CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Taiwan to impose tighter rules on sale, use of two dangerous chemicals

2021-04-01

Taipei, April 1 (CNA) Stricter regulations on the sale and use of the potentially dangerous chemicals ammonium nitrate and hydrogen fluoride will come into effect later this year, the Environmental Protection Administration (EPA) said Thursday.

The chemicals will be controlled under the Toxic and Concerned Chemical Substances Control Act from July 1 and Dec. 1, respectively, the EPA added.

Both substances are already subject to regulation by various government agencies, though the current rules do not provide for close monitoring of how they are used in Taiwan, Hsieh Yein-rui ( ), head of the EPA's Toxic and Chemical Substances Bureau, said at a press briefing on Thursday.

By including the two substances in the act, authorities will be able to track their use more precisely, Hsieh said.

Ammonium nitrate is often imported into Taiwan, and can be used as a fertilizer and an ingredient in explosives. It is also a key component in producing nitrous oxide, commonly known as laughing gas, according to Hsieh.

As laughing gas is already regulated under the act, and an explosion of ammonium nitrate in Beirut, Lebanon last year killed hundreds of people and left hundreds of thousands homeless, the EPA has decided to more strictly regulate the substance, Hsieh said.

Meanwhile, hydrogen fluoride forms hydrofluoric acid when dissolved in water, which is highly corrosive and can cause severe skin burns, Hsieh said.

In Taiwan, the acid is mainly used in the technology and manufacturing industries, but it is also used to clean air conditioners and the exterior of buildings, according to Hsieh.

When the two substances are regulated under the Toxic and Concerned Chemical Substances Control Act, anyone who produces, imports, sells, uses, transports or stores them will have to obtain prior approval from local governments and submit relevant information on their use each month.

The chemicals will be controlled under the Toxic and Concerned Chemical Substances Control Act from July 1 and Dec. 1, respectively, the EPA added.

Under the act, unlicensed users of the substances will be subject to a fine of NT$30,000 (US$1,041) to NT$300,000 and can be ordered to shut down.

In cases where the unlicensed use of the chemicals results in death, the penalty will be seven years to life in a prison and a fine of up to NT$10 million, Hsieh said.

There are also additional regulations for operators that use large amounts of the two substances at high concentration levels, including submitting how they plan to prevent accidents, insuring and training relevant personnel, and installing monitors and alarm devices.

Of the roughly 200 operators using each of the two substances in Taiwan, nine that use ammonium nitrate meet this definition, while 65 meet it for hydrogen fluoride, according to Hsieh.

Read More

Focus Taiwan, 1 April 2021

https://focustaiwan.tw/society/202104010018

REMINDER – WORKPLACE EXPOSURE STANDARDS OPEN FOR PUBLIC FEEDBACK

2021-03-31

Safe Work Australia calls for public comment on the workplace exposure standards for airborne contaminants.

Safe Work Australia is reviewing the Workplace exposure standards for airborne contaminants (WES) to ensure they are based on high quality evidence and supported by a rigorous scientific approach.

Comments on the draft reports and WES values are now open for the final release of 169 draft evaluation reports from paraffin wax to zirconium compounds (release 15).

Consultation closes on 30 July 2021. No extensions or late submissions will be accepted.

Each draft report open for public comment includes:

• a recommended WES value

• information about the basis of the recommendation, and

• a summary of the data relied upon to make the recommendation.

Consultation closes on 30 July 2021. No extensions or late submissions will be accepted.

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Feedback is sought on the WES values and technical comments regarding:

• the toxicological information and data that the value is based on, and

• the measurement and analysis information provided.

The review will result in the development of a list of health-based recommendations for the workplace exposure standards in Australia. This includes recommendation on the workplace exposure standards values, notations, and the list of chemicals.

Read More

Safe Work Australia, 31 March 2021

https://www.safeworkaustralia.gov.au/review-workplace-exposure-standards

Apply for protection of CBI – internationally assessed reported introductions

2021-04-01

This guidance applies to confidential business information (CBI) applications for chemical name or specific end use in relation to a pre-introduction report for the type 'internationally assessed'.

This guidance applies to confidential business information (CBI) applications for chemical name or specific end use in relation to a pre-introduction report for the type 'internationally assessed'.

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Australian Industrial Chemicals Introduction Scheme, 1 April 2021

https://www.industrialchemicals.gov.au/business/apply-confidentiality-data-and-information/apply-protection-cbi-internationally-assessed-reported-introductions

Hazardous Chemical System update

2021-03-06

Safe Work Australia has completed an update of the Hazardous Chemical Information System (HCIS). This update completes the publication of classification information by the Inventory Multi-tiered Assessment and Prioritisation (IMAP) program run by the former National Industrial

This guidance applies to confidential business information (CBI) applications for chemical name or specific end use in relation to a pre-introduction report for the type 'internationally assessed'.

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Chemicals Notification and Assessment Scheme (NICNAS), now the Australian Industrial Chemicals Introduction Scheme (AICIS).

This update adds or updates the classification of 1,219 hazardous chemicals. To see new and amended chemicals, use the advanced search feature to show chemicals revised this week.

Read More

Safe Work Australia, 6 March 2021

http://hcis.safeworkaustralia.gov.au/News

AMERICA

US EPA takes tougher stance on new chemicals

2021-03-30

Agency to evaluate safety of all uses and ensure worker protections

The US Environmental Protection Agency is making major changes to the way it evaluates the safety of new chemicals, the agency announced March 29. To start, the EPA will assess the risks of all uses—known and potential—of a new chemical, and it will mandate necessary protections for workers.

The changes aim to better align risk assessments of new chemicals with the requirements of the Toxic Substances Control Act, the EPA says. The agency intends to make additional changes as necessary to ensure new chemicals do not pose unreasonable risks to human health and the environment.

Under the Trump administration, the EPA commonly justified approving new chemicals without addressing the risks of potential future uses of the chemical by issuing what is known as a significant new use rule (SNUR). A SNUR postpones risk assessment of a potential use until a company tells the EPA it will use a chemical in that way. The agency says that it will no longer rely on SNURs to exclude reasonably foreseen uses from its evaluation of new substances.

"Congress anticipated that EPA would review all conditions of use at the time it made safety determinations on new chemicals," Michal Freedhoff, acting assistant administrator of the EPA's chemicals office, said during a March 29 plenary session at the industry-sponsored GlobalChem Conference. "Under the Biden EPA, when our review leads us to conclude

The agency intends to make additional changes as necessary to ensure new chemicals do not pose unreasonable risks to human health and the environment.

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that one or more uses may present an unreasonable risk or when we lack the information needed to make a safety finding, we will issue an order to address those potential risks," she said.

The EPA will also ensure that new chemicals do not pose a risk to workers. "When we identify a potential unreasonable risk to workers that could be addressed with appropriate personal protective equipment and hazard communication, we'll no longer assume that those protections will be provided," Freedhoff said. "We will mandate necessary protections," she added.

Environmental groups welcome the changes. "By taking this step, EPA will reverse the illegal and unprotective approach the prior administration applied to hundreds of new chemicals over the last several years," Richard Denison, a lead senior scientist at the Environmental Defense Fund, said in a March 29 blog post.

The American Chemistry Council, which represents the chemical industry, is concerned that the changes will lead to delays in getting new chemicals onto the market. Making the EPA's process for approving new chemicals more efficient is one of the ACC's top priorities this year, Chris Jahn, president and CEO of the group said in his opening remarks at the GlobalChem Conference. "Delays in the premanufacture notice review process can have a significant adverse effect on research and development of new sustainable chemistries as well as our ability to bring new innovative products to market," he said.

Read More

Chemical & Engineering News, 30 March 2021

https://cen.acs.org/policy/chemical-regulation/US-EPA-takes-tougher-stance/99/i12

The federal process to develop environmental standards for these chemicals can be lengthy.

Wisconsin takes proactive approach to PFAS regulation

2021-04-01

Tetra Tech's Erica Lawson and Meleesa Johnson, the Director of Solid Waste Management for Marathon County, Wisconsin. wrote this piece to discuss the how the solid waste solutions and wastewater industries work together with state agencies to develop an action plan for per- and polyfluoroalkyl substances (PFAS) regulation.

The original article appeared in Waste Advantage Magazine's March 2021 issue.

The solid waste and wastewater industries are evaluating their intertwined roles in the PFAS life cycle to protect the public from potential adverse health impacts of PFAS. The widespread use of products containing PFAS results in multiple exposure pathways throughout the life cycle of the chemicals, making it difficult to develop a data- and science-driven action plan for mitigating potential public exposure.

The federal process to develop environmental standards for these chemicals can be lengthy. This has caused individual states to develop their own standards to reduce risk. Wisconsin's approach shows great promise as a standard bearer. With the development of a multi-agency PFAS action plan, reliance on carefully vetted data, consideration of public and industry comments and concerns, and active involvement of the Wisconsin Solid Waste PFAS Coalition, the state of Wisconsin is taking the appropriate measures to protect human health and the environment while avoiding the pitfalls of a hasty overreaction.

PFAS and solid waste management

Discarded consumer products and industrial wastes containing PFAS decompose in landfills, releasing PFAS from the waste into landfill gas and leachate. Some of these contaminants make their way into groundwater, surface water, and ambient air. Stormwater runoff and discharges from landfills also can be impacted by PFAS due to source materials used in landfill construction. This transport of contaminants potentially makes landfills a key component of the PFAS life cycle.

Read More

CSRwire, 1 April 2021

https://www.csrwire.com/press_releases/720476-wisconsin-takes-proactive-approach-pfas-regulation

SOR FDA colloquia series will include webcast on the toxicology of nanoparticles

2021-03-30

The Society of Toxicology (SOT) in conjunction with the U.S. Food and Drug Administration (FDA) Center for Food Safety and Applied Nutrition (CFSAN) have partnered to provide a colloquia series on Emerging Toxicological Science: Challenges in Food and Ingredient Safety. The colloquia will present scientific information that is high-quality, cutting-edge, future-oriented toxicological science and is intended to provide a well-grounded foundation to inform the work of FDA employees. On **April 8, 2021**, there will be a live webcast on the toxicology of nanoparticles. Richard Canady, Ph.D., and Kapal Dewan, MS, CLSp(CG), are Colloquium Co-Chairs. The agenda includes:

- Welcome, George Daston, SOT President, Procter & Gamble Company;
- Overview and Speaker Introductions, Richard Canady, Ph.D., NeutralScience LC3;
- Lessons Learned from Nanomaterial Characterization: Critical Quality Attributes that Influence Biological Properties, Anil Patri, Ph.D., National Center for Toxicological Research (NCTR);
- Standard Dose Measurement for Nanomaterials: What to Include in Exposure and Toxicity so That We Can Bound Dose Estimates for Safety?, Christie Sayes, Ph.D., Baylor University;
- Dosing-Related Challenges in Toxicity Studies and Risk Assessment of Titanium Dioxide in Food, Walter Brand, Ph.D., National Institute for Public Health and the Environment (RIVM) in The Netherlands;
- Practical Application to Regulatory Toxicology: Issues Faced in Consideration of Developing Health Guideline Values, Lynne Haber, Ph.D., University of Cincinnati Risk Science Center; and
- Roundtable discussion moderated by Richard Canady, Ph.D., and including all speakers, as well as Timothy Duncan, Ph.D., FDA, and Agnes Oomen, Ph.D., RIVM.

The webcast is open to the public at no charge. Registration will require creating an online account. SOT notes that these sessions are not a public forum to discuss toxicology regulatory issues.

Read More

Nano and Other Emerging Chemicals Technologies Blog, 30 March 2021

https://nanotech.lawbc.com/2021/03/sot-fda-colloquia-series-will-include-webcast-on-the-toxicology-of-nanoparticles

The colloquia will present scientific information that is high-quality, cutting-edge, future-oriented toxicological science and is intended to provide a well-grounded foundation to inform the work of FDA employees.

To permit the use of a CMR substance of category 2, the substance has to be evaluated by the relevant Scientific Committee and found to be safe, in particular in view of exposure.

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EUROPE

EC requests committee opinion on safety of titanium dioxide in toys; committee calls for scientific information

2021-04-01

The European Commission (EC) has requested a scientific opinion from the Scientific Committee on Health, Environmental and Emerging Risks (SCHEER) on the safety of titanium dioxide in toys with regard to a possible derogation from its prohibition. The Toy Safety Directive 2009/48/EC prohibits the use of substances in toys if those substances are classified as carcinogenic, mutagenic, or toxic for reproduction (CMR). The use of such substances may be permitted under certain conditions, however. To permit the use of a CMR substance of category 2, the substance has to be evaluated by the relevant Scientific Committee and found to be safe, in particular in view of exposure. An additional condition is that the substance is not prohibited for use in consumer articles under the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulation. Titanium dioxide in powder form containing one percent or more of particles with aerodynamic diameter ≤ ten micrometers (μm) has been classified as carcinogenic category 2 by inhalation.

SCHEER has called for scientific information on:

- The chemical and physical specifications of titanium dioxide used in toys;
- The size distribution of pigment grade titanium dioxide used in toys;
- The migration or release of titanium dioxide from toys; and
- Exposure measurements on titanium dioxide used in toys.

Submissions are due **April 28, 2021**. The call for information will remain open after this date, however, and additional studies (*e.g.*, ongoing studies and research that are not completed by the deadline) may be passed to the working group at a later stage, if needed.

The EC asked SCHEER:

- To review the available data on the use of titanium dioxide leading to inhalation exposure in particular in toys and toy materials; and
- To evaluate whether the uses of titanium dioxide in toys and toy materials can be considered safe in light of the exposure identified,

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and in light of the classification of titanium dioxide as carcinogenic category 2. Safe toys and toy materials should be indicated.

According to the timeline in the EC's request, the preliminary opinion is expected in **mid-2021,** and the final opinion in **fall 2021**.

Read More

Nano and Other Emerging Chemicals Technologies Blog, 1 April 2021

https://nanotech.lawbc.com/2021/04/ec-requests-committee-opinion-on-safety-of-titanium-dioxide-in-toys-committee-calls-for-scientific-information/

The Netherlands launches regulatory inspection and enforcement rules

2021-03-30

March 29, 2021. Dutch authorities have officially launched new regulatory inspection and enforcement rules under which OR and enterprises will be further required to cooperate to complete the necessary inspection.

