found that slightly more than 60% of the players reported having dreams about the game.

This year, Barrett consulted with the Molson Coors Beverage Company on an online advertising campaign that ran during the Super Bowl. Following her instructions, Coors, which features mountains and waterfalls on its logo, had 18 people (12 of them paid actors) watch a 90-second video featuring flowing waterfalls, cool mountain air, and Coors beer right before falling asleep. According to a YouTube video documenting the effort, when the participants awoke from REM sleep, five reported dreaming about Coors beer or seltzer. (The result remains unpublished.)

Barrett told *Science* she does not consider the intervention to be a real "experiment," and she acknowledged in a recent blog post that the company's ad used scientific terminology "with overtones [of] mind-control experimentation," against her advice. She also thinks advertising strategies like these will have little practical impact. "Of course you can play ads to someone as they are sleeping, but as far as having much effect, there is little evidence." Dream incubation "doesn't seem very cost effective" compared with traditional advertising campaigns, she says.

That doesn't mean that future attempts couldn't do better, says Antonio Zadra, a dream researcher at the University of Montreal who signed the statement. "We can see the waves forming a tsunami that will come, but most people are just sleeping on a beach unaware," he says. Harvard neuroscientist Robert Stickgold, who ran the Tetris study, is even more emphatic: "They are coming for your dreams, and most people don't even know they can do it."

The letter writers say that because there are no regulations specifically addressing in-dream advertising, companies might one day use smart

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speakers like Alexa to detect people's sleep stages and play back sounds that could influence their dreams and behaviors. "It is easy to envision a world in which smart speakers—40 million Americans currently have them in their bedrooms—become instruments of passive, unconscious overnight advertising, with or without our permission," says the letter, which the writers have sent to U.S. Senator Elizabeth Warren (D-MA).

Such a world is worth preparing for, says Dennis Hirsch, a professor of law and privacy expert at Ohio State University, Columbus. But he thinks the U.S. Federal Trade Commission Act, which prohibits "unfair or deceptive" business acts, likely already applies to using smart speakers to do in-dream advertising. He adds that U.S. law is evolving to include more specific prohibitions on subliminal messaging.

Tore Nielsen, a dream researcher at the University of Montreal who did not sign the statement, says his colleagues have a "legitimate concern." But he thinks interventions like this won't work unless the dreamer is aware of the manipulation—and willing to participate. "I am not overly concerned, just as I am not concerned that people can be hypnotized against their will," Nielsen says. "If it does indeed happen and no regulatory actions are taken to prevent it, then I think we will be well on our way to a Big Brother state ... whether or not our dreams can be modified would likely be the least of our worries."

sciencemag.org, 11 June 2021

<https://www.sciencemag.org>

The tamer the cow, the smaller the brain

2021-06-08

Compare a wild boar with a domestic pig and you may notice a few key differences, including the fact that the pig will likely have a smaller head—and brain—than the boar. Scientists have known for decades that domesticated animals like sheep, pigs, cats, and dogs have smaller brains than their wild counterparts—part of what scientists refer to as "domestication syndrome." Now, the first large-scale study of brain sizes across cattle breeds reveals a new wrinkle: Breeds that tolerate more interaction with humans have smaller brains than those that live more independent lives.

Cattle were first domesticated from bison-size animals called aurochs (*Bos primigenius*) in the Middle East about 10,000 years ago, part of a wave of livestock domestication that included pigs, sheep, and goats.

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To find out how the brains of aurochs—which went extinct some 400 years ago—compared with those of their domesticated descendants, paleontologist Ana Balcarcel of the University of Zurich and colleagues used computerized tomography to scan 13 auroch skulls from museum collections across Europe. Next, they scanned the skulls of 317 cows and bulls, also from museum collections, representing 71 different breeds from around the world. They also measured the muzzle width of the skulls to estimate overall body size.

Then the researchers used their scans to calculate average brain size, relative to body size, for wild versus domestic cattle. Following the pattern of other animals that have undergone domestication, they found that the domesticated animals had brains about 25% smaller than their wild forebears, the researchers report today in the *Proceedings of the Royal Society B*.

With the data in front of her, Balcarcel realized she could do more than just compare wild and domesticated cattle—she could compare the breeds with one another. She sorted the extinct and living breeds into five categories based on their primary purpose as livestock: wild, bullfighting, park (referring to cattle that live essentially as pets on rangeland), beef, and dairy. Next, she plotted the breeds' brain sizes and looked for patterns.

She found that bullfighting breeds, which are bred for aggression and tend to have little human interaction outside fighting in the ring, have brain sizes nearly as large as those of wild aurochs. Park cattle, which have relatively little human contact, also have relatively large brains. But beef cattle have far smaller brains, and dairy cattle—which frequently interact with farmers and are bred for their milk yield and gentleness—have the smallest brains of all.

