CHEMWATCH

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ASIA PACIFIC

Methyl bromide reassessment

2021-04-30

The Decision-making Committee has requested further information from recent recapture trials, and an independent review of a recent modelling report from the applicant STIMBR (Stakeholders in Methyl Bromide Reduction).

All parties to the reassessment may now provide comments on the EPA's latest update report. Feedback is due by 5.00pm on 6 May.

Read the EPA's latest update report (PDF, 1.1MB)

Read Direction and Minute WGT033 (PDF, 239KB)

Read Direction and Minute WGT032 (PDF, 232KB)

EPA New Zealand, 30 April 2021

https://www.epa.govt.nz/

Suspected low and no-use chemicals under scrutiny

2021-04-30

Public feedback is sought as part of a fact-finding exercise on the use of 16 hazardous substances, many of which appear to have fallen into disuse in New Zealand.

These are active ingredients in products used to kill bugs and insects in orchards, vineyards, vegetable and cereal crops. They are officially known as organophosphate and carbamate substances (OPCs).

The 16 include carbaryl – a pesticide once considered a go-to for stone fruit, pipfruit, and avocado orchardists. The latest information available to the Environmental Protection Authority (EPA) indicates usage has dropped, as carbaryl products have been withdrawn from sale.

We are also calling for information on the use of:

fenitrothion (used in household insect pest products)

fenthion (found in flea treatment for pets)

maldison (commercial use insecticides used in fruit, vegetable and cereal crops, and pasture)

All parties to the reassessment may now provide comments on the EPA's latest update report. Feedback is due by 5.00pm on 6 May.

propoxur (household insect pest and flea control products).

Together with carbaryl, these are on the EPA's Priority Chemicals List, which details the substances that we believe are most in need of review in New Zealand.

"Our initial information points to the manufacturing and usage of the 16 OPCs falling away over time. We need to hear whether these substances remain in use and, if so, how and in what volume," says the EPA's General Manager of Hazardous Substances and New Organisms, Dr Chris Hill.

"If the risks outweigh the benefits, we must consider whether the approvals for these highly toxic substances should be revoked altogether. If not, there is potential for tighter usage rules to be imposed."

The EPA regulates agrichemicals, household chemicals and other dangerous goods and substances under the Hazardous Substances and New Organisms Act. As well as evaluating and approving substances, we can reassess and make new decisions about whether the hazard classifications and controls (usage rules) need to be updated.

Submissions close at 5.00pm on 28 May 2021.

Read more about the 16 substances in the call for information

Find out about the chemical reassessment process

Read the EPA's Priority Chemicals List

EPA New Zealand, 30 April 2021

https://www.epa.govt.nz/news-and-alerts/latest-news/suspected-low-and-no-use-chemicals-under-scrutiny/

Downstream users to face penalties for using unregistered substances in South Korea

2021-04-29

South Korea's parliament has approved a partial amendment to K-REACH that extends culpability for using unregistered substances to downstream users and sellers.

The amendment, approved by the National Assembly on 13 April, will come into force on 14 October.

Until now K-REACH has not outlined any sanctions on downstream users and resellers of these substances.

The amendment, approved by the National Assembly on 13 April, will come into force on 14 October.

Instead it has focused on manufacturers and importers, which have been subject to fines, business closures and possible imprisonment.

Registration responsibility

Under K-REACH, companies manufacturing or importing 100kg or more a year of new substances, or one tonne or more a year of existing substances, have had to register with the Ministry of Environment (MoE) before starting the activity. Failure to do this can result in penalties or bans.

The latest amendment – to Article 13, clause 1 – will extend these rules to "downstream users, manufacturers, importers or sellers".

And under this, the MoE can also ban these parties from manufacturing, importing, using or selling unregistered substances. If a downstream user incorporates such a substance into a product then it may be subject to recall.

The precise sanctions on downstream users and sellers will be subject to changes in the enforcement rules, which have yet to be finalised.

Read More

Chemical Watch, 29 April 2021

https://chemicalwatch.com/255868/downstream-users-to-face-penalties-for-using-unregistered-substances-in-south-korea

AMERICA

EPA announces expanded chemical reporting requirement

2021-05-05

Late last week, the United States Environmental Protection Agency (EPA) announced its latest environmental justice initiative aimed at expanding Toxic Release Inventory (TRI) reporting requirements to include additional types of chemicals and facilities. Environmental Justice is intended to ensure fair treatment and involvement of people regardless of race, color, origin or income in environmental regulation and enforcement. The TRI is a publicly available database that includes information on toxic chemical releases and waste management activities. The EPA announced its proposal to expand the list of chemicals covered by TRI reporting

Environmental Justice is intended to ensure fair treatment and involvement of people regardless of race, color, origin or income in environmental regulation and enforcement.

requirements, as well as public access to the database, in order to "advance Environmental Justice, improve transparency, and increase access to environmental information."

Expanded TRI Reporting Requirements

There are four key components of the EPA's announcement:

Natural Gas Processing Facilities – The EPA is finalizing a proposed rulemaking that would include natural gas processing facilities on the list of industry sectors covered under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA). Natural gas processing facilities, which separate impurities from natural gas to create "pipeline quality" dry natural gas, would be required to follow TRI reporting requirements. This will increase the publicly available information on chemical releases and other waste management activities at natural gas facilities.

Polyfluoroalkyl Substances (PFAS) - The EPA will continue to add new PFAS chemicals (also known as "forever chemicals") to the TRI reporting requirements. The EPA's authority to add PFAS chemicals to the TRI comes from the 2020 National Defense Authorization Act, which added certain PFAS to the TRI automatically.

Ethylene Oxide (EtO) - EtO is used to make industrial chemicals and sterilize medical devices. Contract sterilization facilities that utilize EtO have not historically been required to report EtO releases. Now, they will be required to do so because "[m]any of these facilities are located near areas with Environmental Justice Concerns."

Toxic Substances Control Act (TSCA) Workplans - The EPA plans to propose adding to the TRI the chemicals included in the TSCA Workplan and other substances designated as high-priority substances under the TSCA.

Read More

JD Supra, 5 May 2021

https://www.jdsupra.com/legalnews/epa-announces-expanded-chemical-1349550/

The United States is finally taking aim at an important type of these lesser-known superpollutants: hydrofluorocarbons, or HFCs, which are used in air conditioners and refrigerators.

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After four years of inaction, the EPA is finally regulating this superpollutant

2021-05-04

Sales of air conditioners are soaring. Regulating the heat-trapping hydrofluorocarbons in them is crucial.

Carbon dioxide gets the fame and attention, out of the greenhouse gases. But there are others that are even more effective at trapping heat; they just exist in much smaller concentrations, so they don't usually face the same level of scrutiny or regulation.

The United States is finally taking aim at an important type of these lesser-known superpollutants: hydrofluorocarbons, or HFCs, which are used in air conditioners and refrigerators. The Environmental Protection Agency announced a rule on Monday, first reported by the New York Times's Lisa Friedman, that it will phase out the coolant's use by 85 percent over the next 15 years. The EPA estimates the rule would cut down on the equivalent of 4.7 billion metric tons of carbon dioxide from 2022 to 2050 — about equal to three years of US power sector pollution.

HFCs have only been used in appliances since the 1990s, as a replacement for ozone-depleting chemicals, but their use has grown at a terrifying rate. While HFCs still only comprise about 1 percent of total greenhouse emissions, they are thousands of times better at trapping heat than carbon over a 20-year period.

Left unregulated, global HFCs would add another half-degree Celsius of warming by 2100, according to the EPA. That half-degree is crucial to avoid — it's the difference between the world we have today and the one we will have soon at 1.5 degrees Celsius, and means crop failures, Arctic ice-free summers, and cities facing unmanageable flooding.

And it's especially important to start phasing out HFCs now, since the global stock of air conditioners is rising rapidly in a warming world: According to United Nations' Climate and Clean Air Coalition, there will be 10 AC units sold every second for the next 30 years. The alternative chemicals all have some impact on global warming, but natural (meaning not human-made) options have a much smaller footprint, according to Project Drawdown. Ammonia, for example, has almost zero impact.

That's why the EPA's new proposed regulation that sets the first cap for manufacturing and importing HFCs in the US is very good news.

Read More

Vox, 4 May 2021

https://www.vox.com/2021/5/4/22417242/air-conditioning-refrigerators-epa-michael-regan-regulation-hfcs-hydroflurocarbons

Washington State enacts cap-and-trade and clean fuels legislation

2021-05-04

In an historic move, the Washington State Legislature passed two major pieces of climate change legislation in the closing days of its recent session over the weekend of April 24-25, 2021.

Once signed by Governor Inslee, the Climate Commitment Act creates a market-based, economy-wide, cap-and-trade program. The other legislation (HB 1091) creates a program to reduce the carbon in transportation fuels.1 These bills follow on the heels of the 2019 Clean Energy Transformation Act (CETA), which requires that the electric generating sector be completely decarbonized by 2045.

Together, these three laws place Washington firmly in the top tier of states addressing climate change. They also strengthen the policy alignment along the West Coast by opening the door to linkage with California's cap-and-trade program and adopting a clean fuels program similar to that of British Columbia, Oregon, and California.

Big Picture

As shown below, Washington State currently emits roughly 100 million metric tons of anthropogenic greenhouse gases (GHGs) annually. Consistent with the Paris Agreement and what the science says is necessary to avoid a global temperature increase greater than 1.5 degrees C, Washington's legislature in 2020 committed to achieving net-zero GHG emissions by 2050.

To achieve this, the legislature established interim GHG emission limitations of 50 million tons by 2030, 27 million tons by 2040, and five million tons by 2050 (with the remaining five million tons of emissions to be offset by an equal amount of GHG capture and sequestration).2 In combination with CETA, the two new bills are designed to meet these ambitious goals.

These bills follow on the heels of the 2019 Clean Energy Transformation Act (CETA), which requires that the electric generating sector be completely decarbonized by 2045.

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JS Supra, 4 April 2021

https://www.jdsupra.com/legalnews/washington-state-enacts-cap-and-trade-9618890/

There are harmful chemicals in North Carolina's waterways. Will lawmakers address the problem?

2021-05-05

The public utility for Wilmington and New Hanover County will spend about $46 million to filter out potentially carcinogenic "forever chemicals" from drinking water for an estimated 200,000 people.

In neighboring Brunswick County, bids totaling $137 million have been approved for a similar filtration system to remove per- and polyfluoroalkyl substances known as PFAS to be completed within the next two years.

In Cumberland County, officials have approved spending $10 million to run public water lines to two schools and homes whose wells have been contaminated with the substances, much of which is the result of contamination emanating from the smokestacks at the Chemours Fayetteville Works plant on the border of Bladen County.

And in the small Chatham County town of Pittsboro, officials are eyeing a $42 million filtration system for the removal of PFAS and perhaps an even more troubling chemical, a likely carcinogen known as 1,4 dioxane. The money would also expand the town's water treatment plant.

If these projects move forward, ratepayers — and not the companies that contaminated the water supplies — will be footing the bills. Brunswick County recently announced in January that it is raising rates to offset filtration costs and expansion of its water treatment plant. Lawsuits have been filed in New Hanover and Brunswick counties in an effort to recoup the money.

Read More

North Carolina Health News, 5 May 2021

https://www.northcarolinahealthnews.org/2021/05/05/there-are-harmful-chemicals-in-north-carolinas-waterways-will-lawmakers-address-the-problem/

The money would also expand the town's water treatment plant.

EUROPE

Revision of EU legislation on hazard classification, labelling and packaging of chemicals

2021-05-04

Summary

For the implementation of the Green Deal, the chemicals strategy for sustainability sets out a number of actions that require a targeted revision of the Regulation on the classification, labelling and packaging of chemical substances and mixtures. Various options for revision will be analysed in an impact assessment and, based on the results, the Commission will present legislative proposals for a revision of both the enacting terms of and the annexes to that Regulation.

Topic

Environment

Type of act

Proposal for a regulation

Type

Inception impact assessment

More about roadmaps

Feedback period

04 May 2021 - 01 June 2021 (midnight Brussels time)

Read More

European Commission, 4 May 2021

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12975-Revision-of-EU-legislation-on-hazard-classification-labelling-and-packaging-of-chemicals_en

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Revealing the impact of 70 years of pesticide use on European soils

2021-05-05

Pesticides have been used in European agriculture for more than 70 years, so monitoring their presence, levels and their effects in European soils quality and services is needed to establish protocols for the use and the approval of new plant protection products.

In an attempt to deal with this issue, a team led by the prof. Dr. Violette Geissen from Wageningen University (Netherlands) have analysed 340 soil samples originating from three European countries to compare the contentdistribution of pesticide cocktails in soils under organic farming practices and soils under conventional practices. This study was a combined effort of 3 EC funded projects addressing soil quality: RECARE (http://www.recare-project.eu/), iSQAPER (http://www.isqaper-project.eu) and DIVERFARMING.

The soil samples were obtained from two case study sites in Spain, 1 case study site in Portugal, and 1 case study site in the Netherlands; which covered four of the main European crops: horticultural products and oranges (in Spain), grapes (in Portugal), and potato production (in the Netherlands). Chemical analyses revealed that the total content of pesticides in conventional soils was between 70% and 90% higher than in organic soils, although the latter soils did also contain pesticide residues.

Although in 70% of conventional soils mixtures of up to 16 residues were detected per sample, only a maximum of five different residues were found in the organic soils. the residues most frequently found and in the greatest quantities were the herbicides Glyphosate and Pendimethalin. The samples were collected between 2015-2018, as no major changes occurred in terms of management, there are indicative of current situation, and likely of other Eu agricultural areas."

Once the presence of these pesticide cocktails in European agricultural soils is unfolded, it becomes necessary to have a greater understanding of the effects that these complex and cumulative mixtures have on soil health, an area in which there is currently a major lack of information.

The research team emphasis the need to define and introduce regulations and reference points on pesticide cocktails in soils in order to protect the soil's biodiversity, and the quality of crop production. Additionally, taking into account the persistence of residues in organic soils it is necessary to reconsider the time required for the transition from conventional

agriculture to organic agriculture, making it dependent on the mix of residues in the soil at starting point and the time they take to degrade.

Read More

Eurekalert, 5 May 2021

https://www.eurekalert.org/pub_releases/2021-05/uoc-rti050521.php

INTERNATIONAL

SweNanoSafe publishes English translation of report from workshop series with education network and roadmap for 2021

2021-05-06

In fall 2020, the Swedish National Platform for Nanosafety (SweNanoSafe) organized three workshops on education within nanosafety, with the goal of starting and consolidating an education network. The first workshop focused on the need for education in nanosafety, the second workshop was on available education on nanosafety in Sweden, and the third workshop discussed concrete opportunities to take various education efforts one step further. On May 5, 2021, SweNanoSafe published *Nanosafety and education: Report from workshop series with SweNanoSafe's education network and Roadmap for 2021*, an English translation of its report summarizing the presentations and discussions conducted in the three workshops and presenting a work plan for the education network in the form of a Roadmap for 2021. The Roadmap consists of four steps:

Step 1:

Target Groups — Working group identifies and describes relevant target groups for nanosafety education; and

Teaching Materials — Working group collects teaching materials through SweNanoSafe's education network and research network;

Step 2:

Sorting — Working group sorts teaching materials that are relevant to cases; and

Development — Several smaller working groups continue to develop materials on specific themes;

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Step 3: Production of teaching modules; and

Step 4: Communication and dissemination.