Overview of Regulatory Inspection and Enforcement Function

*The **Regulatory Inspection and Enforcement Function** is centered on decisions regarding compliance and whether action is required under the corresponding legislation or regulations. Among others, actions may include sending letters indicating remedial steps to be taken, enforcing penalties, filing charges through the court system, and shutting down non-compliant operations.*

In a departure from previous years, the Dutch authorities will not only be comparing customs data with companies' trade data and require them to provide relevant qualification documents. Instead, companies will be under the obligation to provide all trade records for the substances they spot check for any given year.

Read More

REACH14, 30 March 2021

https://www.reach24h.com/en/news/industry-news/attention-netherland-launched-regulatory-inspection-and-enforcement.html

Instead, companies will be under the obligation to provide all trade records for the substances they spot check for any given year.

UK REACH Agency statement on the use of independent scientific knowledge and advice (ISA) and transparency published

2021-04-01

Article 77 in the UK REACH Regulation makes provision for the Agency (the Health and Safety Executive) to obtain and use independent scientific knowledge and advice (ISA) in the formation of relevant Agency opinions.

It also requires the Agency to publish a statement on how it will gather and use this advice, as well as how it will ensure a high degree of transparency when carrying out its functions under UK REACH.

Following public consultation, HSE has published the ISA statement to make transparent to all stakeholders the Agency's approach to gathering and using ISA.

This is part of ensuring on-going transparency in the process of, and trust in, regulatory decisions and processes.

Read More

HSE, 1 April 2021

https://www.hse.gov.uk/reach/reach-independent-scientific-expert-pool.htm?utm_source=govdelivery&utm_medium=email&utm_campaign=chemicals-guidance&utm_term=isa-published&utm_content=reach-1-apr-21

Occupational exposure limits – Call for comments and evidence

2021-03-23

Calls for evidence allow parties to signal their interest and express their views and concerns in the early phases of developing a scientific report on occupational exposure limits on a substance or chemical agent at the workplace.

A call for evidence is additional to and does not take the place of the consultation on the OEL scientific report in support of occupational exposure limits at the workplace.

Consultations close at 23:59 Helsinki time (EET).

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Read More

ECHA, 23 March 2021

https://echa.europa.eu/oels-cce-current-consultation

This is part of ensuring on-going transparency in the process of, and trust in, regulatory decisions and processes.

Janet's Corner

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Can't Fight This (F)eeling

2021-04-09

https://www.coolpun.com/topic/marine+biology#&gid=1&pid=33

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Hazard Alert

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Guthion (Azinphos-methyl)

2021-04-09

Guthion is the common name of an organophosphorus insecticide. It is a formulation that includes the active ingredient of azinphos-methyl. The molecular formula for azinphos-methyl is $C_{10}H_{12}N_3O_3PS_2$. Pure guthion is a colourless to white odourless crystalline solid. Technical-grade guthion is a cream to yellow-brown granular solid. It does not occur naturally in the environment. [1,2]

USES [3]

Guthion has been used on a variety of orchard fruits, cotton, almonds, sugarcane, and other crops; many of these uses have been cancelled and all remaining uses are scheduled to be phased out.

IN THE ENVIRONMENT [3]

- Guthion can be released into the environment during its production and use as a pesticide.
- Guthion is found in all environmental compartments with no pronounced tendency to partition to a particular compartment.
- Guthion is not highly persistent in the environment; mobility in soil and sediment is moderate to low.
- In air, guthion is relatively quickly degraded by photolysis and reaction with hydroxyl radicals; the estimated half-life is a few hours.
- Guthion released to surface water or soil is subject to biodegradation, photolysis, and hydrolysis.
- The half-life of guthion ranges from approximately 3 to 50 days in surface water and 32 to 150 days in soil.
- Guthion is not expected to bioconcentrate or bioaccumulate.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [1]

- Food—primary source of exposure: Exposure to guthion is primarily by ingesting foods treated with this pesticide. Apples, pears, peaches, and cherries are crops most likely to contain guthion residues, but fewer residues are being found as guthion use in agriculture has been diminishing.

Guthion is the common name of an organophosphorus insecticide.

- Air: Exposure may occur via air in areas close to fruit orchards or other crops where guthion is used.
- Workplace: People who work in agricultural jobs such as pesticide applicators, fruit pickers, and other farm workers can be exposed to higher levels of guthion than the average individual, probably by skin contact with the insecticide and by inhalation.
- Families of workers can also be exposed because residues on workers' hands, clothes, vehicles, or other personal items can be brought into the home.
- Children playing on or near areas that have been treated with guthion may be exposed to guthion in soil by skin contact, when they accidentally or intentionally put soil into their mouths, and through hand-to-mouth activity.

Routes of Exposure [3]

- Inhalation – Is the predominant route of exposure for workers during production, handling, and application.
- Oral – Is the predominant route of exposure for the general population from ingestion of contaminated drinking water and particularly food containing guthion residue.
- Dermal – Is the predominant route of exposure for workers during production, handling, and application.

HEALTH EFFECTS

Acute Health Effects [5]

The following acute (short-term) health effects may occur immediately or shortly after exposure to Guthion:

- Exposure to Guthion can cause rapid, fatal organophosphate poisoning with headache, sweating, nausea and vomiting, diarrhoea, muscle twitching, and death.
- Breathing Guthion can irritate the lungs causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary oedema), a medical emergency, with severe shortness of breath.

Chronic Health Effects [5]

- High or repeated exposure may damage the nerves causing weakness, "pins and needles," and poor coordination in arms and legs.

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- Repeated exposure may cause personality changes of depression, anxiety or irritability.

It is not known if guthion causes cancer in humans. Guthion was not carcinogenic in male or female mice or in female rats that were fed this substance for more than 1 year. Some tumours were observed in male rats, but it could not be conclusively shown that guthion had caused the tumours. The Department of Health and Human Services (DHHS), International Agency for Research on Cancer (IARC), and EPA have not classified guthion as to its carcinogenicity. It is unknown if guthion affects the ability of humans to reproduce. Exposure to guthion did not affect fertility in animal studies.

SAFETY [6]

First Aid Measures

- General: When possible, have the product container or label with you when calling a poison control centre or doctor or going for treatment.
- Eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a physician or poison control centre immediately.
- Skin: Wash off immediately with plenty of water for at least 15 minutes. Take off contaminated clothing and shoes immediately. Call a physician or poison control centre immediately.
- Ingestion: Call a physician or poison control centre immediately. Rinse out mouth and give water in small sips to drink. DO NOT induce vomiting unless directed to do so by a physician or poison control centre. Never give anything by mouth to an unconscious person. Do not leave victim unattended.
- Inhalation: Move to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a physician or poison control centre immediately.
- Notes to Physician: This product is a cholinesterase inhibiting organophosphorous pesticide.
- Treatment: Administer atropine sulfate in large therapeutic doses. Repeat as necessary to the point of tolerance. 2-PAM is also antidotal and may be administered in conjunction with atropine. The product inhibits cholinesterase resulting in stimulation of the central nervous system, the parasympathetic nervous system, and the somatic motor nerves. Do not give morphine. Watch for pulmonary oedema, which

may develop in serious cases of poisoning even after 24-48 hours. At first sign of pulmonary oedema, the patient should be placed in an oxygen tent and treated symptomatically.

Exposure Controls & Personal Protection

Engineering Controls

- Maintain exposure levels below the exposure limit through the use of general and local exhaust ventilation.

Personal Protective Equipment

The following personal protective equipment is recommended when handling guthion:

- Eye/Face Protection: tightly fitting safety goggles
- Hand Protection: Chemical resistant nitrile rubber gloves
- Body Protection: Wear long-sleeved shirt and long pants and shoes plus socks.
- Respiratory Protection: When respirators are required, select NIOSH approved equipment based on actual or potential airborne concentrations and in accordance with the appropriate regulatory standards and/or Industry recommendations.

REGULATION

United States [4,5]

OSHA: The Occupational Safety & Health Administration has established a legal airborne permissible exposure limit (PEL) for guthion of 0.2 mg/m^3 averaged over an 8-hour workshift.

NIOSH: The National Institute for Occupational Safety & Health has set a recommended airborne exposure limit for guthion of 0.2 mg/m^3 averaged over a 10-hour workshift.

ACGIH: The American Conference of Governmental Industrial Hygienists has set a recommended airborne exposure limit for guthion of 0.2 mg/m^3 averaged over an 8-hour workshift.

EPA: The Environmental Protection Agency has established tolerances for guthion residues that range from 0.2 to 5 parts per million in raw agricultural commodities.

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Australia [7]

Safe Work Australia: Safe Work Australia has set a Time Weighted Average (TWA) concentration for guthion of 0.2 mg/m^3 averaged over an 8-hour workshift.

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A synthetic cell that grows and divides normally was created in the lab

2021-03-30

The cell is one of the smallest individual components of all living things. Recently, scientists were able to create a simple synthetic cell that grows and divides normally. Researchers on the project say the new findings shed light on mechanisms controlling the most fundamental processes of life.

About five years ago, scientists created a single-celled synthetic organism with only 473 genes that was the simplest living cell ever known. The bacteria-like organism behaved strangely when growing and dividing, resulting in cells with wildly different shapes and sizes. Scientists have now identified seven genes to be added to help control the cell's unruly nature, causing it to divide into uniform orbs.

The new breakthrough is a collaboration between the J.Craig Venter Institute, the National Institute of Standards and Technology, and MIT. Identifying the genes was an important step in engineering synthetic cells able to perform beneficial activities like producing drugs, foods, and fuels. These synthetic cells could also detect disease and make drugs while living inside the human body. Researchers also believe this type of simple cell could function as a tiny computer.

Researchers wanted to understand the fundamental design rules of life and believe the cell could help discover and understand those rules. Researchers constructed the first cell with a synthetic genome in 2010, but that cell wasn't built from scratch. In that research, scientists started with cells from a simple type of bacteria called mycoplasma. They destroyed the DNA in the cells and replaced it with DNA designed on a computer and synthesized in the laboratory, creating the first organism in the history of life on Earth to have an entirely synthetic genome.

Since that success, scientists have been working to strip the organism down to its minimum genetic components. The result was a super-simple cell created five years ago called JCVI-syn3.0 that was too minimalist and didn't divide correctly. The new cell has 19 additional genes added back in, including seven needed for normal cell division creating the new variant dubbed JCVI-syn3A. The new version has less than 500 genes. A human cell, by comparison, has around 30,000 genes. The team currently has a goal of knowing every gene's function, allowing them to develop a complete model of how a cell works.

The bacteria-like organism behaved strangely when growing and dividing, resulting in cells with wildly different shapes and sizes.

slashgear.com, 30 March 2021

https://www.slashgear.com

Microplastic waste creates 'hotspots' of antibiotic resistant bacteria

2021-03-30

Scientists have demonstrated that the bacterial sludge that forms around microplastics in wastewater treatment plants contains genes that promote antibacterial resistance.

The research, which appears in the Journal of Hazardous Materials Letters, provides further evidence of the harmful effects that microplastics can have on human and environmental health.

Microplastics and environmental health

Plastics are one of the defining materials of the modern world. Plastics are so prevalent that researchers have suggested their widespread presence within global archaeological formations indicates a new global epoch: the Anthropocene.

Plastics are one of the defining materials of the modern world.

There is currently much focus on whether or not microplastics — generally understood as smaller than 5 millimeters — pose a significant threat to human and environmental health.

Some researchers have suggested there is not yet enough evidence to know what health effects microplastics may have. However, they also recognize that their potential for damaging health is significant enough that further research is urgently needed.

Antibacterial resistance

Although research has typically focused on damage to ecosystems or human health, one area that has had less focus is the possible relationship between microplastics and antibacterial resistance.

According to a recent article by Prof. Zulqarnain Baloch and colleagues in the journal Infection and Drug Resistance, the development and use of antibiotics exploded between the 1930s and 1960s. They have saved countless lives since then, and they are still crucial to contemporary healthcare.

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However, pathogens have adapted to some of the key antibiotics, developing a resistance that makes antibiotics less effective or not effective at all.

Although the development of some degree of antibacterial resistance is inevitable, a number of human-influenced factors are exacerbating it.

According to Prof. Baloch and colleagues, these include "overpopulation, enhanced global migration, increased use of antibiotics in clinics and animal production, selection pressure, poor sanitation, wildlife spread, and poor sewerage disposal systems."

For the authors of the new study, it is at wastewater treatment plants that microplastics may play a key role in promoting antimicrobial resistance.

According to corresponding study author Dr. Mengyan Li, an associate professor of chemistry and environmental science at the New Jersey Institute of Technology (NJIT) in Newark, "[A] number of recent studies have focused on the negative impacts that millions of tons of microplastic waste a year is having on our freshwater and ocean environments, but until now, the role of microplastics in our towns' and cities' wastewater treatment processes has largely been unknown."

"These wastewater treatment plants can be hotspots where various chemicals, antibiotic resistant bacteria, and pathogens converge, and what our study shows is that microplastics can serve as their carriers, posing imminent risks to aquatic biota and human health if they bypass the water treatment process."

For first study author Dung Ngoc Pham, an NJIT doctoral candidate, "[M]ost wastewater treatment plants are not designed for the removal of microplastics, so they are constantly being released into the receiving environment."

"Our goal was to investigate whether or not microplastics are enriching antibiotic resistant bacteria from activated sludge at municipal wastewater treatment plants, and if so, learn more about the microbial communities involved."

Analyzing two common microplastics

To determine to what extent microplastics might contribute to antimicrobial resistance, the researchers took samples of sludge from three domestic wastewater treatment plants in New Jersey.

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In the laboratory, the team introduced polyethylene and polystyrene — two common microplastics — into samples of the sludge to which the bacteria could attach and create biofilms. They also used sand as a control material for a biofilm to form.

They analyzed the samples using quantitative polymerase chain reaction and next generation sequencing. This let them observe the growth of bacteria on the microplastics and how the genetic makeup of the bacteria changed over time.

Increases in 3 resistance genes

The researchers found varying results for the three genes associated with antibacterial resistance — sul1, sul2, and intI1 — depending on which microplastic they used: polyethylene or polystyrene. The results also depended on which wastewater treatment plant the sample came from.

Across the sample locations, polyethylene biofilms resulted in significant increases of almost all three resistance genes. Although polystyrene biofilms had fewer statistically significant results, this varied a lot by the location of the sample.

The researchers then added the antibiotic sulfamethoxazole, which increased the presence of antibacterial resistant genes by up to 4.5-fold.