Balcarcel suspects that when breeders select for more docile animals in beef and dairy breeds, they are selecting for genes that shrink the parts of the brain that control fear, anxiety, and aggression. The result is smaller brains in breeds with the most human contact. These changes to brain architecture can happen relatively quickly, she notes, as many of the specialized breeds of cattle analyzed in the study have been around for only about 200 years.

"From the very beginning, the animals that were captured by humans were the ones that were less aggressive, so this is just a process that has continued and been accentuated in different breeds," Balcarcel says. In future studies, Balcarcel would like to look at breed-specific brain size

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in dogs and see whether any particular breeding strategies make a difference.

The new study is an important step in understanding how domestication influences animals' brains, says Erin Hecht, an evolutionary biologist at Harvard University. "Our understanding of brain changes during domestication is still in its infancy," she says. "This study points toward interesting avenues for future brain-behavior research."

As for whether their small brains affect docile bovines' intelligence, "Only future research will tell," Hecht says, as the authors didn't specifically test intelligence.

[sciencemag.org](https://www.sciencemag.org), 8 June 2021

<https://www.sciencemag.org>

The mere sight of illness may kick-start a canary's immune system

2021-06-08

For canaries, just seeing their feathered friends get sick may be enough to preemptively rev up their immune systems.

Healthy birds housed within view of fellow fowl infected with a common pathogen mounted an immune response, despite not being infected themselves, researchers report online June 9 in *Biology Letters*.

"It's fascinating that some sort of visual cue could alter immune function," says Ashley Love, a disease ecologist at the University of Connecticut in Storrs. Precisely how much these alterations actually protect the birds remains unclear, she says.

Immune systems are like sentinels, patrolling the body for invaders and calling in the cavalry once a pathogen is detected. Traditionally, pathogens have to actually get into bodies to spur that sort of response.

But some research has previously hinted that perceived threats can whip up immune cells. For example, one experiment in humans found that a mere photo of a sick person increases the activity of inflammation-stimulating chemicals called cytokines. But no one had ever looked to see whether being within eyeshot of an actually sick individual could compel the immune system to preemptive action, Love says.

But some research has previously hinted that perceived threats can whip up immune cells.

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"A lot of wildlife diseases have these obvious physical symptoms," she says. If wild animals can prepare, immunologically, at the first sign they might become infected, they may be better equipped to fight off the invader once it comes.

To test this idea, Love and her colleagues infected 10 caged canaries (*Serinus canaria domestica*) with *Mycoplasma gallisepticum*, or MG, a common bacterial pathogen that causes conjunctivitis and extreme lethargy. Sick birds look "pretty fluffed out," Love says.

Nine healthy birds were housed in direct view of their sick brethren, but far enough away to avoid infection, which requires direct contact. An identical setup, but with all healthy birds, was located in the same room but on the other side of an opaque divider. Over the course of a month, researchers collected blood samples from the birds, measured various aspects of immune activity and tracked how sick the infected birds looked.

As healthy birds witnessed neighbors becoming visibly sick, their immune systems stirred. A measure of the birds' ability to burst foreign cells, called CH50 complement activity, rose in conjunction with how sick the infected birds appeared. White blood cell counts were also significantly different in birds exposed to sick individuals, rather than healthy ones. Cytokine levels did not differ between the two groups.

Blood tests showed that no healthy birds caught MG during the experiment, suggesting that some sort of external cue altered immune function. That cue was likely visual, Love says. The smells and sounds of the sick could reach all birds in the experiment, but only the birds in direct view of the ill birds showed an immune response.

"This was a pretty convincing study," says Dana Hawley, a disease ecologist at Virginia Tech in Blacksburg who wasn't involved in the research. Lots of animals avoid infection by social distancing, she says. For instance, lobsters steer clear of dens occupied by sick individuals, and the house finches that Hawley studies avoid individuals who appear ill.

But social distancing has its costs, especially for highly social species.

For species that forage together, or rely on safety in numbers, ramping up an immune response at the mere sight of illness might confer some protection while still allowing the animals to get up close and personal.