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Nanotech, 6 May 2021

https://nanotech.lawbc.com/2021/05/swenanosafe-publishes-english-translation-of-report-from-workshop-series-with-education-network-and-roadmap-for-2021

Nanoplastics and other harmful pollutants found in disposable face masks

2021-05-04

Swansea University scientists have uncovered potentially dangerous chemical pollutants that are released from disposable face masks when submerged in water.

The research reveals high levels of pollutants, including lead, antimony, and copper, within the silicon-based and plastic fibres of common disposable face masks.

The work is supported by the Institute for Innovative Materials, Processing and Numerical Technologies (IMPACT) and the SPECIFIC Innovation & Knowledge Centre

Project lead Dr Sarper Sarp of Swansea University College of Engineering said: "All of us need to keep wearing masks as they are essential in ending the pandemic. But we also urgently need more research and regulation on mask production, so we can reduce any risks to the environment and human health."

Outlined in a recent paper, the tests carried out by the research team used a variety of masks -- from standard plain face masks to novelty and festive masks for children with many currently being sold in UK retail outlets.

The rise in single-use masks, and the associated waste, due to the COVID-19 pandemic has been documented as a new cause of pollution. The study aimed to explore this direct link -- with investigations to identify the level of toxic substances present.

The findings reveal significant levels of pollutants in all the masks tested -- with micro/nano particles and heavy metals released into the water during all tests. Researchers conclude this will have a substantial environmental

The research reveals high levels of pollutants, including lead, antimony, and copper, within the silicon-based and plastic fibres of common disposable face masks.

impact and, in addition, raise the question of the potential damage to public health -- warning that repeated exposure could be hazardous as the substances found have known links to cell death, genotoxicity and cancer formation.

To combat this, the team advise further research and subsequent regulations be put in place in the manufacturing and testing process.

Read More

Science Daily, 4 May 2021

https://www.sciencedaily.com/releases/2021/05/210504112637.htm

How can the scope of a new global legally binding agreement on plastic pollution to facilitate an efficient negotiation be clearly defined?

2021-04-27

Crossing borders both as a truly globalized commodity and eventually as unmanaged waste, plastic pollution warrants joint global action. Plastic pollution has the potential to spread toxic chemicals intentionally added to them or passively adsorbed from the environment, including persistent organic pollutants, endocrine disruptor chemicals, and heavy metals, posing enormous risks to marine ecosystems, biodiversity, and food availability.(1) With the unprecedented concern already having been raised worldwide, the problem was further aggravated by the COVID-19 pandemic. The urgency of addressing plastic pollution was reiterated by countries at the first session of the Fifth United Nations Environment Assembly (UNEA-5.1) on February 22–23, 2021. At the meeting, delegates stressed the inadequacy of existing international legal and policy frameworks and the trans-boundary characteristics of plastics. At least 40 countries expressed support for a new global agreement on plastic pollution.(2)

In international diplomacy and policy negotiations, the quest for accuracy of wording is almost extreme. A miniscule variation in wording can lead to a huge change in scopes and responsibilities. The terms "marine plastic litter" and "microplastics" are commonly cited in the relevant discussions, policy papers, and resolutions. Other terms, such as "marine litter", "marine debris", and "plastic pollution", were also used by country leaders at UNEA-5.1. The different wordings may, intentionally or not, reflect the speakers' different focuses and objectives with regard to the plastic issue. Thus, the lack of a defined terminology may trigger confusion, misinterpretation,

With the unprecedented concern already having been raised worldwide, the problem was further aggravated by the COVID-19 pandemic.

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and resource-demanding processes. Disentangling these potential differences and defining a common objective early on may contribute to enhancing stakeholder engagement and facilitate a more streamlined negotiation process. This article will shed light on some of the more profound divergences in ongoing international deliberations and some critical intersections on the road to a negotiation mandate for a future plastic agreement.

In each of the UNEA meetings since 2014, plastic has been a key topic. Different framings of the plastic pollution issue can be observed in its resolutions and countries' statements. The resolutions adopted were titled "Marine Plastic Debris and Microplastics" (EA.1/Res.6), "Marine Plastic Litter and Microplastics" (EA.2/Res.11), "Marine Litter and Microplastics" (EA.3/Res.7), and "Marine Plastic Litter and Microplastics" (EA.4/Res.6), the last of of which is currently the most widely accepted. At UNEA-5.1, various countries intervened on the issue using terms such as "marine plastic litter and pollution of microplastics" and "marine litter and plastic pollution". (3) No doubt, the marine ecosystem is the end point of large amounts of pollution and there has been significant global attention paid to the emerging environmental problems related to plastic pollution, particularly to the marine environment. However, the "marine" label may also depict a boundary for action, essentially relegating the solution to the end of the pipe after the plastics are out in the environment and potentially limiting options for eliminating waste across the entire life cycle of plastics. With over 80% of ocean plastic coming from land-based sources, the solution of marine plastic pollution is mainly land-based and upstream. Hence, an overly narrow marine scope of the international deliberations may fail to incorporate key land-based upstream sources and corresponding mitigative measures, such as sustainable design, production, and consumption.

Read More

ACS, 27 April 2021

https://pubs.acs.org/doi/10.1021/acs.est.1c02033#

Statement on the registration of polymers under REACH and list of signatures in support

2021-04-30

People and the environment are widely exposed to polymers, the main constituents of plastics, as these chemicals continue to build up in terrestrial and ocean ecosystems and production is predicted to continue increasing (Geyer et al., 2017), resulting in emissions to our waterways of up to 53 million metric tons (Mt) per year by 2030 (Borrelle et al., 2020). Apart from plastics, polymeric substances are present in many other materials, products and applications, including but not limited to silicones, coatings, paints, detergents, household and personal care products, agricultural fertilizers and wastewater treatment, often leading to direct releases into the environment.

Although polymers are manufactured and used in Europe in extremely high quantities (e.g. plastic production in Europe has been around 60 million tonnes per year over the last years (PlasticsEurope, 2020)), not enough is known about their identity, uses, physical, chemical, and hazardous properties, particularly because polymers have so far been exempt from registration under the European chemicals regulations REACH. To finally initiate the polymer registration process, currently the European Commission (EC) is developing a proposal on how and which polymers to register (Wood and PFA-Brussels, 2020).

As scientists working in the fields of polymer chemistry, ecotoxicology, environmental chemistry, conservation biology, environmental sciences, marine biology, atmospheric pollution, food packaging and sustainability assessment, we would like to provide our expert opinion on the proposed process and criteria for identification of polymers requiring registration (PRR) under REACH, as reflected in the discussion documents from the Competent Authorities for REACH and CLP (CARACAL) subgroup on polymers (CASG-polymers), including the modified PRR flowchart proposal referred to as "New Figure 3.2" in the EC's "BACKGROUND DOCUMENT for the CASG-polymers meeting 16 Dec 2020 14:00-17:30" (see https://circabc.europa.eu/ui/group/a0b483a2-4c05-4058-addf-2a4de71b9a98/library/6381dbc9-2e88-4034-a86d-f5fd20f9ac70/details, accessed 11.04.2021) and the EC's document "An initial thought starter on REACH information requirements for Unique Polymers Requiring Registration" (see https://circabc.europa.eu/ui/group/a0b483a2-4c05-4058-addf-2a4de71b9a98/library/2f699825-5e4a-4d0c-87e6-a015c4da3645/details, accessed 11.04.2021).

To finally initiate the polymer registration process, currently the European Commission (EC) is developing a proposal on how and which polymers to register (Wood and PFA-Brussels, 2020).

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IPCP, 30 April 2021

https://www.ipcp.ch/activities/polymer-statment

How to update information on the SCIP database

2021-05-04

Articles placed on the market may change continually. You can update a previously successfully submitted SCIP notification for different reasons, e.g. if: • there are changes to the already submitted information that are relevant for database users; or • you need to correct a mistake in information you have previously submitted. We have observed a large increase in update submissions (e.g. 10 000 update submissions for one article). In many cases, they do not include any changes to the previously submitted information. Before you submit an update: 1) please ensure that the updated information is relevant for SCIP database users; 2) avoid submitting dossiers without changes; and 3) merge minor changes (e.g. spelling mistakes) in one update. The SCIP database will make the information available as received. The data quality remains the responsibility of data submitters (duty holders).

Read More

ECHA, 4 May 2021

https://echa.europa.eu/documents/10162/32724856/SCIP_updates_May_21.pdf/3f324efb-8263-ee7b-07d3-3a83ede0a8a6

We have observed a large increase in update submissions (e.g. 10 000 update submissions for one article).

Biotransformation of nanomaterials while transferring in food chain

2021-04-29

Read out latest Nanopinion guest column from Dr. Fazel A. Monikh, who talks about the importance of understanding the behaviour of nanomaterials in organisms' tissues and bodies. Because of this, he developed a sensitive workflow to trace and characterize nanomaterials in organisms.

"Adopting the safe by design strategy could be a potential solution to balance between the benefits and the possible ecological effects of nanomaterials. The aim of my research is to support designing safe nanomaterials by understanding the possible effects of these materials in the environment and in organisms."

REACH Update

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Read the full text

Background

Nanopinion is a platform where EUON invites views from different contributors ranging from policy-makers and authorities to industry and civil society on their work and priorities related to nanomaterials on the EU market.

ECHA, 29 April 2021

https://euon.echa.europa.eu/view-article/-/journal_content/title/biotransformation-of-nanomaterials-while-transferring-in-food-chain

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Janet's Corner

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Rich Clouds

2021-05-14

https://parade.com/1193513/marynliles/science-jokes/

Sulphur Dioxide

2021-05-14

Sulphur dioxide is the chemical compound with the formula SO_2. It is a toxic gas with a pungent, irritating smell. [1] It is a liquid when under pressure, and it dissolves in water very easily. [2] Sulphur dioxide gas is heavier than air. In water, the solution is a medium strength acid. It reacts violently with ammonia, acrolein, acetylene, alkali metals, chlorine, ethylene oxide, amines, butadiene. It also reacts with water or steam causing a corrosion hazard. Sulphur dioxide attacks many metals including aluminium, iron, steel, brass, copper and nickel in presence of water and is incompatible with halogens. It attacks plastics, rubber and coatings in liquid form. [3] Sulphur dioxide in the air comes mainly from activities such as the burning of coal and oil at power plants or from copper smelting. In nature, sulphur dioxide can be released to the air from volcanic eruptions. [2]

USES [1]

- Precursor to sulphuric acid: Sulphur dioxide is an intermediate in the production of sulphuric acid. Sulphur dioxide is converted to sulphur trioxide, and then to oleum, which is made into sulphuric acid via a method called the contact process.
- As a preservative: Sulphur dioxide is sometimes used as a preservative for dried apricots, dried figs, and other dried fruits owing to its antimicrobial properties, and it is sometimes called E220 when used in this way. As a preservative, it maintains the colourful appearance of the fruit and prevents rotting. It is also added to sulphured molasses.
- In winemaking: Sulphur dioxide is an important compound in winemaking. It serves as an antibiotic and antioxidant, protecting wine from spoilage by bacteria and oxidation. Its antimicrobial action also helps to minimise volatile acidity. SO_2 is also a very important compound in winery sanitation. Wineries and equipment must be kept clean, and because bleach cannot be used in a winery due the risk of cork taint, a mixture of SO_2, water, and citric acid is commonly used to clean and sanitise equipment.
- As a reducing agent: Sulphur dioxide is a good reductant. In the presence of water, sulphur dioxide is able to decolourise substances. Specifically it is a useful reducing bleach for papers and delicate materials such as clothes. This bleaching effect normally does not last very long. Oxygen in the atmosphere reoxidises the reduced dyes, restoring the colour. In municipal wastewater treatment, sulphur dioxide is used to treat chlorinated wastewater prior to release. Sulphur dioxide reduces free and combined chlorine to chloride.
- Biochemical and biomedical roles: Sulphur dioxide is toxic in large amounts. It is responsible for blocking nerve signals from the pulmonary stretch receptors (PSRs) and abolishing the Hering–Breuer inflation reflex.
- As a refrigerant: Being easily condensed and possessing a high heat of evaporation, sulphur dioxide is a candidate material for refrigerants. Prior to the development of CFCs, sulphur dioxide was used as a refrigerant in home refrigerators.
- As a reagent and solvent in the laboratory: Sulphur dioxide is a versatile inert solvent that has been widely used for dissolving highly oxidising salts. It is also used occasionally as a source of the sulfonyl group in organic synthesis.

Sulphur dioxide is the chemical compound with the formula SO2.

SOURCES OF EMISSION & ROUTES OF EXPOSURE

Sources of Emission [4]

- Industry sources: Fossil fuel combustion sites particularly coal burning power plants; industrial processes such as wood pulping, paper manufacture, petroleum and metal refining and metal smelting, particularly from sulphide containing ores, e.g. lead, silver and zinc ores all emit sulphur dioxide to air.
- Diffuse sources: Small textile bleaching and food preserving facilities and wineries, fumigation activities all emit sulphur dioxide to air.
- Natural sources: Geothermal activity, including hot springs and volcanic activity; sulphur dioxide is produced from the natural decay of vegetation on land, in wetlands and in oceans all emit sulphur dioxide to air.
- Transport sources: Vehicle exhaust.
- Consumer products: Some solvents, dechlorination agents, bleaches and fumigation products.

Routes of Exposure [4]

The main route of exposure to sulphur dioxide is via the inhalation of contaminated air. Upon entry, nose, throat and lungs may be affected. Sulphur dioxide can also enter our bodies when we eat or drink food or beverages (wine), which contain sulphur dioxide as a preservative. Sulphur dioxide can enter the body through skin contact.

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HEALTH EFFECTS [5]

Acute Effects

•Inhalation: Sulphur dioxide is very toxic and can result in death. It can also cause severe irritation of the nose and throat. At high concentrations it can cause life-threatening accumulation of fluid in the lungs (pulmonary oedema). Symptoms may include coughing, shortness of breath, difficult breathing and tightness in the chest. A single exposure to a high concentration can cause a long-lasting condition like asthma. If this occurs, many things like other chemicals or cold temperatures can easily irritate the airways. Symptoms may include shortness of breath, tightness in the chest and wheezing. {Reactive Airways Dysfunction Syndrome (RADS)}.