According to Pham, "[P]reviously, we thought the presence of antibiotics would be necessary to enhance antibiotic resistance genes in these microplastic-associated bacteria, but it seems microplastics can naturally allow for uptake of these resistance genes on their own."

"The presence of antibiotics does have a significant multiplier effect, however."

Eight types of bacteria were highly enriched on the biofilm of the microplastics. These included Raoultella ornithinolytica and Stenotrophomonas maltophilia, which are linked to respiratory infections in humans.

The bacterium Novosphingobium pokkalii was the most common strain, and the researchers believe that it plays a key role in helping form the microplastic biofilm. Furthermore, they believe that the gene intI1 is important in enabling other genes that promote antibacterial resistance to exchange between bacteria.

As Dr. Li explains, "[W]e might think of microplastics as tiny beads, but they provide an enormous surface area for microbes to reside. When

these microplastics enter the wastewater treatment plant and mix in with sludge, bacteria like Novosphingobium can accidentally attach to the surface and secrete glue-like extracellular substances."

"As other bacteria attach to the surface and grow, they can even swap DNA with each other. This is how the antibiotic resistance genes are being spread among the community."

The researchers now hope to investigate if and how bacteria can escape the processing at wastewater treatment plants.

For Dr. Li, "[S]ome states are already considering new regulations on the use of microplastics in consumer products."

"This study raises calls for further investigation on microplastic biofilms in our wastewater systems and [the] development of effective means for removing microplastics in aquatic environments."

medicalnewstoday.com, 30 March 2021

https://www.medicalnewstoday.com

This credit-card sized antenna harvests energy from 5G signals into wireless power for IOT devices

2021-03-30

Harvesting abundant sources of renewable energy and then converting them into something valuable has been the quest humankind has been on for decades. This makes even more sense in current times when we are on the brink of exhausting earth's vital resources, causing unrepairable harm to the planet. As scouts of this very quest, the team at Georgia Tech's ATHENA lab has created a 3D-printed energy harvesting antenna that's capable of garnering electromagnetic energy of the 5G signals to juice modern-day gadgets. The technology is literally about putting the overcapacity 5G network bandwidth to judicious use – turning it into a wireless power grid that could shape the future of our relentless energy requirements for IoT devices or mobile devices.

They've created a flexible Rotman lens-based rectifying antenna (rectenna) that can collect the millimeter-wave in the 28-GHz band – the first of its kind. Previously there have been attempts to harvest the 24 or 35 GHz frequencies, but they were not practical since they only worked when they are in sight of the 5G base station. Emmanouil Tentzeris, Professor in Flexible Electronics in Georgia Tech's School of Electrical and Computer Engineering, rightly summed it up by saying, "The fact is, 5G is going to be

They've created a flexible Rotman lens-based rectifying antenna (rectenna) that can collect the millimeter-wave in the 28-GHz band – the first of its kind.

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everywhere, especially in urban areas. You can replace millions, or tens of millions, of batteries of wireless sensors, especially for smart city and smart agricultural applications."

This one is by far the most potent wireless power grid capable of powering devices at acute range – much better than any existing technology aimed at doing so. The credit card-sized iteration of the technology has a spiky plate around the center, which assimilates the 5G network's millimeter waves. Just to compare, the rectenna design antenna developed by the team is almost 21 times more capable of sucking power from any direction – making it a viable bendable energy harvesting system capable of being employed in future technology implementations for the end-user.

It could be anything from an energy harvesting phone case, a credit card in your wallet that could charge your smartwatch at the end of the day, or a deck of cards that does more than its core intended purpose. For now, however, the innovation is only capable of powering low-energy IoT devices like sensors on your thermostat, but still, it the first step in the limitless possibilities that it promises.

Designer: Researchers at the Georgia Institute of Technology

yankodesign.com, 30 March 2021

https://www.yankodesign.com

Trapped in gloves, tangled in masks: Covid PPE killing animals, report finds

2021-03-30

The masks and gloves protecting people from coronavirus are proving a deadly threat to wildlife when thrown away, a report has found.

A fish trapped in the finger of a rubber glove in the Netherlands, a penguin in Brazil with a mask in its stomach and a fox in the UK entangled in a mask were among the victims.

The researchers searched news sites and social media posts from litter collectors, birdwatchers, wildlife rescue centres, and veterinarians and found incidents on land and in water across the world. But they said much more information is needed and have launched a website where anyone can submit a report.

The study, published in the journal Animal Biology, is the first overview of cases of entanglement, entrapping and ingestion of Covid-19 litter by

The PPE litter was mainly single-use latex gloves and single-use masks, consisting of rubber strings and mostly polypropylene fabric.

animals. The PPE litter was mainly single-use latex gloves and single-use masks, consisting of rubber strings and mostly polypropylene fabric.

The earliest victim the researchers found was an American robin entangled in a mask in Canada in April 2020. Other incidents included a checkered pufferfish found dead after becoming caught in a face mask near Miami Beach in the US, and a shore crab in France killed by a mask.

They also found reports of a serotine bat trapped by two masks in the Netherlands, a hedgehog in the UK entangled in a glove, and a monkey in Malaysia attempting to eat a mask. Pets, especially dogs, were also found to swallow masks.

"Animals become weakened due to becoming entangled, or starve due to the plastic in their stomach," said Liselotte Rambonnet from Leiden University in the Netherlands, one of the authors of the report.

Rambonnet and Auke-Florian Hiemstra, from the Naturalis Biodiversity Center in Leiden, started researching incidents after being alerted by volunteers to a perch trapped in a glove during a canal cleanup. Coots in Dutch canals have also been spotted making nests from masks and gloves.

Rambonnet and Hiemstra hope their study will increase people's awareness of the danger to wildlife of discarding masks and gloves. They called on people to use reusable masks, while others have asked people to cut up disposable gloves and snip the straps on masks before throwing them away, to help prevent animals from getting entangled. Some US states have also raised the fines for littering with PPE.

In September, items of PPE were found on nearly a third of beaches surveyed in the UK by beach-cleaning volunteers.

While the proportion of Covid-19-related litter may be small in comparison with packaging litter, the researchers said, it can be seen as a striking example of our single-use, throwaway society. "People may suffer from the coronavirus pandemic, but nature is getting sick of our plastic," they concluded.

theguardian.com, 30 March 2021

https://www.theguardian.com

"A reorientation towards what is possible."

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Frog skin cells turned themselves into living machines

2021-03-31

Using blobs of skin cells from frog embryos, scientists have grown creatures unlike anything else on Earth, a new study reports. These microscopic "living machines" can swim, sweep up debris and heal themselves after a gash.

Scientists often strive to understand the world as it exists, says Jacob Foster, a collective intelligence researcher at UCLA not involved with this research. But the new study, published March 31 in Science Robotics, is part of a "liberating moment in the history of science," Foster says. "A reorientation towards what is possible."

In a way, the bots were self-made. Scientists removed small clumps of skin stem cells from frog embryos, to see what these cells would do on their own. Separated from their usual spots in a growing frog embryo, the cells organized themselves into balls and grew. About three days later, the clusters, called xenobots, began to swim.

Normally, hairlike structures called cilia on frog skin repel pathogens and spread mucus around. But on the xenobots, cilia allowed them to motor around. That surprising development "is a great example of life reusing what's at hand," says study coauthor Michael Levin, a biologist at Tufts University in Medford, Mass.

And that process happens fast. "This isn't some sort of effect where evolution has found a new use over hundreds of thousands of years," Levin says. "This happens in front of your eyes within two or three days."

Xenobots have no nerve cells and no brains. Yet xenobots — each about half a millimeter wide — can swim through very thin tubes and traverse curvy mazes. When put into an arena littered with small particles of iron oxide, the xenobots can sweep the debris into piles. Xenobots can even heal themselves; after being cut, the bots zipper themselves back into their spherical shapes.

Scientists are still working out the basics of xenobot life. The creatures can live for about 10 days without food. When fed sugar, xenobots can live longer (though they don't keep growing). "We've grown them for over four months in the lab," says study coauthor Doug Blackiston, also at Tufts. "They do really interesting things if you grow them," including forming strange balloon-like shapes.

It's not yet clear what sorts of jobs these xenobots might do, if any. Cleaning up waterways, arteries or other small spaces comes to mind, the researchers say. More broadly, these organisms may hold lessons about how bodies are built, Levin says.

With the advent of new organisms comes ethical issues, cautions Kobi Leins, a digital ethics researcher at the University of Melbourne in Australia. "Scientists like to make things, and don't necessarily think about what the repercussions are," she says. More conversations about unintended consequences are needed, she says.

Levin agrees. The small xenobots are fascinating in their own rights, he says, but they raise bigger questions, and bigger possibilities. "It's finding a whole galaxy of weird new things."

sciencenews.org, 31 March 2021

https://www.sciencenews.org

Scientists detect world's coldest cloud hovering over Pacific Ocean

2021-04-01

A severe thunderstorm cloud that formed over the Pacific Ocean in 2018 reached the coldest temperatures ever recorded, according to a new study.

The very top of the storm cloud reached a bone-chilling minus 167.8 degrees Fahrenheit (minus 111 degrees Celsius), colder than any storm cloud measured before. Thunderstorms and tropical cyclones, a circular low-pressure storm, can reach very high altitudes — up to 11 miles (18 kilometers) from the ground — where the air is much cooler, according to a statement from the U.K.'s National Center for Earth Observation.

But this new temperature is on another level.

But this new temperature is on another level. The top of the storm cloud was about 86 F (30 C) colder than typical storm clouds, according to the statement. The beast of a storm loomed about 249 miles (400 km) south of Nauru in the Southwest Pacific on Dec. 29, 2018, and its clouds' temperature was picked up by an infrared sensor aboard the U.S.'s NOAA-20 satellite orbiting the planet.

Storms typically spread out into an anvil-like shape when they reach the top of the troposphere, the lowest layer of Earth's atmosphere. But if a storm has a lot of energy, it will shoot into the next layer, the stratosphere.

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This phenomenon, known as an "overshooting top," pushes storm clouds to very high altitudes, where it's bitterly cold.

Overshooting tops are "reasonably common," lead author Simon Proud, a research fellow at the National Centre for Earth Observation and at Oxford University told the BBC. Typically, an overshooting top cools by about 12.6 F (7 C) for every kilometer it rises in the stratosphere, he said.

But this storm was particularly extreme. "This storm achieved an unprecedented temperature that pushes the limits of what current satellite sensors are capable of measuring," Proud said in the statement. "We found that these really cold temperatures seem to be becoming more common."

In the last three years, scientists have logged the same number of extremely cold temperatures in clouds as they did in the 13 years before that, he added. "This is important, as thunderstorms with colder clouds tend to be more extreme, and more hazardous to people on the ground due to hail, lightning and wind."

This particular storm may have been energized by a combination of very warm water in the region and eastward-moving wind, according to the BBC. However, it's not clear why these colder temperatures in storm clouds are becoming more common.

At 1.5 degrees of warming, the reef would shrink by 70 to 90 per cent.

"We now need to understand if this increase is due to our changing climate or whether it is due to a 'perfect storm' of weather conditions producing outbreaks of extreme thunderstorms in the last few years," Proud said.

The findings were published March 22 in the journal Geophysical Research Letters.

Originally published on Live Science.

livescience.com, 1 April 2021

https://www.livescience.com

Barrier Reef doomed as up to 99% of coral at risk, report finds

2021-04-01

The Great Barrier Reef is all but doomed, with between 70 and 99 per cent of corals set for destruction unless immediate "transformative action" is taken to reverse global warming, according to a new report.

The Australian Academy of Science says the more ambitious target of the Paris Climate Agreement of keeping global warming to 1.5 degrees has now slipped out of reach and is "virtually impossible".

"Limiting the temperature rise to the lower Paris Agreement target is exceedingly difficult, and with only three or four more years of emissions at current levels remaining, the target has become virtually impossible to achieve," says The Risks to Australia of a 3C Warmer World.

If 1.5 degrees of warming was sustained, the Great Barrier Reef would cease to exist as we know it, says one of the authors, Ove Hoegh-Guldberg, a biologist and climate scientist specialising in coral reefs.

What will happen to our cities (and beaches) at 3 degrees of warming?

At 1.5 degrees of warming, the reef would shrink by 70 to 90 per cent. At 2 degrees, just 1 per cent of the reef would survive.

If warming was stabilised, surviving corals suited to warmer temperatures may eventually return to cover the reef. Should it continue unabated, corals would vanish entirely to be replaced by other organisms such as seaweeds and bacteria, said Professor Hoegh-Guldberg.

"It's questionable that this would produce the $5 billion in income the reef now produces in tourism," he said.

Another of the authors, Distinguished Professor Lesley Hughes of Macquarie University, said at current rates of emissions the world is likely to burn through its 1.5 degree "carbon budget" by 2025.

According to the report, the earth has already warmed by 1.1 degrees since the beginning of the industrial era.

However, warming does not impact on the world uniformly and, according to Professor Hughes, Australia is already experiencing 1.4 degrees warming.

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"The observations that we are seeing of things like unprecedented bushfires and regular frequent bleaching of the Great Barrier Reef are consistent with the predictions that have been made previously about a 1.5-degree world," she said.

"This is already a difficult world and really the main point of the academy report was to show that if you think this is difficult, then imagine double or triple the warming that we've had."

In a world-first, researchers have successfully pioneered small-scale coral restoration using a technique dubbed Coral IVF.

In this scenario Black Summer fires would likely be an annual event and one in a 100-year floods would happen more commonly.

Professor Hoegh-Guldberg said it would be "disastrous" for politicians and policymakers to consider the report an excuse for giving up on reducing emissions.

Rather, he said it was further evidence that governments needed to shift from "gradualism to transformative action". This meant committing not only to net zero targets by 2050, but substantial annual cuts guided by a significant reductions target for 2030.

Professor Frank Jotzo, another contributor to the paper and director of the Australian National University's Centre for Climate Economics and Policy, said he agreed 1.5 degrees was likely out of reach, but serious and immediate action could still see the world stabilise at between 1.5 and 2 degrees, which would make a huge difference to the quality of life on earth.

According to Professor Jotzo the unprecedented growth of wind and solar power over the past few years showed not only that the world has the technology to replace fossils with clean energy, but the energy produced will be cheaper than for traditional fossil sources such as oil and gas.