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"It's great to avoid a pathogen," Hawley says, "but if you can't find food or [you] get taken by a predator, it doesn't really matter."

sciencenews.org, 8 June 2021

<https://www.sciencenews.org>

A hallucinogenic toad in peril

2021-06-07

Late on a Thursday evening in July 2018, three intruders were caught on a wildlife camera at the Spur Cross Ranch Conservation Area, a park north of Phoenix. Holding flashlights, they scoured a Mexican lily-filled pond near a popular hiking trail, on the hunt for Sonoran Desert toads. One girl squealed as she held up a fat one — both hands wrapped around its belly — and dropped it into a plastic bag. Later, a young man wearing a tattered cowboy hat and a tank top came into view, his face and hand looming large in the camera frame as he clenched a grocery bag. A jumble of legs pressed frantically into the thin plastic, captive amphibians trying to escape their new prison.

"That is like the last thing I expected to see," Kevin Smith, Spur Cross Ranch's sole park ranger, said. He estimates, from the footage, that the thieves grabbed at least a dozen toads. Though the recordings — and the story's peculiar nature — made local and national news, briefly causing a stir, the culprits were never caught. What happened to the creatures isn't hard to guess, however: In recent years, psychedelic enthusiasts have been rounding up Sonoran Desert toads in order to obtain their secretions, which contain a powerful hallucinogenic substance called 5-MeO-DMT.

In "toad medicine circles" — underground ceremonies that take place across the country in swanky areas from Malibu and Santa Fe to what one participant described as "on the floor of a chic apartment on the Upper West Side" of New York City — the psychedelic has become the latest trendy shortcut to spiritual awakening. Ceremony participants often lie down on the ground, on blankets and sarongs, and smoke the dried secretions — a Schedule 1 drug — , which induce an otherworldly state that lasts for about half an hour. Many who've undergone the experience refer to the poison as a "god molecule" that has cured their addictions or helped them achieve a deeper connection to the Earth. Toad altars, T-shirts and tattoos all profess a worship of the species.

The practice has gone from an obscure desert phenomenon in the '80s, to an increasingly popular psychedelic in recent years. In his new memoir,

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Hunter Biden, President Joe Biden's son, claimed that 5-meO-DMT helped temporarily cure his addiction to crack. "The experience unlocked feelings and hurts I'd buried deep for too long," he wrote. "It served as a salve. I stayed sober for a year afterward." Since 2018, the World Bufo Alvarius Congress in Mexico has attracted hundreds of participants annually from across the globe. (Bufo alvarius, as the toad was formerly named, has since been renamed Incilius alvarius, and is also sometimes called the Colorado River toad.) Many ceremonies take place in the country, and increasingly for white tourists in popular destinations like Tulum on the Yucatán Peninsula, where retreat costs can range from \$200 a session to all-inclusive packages upwards of \$3,000.

The toad's newfound popularity concerns Robert Villa, president of the Tucson Herpetological Society and a research associate with the University of Arizona's Desert Laboratory on Tumamoc Hill. "There's a psychedelic renaissance that's happening," he said, "and there's a whole sect of this community that is devoted to the Sonoran Desert toad, extracting (it) for psychedelic use." Villa became aware of the toad's growing popularity after working in 2017 as a consultant for an episode of a Vice docuseries, Hamilton's Pharmacopeia, in which Mexican practitioners are on camera noting the decline in local toad populations in the state of Sonora. While those who collect the bufotoxin on both sides of the border claim to do so in a sustainable fashion, often releasing the toads afterward, Villa said there's no real way to do this. "Toads offer those secretions in a defensive context, in a stressed and violent context," he said. "Ultimately, people are self-medicating at the expense of another creature." As the toad's secretions become increasingly popular, Villa is raising the alarm about the practice's cascading cultural and environmental impacts.

THE SONORAN DESERT TOAD, as its common name suggests, is primarily found in the Sonoran Desert, which stretches from California and Arizona to Mexico, its habitat also extends slightly into New Mexico.

The landscape is home to a diverse array of species that have evolved to flourish in the harsh environment. For most of the year, the toad hibernates in underground burrows. In the summer, when the monsoon season hits, it resurfaces to breed in shallow ponds and streams.

It's during this window of time that it is vulnerable to being snatched from its habitat. But determining the scope of the poaching is difficult. The species is listed as threatened in New Mexico — a 2006 U.S. Fish and Wildlife Service report cites myriad reasons for this, including overcollection — while in California it is believed to be extinct. But

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in Arizona, where its range is significantly larger, it is still considered abundant. "We think poaching takes place. And there have been some anecdotal reports of it (happening)," said Thomas R. Jones, Amphibians and Reptiles Program manager with the Arizona Game and Fish Department. "But even our law enforcement guys don't have a good feel for toad poaching," he added, though "that could be because it's not on their radar."

Evidence of the growing demand, however, can be found at the U.S.-Mexico border, where Jeff Moore, a senior wildlife inspector with the U.S. Fish and Wildlife Service, said that people have been caught attempting to bring the toad or its secretions into the United States. "We have encountered it and are working with other partner agencies on the enforcement," Moore said, adding that because of ongoing investigations, he could not comment further on the scope of the trafficking.