•Skin Contact: Sulphur dioxide is corrosive. The gas irritates or burns the skin. Permanent scarring can result. Direct contact with the liquefied gas can chill or freeze the skin (frostbite). Symptoms of mild frostbite include numbness, prickling and itching. Symptoms of more severe frostbite include a burning sensation and stiffness. The skin may become waxy white or yellow. Blistering, tissue death and infection may develop in severe cases.

•Eye Contact: Sulphur dioxide is corrosive. The gas irritates or burns the eyes. Permanent damage including blindness can result. Direct contact with the liquefied gas can freeze the eye. Permanent eye damage or blindness can result.

Chronic Effects

May harm the respiratory system. Can irritate and inflame the airways.

Sulphur dioxide is not known to cause cancer. The International Agency for Research on Cancer (IARC) has classified sulphur dioxide as a Group 3 chemical - Not classifiable as to its carcinogenicity to humans. The American Conference for Governmental Industrial Hygienists (ACGIH) has classified it as: A4 - Not classifiable as a human carcinogen. Sulphur dioxide is a suspect mutagen. May cause genetic damage based on animal information.

SAFETY [6]

First Aid Measures

Inhalation: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

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Skin Contact: Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

Eye Contact: Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

Ingestion: Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

Exposure Controls & Personal Protective Equipment

- Respiratory protection: Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).
- Hand protection: Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.
- Eye protection: Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
- Skin and body protection: Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
- Hygiene measures: Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

REGULATION [7,8]

Exposure Limits

United States

- The Occupational Safety and Health Administration (OSHA) has set a limit of 2 ppm over an 8-hour workday, 40-hour workweek

- EPA has set an air quality standard of 0.03 ppm for long-term, 1-year average concentrations of sulphur dioxide. Short-term, 24-hour air concentrations should not exceed 0.14 ppm more than once a year.

Australia

Safe Work Australia has established the following limits for sulphur dioxide:

- TWA of 2 ppm
- TWA of 5.2mg/m^3
- STEL of 5ppm
- STEL of 13mg/ m^3

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A hidden continent birthed a new subduction zone near New Zealand

2021-05-11

South of New Zealand in the Tasman Sea is a stretch of stormy ocean where the waves regularly swell 20 feet (6 meters) or more and the winds blow at 30 mph (48 km/h) on a good day. Deep below these stormy seas, Earth is unquiet, too. This region is home to the Puysegur Trench, site of one of the youngest subduction zones on the planet. Here, the Australian plate is shoved under the Pacific plate, creating frequent large earthquakes, including a 7.2-magnitude quake in 2004.

Now, new research reveals how this baby subduction zone came to be: Over millions of years, a bit of the "hidden" continent of Zealandia on the boundary between the Australian and Pacific plates, got stretched and shifted in a way that led the denser oceanic crust to slam into — and under — it. This finding that positioning different types of crust against one another at a preexisting plate boundary leads to subduction may help to explain how other new subduction zones around the world form.

"Subduction zones are one of the most important, if not the most important, plate boundaries," said study lead author Brandon Shuck, a doctoral candidate at The University of Texas at Austin. "They're really the main drivers of plate tectonics, so they're the primary reason why the plates on Earth actually move. And also they're very destructive plate boundaries. …We don't really understand well how they start out and how they form in the first place." PLAY SOUND

Research in the 'Furious Forties'

Subduction zone formation is mysterious because subduction zones are, by nature, destructive. When a plate of oceanic crust dives under continental crust, the rocks at the surface twist, break and deform. The oceanic slab, meanwhile, churns into the mantle, where it's melted beyond recognition. This leaves little geological history behind to study.

The subduction zone in the Puysegur margin is young enough that this history has not yet been erased. That makes it an ideal spot to answer the question of how subduction zones form in the first place, Shuck told Live Science. There's not yet any good explanation of how tectonic plates break open and start subducting.

Studying the Puysegur margin is no easy feat, though, because it's in the "Roaring Forties," the latitudes between 40 degrees south and 50 degrees

This region is home to the Puysegur Trench, site of one of the youngest subduction zones on the planet.

south where the winds and currents are brutal. Scientists aboard the research vessel Marcus Langseth set out to this region in 2018 as part of the South Island Subduction Initiation Experiment. It was a challenging trip, Shuck said. The crew had to spend almost a quarter of the time sheltering behind islands to avoid gales.

"Our boat was rolling side to side by like 20 degrees at one point," Shuck said. "It was a mess."

In spite of the weather, the researchers were able to deploy seafloor seismometers and to take seismic surveys of the subsurface, a method which uses reflected sound waves to see underground structures.

The making of a subduction zone

The new data allowed the researchers to put together a history of the young subduction zone, which Shuck presented at the virtual meeting of the Seismological Society of America on April 22, the same day the study was published in the journal Tectonics. It all started about 45 million years ago, when a new plate boundary between the Australian and Pacific plates began to form because of a force called extension -- basically, tectonic forces pulled the two plates apart like putty.

The oceanic crust at the plate boundary responded to this extension predictably: As the crust thin, magma from the mantle pushed up through fractures, hardening into new rock. This process is called seafloor spreading, and it's how new oceanic crust forms.

But there was a catch: The secret continent of Zealandia. Zealandia is a submerged section of continental crust the size of Australia around New Zealand. Zealandia was perched over the north end of this extensional zone. As continental crust is thicker and more buoyant, the extensional forces working at the plate boundary couldn't crack Zealandia. Instead, the continental crust merely stretched as it spread, creating a thinned-out zone now known as the Solander basin.

Now there were two plates. The Australian Plate, to the west, consisted of continental crust from Zealandia in the north and new oceanic crust in the south. The Pacific Plate, to the east, also consisted of oceanic crust in the south. To the north, the Pacific Plate hosted the thinned-out continental crust of the Solander basin. At the plate boundary, oceanic crust bumped up against oceanic crust, and continental crust against continental crust.

Likely little of interest would have happened, if not for another tectonic shift 25 million years ago.

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At that time, the Australian-Pacific plate boundary stopped pulling apart. Instead, the plates started to move past each other, creating what's known as a strike-slip fault. Now, the Pacific plate was moving south, and the Australian plate was moving north. This opposing movement brought the oceanic crust of the Australian plate right next door to the thin Solander basin continental crust on the Pacific plate.

This was the key to starting subduction, Shuck said: Continental crust is more buoyant than denser oceanic crust, and this difference in buoyancy allowed the denser part of the Australian plate to slide under the lighter Pacific one, especially because the boundary between these continental and oceanic plates was already weakened by the earlier strike-slip faulting. The findings drive home how important strike-slip movement is to tectonics, Shuck said.

"How plates rotate is really important," he said. "If you just think about pulling things apart and pushing them together you don't really create that much contrast, but [with] strike-slip, you're translating [sliding a portion of crust] and it's super-efficient. Just imagine, with the plates sliding past each other, you're going to cause materials of different properties to come together eventually."

Moving down the fault

There are other spots around the globe where strike-slip movement is happening in the same place as the compression and convergence of plates, particularly along the Queen Charlotte fault north of Vancouver and south of Alaska, Shuck said. That fault may be a place where a subduction zone could potentially form, he said.

But there are also many questions left to answer about the fault south of New Zealand. Speaking at the Seismological Society of America meeting on April 22, geophysicist Caroline Eakin of Australian National University described a research trip to Macquarie Ridge, an undersea ridge 620 miles (1,000 km) south of New Zealand on the same fault as the Puysegur margin. In October 2020, scientists deployed seafloor seismic instruments at this rugged ridge, which is only 28 miles (25 km) wide but rises 3.7 miles (6 km) from the surrounding topography.

The researchers will return to pick up the instruments and their data in November 2021, as long as the weather allows. If the Puysegur margin is in the "Roaring Forties," Macquarie Ridge is in the "Furious 50s." The research ship encountered 68 mph (109 km/h) winds while trying to deploy the instruments and spent 38% of the mission in such bad weather

that scientists aboard couldn't do anything but shelter in place and wait. Nevertheless, they are hopeful that the new ocean-bottom seismometers (OBS) will open their eyes to what's going on beneath the ridge. Right now, the researchers know there are large quakes originating in the region, but they don't know much about how deep in the crust they are, what kind of faults they occur on or what kind of tsunami risks they pose to coastal areas in Australia.

"The OBS data will also allow us to image the subsurface beneath-the-plate boundary for the first time using different seismic imaging techniques," Eakin told Live Science. "Currently, most of our observations tell us about what is happening at the surface or near-surface, but we have no idea what is happening beneath the surface of the plate boundary in the Macquarie Ridge region."

One question they hope to answer: Will the fault at Macquarie Ridge begin to turn into a subduction zone, too? The Puysegur margin and Macquarie Ridge are related and are experiencing similar changes in plate motion over time, Eakin said, though Puysegur is further along in the process. Macquarie Ridge, being two slabs of oceanic crust coming together, might be more resistant to subduction than the continental crust and oceanic crust boundary at Puysegur, Shuck said; but subduction zones can also spread along a fault from a single point.

"Those two segments could actually link up — maybe — in the future," Shuck said.

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'It's like the embers in a barbecue pit.' Nuclear reactions are smoldering again at Chernobyl

2021-05-05

Thirty-five years after the Chernobyl Nuclear Power Plant in Ukraine exploded in the world's worst nuclear accident, fission reactions are smoldering again in uranium fuel masses buried deep inside a mangled reactor hall. "It's like the embers in a barbecue pit," says Neil Hyatt, a nuclear materials chemist at the University of Sheffield. Now, Ukrainian scientists are scrambling to determine whether the reactions will wink

"There are many uncertainties," says ISPNPP's Maxim Saveliev. "But we can't rule out the possibility of [an] accident."

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out on their own—or require extraordinary interventions to avert another accident.

Sensors are tracking a rising number of neutrons, a signal of fission, streaming from one inaccessible room, Anatolii Doroshenko of the Institute for Safety Problems of Nuclear Power Plants (ISPNPP) in Kyiv, Ukraine, reported last week during discussions about dismantling the reactor. "There are many uncertainties," says ISPNPP's Maxim Saveliev. "But we can't rule out the possibility of [an] accident." The neutron counts are rising slowly, Saveliev says, suggesting managers still have a few years to figure out how to stifle the threat. Any remedy he and his colleagues come up with will be of keen interest to Japan, which is coping with the aftermath of its own nuclear disaster 10 years ago at Fukushima, Hyatt notes. "It's a similar magnitude of hazard."

The specter of self-sustaining fission, or criticality, in the nuclear ruins has long haunted Chernobyl. When part of the Unit Four reactor's core melted down on 26 April 1986, uranium fuel rods, their zirconium cladding, graphite control rods, and sand dumped on the core to try to extinguish the fire melted together into a lava. It flowed into the reactor hall's basement rooms and hardened into formations called fuel-containing materials (FCMs), which are laden with about 170 tons of irradiated uranium—95% of the original fuel.

The concrete-and-steel sarcophagus called the Shelter, erected 1 year after the accident to house Unit Four's remains, allowed rainwater to seep in. Because water slows, or moderates, neutrons and thus enhances their odds of striking and splitting uranium nuclei, heavy rains would sometimes send neutron counts soaring. After a downpour in June 1990, a "stalker"—a scientist at Chernobyl who risks radiation exposure to venture into the damaged reactor hall—dashed in and sprayed gadolinium nitrate solution, which absorbs neutrons, on an FCM that he and his colleagues feared might go critical. Several years later, the plant installed gadolinium nitrate sprinklers in the Shelter's roof. But the spray can't effectively penetrate some basement rooms.

Chernobyl officials presumed any criticality risk would fade when the massive New Safe Confinement (NSC) was slid over the Shelter in November 2016. The €1.5 billion structure was meant to seal off the Shelter so it could be stabilized and eventually dismantled. The NSC also keeps out the rain, and ever since its emplacement, neutron counts in most areas in the Shelter have been stable or are declining.

But they began to edge up in a few spots, nearly doubling over 4 years in room 305/2, which contains tons of FCMs buried under debris. ISPNPP modeling suggests the drying of the fuel is somehow making neutrons ricocheting through it more, rather than less, effective at splitting uranium nuclei. "It's believable and plausible data," Hyatt says. "It's just not clear what the mechanism might be."

The threat can't be ignored. As water continues to recede, the fear is that "the fission reaction accelerates exponentially," Hyatt says, leading to "an uncontrolled release of nuclear energy." There's no chance of a repeat of 1986, when the explosion and fire sent a radioactive cloud over Europe. A runaway fission reaction in an FCM could sputter out after heat from fission boils off the remaining water. Still, Saveliev notes, although any explosive reaction would be contained, it could threaten to bring down unstable parts of the rickety Shelter, filling the NSC with radioactive dust.

Addressing the newly unmasked threat is a daunting challenge. Radiation levels in 305/2 preclude getting close enough to install sensors. And spraying gadolinium nitrate on the nuclear debris there is not an option, as it's entombed under concrete. One idea is to develop a robot that can withstand the intense radiation for long enough to drill holes in the FCMs and insert boron cylinders, which would function like control rods and sop up neutrons. In the meantime, ISPNPP intends to step up monitoring of two other areas where FCMs have the potential to go critical.

The resurgent fission reactions are not the only challenge facing Chernobyl's keepers. Besieged by intense radiation and high humidity, the FCMs are disintegrating—spawning even more radioactive dust that complicates plans to dismantle the Shelter. Early on, an FCM formation called the Elephant's Foot was so hard scientists had to use a Kalashnikov rifle to shear off a chunk for analysis. "Now it more or less has the consistency of sand," Saveliev says.

Ukraine has long intended to remove the FCMs and store them in a geological repository. By September, with help from European Bank for Reconstruction and Development, it aims to have a comprehensive plan for doing so. But with life still flickering within the Shelter, it may be harder than ever to bury the reactor's restless remains.

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US birth rate plunged in 2020

2021-05-05

The U.S. birth rate fell steeply in 2020, reaching a record low for the sixth year in a row, according to a new report.

Last year, there were 55.8 births per 1,000 U.S. women ages 15 to 44, which is 4% lower than the rate in 2019, and the lowest recorded rate since the government started tracking birth rates in 1909, according to the report from the National Center for Health Statistics, which is part of the Centers for Disease Control and Prevention (CDC).

Overall, about 3.6 million babies were born in 2020, which is a 4% drop from the number born in 2019, and the lowest number of births in the U.S. in more than 40 years, the report said.

U.S. births have been declining since 2014, with the birth rate and number of births dropping by an average of 2% per year. This means that the 4% decline in both the birth rate and number of births in 2020 was higher than what has been typically seen in recent years.

Even though the COVID-19 pandemic defined 2020, it likely didn't play much of a role in the year's decline in births, experts say.