As a result we can afford to spend on storage technologies such as batteries and pumped hydro, he said.

At the Paris Climate Conference in 2016 Australia signed up to the agreement to keep global warming below 2 degrees and as close to 1.5 degrees as possible. At the time Australia committed to reduce its emissions by 26-28 per cent based on 2005 levels by 2030. The agreement included a so-called ratchet mechanism designed to encourage nations to raise their targets.

Over the past year the number of countries with targets of net zero by mid-century has leapt from about 25 per cent to 75 per cent.

Now, pressure is mounting on countries to make 2030 targets more ambitious. Professor Jotzo said he believes that the US, which is hosting a climate summit of 40 world leaders this month, will probably double its 2030 target by around 50 per cent, increasing pressure on Australia to significantly raise its target.

A spokesman for Energy and Emissions Reductions Minister Angus Taylor said global warming was "a global problem requiring a global solution".

"The only pathway for all countries to get to net zero is by getting low emissions technologies to commercial parity with existing alternatives," the spokesman said.

"When developing countries are no longer forced to choose between growth and decarbonisation, then global emissions will fall.

"Australia has strong targets, an enviable track record, and a responsible plan to get the cost of low emissions technologies down."

smh.com.au, 1 April 2021

https://www.smh.com.au

How climate change is stunting farm production

2021-04-01

Since 1960 about 21 percent of global agriculture production, including livestock, tree farming, and traditional crops such as corn and soybeans, has been negatively impacted by climate change, according to a new study.

In the research published today in Nature Climate Change agriculture production is defined not just as crop yields or the amount of food or livestock grown, but the overarching energy and input it takes to produce food. This includes manual labor, fertilizers, water, and land. Unsurprisingly, agriculture production worldwide has grown over the last 60 years as a result of improved technologies and greater efficiency, primarily in higher income countries.

But the new study provides the latest evidence that climate change—and the subsequent increase in droughts, flooding, and extreme heat—has held back agricultural gains and impeded global food security efforts.

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"People don't yet realize that the climate has already changed," Ariel Ortiz-Bobea, a Cornell economist and lead author of the new study, told EHN.

"People don't yet realize that the climate has already changed," Ariel Ortiz-Bobea, a Cornell economist and lead author of the new study, told EHN. "That's not something that we often talk about, just about what the impacts will be 50 years from now."

Climate change wipes out improvements

Using models similar to those created by climatologists to predict future climate trends, Ortiz-Bobea and his team charted climate data between 1960 and 2020, and compared it to a model where human-caused climate change never occurred.

They compared the "total factor productivity" between models: how does actual agricultural productivity over time compare to what it could have been without climate change?

"Climate change has basically wiped out about seven years of improvements in agricultural productivity over the past 60 years," Ortiz-Bobea said in a statement.

In other words, if the world were to wave a magic wand and halt the planetary changes associated with greenhouse gas emissions and a warming climate, global agricultural production would have reached the level it is today back in 2013, said Ortiz-Bobea.

Ortiz-Bobea compared the situation to someone running with a strong wind at their front: As a runner attempts to make their way to the finish line, the wind is constantly pushing them back. They're making progress but it's slow compared to a windless day. In this scenario, climate change is the strong wind and the runner's progress is farm production growth.

He noted that if climate change gets worse, a growing possibility as countries fail to set commitments that meet Paris Agreement targets, it's only a matter of time until agriculture production stalls. "[Climate change has] been happening for years, and as the magnitude keeps rising and rising it's going to get harder to ignore," he said

Ortiz-Bobea wasn't expecting such a significant difference in farm production between models with and without climate change. "I didn't even think that the result would be statistically significant," he said. "I was expecting something much smaller, something almost imperceptible. But no matter how we sliced the data or looked at different variations of the econometric model, it was pretty consistent that it's a substantial negative effect."

Developing countries suffer

The greatest climate impacts are seen in countries that are historically warmer such as those in Africa, Latin American, and Asia. As developing regions are often without the same technological advancement or management systems for agriculture, they face the greatest losses as unpredictable weather and warming events threaten crops and livestock. Ortiz-Bobea noted that this issue is as much an equity issue as it is an economic one.

The agriculture sector faces a unique problem in the way of climate change. Historically, the industry has relied on unsustainable practices that further greenhouse gas emissions. One example is in Brazil, where massive Amazon deforestation has taken place in an attempt to grow the country's economy around cattle and soybean farming. The transformation of forests, a crucial carbon sink, into crop lands also contributes to rises in atmospheric carbon levels.

In addition, increased global meat consumption and subsequent cattle production is a common source of methane emissions, a greenhouse gas about 86 times more potent than carbon dioxide.

So what is the best way to produce more food without contributing to a cycle of climate change?

Ortiz-Bobea said that the solution is in a mix of mitigation and adaptation. "Despite all the new, very exciting technologies that we are coming up with like CRISPR, they will still take decades to have an impact." CRISPR is an increasingly popular technology that allows geneticists to modify DNA sequences and gene functions. Often touted as the solution to harmful birth defects in human genomes, conversations have arisen around the use of gene editing to increase food production for a rapidly growing population.

Ortiz-Bobea also highlighted the potential for soil-based strategies. "There are ways to increase soil health that allow soils to improve their water holding capacity, for example," he said. "And so that improves the crop yields and allows farmers to weather the storm, no pun intended there, while at the same time it helps capture carbon from the atmosphere."

ehn.org, 1 April 2021

https://www.ehn.org

With fewer than 800 Tapanuli orangutans left in Batang Toru, the species faces the looming threat of extinction.

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Rarest great ape on Earth could soon go extinct

2021-04-01

Tapanuli orangutans, the most gravely endangered great ape species on Earth, may be even closer to extinction than previously thought, The Hill reported.

The great apes can now be found in the mountains of Batang Toru in North Sumatra, Indonesia, where they occupy less than 3% of the habitat they did in the late 1800s, according to a study published Jan. 4 in the journal PLOS One. With fewer than 800 Tapanuli orangutans left in Batang Toru, the species faces the looming threat of extinction.

If more than 1% of the adult population is killed, captured or translocated each year, the Tapanuli orangutan will become the first great ape species to go extinct in modern times, study author Erik Meijaard, a conservation scientist and founder of conservation group Borneo Futures, told The Hill.

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The study, based on historical records from the region, found that the apes were driven into their current home in the Batang Toru mountains by hunters who targeted the apes, as well as the fragmentation of their former habitat, The Hill reported. Ideally, the orangutans should be able to move between a variety of environments, including lowland areas, to maximize their chance of survival, but instead they remain stuck in highlands that they're not optimally suited for, the authors said.

Even this limited habitat could soon be threatened by a new hydroelectric power plant, which would be located on the Batang Toru River in South Tapanuli Regency, North Sumatra. The 301-acre (122 hectares) plant would block several subpopulations of Tapanuli orangutans from intermingling, which could lead to inbreeding and limit the genetic diversity of the species.

The PT North Sumatera Hydro Energy (PT NHSE) company has paused construction of the plant due to the COVID-19 pandemic. The project also lost key funding from the Bank of China, so the construction may remain on hold for several years. Meijaard and his co-authors want the developer, government, IUCN and Sumatran Orangutan Conservation Programme (SOCP) to use this pause to launch an independent investigation to assess the threat to orangutans.

PT NHSE financed its own assessment previously and concluded that the plant would not threaten the apes' habitat. The International Union for

Conservation of Nature (IUCN) then released its own report, disputing the PT NHSE assessment.

Beyond the power plant, other factors threaten the Tapanuli orangutans' survival. You can read more at The Hill.

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https://www.livescience.com

Astronomers see a ghostly 'radio jellyfish' rise from the dead in the southern sky

2021-04-01

Galaxy clusters are the largest structures in the universe bound together by gravity. They can contain thousands of galaxies, enormous oceans of hot gas, invisible islands of dark matter and — sometimes — the glowing ghost of a jellyfish or two.

In the galaxy cluster Abell 2877, located in the southern sky about 300 million light-years from Earth, astronomers have discovered one such jellyfish. Visible only in a narrow band of radio light, the cosmic jelly is more than 1 million light-years wide and includes a large lobe of supercharged plasma, dripping with tentacles of hot gas.

The structure's jelly-like appearance is both "ghostly" and "uncanny," according to the authors of a new paper published March 17 in the Astrophysical Journal. However, even more astonishing than the space jelly's shape is how quickly the structure vanishes from view, the authors said.

"This radio jellyfish holds a world record of sorts," lead study author Torrance Hodgson, of the International Centre for Radio Astronomy Research (ICRAR) in Perth, Australia, said in a statement. "Whilst it's bright at regular FM radio frequencies, at 200 megahertz the emission all but disappears. No other extragalactic emission like this has been observed to disappear anywhere near so rapidly."

The ghost of jellyfish past

The universe is swimming with energetic structures that are only visible in radio wavelengths, like the mysterious X-shaped galaxies cartwheeling through space, or the twin blobs at the center of the Milky Way. However,

However, even more astonishing than the space jelly's shape is how quickly the structure vanishes from view, the authors said.

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no structure this large has ever been observed in such a narrow band of the radio spectrum.

According to the researchers, that likely means this cosmic jellyfish is actually an odd bird known as a "radio phoenix."

Like the mythical bird that died in flame and rose again from the ashes, a radio phoenix is a cosmic structure that's born from a high-energy explosion (like a black hole outburst), fades over millions of years as the structure expands and its electrons lose energy, then finally gets reenergized by another cosmic cataclysm (such as the collision of two galaxies).

To create a radio phoenix, that last cosmic event must be powerful enough to send shockwaves surging through the dormant cloud of electrons, causing the cloud to compress and the electrons to spark with energy again. According to the study authors, that could cause a structure like the jellyfish cluster to glow brightly in certain radio wavelengths, but dim rapidly in others.

"Our working theory is that around 2 billion years ago, a handful of supermassive black holes from multiple galaxies spewed out powerful jets of plasma," Hodgson said.

That plasma's energy faded over millions of years, until "quite recently, two things happened — the plasma started mixing at the same time as very gentle shock waves passed through the system," Hodgson said. "This has briefly reignited the plasma, lighting up the jellyfish and its tentacles for us to see."

The researchers used a computer simulation to show that this explanation is a plausible origin story for that big jellyfish in the sky, though several big questions — such as where the "gentle shockwaves" came from — remain unanswered. The team hopes to take a closer look at the jellyfish in the future, following the completion of the Square Kilometre Array — a network of hundreds of radio telescope antennas planned for construction in the Australian Outback.PLAY SOUND

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https://www.livescience.com

Bizarre 'worm tornado' in New Jersey has scientists baffled

2021-03-31

Spring rains often bring scores of earthworms to the surface, where they writhe on top of soil and sidewalks. But recently, heavy rainfall in a town near New York City was followed by something a little more unusual: a wormnado.

A resident of Hoboken, New Jersey was out for a morning walk in a park near the Hudson River on March 25, when she spotted hundreds of worms spread along the walkway. The woman, who asked not to be identified, told Live Science that after her initial surprise she noticed something even more bizarre — a number of the worms had formed a cyclone-like shape, creating a spiral where the edge of the grass met the concrete.

The woman took photographs and sent them to Tiffanie Fisher, a member of the Hoboken City Council, who shared the images of the "tornado of worms" on Facebook. "Clearly worms come out after it rains but this is something I've never seen!" Fisher wrote in the post.

When the photographer saw the worm tornado, they weren't actively spiraling, although individual worms still wriggled in place, she told Live Science. There were no open pipes nearby, and though most of the worms were spread out in a big swirl, there were plenty of worms extending beyond the outer curve of the wormnado; they clung to the wall of a nearby building, and dribbled down the curb and into the road, the woman said.

While it's tempting to imagine that the worms were aligning themselves in a swirl in preparation for the Worm Moon — the supermoon that illuminated the night sky just a few days later, on March 28 — it's unlikely that the spiral was a lunar ceremony. So what was the weird wormnado all about?

Worms breathe through their skin, so when heavy or persistent rain saturates the soil with water, the worms must tunnel to the surface or risk drowning, according to the University of Wisconsin–Madison. Earthworms are typically solitary, but they sometimes form herds when they're on the surface . The worms collect in groups and communicate with each other about where to move, researchers reported in 2010 in the International Journal of Behavioural Biology.

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So what was the weird wormnado all about?

The scientists in that study found that earthworms in the species Eisenia fetida would form clusters and "influence each other to select a common direction during their migration," and they did so using touch rather than chemical signals. This collective behavior could help earthworms survive environmental threats, such as flooding or arid soil, and it could also be a defense strategy against predators or pathogens, according to the study.

One exceptional example of earthworm herding was captured on video in 2015 by rangers at Eisenhower State Park in Denison, Texas. In the footage posted to the Texas Parks and Wildlife YouTube channel, several enormous masses of pink earthworms wriggle on a road.

"Recent flooding may have brought out this herding behavior," park representatives wrote in a video description.

But the cause of the Hoboken wormnado is less clear. "This tornado shape is really interesting," said Kyungsoo Yoo, a professor in the Department of Soil, Water, and Climate at the University of Minnesota. Yoo studies how invasive earthworms transform forest ecosystems, and though worms are known for mass-emerging from soil after rain, he had never seen them form a spiral before, Yoo told Live Science in an email.

Aquatic worms, such as the California blackworm (Lumbriculus variegatus), can form an enormous living knot — known as a blob — of as many as 50,000 worms when they're threatened by dry conditions, according to "Worm Blobs," a comic created by the Bhamla Lab at Georgia Institute of Technology's School of Chemical and Biomolecular Engineering, and illustrated by artist Lindsey Leigh. A tightly packed blob of worms is less likely to dry out than one worm on its own, and the worms pull and push to move the blob around, Bhamla Lab researchers wrote in the comic.

Lab leader Saad Bhamla, an assistant professor at Georgia Tech, suggested in an email that sudden changes in the soil's water, in combination with the shape of the landscape, could explain the appearance of a spiraling wormnado.

"The ground there could be dipped," Bhamla told Live Science in an email. "If the water drained that way after flooding, the worms could be following a water gradient." It's difficult to tell the worm species from the photos, but Bhamla and his colleagues have observed that type of behavior in the aquatic blackworms they study, which form massive blobs.

"We've seen them follow trails of water and form all kinds of paths and aggregate structures," Bhamla said. "These aggregations occur once water

leaves." However, as it's unknown what type of worms made the spiral, any conclusions about their behavior would be speculation, Bhamla added.