Whenever demand for a trafficked species grows, however, there are going to be consequences. When the psychedelic peyote, which is native to West Texas and Mexico, became popular with people outside the Indigenous communities where its ceremonial religious use originated, this led to a black market and a steep decline in the cactus. Steven Benally, a Diné founding member of the Indigenous Peyote Conservation Initiative, told the Los Angeles Times last year, "To these outsiders, we say, 'Leave peyote alone. Please.'" Beyond the ecological impacts, this type of trade often has cultural implications. As T aylar Dawn Stagner (Shoshone, Arapaho) wrote in High Country News, describing the current "new age" obsession with white sage: "It's become so popular that it has been commodified to the point of erasure, robbed of its Indigenous roots and cultural importance."

Oddly enough, the toad's secretions have no documented historical use in tribes either in Mexico or the U.S. Yet practitioners are still marketing it as a traditional pan-Indigenous remedy, lumping it together with other substances, including peyote and ayahuasca.

The toad itself is culturally significant to the Yaqui Tribe in the Mexican state of Sonora and the Pascua Yaqui in Arizona, playing a symbolic role in tribal stories and ceremonies. But during the last decade, the tribe has noticed a decline in local populations, according to Villa, who consulted with tribal members in Mexico in 2014.

The toad has not been classified as endangered or threatened at the federal level in either Mexico or in the U.S., and it would require extensive monitoring efforts before such a designation could be achieved. Jones said it's not always easy to determine when to start monitoring a species.

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"What is often the case is that people like me will say, 'Yeah, they're abundant. I see them all the time, like I used to.' And then, after about 10 years, someone says, 'Hey, you know, I haven't been seeing them like I used to.' And then you start monitoring them in some place and discover that either they're still there or that they've declined." Jones said. "But because there's no standard monitoring effort that's going on for a species like that, it's really hard to gauge."

Given that species like the Sonoran Desert toad already face multiple threats, including climate change and rapid urbanization, overcollection can have consequential impacts. "It really kind of shocks me, actually. The fact that people assume, based on its abundance, that it's fine," said Villa, who has spent the last few years raising awareness about the toad and its plight. "When you begin to notice something's happening in those populations, it's too late."

hcn.org, 7 June 2021

<https://www.hcn.org>

Will humans ever learn to speak whale?

2021-06-13

Sperm whales are among the loudest living animals on the planet, producing creaking, knocking and staccato clicking sounds to communicate with other whales that are a few feet to even a few hundred miles away.

This symphony of patterned clicks, known as codas, might be sophisticated enough to qualify as a full-fledged language. But will humans ever understand what these cetaceans are saying?

The answer is maybe, but first researchers have to collect and analyze an unprecedented number of sperm whale communications, researchers told Live Science. [PLAY SOUND](#)

With brains six times larger than ours, sperm whales (*Physeter macrocephalus*) have intricate social structures and spend much of their time socializing and exchanging codas. These messages can be as brief as 10 seconds, or last over half an hour. In fact, "The complexity and duration of whale vocalizations suggest that they are at least in principle capable of exhibiting a more complex grammar" than other nonhuman animals, according to an April 2021 paper about sperm whales posted to the preprint server [arXiv.org](https://arxiv.org).

But will humans ever understand what these cetaceans are saying?

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This paper, by a cross-disciplinary project known as CETI (Cetacean Translation Initiative), outlines a plan to decode sperm whale vocalizations, first by collecting recordings of sperm whales, and then by using machine learning to try to decode the sequences of clicks these fellow mammals use to communicate. CETI chose to study sperm whales over other whales because their clicks have an almost Morse code-like structure, which artificial intelligence (AI) might have an easier time analyzing.

Breaching the surface

The little that humans do know about sperm whales has all been learned quite recently. It was only in the 1950s that we noted they made sounds, and it wasn't known that they were using those sounds to communicate until the 1970s, according to the new research posted by CETI.

This clicking appears to serve a dual purpose. Sperm whales can dive to depths of 4,000 feet (1,200 meters), or three times deeper than nuclear submarines, according to the Woods Holes Oceanographic Institution. Because it is pitch black at these depths, they have evolved to seek out squid and other marine creatures by using clicks for echolocation, a type of sonar. This same clicking mechanism is also used in their social vocalizations, although the communication clicks are more tightly packed, according to the CETI paper.

Figuring out even this much has been challenging, as sperm whales have "been so hard for humans to study for so many years," David Gruber, a marine biologist and CETI project leader, told Live Science. But now, "we actually do have the tools to be able to look at this more in depth in a way that we haven't been able to before." Those tools include AI, robotics and drones, he said.