"It's really unlikely that [the pandemic] had a huge effect in 2020" on births, said Karen Guzzo, acting director of the Center for Family & Demographic Research at Bowling Green State University in Ohio, who wasn't involved in the report. That's because most pregnancies last nine months, so many babies born in 2020 were conceived in 2019, Guzzo noted. And the pandemic largely didn't hit the U.S. until March 2020, meaning the earliest you might expect to see any effect on births would be December 2020, she said. In other words, if the pandemic did have an effect on births, it mostly wouldn't show up until 2021.

That means that other things going on in 2019 and early 2020 likely had a bigger effect on the birth rate, Guzzo said. During that time, leading up to an election year, the country was highly polarized and many expressed concern about the direction of the country, she said. Other ongoing factors, such as job stability and paying off student loan debt may have also played a role.

Effect on preterm births?

Although the COVID-19 pandemic likely didn't affect 2020 births overall, researchers are looking at whether pandemic lockdowns may have

U.S. births have been declining since 2014, with the birth rate and number of births dropping by an average of 2% per year.

influenced another important pregnancy outcome: preterm births. Surprisingly, the new report and other recent studies have found that the pandemic was tied to a reduction in preterm births, or births before 37 weeks of gestation. According to the new report, the U.S. preterm birth rate dipped slightly, from 10.23% in 2019 to 10.09% in 2020, marking the first time preterm birth rates have fallen since 2014.

Researchers have proposed several hypotheses to explain the link. For example, pandemic lockdowns forced many people to work from home, which may have led to a reduction in physical stress for pregnant women, particularly if they had jobs that required them to be on their feet all day. "Maybe this gave them a chance to slow down" and not have such a physically taxing pregnancy, Guzzo told Live Science.

However, more research is needed to determine whether pandemic-related factors really were behind the drop in preterm births, or whether other factors may have played a role, such as a rise in stillbirths, which some studies have suggested, according to Medpage Today.

Future outlook

Guzzo thinks the downward trend in overall births will continue. "[It] will probably be even more sizable next year," when the effects of the pandemic could come into play.

Still, the pandemic sparked some important conversations about the need for childcare and family leave for American parents, Guzzo said. That in turn could lead to policy changes that make it easier to balance work and family life, and may enable more people to have children or increase their family size.

"If you make it easier for people to have families ... then we'll probably see more people having children," Guzzo said.PLAY SOUND

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Meet the marine worm with 100 butts that can grow eyes and a brain

2021-05-11

How many butts is too many? One is usually enough for most animals — unless you're a type of marine worm with a body that divides from a single head into dozens of different directions, and each of those branches ends in a butt.

The worms' weirdness doesn't stop at multiple butts, either. When the worms are ready to reproduce, their butts can grow eyes and a brain.

At this point, you probably have questions; unsurprisingly, scientists did, too. So they peered inside the branching bodies of this many-butted ocean weirdo, which is named Ramisyllis multicaudata and lives in waters near Darwin, Australia. For the first time, researchers have described the oddball creatures' internal anatomy, revealing that the worms' insides are just as peculiar as their outsides.

(Well, almost.)

R. multicaudata is a segmented worm, or annelid, in the family Syllidae. There are about a thousand described species in that family, but only two of them grow massive, branching bodies: R. multicaudata and the deep-sea worm Syllis ramosa.

Branching bodies are quite common in plants and fungi, but in animals this type of body plan is virtually unheard of, according to the Australian Academy of Science. When biologist William McIntosh described S. ramosa in 1879, he remarked on this surprising ability, noting that the annelid had "a furor for budding," scientists reported in a new study, published April 4 in the Journal of Morphology.

Prior examinations of R. multicaudata, which was discovered in 2006 and named in 2012, documented "a high number" of anal openings, or ani, with "one per each posterior end," according to the new study. Those posterior bits become even more interesting once the worm is ready to reproduce. Segmented units called stolons form in the worm's butt ends, producing not only sexual organs but also "a simple head with its own eyes," the scientists reported. "Once a stolon is ready, it detaches from the rest of the body and swims freely until it mates and dies."

However, the inner workings of these free-swimming stolons — and of the worms' internal anatomy — was almost entirely unknown. The researchers therefore turned to microscopy, X-ray computed microtomography

When the worms are ready to reproduce, their butts can grow eyes and a brain.

(micro-CT) scans, tissue staining and chemical analysis to identify the worms' organs and anatomical systems, and to reconstruct them digitally in 3D.

Butt brains

They discovered that there was a brain and nervous system in the stolons, with a dense ring of serotonin-releasing nerve endings positioned just behind each stolon's head. The notion of stolons possessing an autonomous brain was an idea that had been proposed in the 19th century "but had not been confirmed since then," lead study author Guillermo Ponz-Segrelles, a zoologist at the Autonomous University of Madrid, told Live Science in an email.

In the rest of R. multicaudata's body, blood vessels stretched through all the branches, but the researchers found no structures resembling hearts. Circulatory and digestive organs divided and branched wherever the body did, and robust "muscle bridges" — thickened muscular structures that had never been seen before in worms — formed at the junction of each new branch. By analyzing the shapes of these bridges, the scientists could tell which body branches were older and which had formed more recently, they wrote in the study.

Another unusual discovery was that even though the worms' digestive system seemed to be functional, "their intestines seem to be always empty," Ponz-Segrelles said.

R. multicaudata spends much of its adult life embracing a sponge host, with the worm's head buried deep inside the sponge. The scientists' X-rays and digital 3D models showed for the first time that the worm's entire branching body was also deeply embedded in its host, with the worm's branches extending through "a notable portion" of the mazelike canals that were part of the sponge's internal anatomy.

"Our research solves some of the puzzles that these curious animals have posed ever since the first branched annelid was discovered at the end of the 19th century," said study co-author Maite Aguado, a curator of animal evolution and biodiversity in the Biodiversity Museum of Göttingen in Germany.

"However, there is still a long way to go to fully understand how these fascinating animals live in the wild," Aguado said in a statement. "For example, this study has concluded that the intestine of these animals could be functional, yet no trace of food has ever been seen inside them

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and so it is still a mystery how they can feed their huge branched bodies. Other questions raised in this study are how blood circulation and nerve impulses are affected by the branches of the body," she said.

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Body of article

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https://website

China's population still growing, census shows—but barely

2021-05-11

Ending months of speculation about what its 2020 census would find, China reported today that preliminary data show its population is still growing. But major demographic challenges loom. China's population will start to shrink in the next few years, the trends suggest, meaning fewer and fewer people in their working prime will have to support a rapidly growing cadre of elderly. That has triggered discussions about how to increase the country's birth rate, which is far below the replacement level.

"China's population will peak in the future, but there remains uncertainty as to when," National Bureau of Statistics head Ning Jizhe said at a press conference in Beijing today.

China is now home to 1.411 billion people, according to the decadal census, up from 1.339 billion in 2010. The number of citizens increased by an annual average of 0.53% over the past decade, a drop from the 0.57% rate recorded between 2000 and 2010. It was the lowest rate of growth since the early 1960s, when famine caused the population to decline. Those age 60 and over now make up 18.70% of the population, an increase of 5.44 percentage points since 2010. The census also showed that illiteracy decreased, the sex ratio at birth became slightly less skewed toward boys, and the number of years in school and the number of university graduates increased.

That has triggered discussions about how to increase the country's birth rate, which is far below the replacement level.

The top-heavy age pyramid has policymakers worried that China may grow old before it grows rich. In many economic sectors, male employees can retire at 60; female office staff can retire at 55 and female blue-collar workers at 50. Those ages were set in the early 1950s, when life expectancy was less than 45; it has since risen to about 77. Previous efforts to make people work longer foundered because of public opposition. Now, there are "real discussions to push for a retirement age change," says Yong Cai, a demographer at the University of North Carolina, Chapel Hill.

What to do at the other end of the demographic equation is more contentious. China's total fertility dropped precipitously in the 1970s, from 5.8 births per woman in 1970 to 2.8 in 1979. The one-child policy, which took effect in 1980, drove fertility down further but also made it difficult to establish the exact rate because births were underreported. Estimates were "all over the place," Cai says. There is general agreement that fertility dropped below 2.1, the rate at which a population remains stable, in the early 1990s. In a 2013 study in Population and Development Review, Cai figured the total fertility rate in 2010 was 1.5 or lower. Now, the statistics bureau estimates it at 1.3 in 2020. And unlike the United States and Europe, China has next to no immigration to offset low fertility.

Since 2016, Chinese couples can have two children, and a new 5-year plan adopted in March calls for reducing the burdens of having, raising, and educating children by improving child care services and parental leave policies. Parents still face fines if they have more than two children, but there is now talk of allowing parents to have as many kids as they want.

Some would go further. Entrepreneur Liang Jianzhang, who's also an applied economist at Peking University, has long warned a shrinking population will lose its innovative prowess. In a May 2020 op-ed in China Daily he recommended building "a fertility-friendly society" using monthly child care subsidies, tax incentives, and subsidized housing for families with multiple children.

But such incentives are unlikely to reverse what is a worldwide trend toward fewer children, says Zhongwei Zhao, a demographer at the Australian National University. He takes comfort from another new statistic: 15.5% of Chinese people now have a tertiary education, up from 8.9% in 2010. This huge increase in human capital "is going to drive socioeconomic development," Zhao says.

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Scientists fear more lung cancer as radon is released from thawing permafrost

2021-05-04

Massive amounts of uranium are stored in high concentrations underground throughout the Arctic zone. A product of uranium decay is radon gas. Normally, radon is contained in the soil by layers of ground and snow atop of it. However, as permafrost thaws, the radioactive gas seeps out from underground and is released into the atmosphere.

The link between thawing permafrost and increased risk of lung cancer is presented by researchers with the Federal Center for Comprehensive Study of the Arctic with the Russian Academy of Science.

When humans respire radon gas, their lungs are exposed to radiation. Radon is naturally present in air in small amounts. On average, about 0.4 pCi/L of radon can be expected to compose the air. In such small amounts, breathing in radon is fairly harmless, according to the U.S. Environmental Protection Agency (EPA). However, through constant exposure to the gas or to more concentrated quantities of it, the lining of the lungs get damaged. This in turn, increases the chances of developing lung cancer. According to EPA, radon gas is the second greatest contributor to lung cancer after smoking.

Permafrost thawing caused by climate changes is going to increase atmospheric radon levels, which will have horrible health effects on humans and animals in the region, according to the Russian science study.

As radon gas is both odorless and colorless, it is difficult to sensory identify. Arctic animals will not instinctively know that they are in danger. They are likely to continue living in the area but will be increasingly dying prematurely due to higher cancer rates. Local populations will also have difficulty identifying dangerously high levels of the gas without the proper equipment.

It is predicted that if temperatures in the Arctic continue increasing at the pace they have up until now, by the end of the century, about 2.5 million square miles of permafrost will melt. That is 40% of the world's total permafrost, according to estimates by researchers at the Yale University. The Arctic Institute estimates that in the case of global temperatures increasing by 3 degrees Celsius, up to 85% of the Arctic's top permafrost layers will thaw.

According to EPA, radon gas is the second greatest contributor to lung cancer after smoking.

However, radon gas emissions are far from the sole consequence of diminishing permafrost. Permafrost is also a natural reservoir of mercury. In the Arctic region alone, approximately 700 million liters of mercury are accumulated in the soil. When Arctic soil thaws due to climate change, mercury will permeate into water, be absorbed by organisms and eventually travel up the food chain to humans. Exposure to mercury has negative, and at times fatal, effects on the health of humans, especially on their nervous, digestive and immune systems.

The Arctic's permafrost is additionally one of the world's largest carbon sinks and holds an approximate 1,400 gigatons of carbon. With increased regional temperatures, these carbon sinks can enter the atmosphere and further increase global temperatures due to the greenhouse effect. Thawing permafrost will also destroy the Arctic's infrastructure as well as change the region's terrain and ecosystems beyond repair.

Atmospheric radon gas increase is yet another frightening side effect of climate change to be added to the myriad of the already existing ones. As the evidence of doom amasses, it is necessary to act before it is too late.

thebarentobserver.com, 4 May 2021

https://www.thebarestobserver.com

Children born in Sarnia more likely to develop asthma then those in Windsor or London, study indicates

2021-05-04

Children born in Sarnia, Ont., considered home to Chemical Valley, are more likely to develop asthma than those born in nearby cities, according to a population-based study by researchers at Lawson Health Research Institute and Western University.

Researchers followed 114,427 children in Sarnia, London and Windsor who were born between 1993 and 2009 for 10 years. By age 10, nearly a quarter of the study subjects in Sarnia were diagnosed with asthma, compared to 21 per cent in Windsor and 17 per cent in London.

"It's known that cities in southwestern Ontario have varied levels of air pollution because of differences in industry and traffic," said researcher Dr. Dhenuka Radhakrishnan

"We wanted to see if children born in three cities had a different risk of developing asthma due to the differing air pollution levels in the three

By age 10, nearly a quarter of the study subjects in Sarnia were diagnosed with asthma, compared to 21 per cent in Windsor and 17 per cent in London.

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regions, even though the people living in these cities are otherwise comparable in many ways."

The findings indicate air pollution exposure in the first year of life is associated with the development of asthma in children. Overall rates of new childhood asthma diagnosis in southwestern Ontario have been decreasing over time as air pollution levels drop.

Chemical Valley is one of Canada's most industrialized areas, with dozens of chemical plants and oil refineries clustered near Sarnia, at the southernmost tip of Lake Huron on the Ontario-Michigan border.

Members of the Aamjiwnaang First Nation have for years warned about pollution in the Sarnia area and the higher levels of disease among its members.

Researchers accounted for other risk factors associated with asthma, such as gender, socioeconomic status and urban versus rural setting. The findings were most apparent in the first two years of life, but persistent beyond age six.

Asthma is the most common chronic disease in Canadian kids — and the leading cause of emergency department visits and hospital admissions — and has a significant impact on quality of life.

"It's important to find strategies to prevent asthma development, and this study suggests that reducing air pollution exposure, including environmental causes, might reduce the number of children who suffer from asthma," said Dr. Salimah Shariff, a scientist at Lawson and professor at Western University.

There's also growing evidence that pollution exposure during pregnancy can influence whether children develop asthma, said Shariff.

"We need to carefully examine how reducing air pollution exposures within a geographic area translates to reductions in asthma development," she said. "Understanding the amount of air pollution that a mother and infant are exposed to, and how this impacts their personal risk, could enable regions to target safer levels for their residents."

cbc.ca, 4 May 2021

https://www.cbc.ca

Oldest deliberate burial of a human in Africa discovered

2021-05-06

About 78,000 years ago, deep inside a cave near the coast of what is now Kenya, the body of a small child was carefully laid to rest in a tiny grave. Now, an international group of researchers has used advanced scientific techniques to peer into the past, revealing for the first time details of the ancient interment — finding that it is the oldest deliberate burial of a Homo sapiens individual in Africa.