Local weather reports described heavy rainfall the night before the photos were taken — about 1 inch (2.5 centimeters) in all. "That would have resulted in a lot of earthworms coming out from the soil for air," Harry Tuazon, a doctoral candidate in Georgia Tech's Interdisciplinary Bioengineering Graduate Program, told Live Science in an email.

"I think the circular pattern is much more indicative of water draining and the worms being swept, rather than a type of behavioral locomotion," Tuazon said. "Perhaps a sinkhole is forming? It would be interesting if a bunch of earthworms provided telltale signs of a forming sinkhole!"

In any case, whatever may have caused the Hoboken wormnado didn't last. When the woman who photographed it returned to the park a few hours later, the swirl had disappeared.

"There were still plenty of worms all over the walls, curb, sidewalk and road. But the bulk of it was gone — I'm not sure where they went," she said.

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Can palm oil be grown sustainably? Agroforestry research suggests it can, and without chemicals

2021-03-31

A recent investigation by Mongabay demonstrated that oil palm plantations in the Amazon do not appear to be 'green' as the Brazilian government terms them, but rather are associated with deforestation and rampant use of chemical herbicides and pesticides. Our reporter documented that in the municipality of Tomé-Açu in the northern Amazon state of Pará, an Indigenous community's health has declined with the arrival of one such plantation, which began planting and spraying oil palms in direct proximity to their homes, with no buffer zone.

But are chemicals needed to grow oil palms profitably on farms? Mongabay contacted Andrew Miccolis, a researcher from the same area of Pará and country coordinator for World Agroforestry (known also by its acronym ICRAF) to find out. He is part of a group studying the incorporation of this useful oil crop into agroforestry systems, where

Oil palm agroforestry is still a novel idea in the region and throughout the world, since the prevailing technological package has been homogenous monocrop stands of oil palm.

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woody perennial and annual crops are grown together so that the various plants benefit each other while providing habitat for wildlife, building soil and water tables, and sequestering carbon.

A joint research project was started here in 2008 with questions like this in mind, when Miccolis says that cosmetics company Natura joined with Embrapa (the Brazilian Agricultural Research Corporation), and Tomé-Açu Mixed Agricultural Cooperative (CAMTA, a cooperative of agroforestry farmers in Pará), to test the feasibility of oil palm agroforestry systems at three demonstration sites. They called it the SAF Dendê project.

In 2017, World Agroforestry joined these partners to form an alliance supported by the U.S. Agency for International Development (USAID) aimed at adapting such systems to the needs of family farmers, and to counter the belief that oil palms can't be cultivated with other species due to competition for light and nutrients. Miccolis told Mongabay that SAF Dendê research on the participating farms (some of which are just six kilometers from the conventional oil palm operation at the heart of Mongabay's investigation) shows that agroforestry systems can produce high oil palm yields and food while also generating profits and environmental services, including mitigating the effects of climate change.

Mongabay asked Miccolis about these findings and their applicability elsewhere in the world where palm oil is produced. His answers have been edited for brevity and clarity.

Mongabay: To what extent is oil palm found in agroforestry systems in the Tomé-Açu area?

Andrew Miccolis: Oil palm agroforestry is still a novel idea in the region and throughout the world, since the prevailing technological package has been homogenous monocrop stands of oil palm. Since oil palm expanded in Brazil, some farmers have experimented with intercropping cocoa and black pepper, but most have shied away from mixing in any other crop since most of the oil palm companies expressly prohibited intercropping as they claimed it took inputs (fertilizer and labor) away from their main focus: high oil palm yields. So, farmers were greatly discouraged from diversifying their plantations, and those who did insist on intercropping had to do so informally, without the companies' support or approval.

Currently, the alliance partners in the SAF Dendê initiative are supporting 18 demonstration sites of oil palm agroforestry on roughly 60 hectares of land – three of which, now 13 years old, were pioneered by Natura, Embrapa and CAMTA beginning in 2008 – and an additional 15 sites

focusing on family farmers supported by ICRAF. In the systems we co-designed, there are 35 species grown with oil palm, including cash crops like açaí, cupuaçu, taperebá, Spondias mombin (hog plum), and passion fruit; native hardwoods including ipê, andiroba and exotics like mahogany; plus fertilizer species including inga, Gliricidia, and Tithonia diversifolia (tree marigold).

The demo sites were co-designed with family farmers through participatory action research methods with the aim of developing agroforestry options tailored to the specific socio-environmental context, including farmer aspirations, constraints and access to resources.

Do these agroforestry systems harbor biodiversity, too?

Yes, a great deal. Field workers and researchers have spotted a wide variety of native fauna in the oil palm agroforests, including deer, monkeys, sloths, porcupines, tapirs, and many types of birds, reptiles and insects, which indicates ecologically balanced systems. Soil samples have also shown very rich soil properties and a very high potential for sequestering carbon, well above conventional monocrop systems, and akin to secondary forests.

Do oil palms require herbicide and insecticide applications in order to produce a profitable crop?

No. There are examples of large scale organically grown oil palm (even monocrop plantations) using integrated pest management and weeding techniques that don't require pesticides. Planting in biodiverse, successional agroforests, if properly managed, can also substantially reduce or eliminate the need for pesticides because the systems become more ecologically balanced, healthier and thus more resilient. The demonstration sites in the SAF Dendê project, which are predominantly organic and agroecologically managed, are producing high yields.

With a smaller number of palm plants per hectare than conventional forms of cultivation, the SAF Dendê project reached higher yields as compared to monoculture systems: 180 kg of fresh fruit bunches per plant, compared with 139 kg in monocrops of oil palm. The oil yield from the palm fruit in this system was also substantially higher than in monoculture, based on direct measurement of the fruits. The cultivation methods in the SAF Dendê areas were based on agroecological stewardship, with no pesticides.

And while agroecological/organic production can have higher production costs, in agroforestry systems these can be offset by a market

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premium and by lower disease and market-related risks, in addition to potential premiums on ecosystem services for products, or payment for environmental services, such as carbon offsets. If you factor in the environmental and human health costs of conventionally grown monocrop systems, then it's a whole different equation.

Ultimately, though, producing agroecologically requires not just replacing inputs, but also adopting agroecological principles and management practices, such as intercropping with other trees and cycling nutrients through "fertilizer species," plants which are highly efficient at producing biomass that will feed the systems over time and improve the soil through slash and mulch (instead of slash and burn) techniques. While labor intensive, these techniques and key species can quickly restore soil health, thus also enhancing yields, ecosystem services and the health of the systems as a whole.

This is one of the issues the partners are investigating in this research: modeling financial feasibility of different systems, from simpler to more biodiverse, with and without agrochemicals, to assess trade-offs.

Are farmers in the area interested in growing oil palm in agroforestry systems?

Overall there is a large appetite for agroforestry in this region, but not much interest in conventional monocrop oil palm through agreements with companies, because farmers feel it is too risky to devote so much of their land and labor to a single commodity crop that is subject to market fluctuations and disease-related risks: also, the technological package companies require to enter into agreements with farmers, including minimum 6-10 hectares of land, little or no intercropping, use of chemical inputs, and high initial costs that must be paid as the palms begin to produce.

A widely held belief is that oil palm cannot be effectively intercropped because of its dominant crowns and root systems, as well as light requirements, but the alliance has debunked this by showing that technically there is no impediment.

So, we feel that more farmers will be interested in oil palm if they are able to intercrop with one or more other crops that are also highly valuable and will give them something to fall back on in the first five years as the oil palm matures to peak production (or if its yields fall short of their expectations), including key food and cash crops. Some of these crops, such as cassava and maize, may not necessarily have a high market value

but are extremely important to family farmers' food security, and in many communities are an integral part of their culture.

The scaling study we are performing as part of this initiative shows that the main constraints to wider adoption of oil palm agroforestry are related to low farmer access to knowledge, including training and technical assistance, particularly on agroforestry and agroecological farming systems, as well as low access to credit, and low availability of on-farm labor for managing large, relatively complex and labor-intensive systems.

While it is important to underscore that some farmers can make a very good living on oil palm by itself, others don't meet minimum company requirements (land availability and belonging to an association, among others) and the technological package/business model practiced by the oil palm companies is starkly contrasted with the highly diversified and heterogeneous land use and livelihood strategies in which agroforestry plays an important role.

The biggest constraints to producing without pesticides are not technical or agronomic, but mainly a matter of replacing the inputs. The issue is providing farmers access to knowledge on the use of organic inputs, strengthening the supply chain for such inputs, plus adopting agroecological techniques, such as composting to produce organic fertilizer on-farm from available biomass, thus turning a problem into a solution.

How can companies like the one at the center of Mongabay's investigation in Tomé-Açu improve their operations to answer the health and environmental concerns it raised?

Oil palm companies in general (in this region and beyond) can address many of these concerns by adopting agroecological management techniques and principles in their systems, including species diversity through intercropping, introducing trees in plantations, intensive pruning and mulching to accelerate nutrient cycling, and integrated pest management, among others.

What is the potential for agroforestry-grown oil palm in Brazil, and worldwide?

We feel there is a large potential for oil palm agroforestry in Brazil and globally, as it clearly provides options for enhancing ecosystem services while also reducing farmer risk, bolstering livelihoods and abating the effects of climate change. Likewise, the growing interest among industry

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groups and demands from consumer groups and industry watchdogs for more sustainable practices is likely to spur more innovation with oil palm agroforestry.

We are supporting the Para state government in improving the enabling environment through the Amazon Now and Sustainable Territories policies for low carbon development programs, and partnering to attract impact (sustainable) investment. Another main barrier for scaling is the weak germplasm supply chain (planting materials including seedlings, seeds, cuttings), particularly for agroforestry species and native fruit and timber trees, which are key to ensuring more biodiverse systems.

What else do you want to say about your research?

Regenerative practices adopted in the agroforestry systems established in 2008 resulted in greater fertility and soil carbon stocks, considerably higher than monocrop systems, thus increasing its potential for mitigating climate change. Agroecological stewardship also favored a greater diversity of microorganisms, ranging from 92% to 238% in the oil palm agroforest as compared to monocrop.

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https://www.news.mongabay.com

Birds versus bees: Here are the winners and losers in the great pesticide trade-off

2021-04-01

Farms are battlefields, pitting growers against rapacious pests and aggressive weeds in never-ending, costly campaigns that often involve chemical weapons. Those weapons, alas, also harm innocent bystanders such as bees, fish, and crustaceans. Now, a large study charts epic shifts that have occurred in recent decades as U.S. farmers have changed their arsenal of pesticides. Birds and mammals have fared much better, whereas pollinators and aquatic invertebrates are suffering. The toxic impact to land plants has also skyrocketed, likely because farmers are using increasing kinds of chemicals to fight weeds that have become resistant to common herbicides.

"These trends show remarkable shifts over time in toxicity," says John Tooker, an entomologist at Pennsylvania State University, University Park, who was not involved in the new research. "Just the scale of what they

Birds and mammals have fared much better, whereas pollinators and aquatic invertebrates are suffering.

did is really, really impressive," adds ecotoxicologist Helen Poynton of the University of Massachusetts, Boston.

In recent decades, the amount of insecticides used in the United States has gone down by about 40%. But at the same time, active ingredients have become more powerful. For example, pyrethroids, fast-acting insecticides that affect the nervous system, are very toxic at extremely low concentrations. Some require as little as 6 grams per hectare, compared with several kilograms of the older organophosphate and carbamate pesticides. This made Ralf Schulz, an ecotoxicologist at the University of Koblenz and Landau, wonder whether overall toxicity in the ecosystem had changed. A few studies had looked at certain compounds and organisms, but nothing had been done on a national scale.

Schulz and colleagues started with U.S. Geological Survey data on self-reported pesticide use by U.S. farmers from 1992 to 2016. They also gathered acute toxicity data from the U.S. Environmental Protection Agency (EPA) on those same compounds—381 in all. Next, they compared EPA's regulatory threshold levels—the point at which a substance might harm vegetation or wildlife—with the amount of each pesticide applied to farm fields and determined a "total applied toxicity."

The good news is that total toxicity plummeted more than 95% for birds and mammals from 1992 to 2016, the team reports today in Science, largely because of the phaseout of older pesticides. Toxicity for fish declined by less—about one-third—because they are more sensitive to pyrethroids. The bad news: Pyrethroids have caused toxicity to double for aquatic invertebrates, such as plankton and insect larvae that are a key part of food webs. And another popular class of pesticides, neonicotinoids, has doubled the risk to pollinators like honey bees and bumble bees. This overall trade-off—vertebrates impacted less and invertebrates hit harder—has also been seen in a smaller study.

For some pesticides and species, however, estimating the real-world impact is tricky. That's because many factors affect whether a chemical will harm plants or animals, such as the weather or the time of year. To see how directly pesticides affected aquatic crustaceans and insects, the researchers looked at peer-reviewed toxic exposure data from 231 lakes and streams across the United States. When they compared the data with the amount of pesticides applied nearby, they found a "relatively strong" correlation.

Plants have also been impacted. Since 2004, the total applied toxicity from weed killers has doubled in land plants. One of the major herbicides

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contributing to the rise is glyphosate, which has simplified farming, improved soil conservation, and allowed farmers to switch away from more toxic herbicides after the advent of crops genetically modified to tolerate glyphosate in the 1990s. But since then, some weeds have evolved resistance to glyphosate, and farmers are spraying additional types of herbicides. That threatens flowering plants that grow in field margins, providing food and habitat for other species.

Even one crop species genetically engineered to reduce pesticide use—corn containing an insect-killing chemical called Bacillus thuringiensis (Bt)—has seen its toxic exposure rising fast. Total applied toxicity in Bt corn has been increasing just as quickly—8% per year over the past decade—as in non–genetically modified corn. "It was a bit astonishing," Schulz says. "I didn't expect that, I must admit." The reason, Schulz suspects, is that pests are evolving resistance to chemicals that are overused in both types of corn, requiring more frequent applications. "That is really one of the major problems agriculture is suffering from."

Schulz hopes the results will help policymakers and others think more broadly about the complexity of pest and weed control, and the trade-offs for wild species, in order to reduce unintentional harm. Tooker notes that the rising toxicity in plants and aquatic invertebrates could lead to less diverse habitat and food resources that eventually ripple through animal populations, potentially causing losses. "The patterns in the U.S. pesticide use and toxicity data should be a cautionary tale for the rest of the world, much of which seems to be leaning more heavily on pesticide use rather than ecological interactions for pest control."