Pratyusha Sharma, a data science researcher for CETI and a doctoral candidate in the Computer Science and Artificial Intelligence Laboratory at MIT, told Live Science more about recent developments in artificial intelligence and language models, such as GPT-3, which uses deep learning to construct human-like text or stories on command, and last year took the AI community by storm. Scientists hope these same methods could be applied to the vocalizations of sperm whales, she said. The only problem: these methods have a voracious appetite for data.

The CETI project currently has recordings of about 100,000 sperm whale clicks, painstakingly gathered by marine biologists over many years, but the machine-learning algorithms might need somewhere in the vicinity of 4 billion. To bridge this gap, CETI is setting up numerous automated

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channels for collecting recordings from sperm whales. These include underwater microphones placed in waters frequented by sperm whales, microphones that can be dropped by eagle-eyed airborne drones as soon as they spot a pod of sperm whales congregating at the surface, and even robotic fish that can follow and listen to whales unobtrusively from a distance.

But even with all this data, will we be able to decipher it? Many of the machine-learning algorithms have found audio more difficult to analyze than text. For instance, it might be challenging to parse apart where one word begins and ends. As Sharma explained, "Suppose there's a word 'umbrella.' Is 'um' the word or is it 'umbrell' or is it 'umbrella'?" The barriers between spoken words are more ambiguous and less regular, and patterns may therefore require more data to suss out.

That's not the only difficulty CETI will face. "Whether someone comes from let's say Japan or from the U.S. or from wherever, the worlds we talk about are very similar; we talk about people, we talk about their actions," Sharma said. "But the worlds these whales live in are very different, right? And the behaviors are very different."

What's more, sperm whales are known to have dialects, according to a 2016 study in the journal Royal Society Open Science, which analyzed codas from nine sperm whale groups in the Caribbean for six years.

But these difficulties are also what make the project so worthwhile. What exactly one sperm whale says to another remains as dark and murky as the waters they swim in, but this mystery makes any answers CETI finds all the more intriguing. As Gruber put it, "We learn so much when we try to view the world from the perspective of the other."

Originally published on Live Science.

[livescience.com](https://www.livescience.com), 13 June 2021

<https://www.livescience.com>

An ancient creature thought to be a teeny dinosaur turns out to be a lizard

2021-06-14

A tiny creature caught in amber 99 million years ago isn't the smallest dinosaur ever found. It is actually a lizard — albeit a really bizarre one, researchers report June 14 in Current Biology.

The birdlike features led one team of scientists to identify the fossil as a miniature dinosaur — the smallest ever found (SN: 3/11/20).

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Over the last year, scientists have puzzled over the nature of the strange, hummingbird-sized *Oculudentavis khaungraae*, a fossil found in amber deposits in northwestern Myanmar. The fossil consists of only a birdlike, rounded skull with a slender tapering snout and a large number of teeth in its mouth, along with a lizardlike eye socket, deep and conical. The birdlike features led one team of scientists to identify the fossil as a miniature dinosaur — the smallest ever found (SN: 3/11/20).

But other scientists weren't so sure. Another analysis of *O. khaungraae*'s strange assemblage of features suggested it looked rather more like a weird lizard.

Now, a third team of scientists reports the discovery of a second amber fossil that so closely resembles *O. khangraae* as to belong to the same genus. And the new specimen, dubbed *O. naga*, includes parts of the lower body that clearly reveal the members of genus *Oculudentavis* to be lizards, say paleontologist Arnau Bolet of the Institut Català de Paleontologia Miquel Crusafont in Barcelona and colleagues.

The researchers used CT scans to examine both specimens. *Oculudentavis*' lizardlike features include scales, teeth attached to its jawbone directly rather than in sockets (as dinosaur teeth were) and a particular skull bone unique to squamates, or scaled reptiles.

Still, the creatures were markedly different from all other known lizards in their unusual combination of features, such as the rounded skulls and long tapering snouts, the researchers say — probably representing a previously unknown group of lizards.

[sciencenews.org](https://www.sciencenews.org), 14 June 2021

<https://www.sciencenews.org>

Scientists unravel mystery of echidnas' bizarre 4-headed penis

2021-06-14

Scientists in Australia have uncovered the mystery behind the bizarre four-headed echidna penis by creating an advanced 3D model of the peculiar organ.

There are four species of echidnas that, along with platypuses, make up a unique group known as monotremes — the smallest of the three mammal groups — whose members lay eggs like birds and fish, but also produce

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milk like other mammals. Much about this group remains a mystery, the study researchers said.