The child was only about 3 years old when they died. Their body was curled up on their side, as if to sleep or to keep warm, and the child's head seems to have been delicately placed on a rest or cushion. The scientists have named the remains "Mtoto," which is Swahili for "child."

"Only humans treat the dead with this respect, this care, this tenderness," said paleoanthropologist Maria Martinón-Torres, who led the team that first discovered the ancient burial. "This is some of the earliest evidence that we have in Africa about humans living in the physical and also in the symbolic world."PLAY SOUND

Martinón-Torres is the director of the National Center for Research on Human Evolution (CENIAH) in Burgos in Spain.

In 2017, after the grave was excavated from the Panga ya Saidi cave north of Mombasa, archaeologist Emmanuel Ndiema of the National Museums of Kenya carried it inside a block of sediment on a flight from Nairobi to Jena in Germany. From there, Martinón-Torres took it with her during a flight to Burgos.

The scientists knew the sediment block contained ancient bones of some sort, although it was very small. Months of intricate investigations by the CENIAH team, which included using micro-computed tomography (Micro-CT) to examine it with X-rays and create a detailed 3D model of its contents, revealed the skull and bones of a small Homo sapiens child.

Ancient grave

Older Homo sapiens burials have been found in Europe and the Middle East, some dating to about 120,000 years ago.

But the remains of Mtoto, from about 78,000 years ago, are the oldest evidence of a deliberate burial found in Africa to date, said anthropologist Michael Petraglia of the Max Planck Institute for the Science of Human History in Jena.

The scientists have named the remains "Mtoto," which is Swahili for "child."

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Petraglia helped excavate the sediment block from the Panga ya Saidi cave and is one of the authors of a study about the find, published Wednesday (May 5) in the journal Nature.

Petraglia said that the 40,000-year gap between the oldest-known Homo sapiens burials and Mtoto's burial probably reflected the fact that paleolithic archaeology was relatively recent in Africa compared to Europe and Asia, although Africa is the original home of our species and could have burials that are even older.

Some features of the Mtoto burial are similar to earlier burials by both Homo sapiens and Neanderthals (Homo neanderthalensis), which were named after the Neander Valley in Germany where their fossils were first found.

Ancient stone flakes and other evidence show that Panga ya Saidi cave was also used as a temporary residence by groups of Homo sapiens hunter-gatherers, and Neanderthal and Homo sapiens graves have also been found at similar "residential" sites in Eurasia, he said.

The researchers also found that a pit surrounding the child's body had been dug deliberately, showing that it was a true burial and not mere "funerary caching" of a dead body in an available niche, which is seen at some other ancient sites, Petraglia said.

Tender burial

Mtoto appeared to have been laid to rest with much care.

The body was shrouded in some perishable material and the child's head was distinctively tilted, which suggests that it was placed on a head rest of some sort that had since rotted away.

Mtoto was buried lying on their side, in a "flexed" position that was common in many ancient human societies, and which may have been seen as a natural way to place the dead, Martinón-Torres said during an online presentation this week.

Nicole Boivin, the director of archaeology at the Max Planck Institute in Jena, has worked at the Panga ya Saidi cave for about 10 years.

"It's an absolutely beautiful place — it's this cave system where parts of the roofs of the caves have collapsed, and this lets in sunshine … vines are falling in, and there are a lot of plants and flowers and wildlife," Boivin told Live Science.

Although the archaeologists had initially set out to look for traces of ancient burials and artifacts from the later period of early Indian Ocean trade (dating from up to 2,300 years ago), it soon became apparent that the cave had been an important place for much longer than that, Boivin said.

"We have representation of archaeology across an extraordinary time span," she said. "We have an extraordinary cultural record with beautiful stone tools, lots of material culture, symbolic artifacts [and] a lot of beautifully preserved bone."

Archaeologist Ndiema said that the Panga ya Saidi cave was considered a sacred place by some Kenyans today, as it probably was during the Stone Age.

"It still has a very strong cultural and spiritual connection with the local people. … They still use this place for rituals of worship and to seek healing," he said.

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First genetically modified mosquitoes released in US

2021-05-06

The biotech firm Oxitec has released its genetically modified mosquitoes in the Florida Keys, with the goal of suppressing wild, disease-carrying mosquito populations in the region. This is the first time genetically modified mosquitoes have been released in the U.S.

Oxitec previously released its modified Aedes aegypti mosquitoes in Brazil, the Cayman Islands, Panama and Malaysia, and the company reported that local A. aegypti populations fell by at least 90% in those locations, Live Science previously reported. A. aegypti can carry diseases such as Zika, dengue, chikungunya and yellow fever, and releasing modified mosquitoes offers a way to control the population without using pesticides.

Oxitec's modified mosquitoes, all male, have been engineered to carry a lethal gene; when the modified pests mate with wild female mosquitoes, the lethal gene gets passed on to their offspring. Though the gene does not affect the males' survival, it prevents female offspring from building an essential protein and thus causes them to die before reaching maturity.

This is the first time genetically modified mosquitoes have been released in the U.S.

Only female mosquitoes bite people (male mosquitoes exclusively drink nectar), so the modified mosquitoes and their surviving male offspring can't pass diseases to humans.PLAY SOUND

A. aegypti mosquitoes make up about 4% of the mosquitoes in the Florida Keys but cause the vast majority of mosquito-borne disease transmitted to humans in the area, Nature reported. The Florida Keys Mosquito Control District (FKMCD) board typically budgets $1 million a year to control the pest, resorting to costly measures such as spraying aerial insecticides, according to Gizmodo.

Releasing hundreds of millions of genetically modified mosquitoes may be a less expensive and more effective option, the board concluded, especially as mosquito populations become resistant to pesticides over time.

FKMCD first approached Oxitec in 2010, and after a decade of regulatory assessments and local pushback, both the board and the U.S. Environmental Protection Agency (EPA) finally approved the plan to release the genetically modified mosquitoes in the Keys, according to Nature. In late April, the company placed boxes of mosquito eggs at six locations in Cudjoe Key, Ramrod Key and Vaca Key, according to Nature. Over the next 12 weeks, about 12,000 newly hatched male mosquitoes should emerge from the boxes.

This release will serve as an initial trial so that Oxitec can collect data before running a second trial with nearly 20 million mosquitoes later this year, Nature reported. The company will capture mosquitoes throughout the trial to observe how far the insects travel from their boxes, how long they live and whether female mosquitoes are actually picking up the lethal gene and dying off. To make it easier to track the modified mosquitoes, Oxitec introduced a gene that causes the mosquitoes to glow under a specific color of light.

The trial faces strong opposition from a small subset of Florida Keys residents, as well as the Center for Food Safety and the Florida Keys Environmental Coalition, Live Science previously reported. Concerned that the egg boxes might be vandalized, Oxitec placed them on private property and did not disclose their exact locations to the public, Nature reported.

"When something new and revolutionary comes along, the immediate reaction of a lot of people is to say 'wait,'" Anthony James, a molecular biologist who focuses on bioengineered mosquitoes at the University of California, Irvine who is not involved in the Oxitec project, told Nature. "So the fact that [Oxitec] was able to get the trial on the ground in the United States is a big deal."

Questions remain about whether the genetically modified mosquitoes will have unintended effects on local mosquitoes, animals or the ecosystem at large, Live Science previously reported.

For instance, after Oxitec released genetically modified mosquitoes in Jacobina, Brazil, genes from the insects cropped up in local mosquito populations, hinting that the lethal gene failed to kill off some female offspring before they could mate. Their hybrid offspring did not carry the lethal gene, but instead carried genes from the original Cuban and Mexican mosquito populations first used to create the genetically modified mosquitoes, according to a 2019 study published in the journal Scientific Reports. It's unclear whether or how these new genes might have altered the mosquitoes' biology.

Molecular biologist Natalie Kofler, founder of Editing Nature, an organization that advocates for the responsible use of gene editing, told Nature that she hopes the Oxitec trial will be conducted "in a way that's transparent, and in a way that can make some community members feel better about the whole situation," and that the data will offer insight into how the pests might affect local species and ecosystems.

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Neanderthals carb loaded, helping grow their big brains

2021-05-10

Here's another blow to the popular image of Neanderthals as brutish meat eaters: A new study of bacteria collected from Neanderthal teeth shows that our close cousins ate so many roots, nuts, or other starchy foods that they dramatically altered the type of bacteria in their mouths. The finding suggests our ancestors had adapted to eating lots of starch by at least 600,000 years ago—about the same time as they needed more sugars to fuel a big expansion of their brains.

The study is "groundbreaking," says Harvard University evolutionary biologist Rachel Carmody, who was not part of the research. The work suggests the ancestors of both humans and Neanderthals were cooking lots of starchy foods at least 600,000 years ago. And they had already adapted to eating more starchy plants long before the invention of agriculture 10,000 years ago, she says.

The brains of our ancestors doubled in size between 2 million and 700,000 years ago. Researchers have long credited better stone tools and cooperative hunting: As early humans got better at killing animals and processing meat, they ate a higher quality diet, which gave them more energy more rapidly to fuel the growth of their hungrier brains.

Still, researchers have puzzled over how meat did the job. "For human ancestors to efficiently grow a bigger brain, they needed energy dense foods containing glucose"—a type of sugar—says molecular archaeologist Christina Warinner of Harvard and the Max Planck Institute for the Science of Human History. "Meat is not a good source of glucose."

The starchy plants gathered by many living hunter-gatherers are an excellent source of glucose, however. To figure out whether oral bacteria track changes in diet or the environment, Warinner, Max Planck graduate student James Fellows Yates, and a large international team looked at the oral bacteria stuck to the teeth of Neanderthals, preagriculture modern humans that lived more than 10,000 years ago, chimps, gorillas, and howler monkeys. The researchers analyzed billions of DNA fragments from long-dead bacteria still preserved on the teeth of 124 individuals. One was a Neanderthal who lived 100,000 years ago at Pešturina Cave in Serbia, which produced the oldest oral microbiome genome reconstructed to date.

The work suggests the ancestors of both humans and Neanderthals were cooking lots of starchy foods at least 600,000 years ago.

The communities of bacteria in the mouths of preagricultural humans and Neanderthals strongly resembled each other, the team reports today in the Proceedings of the National Academy of Sciences. In particular, humans and Neanderthals harbored an unusual group of Streptococcus bacteria in their mouths. These microbes had a special ability to bind to an abundant enzyme in human saliva called amylase, which frees sugars from starchy foods. The presence of the strep bacteria that consume sugar on the teeth of Neanderthals and ancient modern humans, but not chimps, shows they were eating more starchy foods, the researchers conclude.

Finding the streptococci on the teeth of both ancient humans and Neanderthals also suggests they inherited these microbes from their common ancestor, who lived more than 600,000 years ago. Although earlier studies found evidence that Neanderthals ate grasses and tubers and cooked barley, the new study indicates they ate so much starch that it dramatically altered the composition of their oral microbiomes.

"This pushes the importance of starch in the diet further back in time," to when human brains were still expanding, Warinner says. Because the amylase enzyme is much more efficient at digesting cooked rather than raw starch, the finding also suggests cooking, too, was common by 600,000 years ago, Carmody says. Researchers have debated whether cooking became common when the big brain began to expand almost 2 million years ago or it spread later, during a second surge of growth.

The study offers a new way to detect major shifts in diet, says geneticist Ran Blekhman of the University of Minnesota, Twin Cities. In the case of Neanderthals, it reveals how much they depended on plants.

"We sometimes have given short shrift to the plant components of the diet," says anthropological geneticist Anne Stone of Arizona State University, Tempe. "As we know from modern hunter-gatherers, it's often the gathering that ends up providing a substantial portion of the calories."

sciencemag.org, 10 May 2021

https://www.sciencemag.org

All hail 'Emperor Dumbo', the newest species of deep-dwelling octopus

2021-05-11

A new species of Dumbo octopus, equipped with telltale (and darling) fins on its head, has been dredged from the deep. Nicknamed the Emperor

Nicknamed the Emperor Dumbo, the adorable creature was discovered in 2016.

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Dumbo, the adorable creature was discovered in 2016. Alexander Ziegler of Friedrich Wilhelm University in Bonn, Germany, was aboard the German survey ship R/V Sonne as the resident biologist when a strange creature was caught in one of its nets near the Aleutian Islands.

"It was a really lucky find," Ziegler told Live Science, "because we weren't really looking for it. Plus, the whole animal came to the surface intact." Typically, such nets damage animals made predominantly of soft tissue, like octopuses. This one, however, was in immaculate condition — an impressive feat considering it was fished from the crushing depth of roughly 14,760 feet (4,500 meters).

On board the ship, Ziegler quickly determined that this was an adult male Dumbo octopus, which is a group of small, deep-sea octopuses. Dumbo octopus species can be identified by the umbrella-like webbing joining their tentacles and their cartoonishly ear-like fins that resemble the oversized ears on Disney's Dumbo elephant character. (A more modern observer might be more likely to see a resemblance to Baby Yoda.)PLAY SOUND

Finding an intact Dumbo octopus is rare. They are the deepest-living octopuses known to science, and they are often dredged from the deep as fishing bycatch, often too damaged to be identified.

To identify an octopus to the species level, or to characterize it as a new species typically requires destructive techniques. "You have to look at the internal structure, which would mean disassembling the specimen in order to describe it," Ziegler said.

Instead, Ziegler and his master's student at the time, Christina Sagorny, currently a doctoral student in Ziegler's lab, used magnetic resonance imaging (MRI) and micro-computed tomography (micro-CT) scans to noninvasively examine the internal organs and structure of the octopus without making a single cut except to extract a DNA sample.

By using these techniques, Sagorny and Ziegler found that their endearing deep-sea dweller didn't match any known species. For one, the number of suckers on its tentacles, along with the shape of the gills and beak, suggested something totally new. "Christina [Sagorny] was calculating these values and counting the suckers when we realized it didn't compare to other species," Ziegler said. "That moment when we realized we were describing a new species, obviously, that was a pretty good moment."

The duo named the species Grimpteuthis imperator, and Emperor Dumbo or Kaiser Dumbo as a proposed common name because the specimen was discovered along the slopes of the Emperor seamount chain in the Pacific Ocean.

At the moment, little is known about the Emperor Dumbo. But other Dumbo octopuses live on the seafloor, as deep as 23,000 feet (7,000 m). They survive by feeding on worms and shrimp-like crustaceans called amphipods that they trap by using their tentacle webbing as an umbrella to catch food. And because fast-moving predators are scarce in such nutrient-poor environments, these octopuses gave up their ability to release ink sometime in their evolutionary history.

The new Emperor Dumbo octopus was described April 23 in the journal BMC Biology.

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Can scientists help insects survive their fatal attraction to light at night?

2021-05-04

Each summer, on bridges across the world, mayfly massacres occur. First, warm weather prompts the transformation of the insects' aquatic larvae. Within hours, the short-lived, flying adults pop out of streams, rivers, and lakes, eager to mate and lay eggs by the millions.