Ultimately such decisions come down to how society values various groups of species, says Edward Perry, an agricultural economist at Kansas State University, Manhattan. For example, regulators could restrict the use of neonicotinoids, as has happened in the European Union, to benefit pollinators. But farmers would likely switch to other insecticides that could pose different hazards to species—or face lower yields and higher food prices.

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https://www.sciencemag.org

Though it sounds cute, this abnormal behavior dramatically worsens the bears' chances of surviving in the wild.

Mysterious brain infection makes bears act 'like friendly dogs'

2021-04-02

A mysterious neurological disease in young Californian black bears (Ursus americanus) is making them behave like pet dogs, cozying up to humans in a friendly manner.

Though it sounds cute, this abnormal behavior dramatically worsens the bears' chances of surviving in the wild.

The bears, which are all around 1 year old, appear to be suffering from a form of infectious encephalitis — inflammation of the brain tissue that can be caused by viruses, bacteria, fungi and parasites, as well as part of an autoimmune response. But veterinarians are unsure exactly what is causing the problem or how fast it is spreading among the population.

Symptoms include a prominent head tilt, lethargic movements, muscle tremors, seizures, walking in circles and being significantly underweight, as well as a surprising fearlessness towards humans.

"Infected bears come to our attention because they approach people in a peaceful, friendly and non-aggressive manner," said Ann Bryant, executive director of the BEAR (Bear Education Aversion Response) League who has been involved in rescuing infected bears. "Their behavior is similar to a dog, not a bear."

In the last year, four individuals have been found with the disease — the highest number of cases since it was first detected in 2014, according to the California Department of Fish and Wildlife (CDFW).

The black bear population in California has increased from between 10,000 to 15,000 individuals in 1982 to between 30,000 to 40,000 today, according to the CDFW. As a result, veterinarians aren't too worried about the impacts of the disease on the overall population.

Fearless youngsters

Although cases of encephalitis are rare, the symptoms have made it quite easy to spot infected bears.

"The first bear I personally rescued was diagnosed with encephalitis in March of 2018," Bryant told Live Science. "She walked into a school and entered a classroom where she sat down among the children, behaving very much like a friendly dog."

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In 2019, another infected bear was caught on video trying to climb onto a snowboard alongside its rider. The young male was eventually rescued after the snowboarder and his friends played with him and fed him sandwiches. However, friendly behavior doesn't mean it's safe for humans to be around the bears.

"Bears approaching people who might then treat the animal as if they are tame could easily present a danger," Bryant said. "I would not be comfortable with a member of the public trying to handle one of these, or any, bears."

Instead, if anyone comes across bears displaying symptoms of encephalitis they should report it to the CDFW, Bryant said.

These two particular bears now reside in rescue centers, where they must receive constant medical care to keep the brain inflammation under control, but most other bears aren't so lucky.

The most recent bear found to have the disease, which was discovered in February lying in the back of a truck parked on a residential property, was majorly underweight and covered in fleas, and had to be put down because of its poor physical condition, according to the Sacramento Bee.

Unfortunately, this sad fate has befallen the majority of infected bears, who are not able to take care of themselves and appear to have been abandoned by their mothers.

On the increase?

Veterinarians with the Nevada Department of Wildlife (NDOW) first discovered the encephalitis in bears around Lake Tahoe on the Californian border in 2014, according to the CDFW.

Since then the CDFW has recorded eight cases in California, although the actual number may be higher. Half of the confirmed cases have been detected in the last year, but this doesn't necessarily mean it is on the increase.

"My opinion is that this is not on the increase," Bryant said. "But more studies are now finally being done so we are more aware of it."

The disease also doesn't appear to be transmissible between individual bears, Bryant said. This is encouraging for the rest of the population but has left researchers confused as to what is causing it.

"The worst part about this threat to our bears is that we don't know for sure what causes it," Bryant said. "The unknown is troubling."

Unknown origin

Infected bears are taken to the CDFW's Wildlife Investigations Laboratory, where they can either be treated or, more likely, euthanized due to their poor physical condition.

"Bears that die or are euthanized are necropsied to determine the cause of death," Brandon Munk, senior wildlife veterinarian at the CDFW's Wildlife Investigations Laboratory, told Live Science. "Evaluation of the tissues can confirm whether an animal had encephalitis or not."

Although the vets can identify the disease, determining the cause of the encephalitis has proved much harder.

"The brain inflammation is likely what causes the symptoms," Munk said. "Beyond that, we do not know the specific mechanisms that may be at play."

Potential pathogens have been identified as the cause of the encephalitis, but none have been confirmed so far.

"We have identified five new viruses from black bears, some of which are being pursued further as possible causes of the encephalitis," Munk said. "We are also working with a research lab to further evaluate whether a protozoan parasite might be the cause."

However, it is also possible that there is more than one pathogen responsible for the encephalitis, Munk said.

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Astronomers find the 'safest place' to live in the Milky Way

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Astronomers have searched the entire Milky Way to identify the safest places to live. It turns out, we're in a pretty good spot.

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But if the past year has made you feel ready to relocate to another planet, you might want to look toward the center of the galaxy, according to the new research.

The new findings were made by a group of Italian astronomers, who studied locations where powerful cosmic explosions may have killed off life. These explosions, such as supernovas and gamma-ray bursts, spew high-energy particles and radiation that can shred DNA and kill life. By this logic, regions that are more hospitable to life will be the ones without frequent explosions, the astronomers reasoned.

"Powerful cosmic explosions are not negligible for the existence of life in our galaxy throughout its cosmic history," said lead author on the new study, Riccardo Spinelli, astronomer at the University of Insubria in Italy. "These events have played a role in jeopardizing life across most of the Milky Way."

In addition to finding the deadliest hotspots, the astronomers also identified the safest places throughout the galaxy's history, going back 11 billion years. The results show that we're currently at the edge of a wide band of hospitable real estate. But in the Milky Way's youth, the galaxy's edges were a safer bet. PLAY SOUND

Galactic Goldilocks zone

Many factors make a planet habitable. For instance, planets need to be in a Goldilocks zone, where heat and activity from their host star isn't too much or too little — it's just right. But in addition to these local conditions, life also has to combat harmful radiation coming from interstellar space.

Powerful cosmic events, such as supernovas and gamma-ray bursts, stream dangerous, high-energy particles at nearly the speed of light. Not only can they kill all the lifeforms we know about, but these particles can also strip entire planets of their atmospheres. After such an event, the scientists believe that planets orbiting nearby star systems would be wiped clear of life.

"For planets very close to the stellar explosion it is plausible that there is a complete sterilization," Spinelli told Live Science. "In those far away, a mass extinction is more likely."

The authors wrote in the study that a nearby gamma-ray burst may have played a leading role in the Ordovician mass extinction event around 450 million years ago — the second largest in Earth's history. While there is no concrete evidence linking a specific gamma-ray burst to this extinction

By this logic, regions that are more hospitable to life will be the ones without frequent explosions, the astronomers reasoned.

event, the authors think it could be likely, given Earth's position in the galaxy.

Searching for safety

Using models of star formation and evolution, the astronomers calculated when specific regions of the galaxy would be inundated with killer radiation. Early on in the galaxy's history, the inner galaxy out to about 33,000 light-years was alight with intense star formation, which rendered it inhospitable. At this time, the galaxy was frequently rocked by powerful cosmic explosions, but the outermost regions, which had fewer stars, were mostly spared these cataclysms.

Until about 6 billion years ago, most of the galaxy was regularly sterilized by massive explosions. As the galaxy aged, such explosions became less common. Today, the mid regions, forming a ring from 6,500 light-years from the galaxy's center to around 26,000 light-years from the center, are the safest areas for life. Closer to the center, supernovas and other events are still common, and in the outskirts, there are fewer terrestrial planets and more gamma-ray bursts.

Luckily for us, our galactic neighborhood is getting more and more life-friendly. In the long-term galactic future, there will be fewer extreme events nearby that could cause another mass extinction.

The new paper's conclusions seem reasonable at first glance, Steven Desch, an astrophysicist at Arizona State University, told Live Science.

"I'm pleased to note that they do seem to put [the research] in a rigorous framework and have realistic expectations about what a gamma ray burst would do, and account for factors that sometimes people forget," such as how the energy and material released by gamma-ray bursts isn't equal in all directions, said Desch, who was not involved with the new work. "I haven't gone through their numbers in detail, but at first glance it's reasonable."

The new research, published in the March issue of the journal Astronomy and Astrophysics, might one day help astronomers decide where to search for habitable exoplanets. But for now technology limits astronomers to only searching nearby areas, Desch said.

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These are the 5 costliest invasive species, causing billions in damages

2021-03-31

Invasive species can wreak havoc on local ecosystems. Cleaning up that biological wreckage comes at a big price.

These invaders, often thrust into new environments unintentionally (or intentionally, to combat pests) by humans, can transmit new diseases, devastate crops and eat away at crucial infrastructure. From 1970 to 2017, such invasions cost the global economy at least $1.28 trillion in damages and in efforts to control them, researchers report March 31 in Nature. As the globe becomes increasingly interconnected and invasive species take over new habitats, that cost grows.

"For decades, researchers have been evaluating the significant impacts of invasive species, but the problem isn't well known by the public and policy makers," says Boris Leroy, a biogeographer at the French National Museum of Natural History in Paris. "By estimating the global cost, we hoped to raise awareness of the issue and identify the most costly species."

Leroy and his colleagues screened over 19,000 published papers, ultimately analyzing nearly 1,900 that detailed the costs of various invasions at particular times. The team then constructed a statistical model that estimated yearly costs, adjusting for factors like inflation, different currencies and timescales. Between 1970 and 2017, annual costs roughly doubled every six years, reaching a yearly bill of $162.7 billion in 2017.

Between 1970 and 2017, annual costs roughly doubled every six years, reaching a yearly bill of $162.7 billion in 2017.

Costly critters

Some invasive species cause more economic damage than others. Researchers analyzed published data from the past few decades to rank the 10 costliest species or species groups from 1970 to 2017. Total costs are broken down into damages, costs of managing invasive species, and costs that don't fit neatly into one of those categories. Most of the top offenders are insects — mosquitoes head the list while screw-worm flies round it out — but cats, rats and some snakes are big troublemakers, too. Gaps in data — on plants, for instance — likely skew these rankings.

Intensified global trade over that period gave invaders more opportunities to hitch rides on cargo ships or airplanes, the researchers say. And deforestation and agricultural expansion probably sped their spread by allowing easier access to pristine areas.

On the whole, cleaning up the damage caused by invasive species cost $892 billion, about 13 times higher than the $66 billion spent managing invasions, the researchers found.

"This is a really ambitious effort," says Helen Roy, an ecologist at the UK Centre for Ecology and Hydrology in Wallingford, England. "There are major gaps in the data, which the authors are extremely transparent about," she says. The analysis was heavily weighted towards North America, Europe and parts of Asia and Oceania. Agricultural pests, like insects, tended to be overrepresented in published literature compared with invasive plants.

"Still, getting a global look is very important," Roy says. While this number is almost certainly an underestimate, she says, the study "shows us that this is a massive problem that's getting worse." Investing more in cargo inspections and other biosecurity measures or monitoring could help minimize these costs with comparatively small spending increases. "It's much cheaper than waiting for the species to establish and spread widely before responding," she says.

Here's a closer look at the top five costliest invasive species.

1. Aedes mosquitoes (A. albopictus and A. aegypti): about $149 billion

The Asian tiger mosquito (A. albopictus) arrived in the United States in the mid-1980s, by way of hitchhiking in used tires shipped from its native Asia. First detected in Houston, it rapidly spread to 40 states. It's also invaded parts of Europe, South America, Africa and Australia. A. aegypti, or the yellow fever mosquito, is native to sub-Saharan Africa and spread around the world by similar methods.

Together, these two mosquitoes cause significant damage to public health by transmitting a range of diseases like Zika, chikungunya, yellow fever and dengue, which accounts for the bulk of their cost. As the mosquitoes spread, the toll of these diseases grows (SN: 11/20/19).

2. Rattus (rats): about $67 billion

These rodents' worldwide occupation stems from about 3,000 years of hitchhiking on human boats. Once they arrive in a new location, rats often outcompete other small mammals, but can also harm birds and aquatic species. On islands around the world, rats have driven many species to extinction. For example, the Pacific rat, native to mainland southeast Asia, has snuffed out at least 1,000 species of island birds. Rats' high cost stems

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from these biodiversity losses, but the rodents also can damage crops, destroy property and transmit disease (like the bubonic plague).

3. Felis catus (cats): about $52 billion

Native to Europe and the Middle East, our feline friends have established themselves on all nonfrozen continents. Cats are excellent predators, and can make a quick meal from a variety of prey, from insects to birds. By some estimates, cats kill a billion birds each year in the United States alone (SN: 1/29/13). The bulk of the economic damage inflicted by cats cataloged in Leroy's analysis comes from their impact on native biodiversity and resulting losses in spending on birdwatching and hunting birds like ducks, pheasants and grouse.

4. Coptotermes formosanus (termites): about $19 billion

These subterranean termites native to East Asia have spread around the globe via trade. Termites can thrive wherever there is cellulose (like wood) and moisture, which has helped them quickly establish colonies upon being introduced to a new region. Their appetite for wood can wreak havoc on all kinds of structures, from homes to bridges. While they can also damage crops and tree farms, their high cost in this analysis boils down to their impact on infrastructure.

5. Solenopsis invicta (fire ants): about $17 billion

Fire ants usually become the dominant ant species when introduced to a new region, due to their aggressive foraging tactics, which include potent stings and bites. Native to South America, these ants arrived in the United States in the 1930s by boat, most likely carried in soil from the region. They've also spread to Australia, New Zealand, China and around the Caribbean. Fire ant colonies have wide-ranging impacts; they can feed on a variety of seedlings, from citrus to soybeans, reduce the size of grazing lands for livestock and bite and sting farm animals and humans.

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What causes COVID-19 vaccine side effects?

2021-04-02

The coronavirus vaccines are here, and while some people can't wait to get vaccinated, others are concerned about side effects such as sore arms, fevers and nausea.

It might seem counterintuitive, but side effects are a sign the vaccine is doing its job, experts told Live Science.