One of the biggest monotreme mysteries is the echidna penis, which has four separate heads, or glans, at the end of the shaft. If that wasn't weird enough, only two of the heads are used during each erection, and echidnas can alternate between which two they use.

"Exactly how echidnas do this has always been a mystery," the study researchers said in a statement. "But for the first time we have untangled what is going on anatomically."

Weirdness abounds

In addition to their distinctive shape, echidna penises are also unusual because, unlike those of most other mammals, they are used only for sexual reproduction and not urination. Instead, echidnas use a cloaca — a multipurpose opening for urinating, defecating and, in females, egg laying. When not in use, echidnas' penises are retracted inside their bodies and emerge through the cloacal opening when erect; their testes, which unusually have no scrotum, remain inside their bodies all the time.

In addition to their unconventional genitalia, echidnas' sperm are also unconventional and have the astonishing ability of being able to work as a team.

"Ejaculated semen samples contained bundles of up to 100 sperm that are joined at the tip of their heads so they form a sphere-like shape," Jane Felon, lead author of the study and a reproductive biologist at the University of Melbourne, told Live Science. "These bundles have been observed to swim progressively forward in a vigorous and coordinated pattern, and bigger bundles seem to swim better than individual sperm or smaller bundles."

Very few animals' sperm are known to do this, and the reason behind it is unknown, Felon said.

Scanning the shaft

To understand more about how echidna penises work, Felon's team turned to short-beaked echidnas (*Tachyglossus aculeatus*) at a wildlife sanctuary in Australia. Unfortunately, rescued echidnas tend to have injuries, usually inflicted by road collisions, that are so severe the animals are often euthanized. But luckily for the researchers, the euthanized echidnas' penises are still in good enough shape to study, Felon said.

One of the biggest monotreme mysteries is the echidna penis, which has four separate heads, or glans, at the end of the shaft.

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Researchers took the euthanized echidnas and created 3D models of their penises using specialized CT scans. Normal CT scans only detect hard tissue like bones, so the researchers stained the penises with iodine to enable the soft tissues to be mapped out.

“This meant we could create a 3D model of the whole echidna penis and its important internal structures in order to see how it operates,” the researchers wrote.

Erectile evolution

The 3D computer model revealed that the urethral tube, which the sperm moves through, splits below the heads into two separate tubes, which each split again to allow for sperm to be delivered to each of the four heads. This makes sense, but the finding did not explain why only two of the heads are used during sex.

“Initially, we thought we’d find some sort of valve mechanism” that would “control the one-sided action seen in echidna,” the researchers wrote. But instead of a valve, they found that it was actually the type of tissue within the penis that was responsible.

Mammalian penises consist of two main types of erectile tissue — the corpus cavernosum and the corpus spongiosum. Both tissues fill with blood during an erection, but the role of the corpus cavernosum is predominantly to provide a rigid structure to the penis, whereas the corpus spongiosum keeps the urethral tube open to allow sperm to pass through.

Each tissue starts off as two different structures at the base of the penis. In most mammals, the two corpus spongiosum structures merge into one, while the corpus cavernosum remains separated. But in short-beaked echidnas, the cavernosum was merged while the spongiosum remained separate. This separate spongiosum tissue is what allows echidnas to erect each half, or pair of heads, independently from the other, the researchers said.

“We’re not really sure” why this is beneficial to the echidna males, Fenelon said, “but we think it could be an advantage for male-male competition for females.”

During a separate experiment on a living but anesthetized echidna, the researchers found that by alternating pairs of heads the individual could ejaculate 10 times in a row without significant pause. This may allow some

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males to gain an advantage over others, but more experiments are needed to confirm this idea.

The study was published online April 29 in the journal *Sexual Development*.

Originally published on Live Science.

[livescience.com](https://www.livescience.com), 14 June 2021

<https://www.livescience.com>

These eels can swallow prey on land, thanks to extendable jaws in their throats

2021-06-10

Moray eels have a second, hidden set of jaws that are the stuff of nightmares. These extra jaws can snap forward in an instant to clamp into prey and drag the animal down into the eel’s gullet.

Those terrifying slingshot jaws help a type of moray do something that’s impossible for most fish: swallow their prey while on land, according to a new study. It’s an unnerving sight, with researchers’ video showing prey being yanked down the eel’s throat as the moray’s mouth gapes open.

Fish typically need moving water to carry food from their mouths into their bellies. But snowflake moray eels (*Echidna nebulosa*) can ambush crabs on land by wriggling from the sea to catch their prey during low tide, and researchers recently found that the recoil of the eels’ secondary jaws was strong enough to help morays swallow their meal without having to retreat back into the ocean.