But bridges illuminated with artificial light can lure the newly emerged adults away from the water to a futile death before breeding. Others, fooled by the sheen of reflective pavement, drop their eggs on the bridge road instead of the water. Because mayflies control the growth of algae and are food for fish, the fate of these humble insects may reverberate through ecosystems, says Ádám Egri, a biological physicist at the Centre for Ecological Research in Budapest, Hungary, who is working to save endangered mayflies there.

Mayflies aren't alone in their fatal attraction to what researchers refer to as ALAN: artificial light at night. Studies from around the globe are finding worrisome impacts on insect mating and abundance, says Stéphanie Vaz, an entomologist at the Federal University of Rio de Janeiro's main campus. In the past year, researchers have published the first experimental and

But bridges illuminated with artificial light can lure the newly emerged adults away from the water to a futile death before breeding.

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regional studies of the problem, and in March, Insect Conservation and Diversity devoted a special issue to the topic.

Some researchers think brighter nights may be a factor in recently documented insect declines, says Stephen Ferguson, a physiological ecologist at the College of Wooster. With insect numbers dropping by 80% in some places and 40% of insect species headed for extinction by some estimates, "Some researchers have started to make more noise about the 'insect apocalypse,'" Ferguson says. "ALAN is almost certainly one of the drivers."

Even as they begin to raise the alarm, scientists are pointing to simple solutions. Egri, for example, has found that mounting bright lights low on the sides of bridges keeps the mayflies close to the water. But researchers are "still at the very beginning of the story of global, ecologically friendly artificial lighting," he says.

Many insects and other animals are drawn to light because they depend on the Moon or Sun for navigation, Ferguson says. And light at night is increasing by an average of 2% to 6% and up to 40% per year in remote places, according to ALAN researcher Franz Hölker at the Leibniz Institute of Freshwater Ecology and Inland Fisheries, who calculated this estimate using satellite, energy use, and other data. Cities are using more light-emitting diodes, whose blue light appears brighter than the yellow glow of sodium vapor streetlights.

Even dark areas are no longer very dark. "Protected areas are not able to buffer these light intensities as we thought," Vaz says. On Moon-less nights, artificial sky glow now exceeds the combined light of stars and other natural sources on 22% of the globe's total land, with biodiversity hot spots disproportionately affected, Brett Seymoure, a behavioral ecologist at Washington University in St. Louis, and his colleagues report in the preprint elibrary SSRN.

Given the many other factors also hurting insects, such as habitat degradation and climate change, linking light to species' declines is challenging. "It is a very understudied field," Hölker says. But scattered studies suggest the impact may be powerful. He and others have calculated that Germany's 9 million streetlights attract about 1 billion insects a night, many of which die or are killed by bats and other predators. Researchers have estimated that at least one-third of the insects swarming around artificial lights die of exhaustion or are eaten by predators.

One recent study underscores the magnitude of the effect. On the night of 27 July 2019, the glow of Las Vegas lights lured massive numbers of migrating grasshoppers into the air above the city, according to a 31 March paper in Biology Letters. The clouds of grasshoppers were visible on weather radar; by estimating numbers of insects seen on radar before, during, and after the swarm, Elske Tielens, an ecologist at the University of Oklahoma, Oklahoma City, and her colleagues calculated that at its peak, the swarm weighed 30.2 tons and contained 48 million grasshoppers.

There were "more grasshoppers in the air on that single July night than human visitors to Las Vegas in a whole year," Tielens says. "This is probably happening on smaller scales in many places, and with many more insects," Ferguson adds.

In the Netherlands, a consortium of universities, nonprofit organizations, industry, and government is exploring light's effects on local ecosystems through the Light on Nature project. It set up long-term experiments in seven sets of plots in dark areas. The researchers lit up some plots with lights of different colors and monitored bat and insect communities. Between 2012 and 2016, moth numbers remained steady in dark plots but decreased 14% in lighted areas, Roy van Grunsven, an entomologist at Dutch Butterfly Conservation, and colleagues reported in June 2020 in Current Biology.

"This study represents the only published experimental evidence to date" about ALAN's long-term effects, says Douglas Boyes, an entomologist at the UK Centre for Ecology and Hydrology in Wallingford. "The bottom line is that moths are being bombarded with unnatural night conditions that their sensory systems are not adapted for," Seymoure adds.

Most of the research on artificial light so far has taken place in temperate climates. But Vaz's modeling studies point to light pollution as a possible cause for a decline in firefly diversity in Brazil's Atlantic Forest. And Jessica Deichmann, an applied ecologist at the Smithsonian Conservation Biology Institute, documented what happens when electric lights were first turned on in a remote tropical forest in Peru. "I've witnessed firsthand the truly massive storm clouds of insects drawn to lights when they are first installed, and this sight is hard to forget," she says. Most of the insects, particularly flying ants and flies, die of exhaustion or are eaten.

She worries the nightly tolls will curtail pollination and other ecosystem services provided by these species. So, like more and more ALAN researchers, she is seeking solutions. Her team set up experimental plots

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in the forest lit by lights of different colors and discovered amber lights attracted 60% fewer insects than white light.

But what's good for some flying insects may be bad for others, as Tufts University graduate student Avalon Owens described in January at a virtual meeting of the Society for Integrative and Comparative Biology. Owens evaluated how fireflies and other flying insects reacted to red, blue, and amber light in Kellettville, Pennsylvania, a rural area with little light pollution and so many Photinus carolinus fireflies that the town hosts an annual firefly festival. Observing fireflies in the wild, "I found red light is 'best,' and amber is 'worst' for interfering with courtship," she says.

In the lab, she found that in amber light, "females go almost completely dark," leaving males no way to find them, she and her colleagues reported in the special issue.

Egri and his colleagues, too, tested the impact of color, hanging beacons of different hues low on a bridge, then photographing and counting mayflies. Blue lights, being even brighter than the yellowish road lights, kept more insects close to the water. For two springs now, blue beacons installed on the Tahitótfalu bridge in northern Hungary have shone for 3 hours past sunset, while lights on the roadway are dimmed. This seems to work, Egri says. "No mayflies left the river."

Elsewhere, dimmer, redder lights are being tested, including at a visitor center in Grand Teton National Park. But Egri says his own effort and others "are still too little." Deichmann agrees that more ambitious measures are needed. For the sake of insects and ecosystems, "It is absolutely essential to ensure substantial areas of our planet remain dark forever."

sciencemag.org, 4 May 2021

https://www.sciencemag.org

Scientists get close to taming the chaos of the 'three-body problem'

2021-05-06

Physicists have spent centuries grappling with an inconvenient truth about nature: Faced with three stars on a collision course, astronomers could measure their locations and velocities in nanometers and milliseconds and it wouldn't be enough to predict the stars' fates.

If astrophysicists hope to fully understand regions where heavenly bodies mingle in throngs, they must confront the "three-body problem."

But the cosmos frequently brings together trios of stars and black holes. If astrophysicists hope to fully understand regions where heavenly bodies mingle in throngs, they must confront the "three-body problem."

While the result of a single three-body event is unknowable, researchers are discovering how to predict the range of outcomes of large groups of three-body interactions. In recent years, various groups have figured out how to make statistical forecasts of hypothetical three-body matchups: For instance, if Earth tangled with Mars and Mercury thousands of times, how often would Mars get ejected? Now, a fresh perspective developed by physicist Barak Kol simplifies the probabilistic "three-body problem," by looking at it from an abstract new perspective. The result achieves some of the most accurate predictions yet.

"It does really well," said Nathan Leigh, an astronomer at the University of Concepción in Chile who is involved in testing the new model. "I think Barak's [model] right now is the best one."

What is the volume of chaos?

When gravity draws two objects together, the potential outcomes are simple. The objects might zoom by each other, or they might enter into an elliptical orbit around a shared center of mass. Isaac Newton was able to write down brief equations capturing these motions in the 1600s.

But if one star approaches a pair of stars already orbiting each other, all bets are off. The intruder might zoom by in a predictable way. Or it could enter the fray, initiating a period of furious loops and swerves that might last for moments or years. Eventually, the furor always subsides when one of the three stars is thrown clear of the other two. One of two scenarios will follow: If the third wheel has enough energy, it escapes, leaving the pair to live in peace. Or if it doesn't, that third object will zip away only to fall back toward the pair again and launch another episode of mayhem.

Famed mathematician Henri Poincaré showed in 1889 that no equation could accurately predict the positions of all three bodies at all future moments, winning a competition sponsored by King Oscar II of Sweden. In this three-body case, Poincaré had discovered the first instance of chaos, a phenomenon whose outcome can effectively disconnect from how it began.

Since perfect predictions for individual three-body events are impossibles, physicists turned toward statistical forecasts. Given general information about the three bodies, such as their energy and their collective spin, what

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could one say about the odds that, for example, the lightest one would eventually get kicked out?

To ponder this problem, physicists have abandoned the familiar backdrop of 3D space and moved to an abstract arena known as "phase space." In this expansive new realm, each spot represents one possible configuration of the three stars: That's a 3D position, a 3D velocity and a mass for each of the three bodies — an unchanging21-dimensional space, all told. A specific three-body event (such as one star flying toward a pair) starts at some point in phase space and traces out a path as it evolves from one configuration to another. PLAY SOUND

In this framework, physicists have been able to use chaos to their advantage. For a chaotic system, there is not just one possible outcome, but many. That means that if you let the three-body system evolve over time, it will explore every possible chaotic path, eventually reaching every nook and cranny of some chaotic region of its phase space. For the three-body problem, scientists can calculate, statistically, where each body might end up by precisely computing the volume inside its phase space that represents chaotic motion.

Physicists have used requirements such as conservation laws to cut the whole phase space down to a simpler "playground" of eight dimensions. But precisely defining the (also eight-dimensional) chaotic region within that has been a challenge, in part because three co-orbiting bodies can hop between chaotic and regular motion (by temporarily kicking out a body). Various groups have visualized the volume of the chaotic space in different ways, culminating in a definitive model by Nicholas Stone, of the Hebrew University of Jerusalem, and Leigh in 2019 that eliminated past assumptions to build the most accurate and mathematically rigorous three-body model to date.

"You can't do it better than we did it," said Leigh, who is also affiliated with the American Museum of Natural History in New York. "The only thing you can do is come up with a different model."

A leaky chaos balloon

That's exactly what Kol, also of the Hebrew University of Jerusalem, has done. Stone and Leigh and previous groups have focused on the boundary of that chaotic region, a place where three-body systems transition from chaos to regular motion by kicking out one body.

Kol, at the Hebrew University of Jerusalem, in contrast, studies a metaphorical "hole" in the chaotic volume, where such a transition is more likely to take place. The longer a three-body system bounces around inside the chaotic region, the more likely it is to find such a hole, ejecting a member and escaping chaotic motion. The nature of this exit or exits, Kol believes, tell you everything there is to know about the statistical three-body problem.

Stone and Leigh's previous approach imagined the chaotic region as "a balloon and the entire surface is a little leaky and it has the same leakiness everywhere," Stone said. "Barak [Kol]'s approach is saying that 'No, the balloon has discrete holes and some patches that are leakier than others.'"

Kol captures the shape of the exits from the chaotic balloon in a mysterious function called chaotic absorptivity — the odds that a calm stellar couple with a certain energy will go chaotic if you fire a third star at them (as opposed to the pair immediately rebuffing the newcomer). Using this function and Kol's framework, one can, in principle, answer any statistical question about the whole phase space in all of its multidimensional glory, such as when a trio will eject a member (on average), the odds it will fly away with a certain speed, and the range of possible shapes for the orbit of the remaining pair. His theory was published April 1 in the journal Celestial Mechanics and Dynamical Astronomy.

This theory "has made a huge dent in solving [the statistical three-body model]," said Viraj Manwadkar, a researcher at the University of Chicago helping to test the model. "It has simplified [the problem] greatly."

Who gets the boot?

So far, Kol's ideas seem promising. In a not-yet-peer reviewed paper posted to the preprint database arXiv in January, Manwadkar, Kol, Leigh and Alessandro Trani of the University of Tokyo held a battle royale to see how Kol's theory held up against other statistical three-body forecasts.

They ran millions of simulations of mashups between trios of stars of different masses to see how often each star got kicked out of the group. When the stars have the same mass, the unpredictability of chaotic motion guarantees that each individual has a one-third chance of getting the boot — no fancy models required.

But as the masses skew, a pattern emerges: Lighter stars are easier to eject. When the three bodies have 10-sun (10 times the mass of the sun), 15-sun

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and 20-sun masses, for instance, the 10-sun star gets kicked out in 78% of the simulations. Kol's theory nailed that forecast, while rival theories predicted the lightweight's ejection to take place between 70% and 87% of the time. The new framework does even better as the masses get more lopsided.

"Those predictions are beautifully accurate," Stone said.

From digital stars to astrophysics

The catch is that no one knows how to precisely describe the shape of the hole, the chaotic absorptivity function (which is, in turn, a complicated and multidimensional object). The theory excels at predicting which body would be ejected because that specific calculation in some sense "averages" over many different holes, freeing the researchers from working out the details.

But to make the kind of forecasts astrophysicists really care about, such as the typical shapes of the elliptical orbits of the stellar pairs left behind after a chaotic three-body encounter, the chaotic absorptivity matters a lot. Stone and Leigh's 2019 model, which calculates the volume of the chaotic region over eight dimensions can already make these predictions.

To help Kol's model make similar forecasts, Manwadkar plans to run many simulations of single stars colliding with pairs, which will help sketch out the shape of the enigmatic absorptivity function point by point. Eventually, he hopes for a nice equation that will describe its entire shape, solving the statistical three-body problem.

"The dream is to get a mathematical expression," Manwadkar said, which would enable the most accurate statistical forecasts to date.

If the researchers succeed, the next step will be to see what the theory has to say about real incidents of three-body chaos out there in the universe.

Stars can concentrate in thick stellar clusters where singles regularly run into pairs, and three-body simulations help researchers understand how millions of three-body events change such clusters over time. And three-way meetings between black holes are thought to leave behind some of the pairs that merge and send out gravitational waves. A good statistical three-body solution could help astrophysicists at the Laser Interferometer Gravitational-Wave Observatory (LIGO) and future gravitational wave detectors understand their observations more deeply.

"What I'm excited about is applying one or both [models] to astrophysical problems," Stone said.

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Roswell UFO crash: What is the truth behind the 'flying saucer' incident?

2021-05-07

There is a spaceship that looks like a flying saucer in Roswell. Thousands of motorists drive past it every day, and hundreds of people go inside. It's on North Main Street in this southeastern New Mexico city, its metal skin gleaming as it basks in the glow of the sun. Its neon lighting burns into the retinas of those who view it throughout the evening, and it's rather hard not to admire. After all, aside from its striking looks, who doesn't crave a burger every now and then? That's right: This spacecraft is one of the city's McDonald's restaurants.