But why do the vaccines sometimes cause these unpleasant symptoms, and are they cause for concern? It might seem counterintuitive, but side effects are a sign the vaccine is doing its job, experts told Live Science.

Dr. Susan R. Bailey, an allergist, immunologist and president of the American Medical Association, said side effects develop because your immune system is reacting to the vaccine. People may start to develop fever, fatigue, headache and soreness around the injection area 12 to 24 hours after vaccination.

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Here's why: The COVID-19 mRNA vaccines tell the body to make the coronavirus "spike" protein, which the virus uses to enter and infect cells. (The Johnson & Johnson and AstraZeneca vaccines introduce the spike protein via a weakened common cold virus.) The presence of this spike protein initiates an immune response from three types of cells: macrophages, T cells and B cells, said Dr. Nitin Desai, CEO and chief marketing officer of COVID PreCheck, a digital health passport for recent COVID-19 tests and vaccination. Macrophages are the first of these cells to detect and eliminate harmful organisms, while the T cells that migrate to the region where the vaccine was injected help to remember the coronavirus spike protein for future encounters. Once the vaccine is recognized as foreign, B cells start building up an army of antibodies.

All of these immune cells produce inflammatory proteins known as cytokines. Cytokines are chemical messengers that help coordinate the immune response and also trigger a fever — which is a common side effect of the COVID-19 vaccines. A higher temperature makes the body less hospitable for the virus, and the rise in temperature stimulates the body to create more immune cells. These inflammatory chemicals can also cause muscle pain, fatigue, headaches and other symptoms. But cytokine production plateaus within 24 to 48 hours, which is why most side effects resolve on their own within that time frame, Desai said.

COVID-19 vaccines introduce just enough spike protein to the immune system to trigger a response. Unlike in severe cases of COVID-19, however, the vaccines do not trigger an out-of-control response known as a cytokine storm, where the body is flooded with the inflammatory chemicals, which then damage organs, Desai said.

Range of side effects

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Because side effects can be a sign of a robust immune system training to detect and destroy the virus, younger people may be more likely to have stronger side effects than the elderly. And, in vaccines that require two shots, such as the Pfizer and Moderna vaccines, side effects may also be worse after the second shot than the first one, because the T-cells remember the previous encounter with the spike protein. Without hesitation, the body quickly unleashes a strong immune response to destroy it — including lots of side-effect-inducing cytokines.

"Consistently, the second shot is showing more side effects but better immune response," Desai told Live Science.

The first dose teaches the immune system to recognize the virus and start producing antibodies and T cells against it, and the second shot is what helps the vaccine reach the full 94% to 95% efficacy, Desai said.

So, why do people tend to report stronger side effects from the COVID-19 vaccines than from some other vaccines, such as those for the flu? The mRNA COVID-19 vaccines may trigger stronger side effects than the flu shot in part because these vaccines stimulate a stronger immune response, Desai said.

Related: Who should get the Johnson & Johnson vaccine over the mRNA vaccines?

People who previously recovered from COVID-19 are also likelier to have strong side effects — even after the first shot. That's because their immune systems have already been primed to react to the virus, Bailey said.

Individual differences, such as stress level and diet, can also influence side effects, Desai said.

Still, don't fret if you got the shot and had no side effects; the vaccine is still working.

"Everybody's different in the way that they process vaccines," Bailey told Live Science. "But the clinical studies show that 90% to 95% of patients have a great response to the vaccine whether they have side effects or not."

Rare side effects

Some serious side effects are tied to the vaccine, but they are incredibly rare.

In very rare instances, people may develop anaphylaxis — a life-threatening but easily treatable allergic reaction — to the COVID-19 vaccines. For example, anaphylaxis occurs in just 2.5 per 1 million shots for the Moderna vaccine, according to a January study in the Centers for Disease Control and Prevention journal Morbidity and Mortality Weekly Report. (The Pfizer shot also induces rare cases of anaphylaxis.) The reaction occurs within 15 minutes of someone getting the vaccine, meaning it is very easy for health care providers to treat it if it does crop up. (For this reason, people who receive the vaccine are asked to remain at the vaccination site for 15 minutes after getting the shot.)

Other serious side effects may or may not be tied to some of the vaccines. Several European countries briefly paused the administration of the AstraZeneca vaccine because of reports of blood clots occurring very rarely. Because the coronavirus itself affects clotting, many experts were suspicious that the side effects were related, Bailey said.

However, a European Union investigation determined that the vaccine is safe for the general public and found no definitive link to the clots, though the EU regulator could not rule out a connection.

Meanwhile, there are plenty of side effects — ranging from spider bites, to sunburn, to genital herpes — that have been reported to authorities but have absolutely no link to the vaccine, according to data from the U.K. In other words, just because something happens soon after you get the vaccine, that doesn't mean the vaccine caused it.

Overall, taking your chances with COVID-19 is much riskier than getting a vaccine, Bailey said.

Given the new coronavirus variants spreading worldwide, it's very important to get vaccinated and be willing to get future booster shots, Desai said.

Bailey agreed. "No one is bulletproof, and we need everybody to get vaccinated so that we can develop herd immunity and protect those in the population who haven't had a chance to get the vaccine yet or who may be in an age group that is not entitled to get the vaccine yet," Bailey said.

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The archive of healing is now online: UCLA's digital database provides access to thousands of traditional & alternative healing methods

2021-04-01

Folk medicine is, or should be, antithetical to capitalism, meaning it should not be possible to trademark, copyright, or otherwise own and sell plants and natural remedies to which everyone has access. The entire reason such practices developed over the course of millennia was to help communities of close affiliation survive and thrive, not to foster market competition between companies and individuals. The impulse to profit from suffering has distorted what we think of as healing, such that a strictly allopathic, or "Western," approach to medicine relies on ethics of exclusion, exploitation, and outright harm.

What we tend to think of as modern medicine, the Archive of Healing writes, "is object-oriented (pharmaceuticals, technologically driven) and structured by historical injustice against women and people of color." The Archive, a new digital project from the University of California, Los Angeles, offers "one of the most comprehensive databases of medicinal folklore in the world," Valentina Di Liscia writes at Hyperallergic. "The interactive, searchable website boasts hundreds of thousands of entries describing cures, rituals, and healing methods spanning more than 200 years and seven continents."

In countries like the United States, where healthcare is treated as a scarce commodity millions of people cannot afford, access to knowledge about effective, age-old natural wisdom has become critical. There may be no treatments for COVID-19 in the database, but there are likely traditional remedies, rituals, practices, treatments, ointments, etc. for just about every other illness one might encounter. The archive was curated over a period of more than thirty years by "a team of researchers at UCLA, working under the direction of Dr. Wayland Hand and then Dr. Michael Owen Jones," the site notes in its brief history.

The material from the collection, which was originally called the "archive of traditional medicine," came from "data on healing from over 3,200 publications, six university archives, as well as first-hand and second-hand information from anthropological and folkloric fieldnotes." In 2016, when Dr. Delgado Shorter took over as director of the program, he "reorganized it with an eye to social sharing and allowing for users to submit new data and comment on existing data," notes UCLA's School of the Arts and

The entire reason such practices developed over the course of millennia was to help communities of close affiliation survive and thrive, not to foster market competition between companies and individuals.

Architecture in an interview with Shorter, who describes the project's aims thus:

The whole goal here is to democratize what we think of as healing and knowledge about healing and take it across cultures in a way that's respectful and gives attention to intellectual property rights.

This may seem like a delicate balancing act, between the scholarly, the folkloric, and the realms of rights, remuneration, and social power. The Archive strikes it with an ambitious set of tenets you can read here, including an emphasis on offering traditional and Indigenous healing practices "outside of often expensive allopathic and pharmaceutical approaches, and not as alternatives but as complementary modalities."

The archive states as one of its theoretical bases that health should be treated "as a social goal with social methods that affirm relationality and kinship." Those wishing to get involved with the Archive as partners or advisory board members can learn how at their About page, which also features the following disclaimer: "Statements made on this website have not been evaluated by the Food and Drug Administration. The information contained herein is not intended to diagnose, treat, cure or prevent any disease." Use the information wisely, at your own risk, in other words.

To use the Archive of Healing, you will need to register with the site first.

openculture.com, 1 April 2021

https://www.openculture.com

How stress stops hair growth (in mice)

2021-04-01

When faced with incredible stress, people sometimes shed hair by the handful, but scientists don't know exactly why that is. Now, a new study in mice offers a clue: Stress hormones may put hair growth on pause.

Follicles, the specialized organs that sprout hairs, cycle through "growth" and "rest" stages, where the follicle first actively produces new hair and then falls dormant. In mice, chronically high levels of the stress hormone corticosterone — similar to the human hormone cortisol — keep follicles in the rest stage for longer than usual, according to the new study, published March 31 in the journal Nature. This response prevents hair follicles from entering the growth stage, during which stem cells in the follicle produce new hair.

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"In humans, hairs in the resting phase can shed off more easily than the hairs in [the growth phase]," which might explain how stress leads to hair loss, Hsu noted.

Specifically, corticosterone halts hair growth by plugging into a receptor on cells that sit beneath the base of each follicle and release chemicals to regulate the hair cycle. Once plugged in, corticosterone blocks production of a protein called GAS6; without GAS6, the hair follicle stem cells can't activate to start growing hair.

PLAY SOUND

"So instead of regulating stem cells directly, chronic stress affects the expression of stem cell activating signals," senior author Ya-Chieh Hsu, an associate professor of stem cell and regenerative biology at Harvard University, told Live Science in an email.

This chain reaction may play out slightly differently in human hair follicles, but the mechanism may be very similar, because rodent corticosterone and human cortisol belong to the same family of hormones and interact with the same kind of receptors, she said. "In humans, hairs in the resting phase can shed off more easily than the hairs in [the growth phase]," which might explain how stress leads to hair loss, Hsu noted.

"If the finding can be translated in humans, they have to show that cortisol can push growing hair follicles into the rest phase," said Rui Yi, a professor in the departments of pathology and dermatology at the Northwestern University Feinberg School of Medicine in Chicago, who was not involved in the study.

If the mechanism pinpointed in mice also applies to people, "in principle," treatments could potentially be developed to prevent stress-induced hair loss, Yi told Live Science. But before jumping into new treatments, scientists will need to sort out any differences between the mouse model and humans, he said.

As for mice, "scientifically, it's a really complete story;" the authors traced each link in the chain reaction that resulted in hair growth changes, Yi said.

In the study, Hsu and her colleagues first stalled all stress hormone production in a group of mice by removing the animals' adrenal glands — an endocrine organ that produces stress hormones. These mice's hair follicles entered the growth stage about three times as often as unmodified control mice. In addition, their rest phase significantly shortened, lasting less than 20 days, compared with the usual 60 to 100 days in normal mice.

The study authors found that, if they fed the modified mice corticosterone, their hair follicle cycle fell back in step with that of normal mice. This

hinted that the hormone somehow suppressed their exuberant hair growth. The authors tested this idea in normal mice by exposing them to mild stressors on-and-off for nine weeks and found that, as the stressed animals' corticosterone levels rose, their normal hair growth became stunted.

Seeing this link between hormone levels and hair growth, the authors zoomed in on the hair follicle itself, to see whether corticosterone directly interacts with the stem cells inside. The hormone plugs into the so-called "glucocorticoid receptor," so the authors selectively deleted that receptor in different cells involved in hair growth and then applied corticosterone to the mice.

Removing the receptor from hair-follicle stem cells made no difference; the hormone still stunted hair growth. However, when the team deleted the receptor from nearby dermal papilla cells, hair growth proceeded as usual, without an extended rest phase. So whatever causes the hair growth to pause, it must work at the dermal papilla, the authors thought.

The team subsequently found that normal dermal papilla cells stop producing GAS6 when exposed to corticosterone. They also found that GAS6 usually plugs into hair-follicle stem cells and switches them on, jump-starting hair growth. But without the protein, hair follicles remain at rest. Likewise, injecting GAS6 directly into a mouse's skin can trigger hair growth, even if the animal is stressed and has elevated corticosterone levels, the team found.

It's possible, in theory, that GAS6 or a highly similar protein could also trigger hair growth in stressed-out humans, Yi said. But several big questions must be answered first.

For one, although corticosterone and cortisol are chemically similar, we don't know that they play the exact same role in rodent and human hair cycles, Yi said. Additionally, the rodent and human hair cycles unfold on very different timelines. As mice reach maturity, the rest stage of their hair follicles grows longer and longer, he said. And by the time a mouse is about 1.5 years old, the majority of its hair follicles remain at rest most of the time, meaning its hair stops growing.

"You never see any mice go to the barber shop," Yi said.

In comparison, about 90% of adult human hair follicles can be in the growth stage at any given time, Yi wrote in an independent commentary on the study, also published March 31 in Nature. Given that the mouse

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study only showed how stress hormones can prolong the rest state and prevent growth from starting, it will be interesting to see whether cortisol can not only prolong the rest state in humans, but also force actively growing hair back into the rest state, Yi said.

And finally, while hair usually sheds during the rest state, it's unknown exactly why the dormant hair becomes unmoored from the scalp, Yi said. So, in addition to preventing hair growth, perhaps stress somehow loosens the hair from its place, he said. But that's another mechanism to explore.

While many questions remain to be answered, the mouse study does hint at potential solutions for stress-induced hair loss that could someday be explored in people. "I can imagine manipulations related to the GAS6 pathways might have potential, if the findings are confirmed in humans in the future," Hsu said. The mouse study represents a "first critical step" toward developing those treatments, she said.

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Inside Ibogaine, one of the most promising and perilous psychedelics for addiction

2021-04-05

Amber Capone had become afraid of her husband. The "laid-back, bigger than life and cooler than cool" man she'd married had become isolated, disconnected and despondent during his 13 years as a U.S. Navy SEAL. Typically, he was gone 300 days of the year, but when he was home, Amber and their two children walked on eggshells around him. "Everyone was just playing nice until he left again," Amber says.

In 2013, Marcus retired from the military. But life as a civilian only made his depression, anger, headaches, anxiety, alcoholism, impulsivity and violent dreams worse. Sometimes he'd get upset by noon and binge-drink for 12 hours. Amber watched in horror as his cognitive functioning declined; Marcus was in his late 30s, but he would get lost driving his daughter to volleyball, and sometimes he couldn't even recognize his friends. Psychologists had diagnosed him with posttraumatic stress disorder (PTSD), depression and anxiety, but antidepressants, Ambien and Adderall didn't help. He visited a handful of brain clinics across the country, which diagnosed him with postconcussive syndrome after a childhood of

There was one last option.

football—then a career punctuated by grenades, explosives, rifles and shoulder-fired rockets. But all they offered were more pills, none of which helped either.