PLAY SOUND

All bony fishes — those with skeletons made mostly of bone, rather than cartilage — have pharyngeal jaws in addition to their main jaws. Pharyngeal jaws lie behind the pharynx, or throat. They are smaller than the jaws in fishes’ mouths and are used for gripping and piercing or crushing food, according to the Smithsonian National Museum of Natural History.

But unlike most fishes’ pharyngeal jaws, those in moray eels “are highly mobile” and can spring past the throat and into the morays’ mouths, said Rita Mehta, an associate professor in the Department of Ecology and Evolutionary Biology at the University of California Santa Cruz (UCSC).

These extra jaws can snap forward in an instant to clamp into prey and drag the animal down into the eel’s gullet.

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In 2007, Mehta described how moray eels took advantage of this extreme movement while feeding in the water, with their pharyngeal jaws acting as “these wonderful forceps that grab prey,” she previously told Live Science. In the new study, published June 7 in the *Journal of Experimental Biology*, Mehta and co-author Kyle Donohoe, a research assistant at the UCSC Pinniped Cognition and Sensory Systems Laboratory, filmed eels as they munched on meals while out of the water, Mehta told Live Science in an email.

“Based on what we knew about the mechanics of the pharyngeal jaws, it made sense that if morays were able to capture prey in the intertidal or on land, they could also swallow their prey on the land without relying on water,” Mehta said.

Training snowflake moray eels to feed out of water in lab experiments — and then recording the results — took six years, according to the study. The scientists installed eels in aquariums equipped with platforms and ramps that were above water. They then trained the eels — named Benjen, Marsh, Qani, Jetsom, Frosty, Flatsom and LB — to climb up the ramps for pieces of squid. Over time, the food was moved higher up the ramp, until eventually the eels were independently wriggling out of the water and undulating up the ramps to find food.

“For the majority of terrestrial trials, snowflake morays undulated the upper third of their body from the water to capture prey on the ramp,” the researchers reported. They analyzed 67 videos of eels’ meals in water and on the ramp, finding that the fish used their pharyngeal jaws in the same way and at the same speed while in water or on land.

Morays aren’t your average “fish out of water.” They can function during temporary oxygen deprivation, and studies of a snowflake moray relative, the Mediterranean moray (*Muraena helena*), showed that lipids and mucus in morays’ skin could protect the eels against drying out when they’re exposed to air, the study authors wrote.

The experiments offered previously unseen examples of moray eel behavior, hinting at how morays might combine amphibious traits with a slingshot jaw to make them versatile and formidable hunters in wet or dry environments. These adaptations could allow morays to find new types of food if their regular supply disappears and may help the fish avoid competition in their ocean ecosystems by letting them feed in a different habitat, Mehta said.

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The findings were published on June 7 in the *Journal of Experimental Biology*.

Originally published on Live Science.

[livescience.com](https://www.livescience.com), 10 June 2021

<https://www.livescience.com>

Was Venus once a good home for life? NASA missions aim to find out

2021-06-09

When NASA announced last week it would spend \$1 billion developing two new missions to Venus—the agency’s first visits in decades to Earth’s hothouse twin—planetary scientists were elated, and not just because a long wait had ended. A dramatic shift in thinking about the planet over the past few years has made a visit even more enticing. Venus was once thought to have boiled off all its water almost as soon as it was born 4.5 billion years ago, turning into the parched, hostile world of today. But many scientists now think Venus might have kept expansive oceans for billions of years—a nearly perfect setting for life.

The missions, to arrive late this decade, are equipped to look for signs of that water—and clues to why Venus ultimately declined into an inferno. If their findings support the new picture, Mars, the longtime hope for discovering signs of ancient extraterrestrial life, will have a rival. “Why look at Mars, which had water for 300 million years, when Venus had water for 3 billion years?” asks Darby Dyar, a planetary scientist at Mount Holyoke College who is deputy principal investigator for one of the new missions, VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy).

Early visits to Venus cemented the picture of a dead, waterless planet when they detected no sign of oxygen in its thick carbon dioxide (CO₂) atmosphere, which keeps its surface at a lead-melting 460°C. Venus likely started out with plenty of water, as it formed from roughly the same building blocks as Earth. The thinking was that as the water boiled off, ultraviolet light broke down water vapor molecules. Hydrogen would have escaped to space while oxygen, being heavier, would have lingered in the air. Its absence led scientists to assume Venus lost its water very early on.

In 2014, however, in a computer modeling study of potential exoplanet atmospheres, a team led by Jun Yang, a planetary scientist at Peking

But many scientists now think Venus might have kept expansive oceans for billions of years—a nearly perfect setting for life.