So why is the building shaped that way? It's not that far from the site of a mysterious incident that took place in 1947 — the day when a rancher discovered debris scattered around his sheep pasture, prompting speculation that an unidentified flying object, or UFO, had crashed there.

In June, or possibly early July 1947, William Brazel woke up for a normal day's work on the J.B. Foster ranch in Lincoln County, New Mexico, 75 miles (120 kilometers) north of Roswell, when he made a shocking discovery. He found on the ranch "a large area of bright wreckage made up of rubber strips, tinfoil, a rather tough paper and sticks," Brazel said in an article published on July 8, 1947, in the Roswell Daily Record.PLAY SOUND

Brazel hadn't heard of flying saucers — at least not yet. Sightings, however, were coming in thick and fast around that time. On June 24, pilot Kenneth Arnold claimed to have seen nine unidentified objects "flying like a saucer would across water" near Mount Rainier, Washington. Arnold estimated that the objects were flying at around 1,200 mph (1,930 km/h), Arnold was reported as saying in the East Oregonian; but at the time, there were no known craft that could reach those speeds. The Air Force also said it had no new experimental planes or guided missiles that would fit such a description, according to a U.S. Department of Defense report. That story became front-page news, and the term "flying saucer was born, despite

On June 24, pilot Kenneth Arnold claimed to have seen nine unidentified objects "flying like a saucer would across water" near Mount Rainier, Washington.

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Arnold describing the flying objects as crescent-shape," according to New Scientist.

The country soon became gripped, as Brazel discovered, by the sightings. By July 7, policemen and astronomers were reportedly being harassed for further reports, this time by people from New York and other eastern U.S. states; that was also the day Brazel decided to take action. He hand-delivered a box of accumulated debris, which he'd gathered with the help of his wife and two children, to Sheriff George Wilcox of Roswell, according to Smithsonian Magazine.

By now there was talk of a reward for anyone who recovered one of these unidentified flying objects. In the Roswell Daily Chronicle, Brazel is said to have "whispered kinda confidential-like" that his find may be one of the flying disks, so an equally intrigued Wilcox contacted Colonel William Blanchard, the commanding officer of the Roswell Army Air Field (RAAF), who sent agents to the site to gather the remaining material.

What happened next would cement the idea that the debris represented the remnants of an alien spacecraft. According to David Clarke's book "The UFO Files: The Inside Story of Real-Life Sightings," published by Bloomsbury in 2012, the RAAF's public information officer Walter Haut issued a press release on July 8: "The many rumors regarding the flying disc became a reality yesterday when the intelligence office of the 509th Bomb Group of the Eighth Air Force, Roswell Army Air Field, was fortunate enough to gain possession of a disk through the cooperation of one of the local ranchers and the sheriff's office of Chaves County."

This was reported in the Roswell Daily Record along with the news that Major Jesse A. Marcel was the group intelligence officer dispatched to the scene. He had gone with Counter Intelligence Corps officer Sheridan Cavitt, but on his way back took a detour to his own home. There, he whipped out a couple of boxes of debris that he popped into the trunk of his car and showed to his 10-year-old son, Jesse Jr. One of the objects was said to have hieroglyphic-like markings, something that stuck in the mind of the young boy, according to a report in The Guardian.

But just as quickly as excitement of the find grew, the Army took swift action in debunking the story. The very next day, shortly after government scientists began to arrive at the scene, officials claimed that the debris was actually from a crashed weather balloon, and Marcel was asked to be pictured at a press conference with the debris. And that was that, case closed — or so everyone thought.

But interest began to grow again. In 1978, nuclear physicist, author and UFO researcher Stanton Friedman interviewed Marcel, who said that the discovery made 31 years earlier was not from this world, and that the government had ordered him to keep quiet. Friedman revisited the incident and sought other witnesses, and his work inspired Charles Berlitz and William Moore to write "The Roswell Incident," published in 1980. Their conclusion was simple: There had been a huge cover-up.

The flying saucer conspiracy begins

Other things were happening in the world at the time. Notably, the sci-fi films "Star Wars" and "Close Encounters of the Third Kind" had just been released; studies have suggested that sightings and belief in UFOs rise when popular films and TV shows make their debut, The Times reported in 2009. Nevertheless, testimonies about that day in 1947 were forthcoming, and they continued to come for many years.

Glenn Dennis called a hotline shortly after an episode of "Unsolved Mysteries" featuring the Roswell incident aired in 1989. He suggested that a friend who worked as a nurse at the Roswell Army Air Field saw three alien bodies, according to TIME Magazine. But the real bombshell moment came in 1994. Could it be that the debris really was from an alien craft?

According to the U.S. Air Force, no. The weather balloon story was not true, but it wasn't to hide the fact that little green men had visited Earth. The wreckage was actually that of a classified project that flew microphones on high-altitude balloons to pick up the sound waves generated by Soviet atomic bomb tests. Called Project Mogul, it was said to have run between 1947 and 1949. What's more, the balloons were claimed to have been made up of unusual material — the type that could easily be confused for a UFO. So, case closed? Not at all.

"The ever-changing accounts gave rise to uncertainty," Kenneth Drinkwater, senior lecturer in psychology at Manchester Metropolitan University, U.K., who specializes in the anomalous and paranormal, said in an email. "The first message that went out was unclear. Then they changed the message, and it led to suspicion that something was going on and being covered up. It gives rise to a feeling that something is being hidden from the general population, leading to speculation of possible conspiracy and possibly alien technology."

With such mixed messages, the Roswell files remain open in the eyes of many. Investigators also place great value on the testimonies of those who were there, many of them respected military personnel. "Every

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member of Blanchard's senior staff, with a single exception, suggested the craft was of alien origin," Kevin D. Randle, a retired lieutenant colonel of the U.S. Army Reserve who served in Vietnam and Iraq, told All About Space, a sister publication to Live Science. "Major Edwin Easley, the base provost marshal, told me, when asked if we were following the right path — meaning extraterrestrial — that it wasn't the wrong path."

The "single exception" is Cavitt, the retired lieutenant colonel of the Air Force who accompanied Marcel to the debris site. His careful testimony suggested that nothing untoward happened. He said he had never been threatened by anyone in government and that the debris wasn't extensively scattered. Yet, UFO investigators say that if the wreckage was Project Mogul, then this testimony doesn't ring true. Mogul arrays were big, so the debris field would have been large.

"Everyone agrees that something fell at Roswell, but there is no terrestrial explanation," Randle told All About Space. "Project Mogul fails because the documentation tells us that flight number four — the alleged culprit — was cancelled. It did not fly. All other explanations have failed, too: It wasn't an aircraft accident, not a rocket from White Sands and not a regular weather balloon."

Over the past 40 or so years, there have been new claims and fresh leads, adding to the mystery and keeping the Roswell files very much alive. UFO investigator Calvin Parker, for example, recently spoke of his time with Marcel before he died in 1986, claiming that Marcel revealed that he had hidden three pieces of metal from the crash site in the top of his home's water heater. They have never been recovered, however.

Many UFO investigators are keen to stress that they don't take every testimony at face value. Randle previously said that the credibility of Dennis must be discounted because of inconsistencies, and he told All About Space that the accounts of military personnel are not simply accepted just because of their background. "There are some military witnesses who have been discredited as inserting themselves into the tale," Randle wrote in an email. Likewise, there are civilian witnesses who are compelling.

"There are some very creditable civilian witnesses, such as Brazel and Frankie Rowe," said Randle. Rowe is certainly an interesting case. She was told of the crash by her father, a firefighter, who described creatures he had seen. According to Randle, Rowe said she was shown debris from the crash site, but had been told to stay quiet by the state. She says there was

evidence her phone had been tapped. But of all of the witnesses, perhaps too much weight is being put on Marcel's account.

"If Marcel was standalone, then there would be some real problems here, but he is not. There are many credible witnesses — men who achieved high military rank, men and women who were prominent in their communities — who believe the craft was alien," Randle said. "We have attempted to eliminate the fakers from those who had information to provide. We have been taken in, for a time, by some of those fakers, but in the long-run it was we who investigated the case that removed many of those fakers, though based on evidence and not a belief there is no alien visitation. The point is that Marcel was backed up by other high-ranking officers and many civilians who were part of the case. Marcel told [us] what he had seen and done, and there was little embellishment in his testimony."

Randle appeared in the documentary, "Roswell: The First Witness." It follows the investigations of former CIA operative Ben Smith into Roswell, and a key part of the series is a journal found in Marcel's possessions that was initially thought to have been written by him.

Speculation continues: Was the craft of alien origin?

It turned out that the journal — which consisted of quotes, lyrics and jokes — could be dated to the time of the Roswell incident, but the handwriting didn't match Marcel's. Smith pondered why the former army officer retained the journal, and there was speculation over whether it may have contained a code. If it did, however, it could not be deciphered by even the best of minds, according to the documentary.

Smith also sought to discover what was written in a document held by Brigadier General Roger Ramey, Eighth Air Force commander, during the press conference. It was captured in a photograph taken by Star-Telegram reporter J. Bond Johnson, and ufologists have long wondered whether the words they struggle to make out refer to "victims of the wreck." As Smith found, however, even the best technology could not sufficiently clean the document enough to make the words readable, and they remain a source of debate.

There were other interesting explorations in the documentary series. A body-language expert examined video interviews of Marcel and said it appeared that he was telling the truth, at least as he saw it. Experts including aviation crash investigator David Soucie were also taken to examine the crash site. Interestingly, the wind currents in the area were

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found to be inconsistent with a lightweight balloon crashing in the way that was described.

As the documentary continued, more evidence emerged. Crucially, there was a taped interview conversation between Marcel and author Linda G. Corley in which the military man discussed the items he found in 1947. "I found all this stuff and I was told to keep my mouth shut," he told Corley. "I held on to this premium for 32 years without saying anything at all. See, I was an intelligence officer. I handled intelligence and security for the base. I still hold an allegiance to my country, the vow that I took to keep my mouth shut about everything that might encroach on military secrets."

Just as compelling was an account from the family of Patrick Saunders, the 509th adjutant who is likely to have known about the whole event. He had apparently told people that it wasn't a weather balloon, but something similar to a jet fighter, that files were destroyed or changed and that the world wasn't ready for the truth because it would cause social upheaval. Were the "beings" friendly, he was said to have pondered.

This kind of testimony — particularly the first-hand testimony of Marcel that was chronicled in Corley's book, "For the Sake of My Country" — ensures the incident remains open. The fact the U.S. government admitted there was a cover-up in 1994 only continues to add fuel to the fire.

Yet Drinkwater says failure to provide physical evidence means anecdotal accounts have spread misinformation, and he remains in doubt. "Colonel John B. Alexander offers an excellent insight into the myths and possible conspiracies connected to UFOs, the Roswell incident, the government involvement and so on," Drinkwater said. "I think it's more about a sense of reality and how it can be swayed emotionally. I'm dubious about the nature of a secret operation where many might not have known about the goings on at their level."

Roswell is a town that will be forever linked to one of the greatest mysteries of all time, and we may never truly reach a consensus on the truth that is out there.

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https://www.livescience.com

And so, naturally, a question arose: Is there any sort of pattern to the arrangement of those galaxies, or is it totally random?

Is there a pattern to the universe?

2021-05-08

For decades, cosmologists have wondered if the large-scale structure of the universe is a fractal — that is, if it looks the same no matter how large the scale. After completing massive surveys of galaxies, scientists finally have an answer: No, but kind of, in a way.

In the early 20th century, astronomers — beginning with Edwin Hubble and his discovery of the enormous distance to Andromeda, the closest galaxy to our own Milky Way — started to realize that the universe is almost unimaginably vast. They also learned that we can see galaxies scattered about, both near and far. And so, naturally, a question arose: Is there any sort of pattern to the arrangement of those galaxies, or is it totally random?

At first, it looked random. Astronomers saw giant galaxy clusters, each containing a thousand or more galaxies. And there were also much smaller groups of galaxies, and galaxies hanging out by themselves. Taken together, the observations made it appear as if there were no overarching pattern to the cosmos.

And astronomers were fine with that. They had long assumed an idea called the cosmological principle — that is, that the universe is mostly homogeneous (roughly the same from place to place) and isotropic (roughly the same no matter which direction you look). A bunch of random galaxies and clusters fit right into that principle.

But in the late 1970s, galaxy surveys became sophisticated enough to reveal the beginnings of a pattern in the arrangement of galaxies. Besides the clusters, there were also long, thin filaments of galaxies. There were broad walls. And then there were the voids — vast expanses of nothing. Astronomers called it the cosmic web. This pattern would violate the cosmological principle, because it would mean that large regions of the universe did not look like other large regions of the universe.

So perhaps there was more to the story.PLAY SOUND

A universe within a universe

One proposal came from mathematician Benoit Mandelbrot, the father of fractals. Fractals are frustratingly hard to define, but they can be simple enough to intuit: They are patterns that repeat no matter how far in or out you zoom. Mandelbrot didn't invent the concept of fractals —

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mathematicians had been studying self-similar patterns for ages — but he coined the word "fractal" and ushered in our modern study of the concept.

Fractals are everywhere. If you zoom in on the point of a snowflake, you see miniature snowflakes. If you zoom in on the branches of a tree, you see miniature branches. If you zoom in on a coastline, you see miniature coastlines. Fractals surround us in nature, and the mathematics of fractals have enabled us to understand a vast variety of self-similar structures in the universe.

If fractals are everywhere, Mandelbrot guessed, then perhaps the entire universe is a fractal. Maybe what we saw as the pattern in the arrangement of galaxies was the beginning steps of the greatest fractal possible. Maybe if we built sophisticated enough surveys, we would find nesting structures — cosmic webs inside cosmic webs, filling up the entire universe to infinity.PLAY SOUND

Homogenized and pasteurized

As astronomers discovered more about the cosmic web, they learned more about the history of the Big Bang, and they came up with ways to explain the existence of the large-scale patterns in the universe. Those theories predicted that the universe was still homogeneous, just on much, much larger scales than astronomers had observed previously.

The ultimate test of a fractal universe wouldn't come until this century, when truly gargantuan surveys, like the Sloan Digital Sky Survey, have been able to map the locations of millions of galaxies, painting a portrait of the cosmic web on scales never observed before.

If the fractal universe idea is true, then we should see our local cosmic web embedded inside a much larger cosmic web. If it's wrong, then at some point, the cosmic web should stop being a cosmic web, and a random, large-enough chunk of the universe should look (statistically) like any other random chunk.

The result is homogeneity, but on a mind-blowing scale. You have to go up to around 300 million light-years before the universe appears homogeneous.

The universe is definitely not a fractal, but parts of the cosmic web still have interesting fractal-like properties. For example, clumps of dark matter called "halos," which host galaxies and their clusters, form nested structures and substructures, with halos holding sub-haloes and sub-sub-halos inside those.