Marcus wasn't the only one suffering in his tight-knit community of Navy SEALs and special-operations veterans. A close friend killed himself, and Amber knew her husband could be next. "I truly thought that Marcus would be the one having the suicide funeral," Amber says.

There was one last option.

One of Marcus' retired Navy SEAL friends, who had similarly struggled, had traveled internationally to take ibogaine, a psychedelic drug illegal in the U.S. The ibogaine experience had been transformative for him, and he thought it might be the same for Marcus. "I thought it was crazy," Marcus says. "How can you take another pill to solve all your problems?" But Amber begged him to try it, and Marcus gave in. On Veterans Day in 2017, Marcus checked into a treatment center in Mexico, popped an ibogaine pill, slipped on eyeshades and noise-canceling headphones, and went on his first-ever psychedelic trip. After an hour or so, he entered a waking dream state and watched a movie of his life play out before his eyes. It lasted 12 hours, and it was awful at times. "Imagine some of the worst experiences of your life," Marcus says. "You're going to experience these again."

Life events flipped through his mind's eye in rapid fire. Other times, painful memories slowed to a crawl. Marcus saw himself having conversations with his dead father, with buddies he'd lost to the wars over the years, with God. "You can't hide from the medicine," he says. "It's just going to go down there and basically pull up any traumas, anything hiding in your subconscious that may be affecting you that you don't even realize."

When it was over, Marcus felt as if he'd finally put down a heavy load he'd been carrying for years. For the first time in a long time, he didn't want a drink, and he didn't touch alcohol for a year after. "I was thinking clear. I wasn't impulsive anymore. I had no anxiety. I wasn't depressed," he says. Amber couldn't believe it, but when she picked him up, she knew she had her husband back. "When he walked into the room, it was as though I was witnessing him the first time I met him," she says. "His anger and his darkness and his whole demeanor had changed. All of that was gone. He was easy. He was light. He was present. He was happy. It just absolutely blew my mind."

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Once dismissed as a fringe, counterculture vice, psychedelics are rapidly approaching acceptance in mainstream medicine. These drugs uniquely change the brain, and a person's awareness of experiences, in the span of just a few hours. This fast-acting shift could be useful in mental-health treatments, and research is already supporting this notion. Just one dose of psilocybin, the active ingredient in magic mushrooms, was recently shown to ease depression and anxiety in cancer patients—an outcome that lasted for years after their trip. Researchers are recognizing that psychedelics can provide a radical new approach to mental-health treatments at a time when innovation is desperately needed.

For addiction in particular, the need has never been greater. More Americans died from drug overdoses last year than ever before, aggravated by the COVID-19 pandemic. Weekly counts of drug overdoses were up to 45% higher in 2020 than in the same periods in 2019, according to research from the U.S. Centers for Disease Control and Prevention published in February. Available treatments can't meet the need. They aren't effective for everyone, may require long-term adherence and are sometimes addictive themselves.

Ibogaine is one of the most promising psychedelics for addiction. Few people have heard of it, it's illicit in the U.S., and nobody does it for fun. It's not pleasant. It could kill you. But for extinguishing addiction—and a range of other issues—many people swear there's nothing like it. The drug hails from a shrub called Tabernanthe iboga, which is native to Central Africa. Since at least the 1800s, members of the Bwiti religion in Gabon have eaten iboga bark shavings during initiations and coming- of-age ceremonies; those who consume it report visions of and contact with their ancestors and even God. The wider world encountered the hallucinogenic plant in the form of ibogaine, a compound extracted from iboga bark and packed into a pill.

In France, ibogaine was sold and prescribed as an antidepressant and stimulant called Lambarene for more than 30 years until the 1960s, when the government outlawed the sale of ibogaine. But its antiaddictive effects weren't well known in the U.S. until 1962, when Howard Lotsof—then a 19-year-old completely outside the medical establishment—experimented with it and noticed it wiped out his heroin addiction. It did the same for several of Lotsof's peers when he organized 20 lay drug experimenters, all in their late teens and early 20s, to try many hallucinogens including ibogaine. Seven people in the group were hooked on heroin at the time. After they took ibogaine, all seven said they were no longer in heroin withdrawal, and five of them lost their desire to use heroin

for six months or longer. Ibogaine was the only drug to have this effect. "Suddenly, I realized that I was not in heroin withdrawal," Lotsof later said of his own ibogaine experience. Nor did he crave it. "Where previously I had viewed heroin as a drug which gave me comfort, I now viewed heroin as a drug which emulated death. The very next thought into my mind was, I prefer life to death."

Lotsof found ibogaine so helpful that he launched a campaign to get researchers to dig into it more deeply. But pharmaceutical companies didn't bite. Ibogaine is a naturally occurring plant compound and therefore difficult to patent; plus, nobody knew exactly how it worked, and drug companies historically did not see addiction medications as profitable. In 1970, the federal government classified ibogaine (along with other psychedelics) as a Schedule I drug, declaring it had no medical use and a high potential for abuse. But case studies in which ibogaine had helped heroin users successfully detox—including Lotsof's New York City group and another from the Netherlands in the early '90s—were promising enough that one U.S. government agency took notice.

In 1991, the National Institute on Drug Abuse (NIDA) decided to fund animal research into ibogaine; the resulting studies (and later ones) in rodents found that ibogaine reduced how much heroin, morphine, cocaine and alcohol the animals consumed. This work primed the U.S. Food and Drug Administration (FDA) to greenlight a clinical trial of ibogaine in humans for cocaine dependence, but it fell apart in early stages because of a lack of funding and contractual disputes. NIDA abandoned its interest in ibogaine, citing safety as one concern. There still has been no completed clinical trial in the U.S. to test ibogaine in people.

Now, for the first time, some upstart pharmaceutical companies, including ATAI Life Sciences and MindMed, are realizing there's money to be made here, and they're racing to develop ibogaine or drugs that act like it. But as they start the long slog of chasing FDA approval through clinical trials—with outcomes far from clear—many people are desperate enough to skip the U.S. and try ibogaine in parts of the world where it's unregulated.

Plenty of these people have shared their experiences with researchers through case reports and survey data. The success stories sound eerily alike: a single dose of ibogaine can take you on a visual journey of your most significant life events. You're able to forgive yourself and others for past traumas, and the drug seems to rewire your brain, zapping withdrawal symptoms and extinguishing opioid cravings within hours—with results that can last for weeks, months and sometimes even

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longer. Unlike buprenorphine and methadone, two common approved medications to overcome opioid addictions, ibogaine is not an opioid substitute. "Ibogaine seems to resolve these signs of opioid withdrawal by a mechanism that is different from an opioid effect, and I think that is what is so interesting about it," says Dr. Kenneth Alper, a longtime ibogaine researcher and an associate professor of psychiatry and neurology at New York University School of Medicine.

Scientists don't know exactly what ibogaine does to the brain. There's some recent evidence—in rats—that ibogaine may increase neurotrophic factors in the brain, which are proteins that encourage neuron growth and plasticity (the ability of the brain to change even in adulthood). These appear to be key in helping the brain remodel to overcome an assault like a substance-use disorder. But since other psychedelics also increase neural plasticity, something more is likely going on.

Human clinical trials for ibogaine and addiction are under way. In October, researchers in Spain began testing ibogaine in 20 people trying to wean themselves off methadone. And in an upcoming clinical trial set to begin in Brazil once the pandemic is under control, researchers at the University of São Paulo will give different doses of ibogaine to 12 alcoholic patients to see if it's safe and effective at reducing the amount they drink.

But many are not waiting for studies. If there's even a chance that taking ibogaine will help a person overcome addiction, many are willing to try it. Ibogaine is unregulated in many countries, neither illegal nor approved, and that gray zone has allowed dozens of ibogaine treatment centers to pop up worldwide. Americans desperate to shake their addictions spend thousands of dollars at these clinics, which vary wildly in their practices and treatment standards. Some facilities use licensed physicians and monitor heart activity and other vital signs throughout the trip, while other clinics don't.

Success rates also vary. Some people stop using drugs completely and stay sober for years. Others die. Because of a lack of controlled ibogaine trials, it's difficult to quantify the risks, but the threats to cardiovascular health are particularly concerning. The drug may block certain channels in the heart and slow down heart rate, which can cause fatal arrhythmias. In one observational study published in 2018, researchers followed 15 people as they received ibogaine treatment for opioid dependence in New Zealand, where ibogaine is legal by prescription, and interviewed them for a year after. Eight of the 11 patients who completed the study cut back on or stopped using opioids, and depression improved in all of them. One

person died during the treatment, likely because of an ibogaine-induced heart arrhythmia.

But how much risk is too much when nothing else works?

Four rounds of rehab hadn't touched Bobby Laughlin's heroin addiction. He didn't believe the hype about ibogaine but figured it was his last shot, so he traveled to a clinic in Rosarito Beach, Mexico. Before the flight, he used heroin—and it was the last opiate he ever took. The most valuable outcome of Laughlin's 30-hour ibogaine experience was that it let him bypass withdrawals, he says, opening a window of opportunity. "One thing that was made very clear to me was that I had to change my life dramatically after the experience if I wanted to capitalize on it and have long-term sobriety," he says. Laughlin started a private-equity firm in L.A., then a family. "I've been able to establish myself," he says, eight years later. "All roads lead back to ibogaine as the start."

Alan Davis, a Johns Hopkins University adjunct assistant professor researching psychedelics, has been hired by several clinics outside the U.S.—including the one Laughlin visited—to follow up with clients to see what, if anything, changed in their lives after the treatment. In 2017, Davis published a study in the Journal of Psychedelic Studies in which he surveyed 88 people—most of whom had been using opioids daily for at least four years—who had visited an ibogaine clinic in Mexico from 2012 to 2015. About 80% said ibogaine eliminated or drastically reduced their withdrawal symptoms; half said their opioid cravings diminished, and 30% said that after ibogaine, they never used opioids again. Ibogaine "is not a magic bullet," Davis says, but even a short-term disruption of the sort the psychedelic provides can give addicted people the space and time to make needed changes to their environment, behavioral patterns and relationships.

Addiction may be only the beginning. In a 2020 research paper published in the journal Chronic Stress, Davis and his team found that among 51 U.S. veterans who had taken ibogaine in Mexico from 2017 to 2019, there were "very large reductions" in symptoms related to every domain they measured, including suicidal thoughts, PTSD, depression, anxiety and cognitive impairment. "Their improvement [was] way above what we would see with typical currently approved treatments," Davis says. "Even if you cut these effect sizes in half"—assuming that the data aren't as accurate as they'd be in a rigorous, controlled trial—"that's still two to three times more powerful than our currently approved treatments." More

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than 80% of the vets surveyed said the psychedelic experience was one of the top five most meaningful experiences of their lives.

"We're not actually healing problems with medications that we currently have; we're just trying to treat the symptoms," Davis says. Psychedelics like ibogaine, on the other hand, seem "to be showing that we might actually be getting below just symptom reduction into a place where true healing can happen."

Despite intriguing initial data like these, modern pharmaceutical companies until recently had not touched ibogaine. Now they're interested. ATAI Life Sciences, a three-year-old German biotech company focused on psychedelics for mental health, is trying to develop ibogaine as an FDA-approved drug to treat opioid-use disorder. If clinical trials, which are slated to begin in the U.K. in May, support ibogaine's efficacy, the company's hope is that an ibogaine capsule would be used at detox centers in the U.S. "I'm a hardcore neuropharmacologist and physician by training," says Dr. Srinivas Rao, co-founder and chief scientific officer at ATAI. "I've viewed it a little skeptically … but the stories with ibogaine keep surfacing and [keep] being very similar. People seem to get a lot out of this experience." ATAI is also pursuing noribogaine—the substance ibogaine breaks down to in the body—as a possible addiction treatment.

Fears about how ibogaine affects the heart have scared away most establishment pharmaceutical companies, but Rao calls those worries overblown. "It does hit some of these channels in the heart, and in very uncontrolled settings, it's certainly been associated with issues of arrhythmia," he says. "In the context of more controlled settings with medical support, it has not really been associated with any kind of arrhythmia or significant adverse outcome." Careful dosing and monitoring can lessen risk, Rao says, and trials will eventually uncover ibogaine's true cardiovascular impact. However, some risk might be worth it in the context of the drug's potential benefits. "If this were treating acne, of course—this is not a great choice," he says. But for opioid addiction, which kills about 128 Americans per day, "some degree of cardiovascular risk is probably acceptable."

MindMed, a U.S.-based company aiming to develop medicines based on psychedelics, is pursuing a synthetic derivative of ibogaine called 18-MC for opioid addiction. "We do see merit in hallucinogenic drugs," says J.R. Rahn, CEO and co-founder of MindMed. "We just don't see the merit of ibogaine, because I don't think anyone wants to take medicine and have the risk of having a heart attack." The company's hope is that 18-MC will

have the same impact on withdrawal as ibogaine but won't come with the psychedelic or heart effects. MindMed's Phase 1 trial in Australia has so far found no adverse cardiovascular effects with 18-MC. Phase 2 trials, to test if 18-MC lessens opioid withdrawal, are expected to begin this year.

Other synthetic compounds that act like ibogaine are on the horizon. In a study published in December in the journal Nature, researchers at the University of California, Davis, engineered a compound that's structurally similar to ibogaine but less damaging to the heart. It also appears to be nonhallucinogenic, at least in mice. Called tabernanthalog, or TBG, it increased neural plasticity, reduced heroin- and alcohol-seeking behavior, and even had antidepressant effects in rodents; researchers are considering pursuing a study of TBG's effects on humans.

These innovations are still years off. But in the meantime, Marcus Capone knows that his community of special-operations veterans can't afford to wait. In 2019, he and his wife Amber started a nonprofit called Veterans Exploring Treatment Solutions (VETS) to fund those who want to receive psychedelic therapies like ibogaine abroad. They've funded about 300 veterans so far, with more than 100 currently on the waitlist. VETS is also financing research exploring what ibogaine does to the brains of veterans with symptoms of head trauma.

Marcus hopes that someday, Americans who need it will be able to receive the treatment that, in a single dose, saved his life and gave him a new mission. "This word has to get out," he says.

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