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University, made a striking observation: Planets that rotate as slowly as Venus, which makes one full turn every 243 Earth days, have a very weak Coriolis effect, a twisting force caused by planetary spin. On Earth, the Coriolis causes air flow in each hemisphere's lower atmosphere to split into three cells: the tropical, subtropical, and polar circulations. On a slow spinner, however, winds could flow all the way from the equator to the poles. In a moist atmosphere, the updrafts would create a massive cloud deck shrouding the sunny side of the planet.

Soon after, Michael Way, a climate modeler at NASA's Goddard Institute for Space Studies (GISS), and his colleagues picked up this idea, testing it with a climate model built to simulate early Venus conditions. They found the same result, they reported in 2016: Massive water clouds formed, blocking almost half of the sunlight. In the perpetual twilight, liquid water could have survived for billions of years. On Earth, water lubricates the moving tectonic plates, and it would have boosted the odds that Venus, too, had some sort of plate tectonics—and potentially life, Way says. "I do think this work has changed people's opinions about the viability of a biosphere."

How Venus went bad and what happened to the water's oxygen remained a puzzle. In a paper last year, Way and Anthony Del Genio, also at GISS, suggested Venus could have been struck with multiple continent-spanning eruptions—the kind of catastrophic events that have caused mass extinctions on Earth. The eruptions would have poured CO₂ into the atmosphere, causing a runaway greenhouse effect that boiled the planet dry. Then, perhaps half a billion years ago, the oxygen released by the water could have been purged by reactions with magma and ash from subsequent widespread eruptions, also thought to explain Venus's relatively young surface, which lacks ancient impact craters.

It's a compelling story, Dyar says. "When I first saw Michael Way's paper, I got so excited," she says. Way acknowledges that his model includes many assumptions and little data. But that will soon change, he says. "These missions coming along now are fantastic for testing these models."

VERITAS, developed by NASA's Jet Propulsion Laboratory and led by JPL planetary scientist Suzanne Smrekar, will use radar to peer through Venus's thick clouds of sulfuric acid and trace its topography in 100 times finer detail than Magellan, a NASA mission that ended in 1994. Besides guiding potential future landers, the mapping should show whether blurry features seen in the Magellan data are the signatures of plate tectonics, such as trenches.

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The orbiter will also be armed with a spectrometer capable of looking for chemical signatures in the faint light that reflects off the surface and escapes through the clouds. "We have to work with what Venus has given us," Dyar says. The presence or absence of iron will be critical. Scientists have long thought Venus's rugged highlands, called tesserae, could be the remains of continental crust. On Earth, the continents are rich in granite, an iron-depleted rock that only forms with the help of water and plate tectonics; widespread detection of granite would indicate Venus had a very Earth-like history.

The second mission, DAVINCI+ (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging Plus), would address Way's hypothesis more directly. Developed at NASA's Goddard Space Flight Center and led by GSFC Chief Scientist James Garvin, DAVINCI+ will drop an instrument-laden sphere, armored against the crushing pressure of the venusian atmosphere. During its hourlong plunge, slowed by a parachute, its instruments will measure noble gases, especially xenon, to see whether the abundances match those on Earth, which could suggest a similar early history of water. It will also be able to refine measurements made decades ago of the ratio between light and heavy isotopes of hydrogen, especially in the dense lower atmosphere, which will help pin down how much water Venus has lost over its history.

The probe's cameras and spectrometer, meanwhile, will take aim at a highland region called Alpha Regio, searching again for the signal of granite. Toward the end of its descent, the cameras will capture Alpha Regio's features in superhigh resolution, including a 3D view, complementing the VERITAS maps. "Together we can paint a really wonderful comprehensive picture," says Giada Arney, a deputy principal investigator for DAVINCI+ at GSFC.

On its way down, DAVINCI+'s instruments might also detect a sign not of past habitability, but present-day life: phosphine. In September 2020, astronomers probing the planet's atmosphere with telescopes said they had picked up hints of the gas, which on Earth is a sign of microbial life, but the evidence has sparked debate ever since. The DAVINCI+ team is exploring tweaks to a laser spectrometer that could enable it to sniff out trace abundances of the gas, Arney says.

It's been a long wait for these missions, with proposal after proposal turned down. Dyar still remembers her days as a graduate student at the Massachusetts Institute of Technology in the 1980s, when then-President Ronald Reagan canceled a proposed Venus mission, causing tears in the

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hallway. The new missions could begin to make amends, she says, and the potential payoff is greater than ever. "These questions have been haunting us for 30 years," she says. "It's Venus's turn."

sciencemag.org, 9 June 2021

<https://www.sciencemag.org>

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