Conversely, the voids of our universe aren't entirely empty. They do contain a few faint dwarf galaxies, and those few galaxies are arranged in a subtle, faint version of the cosmic web. In computer simulations, the sub-voids within that structure contain their own effervescent cosmic webs, too.

So, while the universe as a whole isn't a fractal — and Mandelbrot's idea didn't hold up — we can still find fractals almost everywhere we look.

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Eating too much salt could mess with your immune cells

2021-05-06

Eating too much salt may reduce the amount of energy that immune system cells can make, preventing them from working normally, according to a new study.

Eating an excess of sodium has previously been linked to many different problems in the body, including high blood pressure and higher risk of stroke, heart failure, osteoporosis, stomach cancer and kidney disease, Live Science previously reported.

"Of course the first thing you think of is the cardiovascular risk," co-author Markus Kleinewietfeld, an associate professor at Hasselt University in Belgium, said in a statement. "But multiple studies have shown that salt can affect immune cells in a variety of ways." If salt disrupts immune functioning for a long period of time, it could potentially drive inflammatory or autoimmune diseases in the body, he added.PLAY SOUND

A few years ago, a group of researchers in Germany discovered that high salt concentrations in the blood can directly impact the functioning of a group of immune system cells known as monocytes, which are the precursors of Pac Man-like cells called phagocytes that identify and devour pathogens and infected or dead cells in the body.

In the new study, Kleinewietfeld and his colleagues conducted a series of experiments to figure out how. First, they zoomed in on that link in the lab using mouse and human monocytes. They found that within three hours of exposure to high salt concentrations, the immune cells produced less energy, or adenosine triphosphate (ATP).

If salt disrupts immune functioning for a long period of time, it could potentially drive inflammatory or autoimmune diseases in the body, he added.PLAY SOUND

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Mitochondria, the cells' power plants, produce ATP from energy found in food using a series of biochemical reactions, according to the statement. ATP then fuels many different cellular processes, such as powering muscles or regulating metabolism, according to the statement.

Specifically, the researchers discovered that high salt concentrations inhibit a group of enzymes known as complex II in the chain reaction that produces ATP, which leads the mitochondria to produce less ATP. With less ATP (less energy), the monocytes matured into abnormal-looking phagocytes.

The researchers found that these unusual phagocytes were more effective at fighting off infections. Still, that's not necessarily a good thing, the researchers say, as an increased immune response can lead to more inflammation in the body, which in turn, can increase the risk of heart disease.

The researchers then conducted multiple experiments in people; in one, healthy male participants took daily salt supplement tablets of 6,000 milligrams — nearly three times the recommended amount — for two weeks. In another experiment, a group of participants ate a whole pizza from an Italian restaurant.

They found that after eating the pizza, which contained 10,000 mg of salt, participants' mitochondria produced less energy. But this effect wasn't long-lasting; eight hours after the participants ate the pizza, blood tests showed that their mitochondria were functioning normally again.

"That's a good thing," Dominik Müller, a professor at the Max Delbrück Center for Molecular Medicine in the Helmholtz Association and the Experimental and Clinical Research Center in Berlin, said in the statement. "If it had been a prolonged disturbance, we'd be worried about the cells not getting enough energy for a long time."

Still, it's not clear whether mitochondria are affected in the long-term if a person consistently eats a high-salt diet, according to the statement. The researchers hope to understand whether salt can impact other cells, because mitochondria exist in almost every cell in the body, according to the statement.

The findings were published on April 28 in the journal Circulation.

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Tiny dinosaur that looked like an owl hunted like one, too

2021-05-08

A tiny, meat-eating dinosaur had superb low-light vision and hearing that was likely as good as an owl's. And like an owl, the wee dinosaur probably used those exceptional abilities to stalk and catch its desert prey under the cover of darkness.

Owl-like Shuvuuia (shu-VU-ya) was a theropod — a three-toed and bipedal carnivorous dinosaur. There's only one known species, Shuvuuia deserti, and it was smaller than a domestic cat, measuring just 2 feet (0.6 meters) long. Shuvuuia lived about 75 million to 81 million years ago, during the late Cretaceous period (145.5 million to 65.5 million years ago), in what is now the Gobi Desert in Mongolia.

Prior analysis of Shuvuuia's fossilized eye bones revealed that it had large eyes that were specialized for seeing in dim light. But at the time, little was known about dinosaur adaptations for nocturnal activity. In a new study, scientists looked at skulls from dozens of species of extinct theropods and modern birds — the only theropod lineage that survived to the present. By comparing dinosaurs' fossilized eye and ear structures with those in living animals that have nocturnal habits, the researchers were able to see if a dinosaur was adapted for day or night activity.PLAY SOUND

Soft tissue is rarely preserved in the fossil record, but paleontologists can find clues about dinosaurs' eyes and vision in the bones that form a circle in the eye socket, known as the scleral ring. Scleral rings are found in many vertebrates (including extinct dinosaurs), and the diameter of this ring reveals the maximum width that an animal's pupil can dilate, hinting at their ability to see in low light, said lead study author Jonah Choiniere, a professor in the Evolutionary Studies Institute at the University of the Witwatersrand in Johannesburg.

But nighttime hunting doesn't just depend on having good eyesight; specialized hearing is also key. So the researchers examined ear anatomy in 88 bird species and 17 extinct fossil theropods, using computed X-ray

And like an owl, the wee dinosaur probably used those exceptional abilities to stalk and catch its desert prey under the cover of darkness.

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tomography (CT) scans to construct digital 3D models of the animals' skulls.

They paid close attention to the cochlea, the part of the inner ear canal that holds sensory receptors for picking up sound waves. Decades of previous research had shown that the length of this canal is closely linked to how well animals can hear, and the length of Shuvuuia's ear canal suggested that its hearing would have been "off the charts," Choiniere told Live Science.

"Shuvuuia had proportionally longer cochlear ducts than even the bird with the best hearing: the barn owl," Choiniere said. What's more, the size of Shuvuuia's scleral rings showed that it also possessed "incredible night vision — better than any living bird we measured," he added.

The combination of light-sensitive eyes and superior hearing suggested that Shuvuuia would have been highly effective at detecting and ambushing prey at night, as owls do. By comparison, the theropod Velociraptor, which lived in the Gobi Desert alongside Shuvuuia, had an intermediate eye shape, "and was probably more twilight-active," said study co-author Lars Schmitz, an associate professor of biology at the W.M. Keck Science Department at Scripps College in Claremont, California.

This is the first time that such extreme specializations for hearing and vision have been documented in an extinct dinosaur; in combining vision with hearing, the study also provides the best evidence for nocturnal behavior in dinosaurs, Schmitz told Live Science.

A hodgepodge body

Shuvuuia was an odd-looking dinosaur, and though it's related to fearsome meat-eating theropods such as Velociraptor and Tyrannosaurus rex, "it's totally unlike them," Choiniere said.

"It's got a lightly built jaw, and its teeth look like tiny grains of basmati rice. It's got this massive eye, but the beak is very small," he said. Shuvuuia's forelimbs were powerful and bulky, tipped with a huge claw like an aardvark's. Capping off this hodgepodge of features was a pair of long, slender hind legs that were built for running.

However strange its body may have looked, these traits may have made Shuvuuia a better nighttime hunter. Some modern mammals that live in arid desert environments, as Shuvuuia did, combine lengthy hind limbs with digging forelimbs, "and they often have really good night vision and hearing," which helps them track and catch hard-to-find prey, Choiniere

said. Burrowing desert prey would also be an easy meal for Shuvuuia to dig up with its powerful forearms.

"This observation that Shuvuuia could have operated at night makes a lot of sense in light of the rest of the adaptations," he said. "It puts those into perspective and allows us to think it would have fit into a desert ecosystem today really well."

Animals that live together in the same geographical location often require the same resources in order to survive, but they can share them by being either night owls or early birds. Dinosaurs likely did this as well, and this study is just the beginning of paleontologists' discoveries of nocturnal and daytime preferences in these extinct animals and how those preferences might have affected their habits and behavior, Schmitz said.

"That's something that we really don't understand well yet in the fossil record, but we know from looking at living species," he said. "I think there are some exciting discoveries waiting to be made."

The findings were published online May 6 in the journal Science.

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livescience.com, 8 May 2021

https://www.livescience.com

A common antibiotic slows a mysterious coral disease

2021-05-10

Slathering corals in a common antibiotic seems to temporarily soothe a mysterious tissue-eating disease, new research suggests.

Just off Florida, a type of coral infected with stony coral tissue loss disease, or SCTLD, showed widespread improvement several months after being treated with amoxicillin, researchers report April 21 in Scientific Reports. While the deadly disease eventually reappeared, the results provide a spot of good news while scientists continue the search for what causes it.

"The antibiotic treatments give the corals a break," says Erin Shilling, a coral researcher at Florida Atlantic University's Harbor Branch Oceanographic Institute in Fort Pierce. "It's very good at halting the lesions it's applied to."

Divers discovered SCTLD on reefs near Miami in 2014. Characterized by white lesions that rapidly eat away at coral tissue, the disease plagues nearly all of the Great Florida Reef, which spans 580 kilometers from St.

"The antibiotic treatments give the corals a break," says Erin Shilling, a coral researcher at Florida Atlantic University's Harbor Branch Oceanographic Institute in Fort Pierce.

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Lucie Inlet in Marin County to Dry Tortugas National Park beyond the Florida Keys. In recent years, SCTLD has spread to reefs in the Caribbean (SN: 7/9/19).

As scientists search for the cause, they are left to treat the lesions through trial and error. Two treatments that show promise involve divers applying a chlorinated epoxy or an amoxicillin paste to infected patches. "We wanted to experimentally assess these techniques to see if they're as effective as people have been reporting anecdotally," Shilling says.

In April 2019, Shilling and colleagues identified 95 lesions on 32 colonies of great star coral (Montastraea cavernosa) off Florida's east coast. The scientists dug trenches into the corals around the lesions to separate diseased tissue from healthy tissue, then filled the moats and covered the diseased patches with the antibiotic paste or chlorinated epoxy and monitored the corals over 11 months.

Within about three months of the treatment, some 95 percent of infected coral tissues treated with amoxicillin had healed. Meanwhile, only about 20 percent of infected tissue treated with chlorinated epoxy had healed in that time — no better than untreated lesions.

But a one-and-done treatment doesn't stop new lesions from popping up over time, the team found. And some key questions remain unanswered, the scientists note, including how the treatment works on larger scales and what, if any, longer-term side effects the antibiotic could have on the corals and their surrounding environment.

"Erin's work is fabulous," says Karen Neely, a marine biologist at Nova Southeastern University in Fort Lauderdale, Fla. Neely and her colleagues see similar results in their two-year experiment at the Florida National Marine Sanctuary. The researchers used the same amoxicillin paste and chlorinated epoxy treatments on more than 2,300 lesions on upwards of 1,600 coral colonies representing eight species, including great star coral.

Those antibiotic treatments were more than 95 percent effective across all species, Neely says. And spot-treating new lesions that popped up after the initial treatment appeared to stop corals from becoming reinfected over time. That study is currently undergoing peer-review in Frontiers in Marine Science.

This involved arranging four "Pac Man" shapes — circles from which a wedge one-quarter the size of each circle is removed — to suggest the contours of a square.

"Overall, putting these corals in this treatment program saves them," Neely says. "We don't get happy endings very often, so that's a nice one."

sciencenews.org, 10 May 2021

https://www.sciencenews.org

Cats love boxes so much they'll even sit in fake ones

2021-05-12

Anyone who owns cats knows they love to sit in boxes. Now a citizen science project suggests they like to seat themselves within the outlines of squares just as much as they would like to plant down in real ones, showing that cats (like their human owners) can be fooled by optical illusions.

The feline instinct to sit in boxes goes beyond house cats — Florida animal sanctuary Big Cat Rescue has shown lions, tigers, leopards, bobcats and lynxes are fond of boxes too. This urge, at times affectionately dubbed "if I fits I sits," isn't limited to 3D boxes — in 2017, cat fans posted a flurry of photos on Twitter revealing that simply taping the outlines of squares onto floors could prompt cats to step inside.

After hearing a lecture on how dogs reacted to visual illusions and returning home to play with her roommate's cat, study lead author Gabriella Smith, an animal cognition scientist at Hunter College's Thinking Dog Center in New York, "wondered if cats' tendency to sit in squares on the floor would extend to illusory squares," she told Live Science.

Smith and her colleagues focused on the so-called Kanizsa illusion. This involved arranging four "Pac Man" shapes — circles from which a wedge one-quarter the size of each circle is removed — to suggest the contours of a square.

The scientists reached out to more than 560 cat owners over Twitter to take part in the project. Over the course of six days, the volunteers used paper, scissors and rulers to create square outlines, the Kanizsa square illusion and a bunch of "Pac Man" shapes oriented in a way to not generate the illusion. To prevent the owners from accidentally influencing the cats in any way, they were instructed to wear sunglasses to hide their eyes.

Once the owners had taped the shapes onto the floor, they let their cats into the room. The volunteers then checked to see which shapes, if any, the cats sat in for more than 3 seconds within 5 minutes after entering the room, and they recorded the tests on video.

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"Due to known research that cats behave most naturally in familiar settings like the home, the citizen science format of this study was the perfect match," Smith said.

In the end, only 30 owners completed all the tests. Of these, only nine cats made at least one choice during the experiment. The researchers found the felines chose the illusory square seven times, nearly as much as the eight times the cats chose the real squares, "indicating that they were susceptible to the illusion," Smith said. The discovery "informs us about the evolution of their vision, specifically their sensitivity to contours and how it compares to humans and other animals."

Oddly, one time one of the cats, Totoro, chose the third "control" choice, where the Pac Man shapes were placed in a way that should not have generated an illusion. "It is unclear why this happened, though it could be explained as an attraction to the novel stimuli on the floor, and not necessarily attraction to any boxlike attributes of the control," Smith said.

The scientists noted they would have liked to look at more cats for the study. "If performed again, we'd aim to avoid participant attrition by shortening the study from its original six-day format," Smith said.

It remains a mystery what drives cats to sit in boxes, or real or illusory squares. "Cats may like boxes or laundry baskets due to the comforting pressure they provide," Smith said. Another possibility is that boxes may kindle a cat's instinct to ambush prey, she noted. The attraction to squares on a floor, real or illusory, may therefore stem from their instinctive weakness for boxes, Smith noted.

In the future, the researchers would like to see if cats are fooled by a 3D version of the Kanizsa illusion. They would also like to see if non-domesticated big cats are vulnerable to these illusions.

Smith noted she has a cat of her own, "a spunky, 1-year-old tabby named Pancetta who I adopted after I performed the study. I have not tried the test on her yet, although she is a big fan of new delivery boxes."

The scientists detailed their findings online April 30 in the journal Applied Animal Behaviour Science.

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